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The Handbook of Maritime Economics and Business 2ND EDITION

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Costas Th. Grammenos

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SECOND EDITION

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This second edition of the *Handbook of Maritime Economics and Business* is

Dedicated to:

Professor Ernst G Frankel, of Massachusetts Institute of Technology

Professor Richard O Goss, of University of Cardiff

Professor Arnljot Stromme Svendsen, of the Norwegian School of Economics and Business Administration

And in memory of:

Professor Zenon S Zannetos, of Massachusetts Institute of Technology

Professor Vassilis Metaxas, of University of Piraeus

All these Professors have shown in their published texts a pioneering insight on various aspects of the maritime industry and thus command our respect and warm thanks.

Professor Costas Th. Grammenos

London, June 2010

About the Editor

Costas Th. Grammenos, CBE, BA (Athens), MSc (Bangor), DSc (City), FCIB, Hon FIMarEST, FRSA is Professor of Shipping, Trade and Finance; Pro Vice-Chancellor of City University London and Deputy Dean of its Cass Business School, where he founded the Centre for Shipping, Trade and Finance in 1983 (renamed The Costas Grammenos International Centre for Shipping, Trade and Finance in April 2007). The Centre carries out research through members of its staff and PhD students and cultivates international dialogue by formal and informal meetings. He designed two world-class Masters of Science: Shipping, Trade and Finance introduced in 1984; and Logistics, Trade and Finance commenced in 1997 (since 2008 known as MSc Supply Chain, Trade & Finance); while the MSc in Energy, Trade and Finance was introduced in 2003.

In 1977 he established credit analysis and policy in bank shipping finance which has been applied by many international banks; and, in 1978, published his monograph *Bank Finance for Ship Purchase* (University of Wales Press), which formed the key principles in shipping finance. In addition, since mid-1980s, he concentrated on and promoted the utilisation of international capital markets for raising funds for shipping companies through his lectures, teaching at University, conferences and since early 1990s through his published research. In 2006 he was appointed by the Greek government as President of the Managing Board of the International Hellenic University in Thessaloniki, Greece, with the mandate to establish and operate it. His research interests are in Bank Shipping Finance, and Capital Markets.

In 1999 Costas Grammenos was awarded by City University London the highest academic accolade, the Doctor of Science degree (DSc) for creating, through his published research, shipping finance as a new academic discipline.

He is a member of the Board of Directors of the Alexander S Onassis Public Benefit Foundation; a Founding Trustee of the Institute of Marine Engineers Memorial Fund; and a Non-executive member of the Board, Marfin Investment Group (MIG).

He is Fellow of the Chartered Institute of Bankers; Honorary Fellow, Institute of Marine Engineers, Science and Technology; Fellow of Royal Society of Arts and Member of the Baltic Exchange; Member of the American Bureau of Shipping; Liveryman of the Worshipful Company of Shipwrights; Freeman of the City of London; Founder and Chairman of the City of London Biennial Meetings; Visiting Professor at the University of Antwerp; and he was President of IAME (1997–2002).

He was 1998 Seatrade Personality of the Year; in 2008 he was awarded the prize of Distinguished Personality for his outstanding contribution to the shipping industry by the Association of Banking and Financial Executives of Hellenic Shipping; and in 2009 was awarded the ‘Achievement in Education’ at the Lloyd’s List Shipping Awards; he was made OBE (Officer of the British Empire) in 1994 for his contribution to international shipping and finance and appointed CBE (Commander of the British Empire) in 2008 for services to teaching and research.

Preface to the Second Edition

In the seven years that have passed since 2002, when the first edition of this *Handbook* was published, each one of us would have noticed major events or conditions that have strongly impacted the shipping markets and produced results that we would include in our lectures – often we categorise these as extraordinary.

I have in mind the explosive rate of growth in China; the almost unstoppable increase in seaborne trade and in investments in new vessels; in the expansion in number and size of Chinese shipyards; in the continuation of bank finance as the strong source of funds for shipping companies; in the mergers or acquisitions of shipping companies and, generally, in the increase of their size; and in the emergence of capital markets as a serious means of raising funds for a sizeable number of shipping companies.

All this activity was abruptly shaken in 2007 when the world recession shyly emerged and the subprime crisis of US residential mortgages, and the toxic products based on them, hit the international financial system and froze the liquidity in it.

It seems we have not seen the end of the mega drama that we have witnessed in these seven years.

Our *Handbook* has been directly or indirectly influenced by events of the first decade of the 21st century which have been embodied in our data analysis. The structure of this volume remains the same as the edition published in 2002. However, in addition to the rewriting or updating of the chapters, some new topics have been included in the volume, such as the historical analysis of freight rates fluctuations in chapter 10; measures for global control of air pollution from ships in chapter 16; measures for business performance in shipping in chapter 22; while capital markets as a source in shipping finance and a holistic survey in strategy literature relevant to shipping are discussed in chapters 28 and 29 respectively.

The first edition established the *Handbook* as an authoritative source of academic research that is useful for university students and researchers and, at the same time, it satisfies the curiosity of the well-informed practitioner and widens its knowledge horizon. It is a pleasure to know that the *Handbook* is now called “The Maritime Bible” in more than 30 countries.

I want to thank all my colleagues for their enthusiasm to participate in the 2002 and 2010 editions and to thank them profoundly for the high quality of their contributions.

Finally, I want to thank my Personal Assistant, Chrysoula Zevgolatakou, for controlling the logistics of incoming and outgoing chapters and the Informa editorial and printing staff, in particular Liz Lewis and Leigh Stutter, for their cooperation and patience in meeting tight deadlines.

Needless to report that as contributors we again gave up our royalties in favour of the International Association of Maritime Economies (IAME) and continue to be loyal members.

Professor Costas Th. Grammenos

London, June 2010

Preface to the First Edition

In the late 1960s, when I started focusing on shipping finance, there were only a limited number of publications on Maritime Economics which mainly analysed the broader theoretical topics. Now, after almost thirty-five years, this unique volume is published, covering for the first time a wide variety of maritime issues and sectors, written by fifty-one members of the International Association of Maritime Economists (IAME). Over forty of the contributors are well-known academics, with the remaining younger ones already showing recognisable academic presence, all teaching and conducting research at thirty universities, in seventeen countries.

IAME was established in 1992 with an aim to promote the development of maritime economics as a distinct discipline, to encourage rational and reasoned discussion within it, and to facilitate the international exchange of ideas and research. Throughout this decade, IAME has worked towards these aims most successfully, and here one should mention the organisation of international conferences, on an annual basis; this year (on its tenth anniversary), members will meet in Panama.

The *Handbook of Maritime Economics and Business* contains thirty-nine refereed chapters which are, primarily, based on research carried out over a number of years, covering eleven broad areas of Maritime Economics, *viz*: Maritime Economics and Globalisation; International Seaborne Trade; Economics of Shipping Markets and Cycles; Economics of Shipping Sectors; Issues in Liner Shipping; Maritime Safety and Labour Markets; National and International Shipping Policies; Aspects of Shipping Management and Operations; Shipping Investment and Finance; Port Economics and Management; and Aspects of International Logistics.

As I was studying these chapters, not only did I recall the questions that arose when I was collecting data for my study in Bank Shipping Finance, all those years ago, when so many answers were not readily available in published paper form or any other publication, I also found myself smiling many times, with great satisfaction, as I measured the width and depth of research presented here, in the wider spectrum of Maritime Economics. Indeed, *The Handbook of Maritime Economics and Business* is unique as it demonstrates the immeasurable progress, since the 1960s, in this area of research and teaching.

Because of its high quality output and its relevance to real life business, it will serve as a very valuable instrument for the stakeholders of the broader maritime world, including: university undergraduate and postgraduate students; shipowners; shipbrokers; shipmanagers and operators; bankers; underwriters; lawyers; shipping consultants; international logistics companies; port authorities; governmental maritime agencies; and official international organisations.

Over the last six months, I have worked closely with all the contributors and I thank them *de profundis* for the spontaneous acceptance of my invitation and the prompt delivery of what they promised. I am also grateful to them for agreeing, like myself, to waive their royalties in favour of IAME. My sincere thanks go to David Gilbertson, Chief Executive of Informa Group, who from the early days has strongly supported the idea of this volume; also to the LLP editorial and printing staff, in particular Vanessa Larkin and Tony Lansbury, for their cooperation and patience in meeting the tight deadlines. Finally, I thank very warmly two members of my staff: Dr Amir Alizadeh, also a contributor to this volume, and my Personal Assistant, Mrs Gladys Parish, for their enthusiasm and valuable assistance in the preparation of this *Handbook*.

Professor Costas Th. Grammenos
London, September 2002

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Born in 1931 and educated for the usual period, though left the sixth form to run away to sea in 1948 in BTC (later known as BP Tankers). Later in 1959, after trying most types of ships, he obtained his Extra Masters Certificate and lectured in one of the two navigation schools in London that in the late 1960s were amalgamated into the City of London Polytechnic. In the 1970s he moved to the Transport Department of the CLP and worked on his MPhil which he obtained in 1973. In 1989 he joined the World Maritime University as Professor of Ports and Shipping where he remained until he retired in 1995. Since then he has been a visiting professor at the London Metropolitan University. Publications include *Sea Transport – Operations & Economics* (6th edn) and *Port Management and Operations* (3rd edn), plus over 100 papers, articles and chapters in various books.

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Alfred J. Baird is Professor of Maritime Transport at the Transport Research Institute (TRI), Edinburgh Napier University. His doctoral research concerned the study of strategic management in the global container shipping industry. He has a BA (Hons) in Business Studies and is a Member of the Chartered Institute of Logistics & Transport. Prior to his academic career he worked for a liner shipping company. With an emphasis on the ferry and container shipping sectors, and the ports industry in general, Professor Baird has researched, published, advised, and taught across a range of maritime transport subjects including: strategic management in shipping, shipping market and industry analysis, ship and port cost modelling, shipping service scheduling/planning, competition, privatisation, procurement and tendering of shipping services, government policy, state subsidies, and assessing the feasibility of shipping services and port facilities.

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Mary R. Brooks is the William A. Black Chair of Commerce at Dalhousie University, Halifax, Canada. From February 2002 to April 2008, she chaired the Committee on International Trade and Transportation, until recently served on the Committee for Funding Options for Freight Transportation Projects of National Significance, and currently serves on the Publication Board of the *Transportation Research Record*, of the Transportation Research Board, Washington DC. She was appointed to the Marine Board of the US National Academy of Sciences for three years in November 2008. She chairs the Port Performance Research Network, a network of scholars interested in port governance and port performance issues. She was a Canada–US Fulbright scholar at George Mason University in 2005. Her latest book, *North American Freight Transportation: The Road to Security and Prosperity*, was published in June 2008. In November 2006, she was named by the Women's Executive Network as Canada's Most Powerful Women: Top 100 in the professional category.

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Steve Christy is Head of Consultancy & Research at Gibson Shipbrokers, based in London. He has more than 25 years' experience in the tanker and oil industries, covering oil supply and transportation developments. He is now responsible for Gibson's analysis of all the shipping markets. This includes research into market and industry developments impacting on the tanker industry, the implications for future supply and demand of tankers and forecast analysis of charter rates and earnings.

He has worked on a number of major projects, including various tanker market forecasts for different shipowners, charterers and investment clients. He is also involved in cost analysis, transportation options and shipping economics, and tanker investment appraisal, as well as acting as an expert witness in legal cases.

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Douglas Fleming is a maritime geographer and professor emeritus at the University of Washington, Seattle. He earned an undergraduate degree in Geology at Princeton in 1943 and a PhD in Geography at Seattle in 1965. He served with the US Navy from 1944 to 1946. He was employed by a commercial steamship line for 15 years in various capacities including chartering brokerage and as vice president of States Marine and Isthmian traffic operations in New York, Houston and Seattle. From 1965 to 2002 he taught various classes in Geography and Marine Affairs at the University of Washington,

Seattle. He has contributed numerous articles to American and European journals and has served periodically on editorial boards in Europe.

Dr David Glen

David Glen is Reader in Transport in the Business School, London Metropolitan University, having joined the Centre for International Transport Management in 1995, as a Research Fellow. He obtained his PhD from London Business School in 1987, which examined differentiation in the tanker market. He has published in a number of journals, including the *Journal of Transport Economics and Policy* and *Maritime Policy and Management*. He is presently on the editorial board of the latter. Dr Glen served on the Council of IAME for a number of years, and was Secretary from 2000 to 2003. He is also a member of the International Maritime Statistics Forum. His research interests include shipping market structures and dynamics, seafarer statistics, maritime pollution and international trade flows. Since 1997, he has been involved UK Department for Transport projects on monitoring and improving the quality of UK seafarer numbers.

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Professor Gelina Harlaftis

Gelina Harlaftis graduated from the University of Athens and completed her graduate studies in the Universities of Cambridge (MPhil) and Oxford (DPhil), in St Antony's College between 1983 and 1988. She taught at the University of Piraeus from 1991 to 2002 and since 2003 has been at the Department of History of the Ionian University. She was President of the International Association of Maritime Economic History from 2004 to 2008. During the fall of the academic year 2008–2009 she was Alfred D. Chandler Jr. International Visiting Scholar in the Business History Program of the Harvard Business School and in the spring a Visiting Fellow at All Souls College, Oxford. She is the author of several books including *Greek Shipowners and Greece 1945–1975* (Athlone Press, 1993), and her latest book, *Leadership in World Shipping: Greek Family Firms in International Business* with Ioannis Theotokas, was published in 2009.

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Previously, he spent six years with the United Nations Economic Commission for Latin America and the Caribbean, Santiago de Chile, and two years with the IMO, London. Prior to this, he held part-time positions as assistant professor, import-export agent, translator, consultant and seafarer for a tramp shipping company.

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Dr Gordon Hui

Gordon Hui graduated as a MPhil in Physics in 2006. He specialised in computer simulations for condensed matter systems by matrix & Monte Carlo algorithms.

He started his career in financial industry as a quantitative researcher in a Commodity Trading Advisor; his areas of expertise being Monte Carlo simulations in risk management and rebalancing portfolios, volatility modelling in various time frame, backtesting in Market-On-Close, day-trading strategies & HK index arbitrage. Afterwards, he worked as a quantitative day-trader in a propriety trading house. In 2009, Gordon joined Tufton as an analyst.

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Shuo Ma is a professor of shipping and port economics and policy at the World Maritime University in Malmö. He is also Vice-President (Academic) at WMU. Dr Ma is an active researcher and consultant in the area of shipping and port economics and policy. For the last couple of years, he has been actively involved in maritime research and education in China. He has been associated with numerous research projects and activities in the field of maritime transport in China both at national and regional levels. He is the Director of two joint MSc programmes, which he created in 2004, between WMU and two Chinese Maritime Universities in Shanghai and Dalian.

Professor Peter Marlow

Peter Marlow is Professor of Maritime Economics and Logistics at Cardiff University in the UK. He has over 30 years' experience in academia and research work and is the author of more than 100 published works. He is currently the Head of Logistics and Operations Management at the Cardiff Business School and is a transport economist with considerable expertise in maritime and land transport as well as logistics. From 1998 to 2001 he was President of NEPTUNE, an EU-based network of universities and research institutions and is currently President of the International Association of Maritime Economists and Visiting Professor at Dalian Maritime University. His research interests include the fiscal treatment of shipping; the choice of flag in international shipping; the value added by transport in logistics supply chains; short sea shipping; port economics and logistics; maritime clusters; and inter-modal transport.

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Her research activities are on the intersection of transportation economics, macroeconomics and quantitative modelling. This enables her to link the evolution in the world economy to specific transportation problems.

She is involved, directly or indirectly, in a large number of research projects on topics such as international transport infrastructure investment, modelling and forecasting transport, empirical analysis of port competition, inland navigation, mode choice, sustainable mobility, etc.

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David Menachof is the Peter Thompson Chair in Port Logistics, based at the Logistics Institute at Hull University Business School. He received his doctorate from the University of Tennessee, and was the recipient of the Council of Logistics Management's Doctoral Dissertation Award in 1993. He is a Fulbright Scholar, having spent an academic year in Odessa, as an expert in Logistics and Distribution. He has previously taught at the Cass Business School, City University London, the University of Charleston, South Carolina, and the University of Plymouth, England. His research interests include supply chain security and risk, global supply chain issues, liner shipping and containerisation, and financial techniques applicable to logistics.

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Kunio Miyashita is the Professor of International Logistics and Transportation at the Faculty of Business Administration, Osaka Sangyo University, Japan. He is also the professor emeritus of Kobe University and holds a PhD from this University. He is the author of six books, including *Market Behaviors in Competitive Shipping Markets*) and *Global Competition of Japanese Logistics Industry*. He is the President of the Japanese Society of Transportation Economics, the former President of the Japanese Society of Logistics and Shipping Economics, and the Honorary Editor-in-Chief of *The Asian Journal of Shipping and Logistics*.

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Enrico Musso (Genoa 1962) is full professor in Applied Economics at the University of Genoa, where

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Former director of the PhD programme in *Logistics, Infrastructure and Territory* of the University of Genoa; lecturer in the Masters *Transport and Maritime Management* and *Transport and Maritime Economics*; visiting professor in many universities in Italy and abroad; director of international research programmes concerning ports, maritime transport, urban mobility.

Author, co-author or editor of more than 130 scientific publications, among which important volumes or chapters in volumes in maritime and port economics.

Editor-in-chief of the *International Journal of Transport Economics*. Member of the editorial board of *Maritime Economics and Logistics* and *European Transports*.

Chairman of the Italian Society of Transportation Economists. Co-chair of the *Maritime Transport and Ports Special Interest Group* at the *World Conference on Transport Research Society* . Co-founder of *Transportnet*, a research network of eight European universities, and of the Italian Centre of Excellence for Integrated Logistics.

Professor Nikos K. Nomikos

Nikos Nomikos is a Professor in Shipping Risk Management and Director of the MSc degree in Shipping, Trade and Finance at Cass Business School, City University London. He holds an MSc and PhD from Cass Business School. He started his career at the Baltic exchange as Senior Market Analyst, being in charge of the freight indices and risk management divisions. Since November 2001, he has been with the Faculty of Finance at Cass Business School where he specialises in the area of freight derivatives and risk management. His research papers on derivatives pricing and modelling have been published in international journals and have been presented in conferences worldwide. He has also published a book on *Shipping Derivatives and Risk Management* and has developed postgraduate and executive development courses in that area.

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He is currently Project Director of another EU part-funded project on safety and security of international road freight transport (CASH).

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Dr Photis M. Panayides

Photis M. Panayides is Associate Professor in Shipping Economics at the Department of Commerce, Finance and Shipping, Cyprus University of Technology. He holds a first class Honours degree and a PhD in Shipping Economics and Management (1998) from the University of Plymouth, UK. Photis held academic appointments among others at the University of Plymouth, the Hong Kong Polytechnic University, the Copenhagen Business School, and the National University of Singapore to the level of

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Photis has authored three books and over 30 scientific journal papers in the fields of shipping economics, logistics and transportation. He reviews for major journals and has contributed several conference papers. He pioneered the development of academic and professional programmes in shipping and logistics and has also consulted for several companies. Photis is an elected member of the Board of the International Association of Maritime Economists and serves on the Board of Directors of the Cyprus Ports Authority.

Professor Anastassios N. Perakis

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Michael Roe holds the Chair of Maritime and Logistics Policy at the University of Plymouth. He previously worked with the Greater London Council and the Universities of Aston, Coventry, London Metropolitan and City. The author of over 50 refereed journal papers and 11 books, he specialises in Eastern European maritime policy and the wider governance of maritime affairs. His wife, Liz, provides moral and intellectual support whilst his children, Joe and Siân, provide entertainment and expenses. He has active interests in modern European art and literature, restoring VW Beetles, the work of Patti Smith and New Order and the exploits of Charlton Athletic FC.

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Merv Rowlinson has served in towage and merchant shipping and has nearly 30 years' teaching experience in shipping and logistics experience at the Merchant Navy College, Warsash School of Navigation (Southampton) and London Metropolitan University. He has successfully supervised five PhD programmes. He has an M.Phil from Liverpool Polytechnic and a PhD from the City of London Polytechnic both in maritime business. He currently divides his time between Copenhagen Business School, Hamburg School of Shipping & Transportation, Lloyd's Maritime Academy and the European College of Business Management (London & Aachen). His research interests are inter-modal transport, particularly short sea shipping and its potential for delivering sustainable transport.

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(England), University of Sydney (Australia), City University London (United Kingdom), University of Antwerp (Belgium) and University of Wollongong (Australia) and visiting US positions at the Woods Hole Oceanographic Institution (Woods Hole, Massachusetts), Transportation Systems Center, US Department of Transportation (Cambridge MA), Interstate Commerce Commission (Washington DC) and the National Aeronautics and Space Administration (Langley, Virginia). He is the Editor-in-Chief of *Transportation Research Part E: Logistics and Transportation Review* and deputy Editor-in-Chief of the *Asian Journal of Shipping and Logistics*. His 2009 book, *Port Economics*, is the first textbook in this area.

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He has published in academic journals such as *Energy Economics, Energy Policy, Journal of Alternative Investments, Journal of Derivatives, Logistics and Transportation Review* and *Maritime Policy and Management*.

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Helen A. Thanopoulou studied at the University of Athens and University of Paris (Panthéon-Sorbonne). She holds a Doctorate in Maritime Studies from the University of Piraeus where she taught briefly. She spent eight years in Wales, as Lecturer and later Senior Lecturer at Cardiff University serving, after 1999, as a Director of shipping-related postgraduate courses. She returned to Greece in 2004 taking an Assistant Professor's post at the University of the Aegean, in the Department of Shipping, Trade and Transport on Chios island. She has published on shipping-related subjects including crises, competitiveness, investment patterns, liner alliances and ports and maritime innovation. In 2008, in Dalian, she was elected Council member of the International Association of Maritime Economists (IAME). She is serving her second term as Council member of the Hellenic Association of Maritime Economists (ENOE). She has been a Guest Editor and member of Editorial Boards, currently of the *Journal of Shipping, Trade and Transport*. She is a regular guest lecturer at academic institutions in Greece and abroad.

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Eddy Van de Voorde is Full Professor at the University of Antwerp, Faculty of Applied Economics. His activities are situated in Maritime Economics, Port Economics, Air Transport and Logistics. He is in charge of many new research projects, financed by various Belgian and international governments and private organisations. Much of his research, particularly in the field of modelling freight transport, results in a long list of publications in important journals. Recently, he was co-author of various standard-works in the field of transport economics and models.

He is also a professor at the University of Ghent and at the Technical University of Delft, and he is visiting professor at different foreign universities, such as Lisbon, Bari, London and MIT (Cambridge, Boston). In the past years he fulfilled different functions in international scientific associations, such as being the vice-chair of the International Association of Maritime Economists (IAME), vice-chair of the scientific committee of the World Conference on Transport Research Society (WCTRS) and vice-chair of the Benelux Interuniversity Association of Transport Economists (BIVEC). He is also a member of a scientific editorial staff of seven international journals, such as *Maritime Policy and Management*, *Transport Policy*, *Transportation Research-E*, and the *International Journal of Transport Economics*.

In 2005, he was awarded in Genoa a prestigious international prize, the Premio Internationale delle Communicazioni “Cristoforo Colombo”, for his scientific research in the field of Maritime Economics.

Dr Andreas Vergottis

Andreas Vergottis was awarded his MSc Econometrics from the London School of Economics in 1984 and his PhD in Business Administration from City University Business School in 1988. In 1989 he joined Tufton Oceanic Ltd as shipping analyst, responsible for screening various projects involving debt, mezzanine and equity financing of shipping transactions. In 1996 he was recruited by Warburg (subsequently acquired by UBS) as sector coordinator for global shipping analysis. In addition to regular research coverage on 30 listed shipping companies, he participated in several IPO and M&A transactions within the shipping industry. In 2002 he rejoined Tufton Oceanic Ltd as Head of Research. He assisted in launching the Oceanic Hedge Fund with $5m starting capital which currently has grown to $1.8bn assets under management. He is presently based in Hong Kong, where Tufton Oceanic Ltd have recently opened a new representative office. He is a visiting professor at Cass Business School, City University London.

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Kurt Vermeulen is a Visiting Lecturer on Shipping Strategy at Cass Business School, City University London. He provides consultancy services in this area. Assignments focus on multidisciplinary approaches involving issues pertaining to strategy, business intelligence, competitive intelligence and corporate finance. Prior to this, Kurt was a Vice President in Mergers & Acquisitions (M&A) at a predecessor bank of JP Morgan Chase. His transactional experience focused on the transport, chemicals and financial services industries. He was a Guest Lecturer on M&A to MSc Shipping, Trade & Finance students at Cass Business School. Previous to that, Kurt worked as a solicitor on corporate and commercial law matters. He has a Lic. Iuris. (LLM) *cum laude* in commercial and financial law from the University of Gent (Belgium) and also studied German and EU competition law (Wettbewerbsrecht, Kartellrecht) and law and economics at the Law Faculties of the University Hamburg (Germany) and the University Osnabrück (Germany). He subsequently obtained, whilst employed, a Spec. Lic. (MSc) Port & Marine Sciences *magna cum laude* from the University of Gent, a MA in Eastern European Studies *cum laude* from the University of Gent and a MSc in Shipping, Trade and Finance from Cass Business School. He is a member of the Society of Competitive Intelligence Professionals (SCIP).

Dr Michalis Voutsinas

Michalis Voutsinas works as an independent researcher with particular interests in shipping financial history and risk management of shipping companies. He was awarded with an MSc in Shipping, Trade and Finance from Cass Business School, City University London, an MSc in Applied Economics and Finance from Athens University of Economics and Business and a BSc in Economics from the same institution. Michalis was honoured with a prize, from Athens University of Economics and Business and a scholarship from Greek Shipowners' Association.

Professor Manered Zachcial

Manfred Zachcial belongs to the Board of Directors of the Institute of Shipping Economics and Logistics (ISL), Bremen, and has a chair of economics and statistics at Bremen University. Manfred Zachcial has been working on economics, land and maritime transport projects since 1972. He is a leading authority on shipping economics, statistics, transport planning, logistics and maritime information systems. In addition to his academic responsibilities, Professor Zachcial advises governments and international agencies on transportation strategies, port and shipping, and on the feasibility of various transport infrastructure developments. His research activities have resulted in numerous published works on modelling in both land and maritime transport, including transhipments at European sea ports. One of his major research activities is the analysis and forecast of world container shipping along the whole transport chains including hinterland transports and their determinants.

Part One
Shipping Economics and Maritime Nexus

Chapter 1
Maritime Business During the Twentieth Century: Continuity and Change

Gelina Harlaftis[*] *and Ioannis Theotokas*[†]

1. Introduction

The historical process is dynamic, and the changes that occurred during the course of world shipping in the past century, embedded some of the structures of the nineteenth century. The methodological tools of a historian and an economist will be used in this chapter, tracing continuity and change in the twentieth century shipping by examining maritime business at a macro-and micro level. At the core of the analysis lies the shipping firm, the micro-level, which helps us understand the changes in world shipping, the macro-level.

The shipping firm functions in a specific market, and the shipping market can only be understood as an international market, in a multiethnic environment. The first part of this chapter follows the developments in world shipping, analysing briefly the main fleets, the routes and cargoes carried, the ships and the main technological innovations. The second part provides an insight on the main structural changes in the shipping markets by focusing on the division of liner and tramp shipping. The third part reveals from inside the shipowning structure and its changes in time in the main twentieth century fleets: the British, the Norwegians, the Greeks and the Japanese; it is remarkable how similar their organisation and structure proves to be.[1] Maritime business has always been an internationalised business. In the last five centuries of capitalist development, European colonial expansion was only made possible with the sea and ships; the sea being but a route of communication and strength rather than of isolation and weakness. Wasn't it Sir Walter Raleigh in the late sixteenth century, one of Elizabeth's main consultants who had set some of the first rules for the British expansion? "He who commands the sea commands the trade routes of the world. He who commands the trade routes, commands the trade. He who commands the trade, commands the riches of the world, and hence the world itself." The real truths are tested in history and time.

2. Developments in World Shipping

There were two main developments in the nineteenth century that pre-determined the path of the world economies: an incredible industrialisation of the West and its dominance in the rest of the world. During that period the world witnessed an unprecedented boom in world exchange of goods and services, an unprecedented boom of international sea-trade. The basis of the world trade system of the twentieth century was consolidated in the nineteenth century: it was the flow of industrial goods from Europe to the rest of the world and the flow of raw materials to Europe from the rest of the world. In this way, deep-sea going trade became increasingly dominated by a small number of bulk commodities in all the world's oceans and seas; in the last third of the nineteenth century, grain, cotton and coal were the main bulk cargoes that filled the holds of the world fleet. At the same time, the transition from sail to steam, apart from increasing the availability of cargo space at sea, caused a revolutionary decline in freight rates, contributing further to the increase of international sea-borne

trade. Europe, however, remained at the core of the world sea-trade system: until the eve of the World War I, three quarters of world exports in value and almost two thirds of world imports concerned the old continent.[2]

It does not come as a surprise then, that European countries owned the largest part of the ocean-going world fleet during this period. Due to technological innovations, the international merchant fleet was able to carry an increasing volume of cargoes between continents with greater speed and lower cost. By the turn of the twentieth century Great Britain was still the undisputable world maritime power owning 45% of the world fleet, followed by the United States, Germany, Norway, France and Japan, (see Table 1). Over 95% of the world fleet belonged to 15 countries that formed the so-called "Atlantic economy"; what is today called the "developed" nations of the OECD countries. Meanwhile, at the rival Pacific Ocean, Japan was preparing to be the rising star of world shipping in the twentieth century.

Pax Brittanica and the incredible increase of world economic prosperity of more than one hundred years closed abruptly with the beginning of World War I. The main cause was the conflict of the big industrial European nations for the expansion of their economic and political influence in the non-European world. It was the result of the competition of western European nations for new markets and raw materials that determined the nineteenth century and peaked in the beginning of the twentieth century as the influence of the industrialisation of western European nations became more distinct. At the beginning of the twentieth century almost all of Asia and Africa were in one way or another under European colonial control.

The factors that created the international economy of the nineteenth century proved detrimental during the two destructive world wars of the twentieth century by multiplying their effects. Firstly, the formation of gigantic national enterprises in Europe and the United States and their concentration in vast industrial complexes with continuous amalgamations of small and medium companies resulted in an exponential increase of world production. Second, the search for markets beyond Europe that would absorb the excessive industrial production, resulted in the fierce competition of British, German, French and American capital in international capital investments worldwide. The result was the creation of multinational companies and banks that led to the development of monopolies on a national and international level. Within this framework, the great expansion of the United States and German fleets took place, along with the multiple

Table 1: The largest fleets of the twentieth century (in millions)

Country	1914		1937		1963		1992		2008	
	grt	*%*	*grt*	*%*	*grt*	*%*	*dwt*	*%*	*dwt*	*%*
Great Britain	*21.0*	*43%*	*20.6*	*31%*	*21.6*	*15%*	*23.6*	*3.4*	*26.0*	*2.5*
Germany	5.5	11%	3.9	6%	5.0		16.9	2.4	94.2	9.1
U.S.A.	5.4	11%	12.4	18%	23.1	16%	59.1	8.5	39.8	3.8
Norway	*2.5*	*5%*	*4.3*	*6%*	*13.7*	*9%*	*54.1*	*7.8*	*46.9*	*4.5*
France	2.3	5%	2.8	4%		4%	7.0	1	6.5	0.6
Japan	*1.7*	*4%*	*4.5*	*7%*		*7%*	*90.2*	*12.3*	*161.7*	*15.6*
Italy	1.7	3%	3.2	5%	5.6	4%	11.7	1.7	17.7	1.7
Holland	1.5	3%	2.6	4%	5.2	4%			8.6	0.8
Sweden	1.1	2%	1.5	2%	4.2		12.2	0.3	6.9	0.7
Russia-U.S.S.R.	1.0	2%	1.3	2%	5.4	4%	19.2	2.8	18.0	1.7
Spain	0.9	2%	1.0	1%	2.0		5.1	0.7	4.5	0.4
Greece	*0.8*	*2%*	*1.9*	*3%*	*15.0*	*10%*	*100.6*	*14.5*	*174.6*	*16.8*
Hong-Kong			0.3		0.8		31.6	4.5	33.4	3.2
China			0.6		0.5		27.5	3.9	84.9	8.2
South Korea					0.1		18.2	2.6	37.7	3.6
World total	49.1	100%	66.7	100%	145.9	100%	694.6 (444.3 grt)		1038.3 (774.7 grt)	

Notes: 1992 and 2008 include real ownership including all flags. Data for 2008 include ships of 1000 grt and above.
Sources: Lloyd's Register of Shipping 1914, Lloyd's Statistical Tables 1990, 1992; Gelina Harlaftis, *A History of Greek-owned shipping, 1830 to the present day* (Routledge 1993), Table 6.3, and UNCTAD (2008), *Review of Maritime Transport 2008*, UNCTAD, Geneva.

mergers and acquisitions in the northern European liner shipping business and the gradual destruction of small tramp shipping companies, particularly in Great Britain.

The interwar economy never recovered from the shock of World War I that influenced the whole structure of the international economy resulting in the worst economic crisis that the industrial world had seen in 1929. During the interwar period world shipping faced severe problems stemming from a contracting world sea-trade, decreasing world immigration and increasing protectionism. The economic crisis did not affect the main national fleets in the same way. The impact was particularly felt in Britain. This is the period of the economic downhill of mighty old Albion. It was World War I that weakened Britain and allowed competitors to challenge its maritime hegemony. The withdrawal of British ships from trades not directly related to the Allied Cause opened the Pacific trades to the Japanese. Moreover, both Norway and Greece were neutrals, which meant that their fleets were able to profit from high wartime freight rates (Greece entered the war in 1917). Norwegian and Greek ships were able to trade at market rates for three years while most of the British fleet was requisitioned and forced to work for low, fixed remunerations. Freight rates in the free market remained high until 1920, after which they plummeted; while there was a brief recovery in the mid-1920s, the nadir was reached in the early 1930s.

Table 1 records the development of the world fleets of the main maritime nations from 1914 to 1937. During this period the world fleet increased at one third of its prewar size. The British fleet remained at the same level with a slight decrease of its registered tonnage, but its percentage of the ownership of the world fleet decreased from 43% to 31% due to the increase of the fleets of other nations. The interwar period was characterised by the unsuccessful attempt of the United States to keep a large national fleet with large and costly subsidies to shipping entrepreneurs. Most of the

increase of the world fleet in the interwar period apart from the US was due to the Japanese, the Norwegians and the Greeks, who proved to be the owners of the most dynamic fleets of the century. Their growth was interconnected with the carriage of energy sources. The most important change in the world trade of the interwar period was the gradual decrease of the coal trade and the growing importance of oil.

The main coal producer (and exporter) in 1900 was the UK, with 225 million metric tons or 51% of Europe's production. By 1937 Britain was still Europe's main producing country with 42% of European output. In 1870 the production of oil was less than 1 million tons and in 1900 oil was still an insignificant source of energy; world production of 20 million tons met only 2.5% of world energy consumption. Because production was so limited there was little need for specialised vessels; tankers, mostly owned by Europeans, accounted for a tiny 1.5% of world merchant tonnage. But all this changed in the interwar period: by 1938 oil production had increased more than 15 times; it was 273 million tons and accounted for 26% of world energy consumption.[3] The tanker fleet, had grown to 16% of world tonnage, and although it was mostly state-owned, independent tanker owners started to appear in the 1920s. The largest independent owners of the interwar period were the Norwegians.[4]

Technological innovations continued in the twentieth century; the choices and exploitation of technological advances by shipping entrepreneurs determined the path of world shipping. The first half of the twentieth century was characterised on the one hand by the use of diesel engines and the replacement of steam engines and on the other, by the massive standard shipbuilding projects during the two world wars. Diesel engines that appeared in 1890 were only used in a more massive scale on motor ships during the interwar period particularly in Germany and the Scandinavian countries; the cost of fuel being 30% to 50% lower than that of the steam engines. Standardisation of ship types and shipbuilding programmes were introduced in World War I when Germans sunk the allied fleets in an unprecedented submarine war. The world had not yet realised what industrialisation and massive production of weapons for destruction could do. The convoy system had been abandoned and naval battleships with their complex weapons were ready to confront the enemy. But it was the allied merchant steamships that were the artery of the war, transporting war supplies. And this armless merchant fleet became an easy target to the new menace of the seas: the German submarines. From 1914 to 1918, 5,861 ships or 50% of the allied fleet was sunk.

Replacement of the sunken fleet took place between 1918 to 1921 in US and British shipyards. It was the first time that standard types of cargo ships, the "standards" as they came to be called, were built on a large scale. The "standard" ships became the main type of cargo ship during the interwar period; they were steamships of 5,500 grt. It was these "standard" ships that Greeks, Japanese and Norwegian tramp operators purchased *en masse* from the British second hand market and expanded their fleets amongst the world economic crises. For similar reasons during World War II the United States and Canada launched the most massive shipbuilding programmes the world had known, using new and far quicker methods of building ships: welding. During four years they managed to build 3,000 ships, the well-known Liberty ships, that formed the standard dry-bulk cargo vessel for the next 25 years.[5] Greek, Norwegian, British and Japanese tramp operators all came to own Liberty ships, in one way or another up to the late 1960s.

The second half of the twentieth century was characterised by an incredible increase of world trade

that towards the end of the century was described as the globalisation of the world economy. The period of acceleration was up to 1970s; world trade from about 500 million metric tons in the 1940s climbed up to more than three billion metric tons in the mid-1970s. If the history of world maritime transport in the first half of the twentieth century was written by coal and tramp ships, in the second half the main players were oil and tankers. During this period, sea-trade was divided into two categories: liquid and dry cargo. Almost 60% of the exponential growth of world sea trade was due to the incredible growth of the carriage of liquid cargo at sea, oil and oil products. There was also impressive growth in the five main bulk cargoes: ore, bauxite, coal, phosphates and grain. To carry the enormous volumes required to feed the industries of the West and East Asia, the size of ships carrying liquid and dry cargoes had to be increased. The second half of the twentieth century was characterised by the gigantic sizes of ships and their specialisation according to the type of cargoes. The last third of the century was marked by the introduction of container ships. The new "ugly" ships revolutionised the transport system for industrial goods.

Up to the 1960s the main carriers of the world fleet remained the same with the US and Britain continuing to hold their decreasing shares in world shipping, followed by the continually rising Greece, Japan and Norway (Table 1). Flags of convenience were used informally by all maritime nations but in the immediate post-war years more extensively by Greek and American shipowners. Flags of convenience that were later to be called open registries became a key manifestation of the American maritime policy and a determining feature of post war shipping that guaranteed economical bulk shipping.[6] By using flags of convenience, shipowners of traditional maritime countries were able to maintain control of their fleets benefiting from low cost labour. Sletmo relates the third wave of shipping with the transnationalisation of shipping through flagging out and dependence upon manpower from low-cost countries.[7] After the repetitive freight rates crises of the 1980s flag of convenience were extensively used by all western and eastern maritime nations.

The 1970s marked a new era: this period was characterised by the final loss of the pre-dominance of European maritime nations, with the exception of the Greeks that continue to keep their first position to the present day, and of the Norwegians that despite the great slump of the 1980s, kept their share of the market in the 1990s. During the last third of the twentieth century the increase of the size of the world fleet shipping continued but slowed down. The United States has kept, mostly under flags of convenience, a much lower percentage, while Japan remains steadily in the second position (Table 1). The rise of new maritime nations from Asia was evident; by 1992 China owned more tonnage than Great Britain, while South Korea was close. The world division of labour in world shipping had changed dramatically.[8] The booming markets of the period 2004–2008 contributed to the sharp increase in the world fleet, and to the slight change in the hierarchy of world maritime powers. Great Britain and Norway decreased their fleet and share in the world shipping, while Greece and Japan followed the opposite direction and increased both their tonnage and share. Germany made a very impressive comeback rapidly increasing its tonnage, especially of containerships. A remarkable change was that of China. Being the driving force of the world economy, China is continually developing its fleet. The conditions that prevail in the world shipping and shipbuilding markets after the collapse of the freight markets in 2008, make safe the forecast that sooner or later, China will become the driving force in world shipping.

3. Shipping Markets

Following world shipping developments, the shipping markets had taken its twentieth century form since the last third of the nineteenth century. Before the 1870s the shipping market was unified. By the last third of the nineteenth century the distinction of the shipping market into two categories, liner and tramp shipping started gradually to adapt. Liner ships carried general cargoes (finished or semi-finished manufactured goods) and tramp shipping carried bulk cargoes (like coal, ore, grain, fertilisers, etc.) For the next 100 years, until the 1970s, liner and tramp shipping markets continued more or less on the same lines. This one century of shipping operations can be distinguished into two sub-periods (Figure 1).

During the first period, from the 1870s to the 1940s, the cargoes carried by liner and tramp shipping were not always clearly defined: liner ships could carry tramp cargoes and *vice-versa*. Although there was a substitution between the two distinct markets, the main structures of each one were diametrically different: oligopoly and protectionism for the liner market with the formation of the shipping cartels from the 1880s, the conferences, and almost perfect competition for tramp ships.

The unprecedented increase of world production and trade in the first post-World War II era brought more distinct changes in the structure of the markets that led to a gradual decrease of substitution between the markets.[9] In tramp/bulk shipping, the introduction of new liquid bulk cargoes on a massive scale, like oil, and of the main dry bulk cargoes as mentioned above (coal, ore, fertilisers and grain) led to the creation of specialised bulk markets and to the building of ships to carry specific cargoes (Figure 1) . The liner market continued along the same lines of oligopoly but witnessed increased competition into their protected markets from competitors from developing and socialist countries.

The 1970s were the landmark decade for the liner industry; unitisation of the cargoes, called also containerisation, had been introduced during the 1960s but became widespread during the 1970s, brought a revolution in the transport of liner cargoes (Figure 2).While in 1970 the world container fleet was of 500,000 TEU by 1980 this had increased by more than six times to reach 3,150,000 TEU.[10] The new organisation of liner shipping that demanded excessive investments in infrastructure (terminals, cargo handling facilities, ships, equipment and agencies), led to an increase in ship and port productivity, an increase in ship size,[11] and economies of scale and decrease of transport cost.[12]

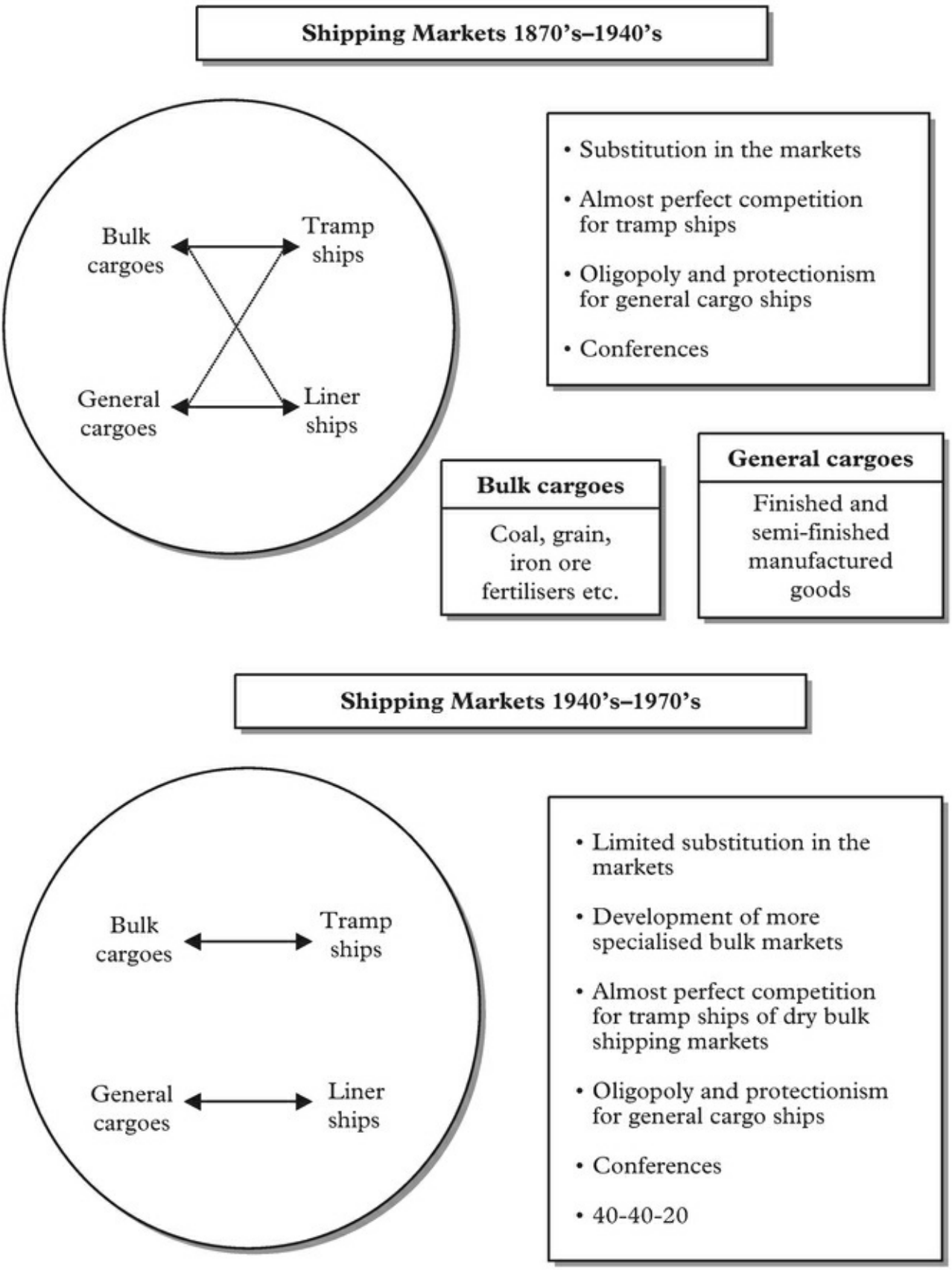

Figure 1: Shipping markets, 1870s–1970s

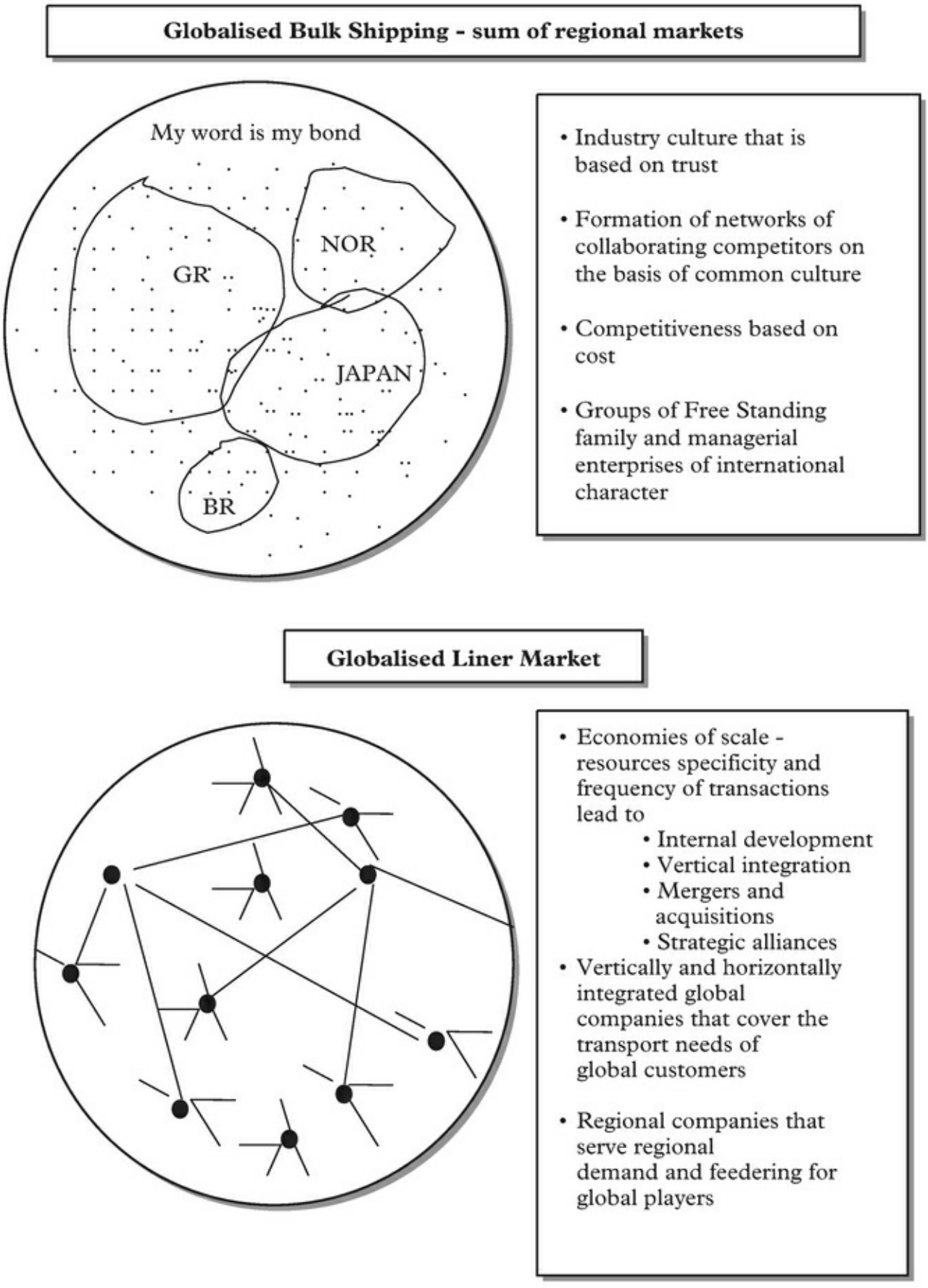

Figure 2: Shipping markets, 1970s–2000s

Containerisation included radically new designs for vessels and cargo-handling facilities, global door-to-door traffic, early use of information technology, and structural change of the industry through the formation of consortia, alliances and international mega-margers.[13] The above led to a total

transformation of the liner shipping companies that became the archetype of a globalised multinational shipping company. The high capital investments required to operate a unitized general cargo transport system led to consolidation in liner shipping.[14] This transformation was further provoked by the continuous trend to globalisation. Liner companies ought to serve the transport needs of their customer on a global basis. Although consolidation in liner shipping was increasing from the 1970s, during the 1990s it progressed faster. Liner companies were enforced to establish global networks in order to meet their customers' needs. The enlargement of the companies' size through mergers and acquisitions and the formation of global alliances were the necessary steps toward this. Strategic alliances between competitors have become the dominant form of cooperation in liner shipping.[15] Alliances allow competing liner operators to exploit economies of scope and to offer to shippers global geographical coverage.[16] It has been stated that increased complexity and intra-alliance competition among partners undermine the stability of strategic alliances.[17] Indeed, many changes have been noted over the years. For example, the Grand Alliance in 1995 had as members the Hapag Lloyd, NYK, NOL, and P&O. A few years later MISC entered the alliance while NOL left to follow the New World Alliance. Recently MISC withdraw and today the alliance includes the Hapag-Lloyd, the NYK and the OOCL, the seventh, ninth and twelfth biggest liner companies.[18]

In parallel, strategies of internal development, merger and acquisitions have led to an increase in the concentration of the supply of liner services. The combined market share of the top four liner companies increased by 7% in a period of three years, i.e. from 31% in 2004 to 38.4% in 2007, while the Herfindahl—Hirschmann Index of the top four players (HHI–4) increased by 182%, from 268 in 2004 to 449 in 2007.[19]

For example, the biggest liner shipping company in the world, the Danish Maersk, which has a market share of 15%, operates more than 500 containerships ((two millions TEU) of which 211 are owned by the company) and more than 50 terminals worldwide, while its network includes more than 150 local offices worldwide. In 1999 Maersk acquired Sealand, the biggest American liner shipping company, the first company in the world to introduce innovative container technology, while in 2005 it acquired P&O Nedlloyd, then the third biggest liner company. It is thus evident that such a multinational company is a global network by itself and offers global services to its clients. This kind of development resulted in a total re-structuring in the port systems of the various regions and created the need for minor shipping lines to serve regional transport needs or offer feeder services for global liner companies. The major liner companies approach main international ports, from which minor shipping lines distribute the products to regional ports through the so-called feedering services.[20] These two groups of companies, the big and minor container companies are not in competition with each other, rather they complement each other.

On the contrary, the development of tramp shipping did not involve such innovative technological developments and no dramatic changes took place in the organisation and structure of markets. The general pattern has not changed over the last 140 years. However, since the 1970s we are not talking of tramp shipping, but of bulk shipping since the type of ship does not characterise the market anymore, but instead the cargoes that are transported. Four main categories of bulk cargo are distinguished:[21] the liquid bulk (crude oil, oil products and liquid chemicals), the five major bulk (iron ore, grain, coal, phosphates and bauxite), minor bulk (steel products, cement, sugar forest products etc) and specialist

bulk cargoes with specific handling or storage requirements (motor vehicles, refrigerated cargo, special cargoes). Gradually need adapted to demand, and the “tramp” ship was replaced by specialised ships that were built according to the bulk cargoes and the specialised bulk shipping markets; reefer ships for the refrigerated cargo, chemical tankers for chemical gases, lpg and lng for liquefied petroleum and natural gas, heavy lift vessels for specific cargoes etc.

Globalised bulk shipping, even to the present day, is an industry based on trust. Companies form networks of collaborating competitors on the basis of common national cultures of traditional maritime nations such as Britain, Greece, Norway and Japan (Figure 2). Even members of the same network compete with each other and competitiveness is based on cost. During the twentieth century size did not play an important role in the competitiveness of the company.[22] Bulk shipping consists of companies of various sizes – these vary from large companies of more than 50 large ships to single-ship companies that directly compete with each other. For example in 1970, the Greek-owned shipping company of Stavros Niarchos and the Norwegian shipping company of Wilhem Wilhelmsen which operated more than 60 ships co-existed and competed with the British Turnballs that operated five ships and the various Bergen-based and Piraeus-based small companies that operated ships of similar characteristics. Tramp shipping was mainly formed by groups of family enterprises which retained many characteristics of a multinational enterprise.[23] No matter what the size of these enterprises, their organisation, structure and strategies had a lot in common.[24]

4. Shipping Companies

Overall analysis of the main trends in world shipping fleets and their markets throughout the twentieth century does not provide us with an understanding of the structure of the maritime industry. The core of the economy is the firm; the core of the maritime industry is the shipping company. In this section we will briefly review the actual players, the shipping companies of the four main twentieth century nations: the British, the Norwegians, the Greeks and the Japanese. In the first three European nations, we can distinguish similar patterns of organisation and structure in the shipping companies worldwide that concerned both liner and tramp shipping. First an important aspect of shipping companies was their connection with a specific home port; second was the ownership and management of the company by distinct families for multiple generations; third was the use of a regional network for drawing investment funds, and fourth was the existence of an international network of overseas agencies that collaborated closely with trading houses on a particular oceanic region, or on a particular commodity trade.[25]

4.1 The British

British commercial and shipping business in the nineteenth century developed along the lines of its colonial empire, and the inter-Empire and British external trade that was operated by close-knit global business networks. At the beginning of the twentieth century British shipping was world’s largest fleet owning 40% of the world’s tonnage, followed by Germany which owned one-fourth of its size. In 1918 a government committee reported that “at the outbreak of war, the British Mercantile Marine was the largest, the most up-to-date and the most efficient of all the merchant navies of the world”.[26] The fleet was particularly hit during the interwar period, where it saw some of its leading shipping companies like the Royal Mail disintegrate and some of its main tramp-shipping owners leave the stage. It has been argued that British performance has been affected by the “unfair competition” of countries that

subsidised their liner fleets like France, Germany, Italy, Japan and the United States, or the low-cost tramp operators like the Greeks that took large portions of its share in the Atlantic trade, and by the reluctance of British shipowners to invest in the new technology of diesel engines and tankers during the interwar period.[27]

World War II did not really affect the British share in world shipping which by 1948 had reached its pre-war level. Until 1967, Britain despite its decreasing share, remained world's maritime leader and UK fleet continued to grow until 1975. Part of its 1975 tonnage, however, the year when the British fleet reached its peak, was foreign-owned and this "masked the extent to which British interest in merchant shipping had already declined before the downward plunge after 1975".[28] From 1975 to the beginning of the twenty-first century there was a continuous decrease in the UK register due to the "flagging-out" of the British-owned fleet. By 2007 British shipping under all flags was in tenth position with only 2.35% of world tonnage.[29]

The regional dimension in maritime Britain has played an important role in the organisation of both tramp and liner business. The main poles of liner shipping have traditionally been Liverpool and London followed by Glasgow and Hull. The newly emerging liner shipping companies from the mid-nineteenth century onwards were very strongly connected with a big home port, like London, Liverpool, Glasgow and Hull, where strong shipping elites were formed.[30] For example, the Peninsular and Oriental (P&O), based in London, was established by Wilcox and Anderson in 1837 and specialised in trade with India and Australia; the Cunard Company, established by Samuel Cunard, Burns and the MacIvers in 1839 specialised in the north Atlantic; the British India (BI) shipping company, based in Glasgow, was established in 1856 by the MacKinnon shipping group and specialised in the Indian ocean; the Ocean Steam Ship Company known as the Blue Funnel Line, based in Liverpool, was established by the Holt family in 1865 and specialised in trade with southeastern Asia. The Union-Castle Line, was established in the 1850s and run by Donald Currie, specialised in South Africa by the 1870s, the Elder-Dempster based in Liverpool, was formed by Alexander Elder and John Dempster in 1868 and specialised in African trade; Lleyland, Moss, McIver and Papayanni, all based in Liverpool, were established in the 1840s and 1850s and were involved in the Mediterranean. Hull was the home port of the Wilson Line, established by the Wilson family – "Wilson's are Hull and Hull is Wilson's" –, that traded in all oceans and seas. [31] In 1910 there were 65 liner companies that owned 45% of the British fleet. And all, during the previous 30 years, had organised themselves in closed cartels of the sea, the conferences, according to the oceanic region they traded, securing their share in the world market.[32]

The five largest liner companies in 1910 were British India, White Star Line, Blue Funnel Line, P&O and Elder Dempster (see Table 2). Low freight rates and a widespread depression in the late 1910s led to intense competition and a wave of mergers that produced giant lines in the five years before World War I. The most notorious example is the Royal Mail Steam Packet Co that from 1903 to 1931 was led by Owen Philipps (later Lord Kylsant). Within 30 years Royal Mail reached its peak, owning 11% of British fleet, and its nadir in 1931 when it was liquidified, producing a major crisis

Table 2: The largest British shipowning groups of the twentieth century (in thousand grt)

1910		1939		1960		1970		1998	
Name	**Nrt**	**Name**	**Grt**	**Name**	**Grt**	**Name**	**Grt**	**Name**	**Dwt**
Tramp/Bulk Shipping									
Furness Withy	179	British Tanker Co	595	British Petroleum	1383	BP Tanker Co. Ltd	2439	BP Shipping Ltd	2823
Usmar John Henry (Anglo-American Oil Co)	108	Anglo–Saxon Petroleum	376	Runciman (United Molasses)	361	Trident Tankers Ltd	985	P&O Bulk Carriers Ltd	2654
Ropner R.	93	Ropner Group of Companies	243	Hunting group	193	Denholm (Management) Ltd	801	Trader Navigation Agencies Ltd	1381
Hain Edward & Sons	93	Eagle Oil shipping	229	Watts, Watts & Co	187	Common Brothers (Management) Ltd	707	Ocean Agencies Ltd	797
Burrell & Son	79	Hain steamship	159	Denholm Co	160	Maritime Overseas Corp.	436		
Liner Shipping									
British India Steam	304	P&O group (British India Steam Navigation)	663	P&O group	2369	Ocean Steam Ship Co. Ltd	755	P&O Nedlloyd BV*	2890
Ismay Imrie (White Star Line)	232	Ellerman Group of companies	651	Furness group	1420	Cayzer, Irvine & Co. Ltd	610		
Holt A. (Blue Funnel Line)	219	Holt A. (Blue Funnel Lines)	562	Blue Funnel group	971	P&O Steam Navigation Co.	396		
Peninsular & Oriental	203	Cunard Group of Companies	461	Cunard group	947	Houlder Brothers & Co. Ltd	366		
Elder Dempster Group of Companies	202	Furness Lines	426	British and Commonwealth	872				

Note: For the years 1914 and 1939 ships above 500 grt, for the years 1970 and 1998 ships above 1000 grt.
* Joint-venture of British and Dutch interests.
Sources: Processed data from *Lloyd's Register of Shipping*, 1910, 1939, 1970, *Shipwatch Directory*, 1998. For 1960 data from Sturmey, S.G. (1962): *British Shipping and World Competition* (Athlone Press), Table 50.

in British shipping business circles. In a remarkable series of acquisitions Royal Mail acquired Elder Dempster in 1910, Pacific Steam in 1910, Glen Line and Lamport Holt in 1911 and Union-Castle in 1912.[33] Another giant emerged just before the war, when Peninsular and Oriental apart from the Blue Anchor Line, acquired British India Steam Navigation and its extensive shipping and trading interests in India. P&O continued its acquisitions and mergers throughout the interwar period and in contrast to Royal Mail, remained the largest British shipping concern throughout the twentieth century.

Mergers and amalgamations of lines into groups under common ownership continued in the interwar period and changed the structure of British liner shipping.[34] The economic crisis of the 1930s hit British shipping hard. The contraction of the tramp shipping sector (which was lost to Norwegians and Greeks) and the concentration to fewer liner companies was evident: in 1939 there were 43 British liner companies which owned 61% of the fleet. The demolition of Royal Mail, and the intervention of the British banking system to save Britain's largest liner concerns, brought a restructure of liner ownership in the 1930s that defined its path in the second half of the twentieth century.

As Table 2 indicates, in 1939 P&O, the Ellerman group of companies, Cunard, Blue Funnel and Furness Lines appeared in the top five positions. P&O through consecutive mergers and amalgamations became the indisputable queen of the Indian Ocean and Pacific routes; apart from British India Steam Navigation in 1914. In 1917 and 1919 it acquired another seven lines that serviced those routes. In the 1960s and 1970s P&O remained the largest shipping group of the world; after the 1970s it adjusted to the container revolution, adopted a globalised ownership, expanded to the port terminal business and diversified into the bulk, ferries and cruise sectors. In 1996 P&O Container Limited, the liner branch of the group, merged with Nedlloyd to form P&O Nedlloyd and the new company became the third biggest liner company, before its acquisition by Maersk Line. Ellerman

acquired a number of smaller Liverpool lines that traded in the Mediterranean before World War I and its biggest acquisition was in 1916 when it amalgamated with Wilson Line; its importance contracted in the post-World War II period. Cunard, another giant of the "big five" of British shipping traditionally engaged in the Atlantic passenger services since 1840s, had acquired three or four lines during the second and third decade of the twentieth century. It profited largely from the demolition of Royal Mail when it acquired White Star Line in 1934. Persisting in passenger shipping, however, it eventually lost its importance in the post-war period.

The Blue Funnel (Ocean Steam Ship Company) group of companies owned by the Holt family exemplified family capitalism in liner shipping. Based in Liverpool and specialising in far eastern trade, it also profited from the demolition of Royal Mail and amalgamated with Elder Dempster which held the African trades. It continued to trade strongly well into the second half of the twentieth century. The Cayzer family from Glasgow formed the Clan Line in 1890, established the British and Commonwealth group in 1956 by amalgamating with the Union-Castle Line, another line that had belonged to the disintegrated Royal Mail group; it continued its business throughout the twentieth century. Until the beginning of the twentieth century the Furness group was one of the main British tramp shipping operators, who later diversified into liner shipping. By taking part in the acquisitions and amalgamations and exploiting the demolition of Royal Mail of which it acquired a fair share, it proved, along with P&O, to be one of the most important shipping groups of the twentieth century; it has also been among the first British liner groups to continue operating in tramp/bulk shipping.

Liner shipping companies are associated with the most glorious part of British shipping. Liner companies owned the most famous, luxurious steamships of the latest technology. British liner steamships carried millions of passengers, and became widely known as the proud manifestation of power of the mighty British Empire which ruled the waves. Most of the owners of British liner companies, among Britain's most powerful capitalists, were commoners who became Lords or were knighted: Lord Kylsant of Royal Mail, Lord Inchcape of British India, Sir Alfred Jones of Elder Dempster, to mention only a few. British historians have told the stories of the main British liner business.[35] But liner shipping throughout the nineteenth and twentieth centuries formed less than half of the large British fleet.

In fact, it was the less glorious ships of less technological achievement that formed more than half of the British fleet which fed the industries of the Empire. Tramp shipping formed the largest part of the British mercantile marine up to the Great War with 462 companies owning 55% of the fleet. The Industrial Revolution determined the areas in which British tramp operators developed in close connection with deep-sea export coal trade: The Northeast ports and Wales became the main hubs of British tramp-operators in combination with those of the Clyde in Scotland who were traditionally connected with the trading worldwide networks of the Scottish merchants.

In 1910 the shipping companies of the Northeast ports, namely Newcastle, Sunderland, Hartlepool, Middlesbrough, Whitby, Scarborough and Hull handled almost one third of British tramp shipping tonnage.[36] Some of the most powerful British shipping families came from this area: the Furnesses, Turnballs, Ropners and Runcimans. The next most dynamic group in tramp shipping were Scottish tramp operators who handled 18% of British tramp shipping in 1910. Some of the best known Scottish tramp shipowning families were the Burrells and the Hoggarths. Wales also emerged as a generator of

tramp companies. Wales drew human capital from the West Country as well and shipping companies established in Wales operated 9% of the British tramp fleet in 1910. With Cardiff as the central port, tramp shipping thrived in the Welsh ports from Chester to Llanelli.[37] The best known Cardiff tramp operators were the Hains, Morells, Tatems and Corys. London and Liverpool drew branch offices from almost all these tramp operators and both cities handled 42% of the British tramp fleet in 1910.

Table 2 indicates the evident importance of tankers and the non-existence of independent tanker owners; one of the great failures of British tramp owners was that they did not enter the tanker business. The main big tanker owners remain the petroleum companies like the Anglo-American Oil Co in 1910, British Tanker Co and Anglo-Saxon Petroleum in 1939 and British Petroleum in the post-World War II period. The new structure in the organisation of tramp/bulk shipping, were the management companies under which one finds some of the traditional British tramp owners. Denholm Management is a good example of a management company. In 1970 it managed 38 ships for 17 shipping companies including Turnbull Scott Shipping.[38]

Contrary to the beliefs that want family capitalism to belong only to the Mediterranean, family prevailed in both the British liner and tramp maritime business. Big liner companies might have been joint-stock companies, but ownership was usually spread among a select circle of family and friends; families like the Cayzers, Ellermans, Brocklebanks, Holts, Furnesses and Swires retained their command over major British lines.[39] The case was stronger in British tramp companies, that were family-owned companies that kept ownership and management of the companies and used intermarriages to expand and keep the business within closed circles. From the most prominent ones like the Runcimans, the Turnbulls, the Ropners, to the medium and smaller ones, kept business in the family for several generations. One of the great handicaps of British shipping, however, has been the loss of the importance of the regional dimension of maritime Britain; regions and ports that reproduced shipping entrepreneurship.

4.2 The Norwegians

Norway is considered as a leading maritime nation not only due to the high percentage of owned tonnage since the nineteenth century, but also due to the shipping sector's position in the economy.[40] In Norway, "shipping is indeed an industry of its own".[41] Norwegians have traditionally carried bulk cargoes, lumber, grain and fish along the Northern European and Atlantic routes.[42] Shipowing has been an important business in all ports of Norway's extensive coastline. The regions of Oslo and Oslofjord, the South Coast, the Western and Northern Norway included almost 60 ports active in shipping and shipowning activities, most of whom were engaged in tramp shipping. More importantly, shipping absorbed a large portion of investment and labour of the country. The success of the Norwegian shipping industry during the nineteenth century is related to the "collective mobilisation of resources" at the local level, i.e. the *partsrederi* system, according to which, members of the local community provided resources for the construction and operation of a ship, becoming shareholders of the shipowning company and receiving the resulting profits.[43]

With a developed expertise in wooden and later metallic sailing ships that continued well into the twentieth century some areas, closely connected to the traditional shipbuilding industry failed to make the transition from sail to steam. The region of Adger in the South Coast of Norway for example, during the years prior to World War II, owned between 55% and 58% of the Norwegian iron and steel

sailing ship tonnage, but failed to invest successfully into steam shipping.[44]

The structural transformations of Norwegian shipping differentiated the relative importance of each port to its development, without changing the regional pattern. Shipping companies continued to be located in specific ports throughout the twentieth century. While the majority of shipping companies are now established in Oslo, ports like Bergen, Grimstad, Stavanger, Arendal and Kristiansand still remain important maritime centres. It is argued however that the transition of the Norwegian shipping from sail to steam meant the emergence of a new "industry (mostly) outside the old one". According to Wicken: "The shipping companies were established in urban areas, mostly around Oslo and Bergen. Many companies were not closely incorporated into local communities, but emerged from interaction between individual Norwegian entrepreneurs and large international corporations."[45]

As Norway's external trade could not support the development of a competitive shipping industry, Norwegian shipowners, like the Greeks, based their expansion on their ability to produce cost-effective shipping services and to serve the needs of international trade. Equally, they exploited their competence in managing ships and the abundance of low cost and high quality Norwegian seamen and became the main cross trader fleet of the world in the last third of the nineteenth century and the first half of the twentieth century. Their involvement in liner shipping was limited and with the exception of the interwar period, when a percentage between 25% and 30% was engaged in liner trades, the corresponding figures for the whole of twentieth century has not surpassed 15% of the fleet.[46] Norwegians invested heavily in bulk shipping and especially in tankers and have been major players in this sector since the 1920s. The high share of tankers in Norwegian fleet, along with the high share of motorships and the low average age of the vessels, are considered as the main features of Norwegian shipping's rapid expansion during the interwar period.[47] The business strategy of expanding the market share in tanker shipping proved to be a source of strength as well as of weakness. Norway prospered during the expansion of the tanker market until the 1970s when it was hit hard during the crisis of 1973.[48] Its massive orders for supertankers along with their low ratio of liquid to fixed asset made them highly vulnerable.[49] Despite its diversification to offshore activities and its exploitation of the know-how in managing ships to enter the market of third party ship management, it remains a major power in the bulk shipping industry. However, its leading position in the world fleet is very much down to the innovative strategies of the many shipping companies which from the 1960s onwards entered specialised bulk shipping markers like those of gas, and chemicals. They are now considered to be the leading group[50] of these markets or that of open-hatch bulk carriers.[51]

Norwegian shipping is characterised by rivalry and cooperation and a strong emphasis on competence and networking.[52] A large percentage of shipping companies can be considered as network firms whose relationships with partners rely on trust.[53] In this context, the role of families in the establishment and development of shipping companies was crucial. Companies are family owned enterprises of family owned conglomerates.[54] Various families, tied to particular ports, established their companies during the end of the nineteenth century or the first decades of the twentieth century, and most of them continue to be active to the present day. Bergesen, Olsen, Knutsen, Naess, Reksten, Odfjell, Rasmussen, Wilhelmsen, Stolt Nielsen, Fredriksen, Westfal-Larsen, Hoegh and Uglands are only a few of the families that ran the leading companies of the Norwegian shipping during the twentieth century. Representative cases of family businesses with a long tradition in shipping are

Wilh. Wilhemsen and Odfjell, as both remained at the forefront of world shipping for the whole of their history.

The company of Wilhelm Wilhemsen was founded in 1861 in Tonsberg by Morten Wilhelm Wilhelmsen who was also a successful shipbroker. As early as 1870 he started to invest in steamships acquiring shares in various ships and in 1887 he made his first steamship purchase.[55] By 1910, when the founder of the company died, the fleet consisted of 31 steamships. In 1911, the company, after several years of scepticism, finally entered the liner trades in cooperation with Fearnley and Eger operating the Norwegian Africa and the Australia Line. At approximately the same time Wilhelmsen entered the tanker market. In 1912 the first two tankers were ordered and a fleet of this type of ships was created. In the forthcoming years Wilhelmsen's involvement in liner trades became stronger while the tanker operation was abandoned. After World War II, Wilhelmsen focused again on tanker business and in expanding in the liner trades. Although during 2000 it was still active in the bulk sector, its core activity was in liners and it was considered as the leader of Ro-Ro and Car Carriers sector.[56] In 1999 the Wilhelmsen Lines merged with the Swedish Wallenius Lines creating a worldwide network, which was further expanded with the acquisition of the car carrier division of Hyundai Merchant Marine in 2002. Today, the Wilhelmsen group is involved in many sectors of international shipping. Operating a fleet of 166 car cariers and Ro-Ro through three different operating companies (Wallenius-Wilhelmsen Logistics, EUKOR Car Carriers and American Roll-on-Roll off Carrier) controls 27% of the global car carrier fleet.[57] The Group is also active in the third-party management sector as well as in maritime services and logistics. After more than 140 years, Wilhelmsen is still a dynamic globalised shipping group, which remains family controlled.

Odfjell was established in 1916 in Bergen by Abraham and Frederik Odfjell, both captains. During its early years the company was active in tramp shipping, operating dry cargo ships, while during the late 1930s it expanded to specialised tankers which carried different liquid cargoes. During the late 1950s the Odfjell family decided to increase involvement in the specialised market for chemical cargoes. The company gradually reduced its involvement in bulk markets focusing on chemicals.[58] During the late 1960s Odfjell entered the tank storage business. This shift to specialisation included certain innovative strategic decisions that gave Odfjell a clear head in the chemical market and made the company the leading Norwegian chemical tanker operator. Cooperation with other companies, (for example the Westfal-Larsen & Co and Christian Haaland of Haugesund), technological innovation and vertical integration contributed to Odfjell's dominance in the chemical market.[59]

In 1986 the company was listed on Oslo Stock Exchange but the control remained with the Odfjell family. In 1990s Odfjell implemented a strategy of expansion with sophisticated new ships as well as with second-hand purchases.[60] In 2000 following the consolidation trends in the chemical market it merged with the chemical branch of Greek-owned company Ceres which owned a fleet of 17 chemical tankers operating in the Seachem pool. After the merger the Odfjell family owns 28% of the shares and the Livanos family 18.5%. This merger brought together two traditional families and created synergies not only on the tangibles, but even more importantly on the intangibles.

Odfjell cooperates mainly on a 50–50% basis with companies that are active in regional trades. Its fleet consists of 93 parcel tankers (March 2009). It owns and operates tank terminals in Europe, America and Asia, while it is also active in the tank container business. Odfjell considers itself as a

“leading logistics service provider of specialty bulk liquids” on a worldwide basis,[61] which continues to operate its businesses from Bergen.

Norwegian shipping also consists of leading entrepreneurs like E.D. Naess and H. Reksten, whose lives were constantly compared with the Greeks Onassis and Niarchos. The Norwegian US citizen Erling Dekke Naess became active in shipping after having studied and worked in the UK. Having invested extensively in whaling in the 1920s, he entered the tanker business in the 1930s. With the outbreak of World War II Naess moved to New York and there he became head of Nortraship, the governmental organisation that administered Norway’s requisitioned merchant fleet to the Allies. Naess became one of the major shipping players in the newly emerging America’s economic capital New York. His relations with American oil companies and his involvement in the tanker business and flags of convenience made him among world’s largest cosmopolitan shipowners. Involved both in dry and liquid bulk shipping, like his Greek counterparts, in the 1950s he turned to the cheap and efficient Japanese shipyards to order his bulk carriers and tankers. Using Bermuda as his official base, he really administered his fleet from London with his Anglo-American Shipping company. This eventually became Anglo-Norness and collaborated closely with the British P&O.

But it was his decision to sell his fleet for $208 million a few months before the first oil boom and the great depression in the tanker freight markets that made him known as the shipowner who predicted the oncoming crisis. Naess attributed this decision to his study of the business cycles.[62] It is very probable, however, that at that point in time Naess was not the owner of “his” fleet which belonged to the company Zapata Norness, but was only “an honorary chairman of the board” as it was reported that he had already sold his fleet for a much lower price in the 1960s.[63] Whatever the truth, his exodus remained glamorous, and he never stopped his interests in shipowning. In collaboration with the Greek tanker owners he established the Intertanko in the mid-1970s of which he became President, while he returned to business again in the early 1980s. His use of various nationalities to shelter his companies, of various flags on his ships, and of crews of various nationalities mean that most Norwegian analysts not regard him as a Norwegian shipowner, and not to include his ships in the Norwegian fleet. A nation that prided itself on its maritime infrastructure only accepted the term Norwegian-owned after the 1980s crisis and the formation of NIS.

Hilmar Reksten followed a path similar to that of Naess – his ending however was different, as he was hardly hit by the depressed freight rates of the 1970s. In his case, the strong involvement in tanker business functioned both as strength and weakness in the different phases of the downfalls and upheavals in the shipping business. Reksten ordered his first tanker in 1938 and expanded into the tanker sector after World War II. He was convinced about the high profits to be made from tankers, so he focused on the market for oil transport, created a fleet of large tankers and operated them in the spot market.[64] This strategy proved extremely successful in the period before 1973, when the freight rates were continuously rising. Reksten became one of the biggest tanker owners worldwide, but this strategy proved unsuccessful in the depressed freight markets after 1974 and finally led to bankruptcy in the late 1970s. His chartering strategy made him the shipowner who “had more tonnage available for assignments in the red-hot spot market” than any other, but a few years later made him the one who “had more tonnage laid up than any other”. Thus, his “spectacular rise was overshadowed by his even more spectacular downfall”.[65]

But Norway is a maritime nation, and apart from the above mentioned well-known shipowning families, the backbone of the fleet still rests in the hundreds of small shipping companies active in shipping for shorter or longer periods, which although not as innovative and dynamic as the larger companies, have contributed to making Norway among the top maritime nations worldwide. The shipping companies are at the core of the Norwegian Maritime Cluster which consists of various internationally competitive sectors (shipping, ship brokers, ship consultants, yards, equipment, other shipping services, shipbuilding, shipbrokering, classification etc) located along the Norwegian coast.[66]

4.3 The Greeks

If at the northest tip of Europe lies one of the most dynamic European nations, at the southeast tip of Europe lies another dynamic maritime nation that became the world leader in the maritime business over the last 30 years. Greek-owned shipping developed since the nineteenth century as an international cross trader almost exclusively involved into tramp shipping. It carried bulk cargoes, particularly grain, from the Black Sea and coal from north western Europe, along the routes of Mediterranean waters. Greek-owned shipping eventually evolved into a worldwide tramp shipping fleet in the twentieth century. Its main strength was the development of a tight maritime business network in Europe in the nineteenth century and globally in the twentieth.[67]

In 1850, just 20 years after the formation of Greece, the small backward state owned a fleet almost equivalent to that of Holland and Norway. Although by 1880 the Greek fleet could not compare to those of Britain, Norway, Italy, France or Germany, it was in the same league as Russia, Sweden and Spain and was larger than those of Denmark, the Netherlands, Austria-Hungary or Portugal. In 1910 Greece had the ninth largest fleet in Europe, which consisted almost exclusively of ocean-going vessels for the transport of bulk cargoes and tramp ships engaged in the international cross trades. By comparison, the fleets of Russia, Austria-Hungary, Italy, France and Spain consisted mostly of liners operating on regular routes and owned by large, often subsidised, shipping companies which essentially carried passengers and industrial or package products.[68]

During the interwar period world shipping faced severe problems stemming from a contraction of seaborne trade, decreased world migration and increasing protectionism. World War I weakened Britain and allowed competitors to challenge its maritime hegemony. The Greeks took advantage of the disposal of tonnage at extremely low prices and were able to expand during the worst period of the crisis. The fleet, which suffered severe losses during World War II not only reconstructed itself after the War, but also grew at an unprecedented rate. Until the 1960s the main maritime nations remained the same, with Britain and the US clinging to their decreasing share of world shipping, followed by Greece, Japan and Norway. Although flags of convenience were widely used, in the immediate postwar years they were resorted to more extensively by Greek owners. The 1970s marked the start of a new era; this was characterised by the final loss of the pre-dominance of European maritime nations, with the exception of the Greeks who have maintained their leadership to the present day.

Timely adjustments to changes of world trade and to technological shifts kept Greek shipowners in the forefront of world shipping. The spectacular growth of Black Sea grain exports in which the Greek sailing ship fleet was involved, provided the capital for the subsequent transition from sail to steam by Greek shipowners that was completed at the turn of the twentieth century. After World War I the lost

steamships were replaced by the “standard” type of cargo ships that were built during the war while after World War II, the lost ships were replaced by the war-built “Liberty ships” which became the standard dry-bulk cargo vessels for the next 25 years.

Part of the Greeks’ success during the postwar period was due to their entry into the tanker market in the late 1940s and the 1950s. The first shipowners to do so were Aristotle Onassis and Stavros Niarchos, both of whom benefited from the Norwegian experience in tankers at this propitious international conjuncture. Niarchos’ and Onassis’ expansion strategy was quickly followed by many of the successful “traditional" shipowners, primarily those who had settled in New York during the World War II. The trailblazers’ success also created access to the American financial market for other Greek shipowners. By 1974 the Greek-owned tanker fleet had become the largest in the world, comprising 17% of the global fleet. Starting from scratch in 1945, this fleet reached 8.2 million grt in 1965; 14.7 million grt in 1970; and 21.8 million grt in 1974. Tankers represented between 40 and 48% of the overall capacity of the Greek-owned fleet in the years 1958–1975.

Family capitalism that prevailed in the structure of Greek-owned maritime business was also pivotal in the success of the fleet. At the beginning of the twentieth century there were about 200 families, all specialised now in shipping, running 250 shipping firms. By the end of the twentieth century about 700 families were running more than 1,000 shipping firms. After a short interval in New York, in the 1940s and 1950s, by the last third of the twentieth century the Greek-owned fleet had the same operational centres (Piraeus and London) as at its beginning, but its entrepreneurial network was not now confined to European waters but extended to all oceans of the world.

The management, and all the branch offices of Greek shipping companies throughout the twentieth century continued to be in the hands of members of the same family

Table 3: The largest Greek shipowning groups of the twentieth century (in thousands)

Name	Nrt	Name	Grt	Name	Grt	Name	Grt	Name	Dwt
1914		**1938**		**1958**		**1975**		**2008**	
Embiricos Group	92.5	Kulukundis Group	145.3	Goulandris P. sons	1,176	Goulandris P. sons	2,578	Angelicoussis I. (Maran Tankers-Maran Gas)	9,130
Scaramanga Bros	24.2	Goulandris Bros	74.5	Onassis A.	1,098	Onassis A.	2,562	Economou G. (Cardiff-Dryships)	8,754
Dracoulis Bros	20.4	Livanos S.G. (Theofano)	57	Niarchos Stavros	1,033	Lemos C.M.	2,274	Tsakos P. (Tsakos–TEN)	6,639
Svoronos	20.1	Nomikos Petros	39.9	Livanos S.G.	785	Niarchos Stavros	1,786	Prokopiou G. (Dynacom)	5,911
Michalinos	19.3	Chandris I.D.	37.7	Kulukundis Group	730	Kolokotronis M.	1,581	Diamantidis D. (Marmaras-Delta)	5,082
Vagliano A.S.	18.1	Lykiardopoulos N.D.	36.3	Lemos C.M.	530	Goulandris N. sons	1,333	Restis V.(Enterprises-Golden Energy)	4,904
Panellinios Atmoploia	17.8	Kassos Navigation (Rethymnis, Pneumaticos)	35.4	Goulandris N.G. sons	420	Livanos G.S.	1,219	Georgiopoulos P. (Genmar-Genko)	4,620
Lykiardopoulos	14.4	Nikolaou	34.7	Goulandris Bros	320	Coulouthros N.	817	Haji-ioannou P. (Polyar)	3,932
Greek Transatlantic Steamship Co	12.8	Yannoulatos Bros (ELMES)	31.7	Embiricos S.G.	280	Chandris Bros	791	Martinos C. (Thenamaris)	3,816
Yannoulatos Bros	11.9	Embirikos S.G.	27.6	Chandris Bros	200	Kulukundis Bros	712	Panayiotides G. (Excel-Quintana)	3,615
Total of ten companies	251.5		520.1		6,572		15,653		56,223
Total of Greek-owned fleet	822.9		1,889		10,425		45,392		174,570
Share of ten largest	31%		28%		53%		34.5%		32.2%

Source: Gelina Harlaftis (2001). *A History of Greek-owned Shipping, 19–20th centuries*, Nefeli, Athens, Table 11.5, (in Greek), *Naftiliaki*, Summer 2008.

or co-islanders. In this way kinship, island and ethnic ties ensured the cohesion of the international Greek maritime network. The unofficial but exclusive international “club” was extremely important for their economic survival. It provided access to all the expertise of shipping: market information, chartering, sales and purchase, shipbuilding, repairing, scrapping, financing, insurance and P & I clubs. It also provided consultancy from older and wiser members and information about the activities of the most successful members of the group. Imitation proved an extremely useful “rule-of-thumb". The main strength of the Greeks then, has been the formation of an exclusive “Greek” transnational network of family enterprises that interacted with local, national and international shipping networks and organisations, local, national and international financial institutions and organisations.

The regional dimension has also proved extremely important in Greek-owned shipping. During the first two thirds of the twentieth century the so-called traditional shipping families, all involved for multiple generations in shipping activities, predominate and came from the islands of the Ionian and the Aegean. On the eve of World War I the biggest shipowning groups came almost exclusively from the islands of the Ionian sea, as a continuity of the entrepreneurial networks of the nineteenth century. Apart from the Embiricos family that originated from the Aegean island of Andros, and formed the most powerful shipowning group of the first third of the century, the rest, Dracoulis Bros, Svoronos, Lykiardopoulos, Yannoulatos and Vaglianos came from the Ionian islands of Cephalonia and Ithaca (see Table 3). The importance of shipowners from Chios did not begin but later; in 1914 only the shipowning groups of Scaramanga and Michalinos stemmed from Chios.

If the Ionian Sea dominates in the first third of the century, in the last two thirds the Aegean took over. It is in the interwar period that the family groups of the maritime islands of the Ionian were

replaced by the family groups of the Aegean islands. In this way, the five brothers of Ioannis Goulandris from Andros, the five sons of Elias G. Kulukundis from Kasos, the sons of the Embiricos from Andros, the four sons of George Livanos, the two sons of the Ioannis Chandris and those of the large family of Laimos, all from Chios, served as officers on their fathers' steamships and eventually became directors in the offices in Piraeus and London and shipowners themselves. For more than 60 years, as Table 3 indicates, the same names of the above mentioned families figure in the top ten positions of Greek shipping. The only " foreigners" that broke into the tightly knit shipowning circle were Aristotle Onassis and Stavros Niarchos, both of whom, however, followed the rules. They married within the traditional shipowning circle – the daughters of Stavros Livanos. The importance of the old traditional families, most of them active for at least three generations, eventually started to fade and give way to new shipowners; the new blood in Greek-owned shipping came from masters, first engineers and employees of shipping companies. In the list of the top shipowners of 2008 as it appears in Table 3, none of them came from traditional families. They were new, post-war shipowners: Angelicoussis, Economou, Tsakos, Prokopiou, Diamantidis, Restis, Georgiopoulos, Haji-ioannou, Martinos and Panayiotides. The strength of Greek-owned shipping was that it managed to reproduce itself and provide new and dynamic entrepreneurs that enlarged the fleet to unprecedented size at the beginning of the twenty first century. And as in the Norwegian case, apart from those found in the top, it is the hundreds of medium- and small-scale shipowning companies who form the backbone and the seedbed for the expansion of Greek-owned shipping.

4.4 The Japanese

Japan's unique seclusion from the world trade for more than two centuries, makes its maritime history of the last 100 years quite extraordinary. The Japanese could not escape integration into the world economic system; the United States needed bases for their merchant fleets and were able to persuade Japan to open up to the "barbarians" in 1853. The demand for modernisation brought the end of the old feudal system and the shogun. Japanese business, its dominance in the world economy of the twentieth century has attracted the attention of a number of economists and historians; the incredible "otherness" however, combined with the language barriers, still means that its maritime business history remains, for many, a *terra incognita*.[69] For the purposes of this chapter we will limit ourselves to a short analysis of the continuity and change of the Japanese maritime business, which remains highly comparable to that of its European counterparts.

It was really by following the Meiji (the enlightened power) Restoration in 1868 and the nation's industrialisation that Japan's shipping showed a remarkable expansion: in the mid-nineteenth century Japan did not own a single ocean going vessel – 60 years later it was third in the world maritime powers. The rapid development of Japanese shipping was the product of a combination of government initiative and active entrepreneurship. Japanese shipping developed, like the British, by serving the country's external trade and has been equally divided between liner and tramp. The competitiveness of Japanese shipping firms however, was to a great extend the result of a strategy of creating cooperating links with foreign companies in global webs that connect networks of different countries.[70] The first period of Meiji Restoration was marked by the government support to the private line Mitsubishi Shokai. In the early 1880s the Government provided half of the capital for the establishment of a new firm, the Kyobo Unyu Kaisha. The intense competition between the two companies led the

Government to pursue their amalgamation, thus, a new state aid firm, the Nippon Yusen Kaisha (NYK, Japan Mail Steamship Company Ltd) was established. The company operated with this status, providing specified services up to 1892, when it became a private enterprise.[71] It expanded into transoceanic business in 1890s by opening lines to India, the USA, Australia and Europe.[72] NYK remained the largest Japanese shipping company for most of the time after its founding. Based in Tokyo, it was meant as a liner company from the beginning. The other company emerged from Japan's private businessmen and in that contrasted the formation of NYK. Based in Osaka, Osaka Shosen Kaisha (OSK, Osaka Mercantile Steamship Co) emerged in 1884 from the combined forces of Osaka's leading 55 shipowners and merchants. OSK was subsidised and in return provided regular services. Both NYK and OSG operated in a way similar to that of British firms, purchased their ships from Britain and employed western deck officers and engineers.[73] Unlike its competitor NYK, the OSK operated its fleet mainly within East Asia up to the early stage of the interwar years.[74]

Japanese shipping companies were of two types. The first type was called shasen and included those companies that owned most of their ships, operated regular lines and were receiving government subsidies. The second type was called shagaisen and included firms that, usually, operated irregular lines and did not receive subsidies. This second type included firms that were owners of their ships, others that were operators and others that combined both functions.[75] Since these two large shipping companies were distinguished from all others in terms of their size, type of operation and government subsidy, their ships were called *shasen* (company ships), while all the others were called *shagaishen* (non-company ships). These terms roughly indicated the difference between liner and tramp shipping. Numerous shagaishen firms stemmed from the traditional shipowners or operators that traded in the coastal trade and Japanese seas. They were mainly tramp operators who, particularly during and after World War I, extended their activities in overseas trade to Korean and Chinese coasts.

Being able to operate more freely and flexibly during World War I Japanese shipping was one of the primary beneficiaries of the war, in terms of profitability.[76] The limited loss of Japanese fleet during World War I (7% of its tonnage) meant that in the interwar period, Japanese shipping expanded and its network of routes was extended to all regions of Southeast Asian, to India, Africa and South America. NYK and OSK were able to become part of the British system of conferences and opened their path to the City of London and the Baltic Exchange. During the shipping boom of World War I a large number of capitalists invested in ships and the tonnage of shaigasen companies increased impressively. Most of the shaigasen shipowners were not operators themselves but chartered their ships to foreign and Japanese trading companies as well as to the NYK and OSK. In the 1930s five large-scale shaigasen operators, Yamashita, Mitsui, Kawasaki, Kokusai and Daido came to dominate Japanese shipping along with the NYK and OSK. Yamashita, based in Kobe, specialised in long-distance ocean-going shipping, while Kawasaki profited from its connection with its production in its shipyards. All shaigasen Japanese companies had access in the London maritime market and were involved in the British second-hand sales and purchase market.

The third forerunner of Japan's steam shipping, and different from the above started from the Mitsui family, who had prospered in Japan as merchants and financiers since the late seventeenth century, and who were the prime financiers of the new Meiji government. They established in 1876 the Mitsui Bussan Kaisha (MBK, Mitsui Trading Co) that with branch offices in Shanghai, Hong

Kong, Paris, New York, London and Singapore was oriented in foreign trade, dealing with both bulk trade (coal, rice, cotton) and general manufactured goods.[77] Mitsui, that was part of the *sogoshosha* (general trading company) system, operated a large fleet to cover its transport needs. This company proved to be the pioneer in the eventual expansion of Japanese firms on a global basis. It was the first Japanese firm to penetrate global commercial networks, as it opened its London branch in 1879.[78] In the post-war era, the company expanded and eventually became the main competitor of NYK by merging with OSK – what came to be called MOL (Mitsui-OSK Lines).[79] The merger was the result of the consolidation process of Japanese shipping, which, apart from it, resulted also to the merge of Nitto Shoshen and Daido Kaiun to form the Japan Line and the Yamashita Kisen and Shinnihon Kisen to form the Yamashita Shinnihon Steamship Co.

If the first half of the twentieth century formed the base for the development of Japanese shipping, the second half created the conditions for its proliferation. The ships lost during the World War II were quickly replaced by new, technologically advanced ships. Demand conditions and the existence of related and supporting industries are considered to be among the features that can define the prospects of a national industry to compete in the world markets.[80] During its modern history, but especially in the second half of the twentieth century, Japanese shipping developed to respond on the needs of a high volume internal demand. In 2001 the import dependency of Japan in major resources accounted 97.9% for coal, 99.7% for crude oil, 96.9% for natural gas, 100% for iron ore, wool and raw cotton, 94.7% for soy beans, 88.8% for wheat and 84.6% for salt.[81] Japan's dependency on seaborne trade led the shipping industry in search of technological and managerial innovations that, on the one hand would increase the effectiveness of shipping companies, while on the other would decrease the transport cost of both the raw materials and the final products of the industries. These innovations have allowed, for example, the Japanese steel firms to be competitive in world markets, although they have to import very much of their needed raw materials.[82]

The internationally competitive shipbuilding industry of Japan played a crucial role in this effort and continues to do so. Its development however, was not depended on the development of shipping industry. Of course, it offered the demand conditions that defined the prospects of shipbuilding industry to become competitive and penetrate the export market and to attract orders by shipowners of new dynamic fleets, like the Greeks, who became the main customers of the Japanese shipbuilders from 1960s onwards. This self-contained path of shipbuilding industry explains why its market share achieved the 50% (the late 1960s) while the respective of the shipping industry did not exceed the 15.5% (in 2008).[83]

Japanese shipping continues to be dominated by a few number of giant shipping groups, who manage a great number of owned ships, as well as an even greater number of chartered ships, many of them owned by other Japanese companies. For example, Mitsui OSK Lines operates a diversified fleet of more than 800 ships, the NYK a fleet of almost 800 ships and the K-Line a fleet of almost 500 ships. In parallel, a great number of medium sized operators, active mainly in bulk shipping add to the dynamism of Japanese shipping industry.

5. Continuity and Change

The analysis of the shipping industry and of the main markets has revealed the structural transformations and changes that occurred during the twentieth century. The hierarchy of maritime

powers changed, as new maritime nations emerged and most traditional maritime countries lost their competitiveness and decreased their market share. The changing patterns of development in the international trade along with the technological advances determined the path of the industry. Shipping markets have followed the path to globalisation and specialisation has become the drive for their development.

In this context, shipping companies have moved towards the necessary organisational adaptations. Liner shipping companies expanded to the newly developed markets and served almost any destination worldwide. The need for efficiency and effectiveness led them to adapt to unitisation investing in containerships and terminals and gradually turned to become transport providers that cover the needs of their customers in a global basis. The main drive for the achievement of both the critical size and the global coverage are new forms of cooperation that is, the consortia and the strategic alliances. Either through cooperation, internal development or mergers and acquisitions, liner operators strive to become the global players of a global market. In a rather playful game of fate, the beginning and the end of the twentieth century were marked by the same trends.

Bulk shipping continues to be a sum of markets that are organised along the needs of the cargoes they transport. Contrary to the liner sector, bulk shipping continues to be characterised by volatility, which increased the risk for the companies. Decisions regarding the choice of the type of ship, the timing of the investment and chartering determine the long-term survival of the companies. Information remains one of the most critical factors for success. Dry, liquid and specialised markets like gas and chemicals create a mosaic that incorporates many distinct organisational forms. For the more recently created specialised markets, concentration of tonnage and consolidation of companies were the means for companies who seek to cover the transport needs of global customers. For the dry and liquid markets on the other hand, the tramp character continued to exist throughout the past century, although certain transformations have diminished its presence.

Structural changes on the demand side have provoked the introduction and disparity of cooperation of the commercial side of their operation, mainly through the formation of pools. Trust continues to be at the core of the business: for the main players it is the factor that allows the formation of networks of collaborating competitors. Bulk shipping has traditionally been a sector that rewarded the entrepreneurial spirit, adaptation and flexibility. The business environment for bulk shipping companies during the past century became more regulated and shipping operation more formalised. To a certain extent however, these changes diminished the entrepreneurial character and created the need to balance between the necessity to conform to the business's environment requirements and the necessity to adapt for competitiveness. Still, the beginning and the end of the past century saw the largest part of world's main tramp operators work more or less on similar lines.

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Endnotes

1. Harlaftis, G. and Theotokas, I. (2004): "European family firms in international business: British and Greek tramp shipping firms", *Business History,* Vol. 46, No. 2, 219–255.
2. Fischer, L.R. and Nordvik, H.W. (1986): "Maritime Transport and the Integration of the North

Atlantic Economy, 1850–1914", in Wolfram Fischer, R., Marvin McInnis and Jurgen Schneider (eds.) *The Emergence of a World Economy, 1500–1914* (Wiesbaden, Franz Steiner Verlag). See also O'Rourke, K. and Williamson, J.G. (1999): *Globalization and History. The Evolution of Nineteenth Century Atlantic Economy* (MIT Press), and Harlaftis, G. and Kardasis, V. (2000): "International Bulk Trade and Shipping in the Eastern Mediterranean and the Black Sea", in Williamson, J. and Pamuk, S. (eds.) *The Mediterranean Response to Globalization* (Routledge).

3. Eden, R. and Posner, M. (1981): *Energy Economics* (New York); Harley, C.K. (1989): "Coal Exports and British Shipping, 1850–1913", *Explora tions in Economic History*, XXVI.
4. Sturmey, S.G. (1962): *British Shipping and World Competition* (The Athlone Press), pp. 75–79. In fact, expansion of Norwegian shipowners to the ownership of tankers is considered as one of factors that contributed to the rapid development of Norwegian fleet during the interwar period. See Tenold S. (2005): "Crisis? What Crisis? The Expansion of Norwegian Shipping in the Interwar Period", *Discussion Paper 20/05*, Economic History Section, Department of Economics, Norwegian School of Economics and Business Administration.
5. More on the subject and for further bibliography see Harlaftis, G. (1996): *A History of Greek-owned Shipping, 1830 to the Present Day* (Routledge), Chapters 6 and 8.
6. For an insightful analysis see Cafruny, A.W. (1987): *Ruling the Waves. The Political Economy of International Shipping* (University of California Press). For a classic on flags of convenience, see Metaxas, B.N. (1985): *Flags of Convenience* (London, Gower Press). For the resort of the Greeks to flags of convenience see Harlaftis, G. (1989): "Greek Shipowners and State Intervention in the 1940s: A Formal Justification for the Resort to Flags-of-Convenience?", *International Journal of Maritime History*, Vol. I, No. 2, 37–63.
7. Sletmo, G.K. (1989): "Shipping's fourth wave: ship management and Vernon's trade cycles", *Maritime Policy and Management*, Vol. 14, No. 4, 293–303.
8. See Thanopoulou, H. (1995): "The growth of fleets registered in the newly-emerging maritime countries and maritime crises", in *Maritime Policy and Management*, V ol. 22, No. 1, 51–62.
9. More on the substitution relationship of the tramp with the liner see Metaxas, B.N. (1981): *The Economics of Tramp Shipping* (2nd edn) (London, Athlone Press), pp. 111–116.
10. Data contained in Stopford, M. (1997): *Maritime Economics* (2nd edn) (London, Routledge), p. 341.
11. According to data of AXS-Alphaliner, in 1 July 2009 the 38 ships in range of 10,000 to 15,500 TEU consisted of the 0.9% of the the world liner fleet while the same percentage of the orderbook was 18.1% (173 out of 955). Data available at www.axs-alphaliner.com (accessed on 15 July 2009).
12. For an analysis of the evolutions in the liner shipping, see Haralambides, H. (2007): "Structure and Operations in the Liner Shipping Industry", in Hensher, D.A. and Button, K.J. (eds.) *Handbook of Transport Modelling* (Elsevier), pp. 607–621.
13. See the excellent analysis of Broeze, F. (2003): *The Globalisation of the Oceans. Containerisation from the 1950s to the Present*, Research in Maritime History, (St. John's, Newfoundland).
14. Stopford, M. (1997): *op. cit.*, p. 377.

15. Ryoo, D.K. and Thanopoulou, H.A. (1999): "Liner alliances in the globalization era: a strategic tool for Asian container carriers", *Maritime Policy and Management*, Vol. 26, No. 4, 349–367.
16. Haralambides, H. (2007): *op. cit*.
17. Midoro, R. and Pitto, A. (2000): "A critical evaluation of strategic alliances in liner shipping", *Maritime Policy and Management*, Vol. 27, No. 1, 31–40.
18. According to data of AXS-Alphaliner available at www.axs-alphaliner.com/top100/index.php (accessed 21 July 2009).
19. UNCTAD (2007): *Transport Newsletter*, No. 36, Second Quarter (Geneva, UNCTAD). The following data for the bulk shipping could be mentioned as an evidence of the different ownership structure of Liner and Bulk shipping. According to data of Clarkson Rersearch Studies, during 2003, there were five companies operating more than 100 ships, whose fleet percentage of the bulk carrier fleet was 14.3%. See Clarkson (2004): *The Tramp Shipping Market*, Clarkson Research Studies, p. 37.
20. Broeze, F. (1996): "The ports and port system of the Asian Seas: an overview with historical perspective from the 1750" *The Great Circle*, Vol. 18, No 2, 73–96.
21. Stopford, M. (1997): *op. cit*, pp.16–17.
22. However, regulations imposed on the shipping industry during the 1990s are among the factors that have contributed to the increase of the importance of the company size to the competitiveness of bulk shipping companies. For more on the subject see Theotokas, I.N. and Katarelos, E.D. (2001): "Strategic choices for small bulk shipping companies in the post ISM Code period", Proceedings of WCTR, Seoul, Korea.
23. Carvounis, C.C. (1979): "Efficiency contradictions of multinational activity: the case of Greek shipping", unpublished Ph.D. thesis (New School of Social Research), p. 81.
24. Harlaftis, G. and Theotokas, I. (2004); *op. cit.*
25. *Op. cit.*
26. Cited in Palmer S. (2009): "British Shipping from the Late Nineteenth Century to the Present", in Fischer, L.R. and Lange, E., *International Merchant Shipping in the Nineteenth and Twentieth Centuries. The Comparative Dimension*, Research in Maritime History No. 37 (St John's, International Maritime Economic History Association), pp. 125–141, 129.
27. Thornton, R.H. (1959): *British Shipping*; Sturmey St. (1962): *British Shipping and World Competition*. See also Palmer, S. (2009): *op. cit.* for an overall view of these arguments and the counterarguments.
28. Palmer, S. (2009): *op. cit.* Figure 4, 135.
29. *Op. cit.*
30. There is a large bibliography on the liner shipping companies; leading role was played by the so-called "Liverpool School" founded by Professor Francis Hyde, main factor also in the creation of *Business History*. See Hyde, F.E. (1956): *Blue Funnel: A History of Alfred Holt & Company of Liverpool 1865–1914* (Liverpool); Hyde, F.E. (1967): *Shipping Enterprise and Management, 1830–1939: Harrisons of Liverpool*, (Liverpool); Marriner, S. and Hyde, F.E. (1967): *The Senior: John Samuel Swire 1825–98. Management in Far Eastern Shipping Trades* (Liverpool); Hyde, F.E. (1975): *Cunard and the North Atlantic, 1840–1914* (Liverpool); Davies, P.N.

(1973): *The Trade Markets: Elder Dempster in West Africa* (London); *Sir Alfred Jones: Shipping Entrepreneur par Excellence* (London). For P&O see Cable, B. (1937): *A Hundred Year History of the P&O 1837–1937* (London); Howarth, D. and Howarth, S. (1986): *The Story of P&O* (London) and Rabson, S. and O'Donoghue, K. (1988): *P&O. A Fleet History* (Kendal); Napier, C.J. (1997): "Allies or Subsidiaries? Inter-Company Relations in the P&O Group, 1914-39", *Business History*, Vol. 39, 67–93. For British India (BI) see Munro, Forbes J. (1988), "Scottish Overseas Enterprise and the Lure of London: The Mackinnon Shipping Group, 1847–1893", *Scottish Economic and Social History,* Vol. 8, 73–87. "Sir William Mackinnon" in Slaven, A. and Chekland, S. G. (ed.) *Scottish Dictionary of Business Biography* (Glasgow, 1990), Vol. 2, pp. 279–301. "Suez and the Shipowner: The Response of the Mackinnon Shipping Group to the Opening of the Canal, 1869–84" in Fischer L. and Nordvik, H. (1990): *Shipping & Trade*, pp. 97–118; Munro, Forbes J. (2003): *Maritime Enterprise and Empire: Sir William Mackinnon and his Business Network, 1823–93* (Woodbridge, Boydell Press 2003).

31. Starkey, D.J. (1996): "Ownership Structures in the British shipping industry: the case of Hull, 1820–1916", *International Journal of Maritime History*, Vol. VIII, No. 2, December, 71–95.

32. More on conferences in also Sturmey, S.G. (1962): *op. cit*. and Cafruny, A.W. (1987): *op. cit.*

33. For the story of Royal Mail see Green, E. and Moss, M.S. (1962): *A Business of National Importance. The Royal Mail Shipping Group, 1902–1937* (London, Methuen).

34. See also Sturmey, S.G. (1962): *op. cit.*, chapt. IVX; and Boyce, G. (1995): *Information, Mediation and Institutional Development. The Rise of large-scale Enterprise in British Shipping, 1870–1919* (Manchester University Press).

35. See fn 29.

36. Harlaftis, G. and Theotokas, I. (2004): *op. cit.*

37. There has been remarkably little research on British tramp shipping in the last 25 years with an important exception of Gordon Boyce (1995). *Information, Mediation and Institutional Development. The Rise of Large-scale Enterprise in British Shipping, 1870–1919* (Manchester University Press) and Forbes Munro, J. and Slaven, T. (2001): "Networks and Markets in Clyde Shipping: The Donaldsons and the Hogarths, 1870–1939", *Business History*, Vol. 43, No. 2, April, 19–50. But it has been the work of the ground-breaking maritime historian Robin Craig that has revealed the main aspects of tramp shipping. See Craig, R. (1980): *The Ship. Steam Tramps and Cargo Liners, 1850–1950* (London, HMSO); (1973): "Shipowning in the South-West in its National Context, 1800–1914" in Fisher, H.E.S. and Minchinton, W.E. (eds.) *Transport and Shipowning in the West country* (University of Exeter); "Capital formation in Shipping", in Higgins, J.P.P. and Pollard, S., *Aspects of Capital Investment in Great Britain (1750–1850)* (Methuen); (1986): "Trade and Shipping in South Wales – The Radcliffe Company, 1882–1921", in Baber, C. and Williams, L.J. (eds.) *Modern South Wales: Essays in Economic History* (Cardiff, University of Wales Press), pp. 171–191. Craig, Robin (2003): *British Tramp Shipping, 1750–1914*, Research in Maritime History No. 24, No. 3 (St John's, International Maritime Economic History Association).

38. *Lloyd's Register of Shipping* 1970.

39. For the expansion and re-invention of some of these companies see Jones, G. (2000): *Merchants to Multinationals. British Trading Companies in the Nineteenth and Twentieth Centuries*

(Oxford, Oxford University Press).

40. Tenold S., "Norwegian Shipping in the Twentieth Century" in Fischer L.R. and Lange E., *International Merchant Shipping in the Nineteenth and Twentieth Centuries. The Comparative Dimension*, Research in Maritime History No. 37 (St John's, International Maritime Economic History Association), pp. 57–77.
41. Ojala, L. (1994): "A transaction cost analysis of Finnish, Swedish and Norwegian shipping", *Maritime Policy and Management*, Vol. 21, No. 4, 273–294.
42. Nordvik, H.W. (1985): "The Shipping Industries of the Scandinavian Countries, 1850–1914", in Fischer, L.R. and Panting, G.E. (eds.) *Change and Adaptation in Maritime History, the North Atlantic Fleets in the Nineteenth Century* (St John's, Newfoundland, Maritime History Group), pp. 117–148.
43. Wicken, O. (2007): "The Layers of National Innovation Systems: The Historical Evolution of the National Innovation System in Norway", *TIK Working Paper of Innovation Studies No. 20070601*.
44. Johnsen, B.E. (2001): "Cooperation across the North Sea: the strategy behind the purchase of second-hand British iron and steel sailing ships by Norwegian ship owners, 1875–1925", Paper presented in the International Conference "Maritime History: Visions of shore and sea", Freemantle, Australia, December.
45. Wicken, O. (2007): *op. cit.*
46. Tenold, S. (2000): *The Shipping Crisis of the 1970s: Causes, Effects and Implications for Norwegian Shipping* (Bergen, Norwegian School of Economics and Business Administration), p. 29.
47. Tenold, S. (2005): "Crisis? What crisis? The expansion of Norwegian shipping in the interwar period", *Discussion Paper 10/05* (Economic History Session, Depart ment of Economics, Norwegian School of Economics and Business Administration).
48. For an analysis of the Norwegian shipping during the crisis of the 1970s see Tenold, S. (2000): *op. cit.*
49. Drury, C. and Stokes, P. (1983): *Ship Finance: The Credit Crisis – Can the Debt/ Equity Balance be Restored?* (London, Lloyd's of London Press), p. 37.
50. Ostensjo, P. (1992): *A Competitive Norway: Chemical Shipping* (Bergen, SNF, NHH).
51. Stokseth, B. (1992): *A Competitive Norway: Open-Hatch Bulk Shipping* (Bergen, SNF, NHH).
52. Jenssen, J.I. (2003): "Innovation, Capabilities and Competitive Advantage in Norwegian Shipping", *Maritime Policy and Management*, Vol. 30, No. 2, 93–106.
53. Solberg, C.A. (2001): "Market information and the role of networks in international markets", *IMP 2001* (Norwegian School of Management BI).
54. Ojala, L. (1994): *op. cit.*
55. Bland, A.L. and Crowdy, M. (1961): *Wilh. Wilhelmsen, 1861–1961. The Firm and the Fleet* (Kendal, World Ship Society).
56. Wil. Wilhelmsen ASA, *Annual Report 2000*.
57. Wil. Wilhelmsen ASA, *Annual Report 2008*.
58. For more on the Odfjell's history, see Thowsen, A. and Tenold, S. (2006): *Odfjell – The History*

of a Shipping Company (Bergen, Odfjell ASA); Tenold S. (2006): "Steaming ahead with stainless steel – Odfjell's expansion in the chemical tanker market 1960–75", *International Journal of Maritime History*, Vol. XVIII, No. 1, 179–198.

59. Tenold, S. (2008): "So nice in niches – Specialization strategies in Norwegian Shipping, 1960–1977", *Fifth International Conference of Maritime History*, University of Greenwich.

60. Trygve, S. (2000): "Entry barriers and concentration in chemical shipping", *SNF Report No 07/00* (Bergen, Foundation for Research in Economics and Business Administration).

61. Odjfell (2008): *Annual Report 2008* (Bergen).

62. Naess, E.D. (1977): *Autobiography of a Shipping Man* (Colchester) (1990): "61 Years in the Shipping Business", in Strandenes, S.P., Svendsen, A.S. and Wergeland, T. (eds.) *Shipping Strategies and Bulk Shipping in the 1990s* (Institute for Shipping Research, Center for International Business), p. 1.

63. Tenold, S. (2000): *op. cit.*, p. 15.

64. *Op. cit*., pp. 231–2.

65. Tenold, S. (2001): "The harder they come … Hilmar Reksten from boom to bankruptcy", *The Northern Mariner*, Vol. XI, No. 3, 41–53.

66. Benito, G.R.G., Berger, E., de la Forest, M. and Shum, J. (2003): "A cluster analysis of the maritime sector in Norway", *International Journal of Transport Management*, Vol. 1, No. 4, 203–215.

67. For an English-speaking bibliography on Greek shipping, see Metaxas, B. (1981): *op. cit.*; (1985): *op. cit.*; Harlaftis, G. (1993): *Greek Shipowners and Greece, 1945–75. From Separate Development to Mutual Interdependence* (London, Athlone Press); (1996): *op. cit.*; Theotokas, I. (1998): "Organisational and Managerial Patterns of Greek-Owned Shipping Enterprises and the Internationalization Process from the Interwar Period to 1990", in Starkey, D.J. and Harlaftis, G. (eds.) *Global Markets: The Internationalization of the Sea Transport Industries since 1850*, Research in Maritime History No. 14, IMEHA (St John's, Newfoundland); Serafetinides, M., Serafetinides, G., Lambrinides, M. and Demathas, Z. (1981): "The development of Greek shipping capital and its implications for the political economy of Greece", *Cambridge Journal of Economics*, September; Carvounis, C. (1979): *op. cit.*; Grammenos, C.T. and Choi, J.C. (1999): "The Greek shipping industry: Regulatory change and evolving organizational forms", *International Studies of Management and Organization*, Vol. 29, No.1, 34–52; Theotokas, I. (2007): "On Top of World Shipping: Greek Shipping Companies Organization and Management" in Pallis, A.A. (ed.) *Maritime Transport: The Greek Paradigm* (Elsevier); Research in Transportation Economics, Vol. 21, 63–93; Lagoudis, I. and Theotokas, I. (2007): "The Competitive Advantage in the Greek Shipping Industry" in Pallis, A.A (ed.) *op. cit*. pp. 95–120; Thanopoulou, H.A. (2007): "A Fleet for the 21st Century: Modern Greek Shipping", in Pallis, A.A. (ed.), *op. cit.*, pp. 23–61; Theotokas, I. and Harlaftis, G. (2009): *Leadership in World Shipping. Greek Family Firms in International Business* (Palgrave).

68. Gelina, Harlaftis, (2009): "The Greek Shipping Sector, c. 1850–2000" in Fischer L.R. and Lange E., *International Merchant Shipping in the Nineteenth and Twentieth Centuries. The Comparative Dimension*, Research in Maritime History No. 37 (St John's, International

Maritime Economic History Association), pp. 79–104.

69. Bibliography in English on Japanese maritime business is rather limited with the exception of its two main shipping companies. Exceptions to this rule are: Yui, T. (1985): "Introduction", in Yui, T. and Nakagawa, K. (eds.) *Business History of Shipping, Proceedings of the Fuji Conference* (University of Tokyo Press); Nagakawa, K. (1985): "Japanese Shipping in the Nineteenth and Twentieth Centuries: Strategies and Organization", in Yui, T. and Nakagawa, K. (eds.) *Business History of Shipping, Proceedings of the Fuji Conference* (University of Tokyo Press); Miwa, R. (1985): "Maritime Policy in Japan: 1868–1937" in Yui, T. and Nakagawa, K. (eds.) *Business History of Shipping, Proceedings of the Fuji Conference* (University of Tokyo Press). Otherwise there is extensive bibliography on the leading companies. See Wray, W.D. (1984): *Mitsubishi and the NYK, 1870–1914: Business Strategy in the Japanese Shipping Industry* (Cambridge, MA); (1985): "NYK and the Commercial Diplomacy of the Far Eastern Freight Conference, 1896–1956" in Yui, T. and Nakagawa, K. (eds.) *Business History of Shipping, Proceedings of the Fuji Conference* (University of Tokyo Press); (1990): "The Mitsui Fight", in Fischer L.E. and Nordvik, H. *Shipping & Trade 1750–1950* (Lofthouse Publications); (1993): "The NYK and World War I: Patterns of discrimination in freight rates and cargo space allocation", *International Journal of Maritime History*, Vol. 5, No. 1, 41–63; Goto, S. (1998): "Globalization and International Competitiveness – An Historical Perspective of Globalization of Japanese Merchant Shipping" in Starkey, D.J. and Harlaftis, G. (eds.), *Global Markets: The Internationalization of the Sea Transport Industries since 1850*, Research in Maritime History No. 14, IMEHA (St John's, Newfoundland); On shipbuilding, Chida, T. and Davies, P.N. (1990): *The Japanese Shipping and Shipbuilding Industries. A History of their Modern Growth* (London, The Athlone Press). Is invaluable.

70. Wray, W.D. (2005): "Nodes in the Global Webs of Japanese Shipping", *Business History*, Vol. 47, No. 1, 1–22.

71. Davies, P.N. and Katayama, K. (1999): "Aspects of Japanese shipping history", *Discussion Paper JS, 376*. (Suntory and Toyota International Centres for Economics and Related Disciplines, London School of Economics and Political Science).

72. Wray, W.D. (2005): *op. cit*.

73. Davies, P.N. and Katayama, K. (1999): *op. cit*.

74. Wray, W.D. (2005): *op. cit*.

75. Wray, W. (2000): "Opportunity vs Control: The Diplomacy of Japanese Shipping in the First World War", in Kennedy, G. (ed.), *The Merchant Marine in International Affairs, 1850–1950* (London, Frank Cass), pp 59–83, p. 60.

76. See Wray, W.D. (2000): *op. cit*.

77. Nagakawa, K. (1985): "Japanese Shipping in the Nineteenth and Twentieth Centuries: Strategies and Organization", in Yui, T. and Nakagawa, K. (eds.), *Business History of Shipping, Proceedings of the Fuji Conference* (Tokyo, University of Tokyo Press), p. 5.

78. Wray, W.D. (2005): *op. cit*.

79. Japan Business History Institute (1985): *The First Century of Mitsui OSK Lines Ltd* (Osaka).

80. Along with factors such as the role of other factors, such as the governmental policies, the

related and supporting industries, the firm strategy, structure and rivalry. See Porter, M. (1990): *The Competitive Advantage of Nations* (London, Mcmillan).

81. JSA (2004): *The Current State of Japanese Shipping*, Japanese Shipowners' Association.

82. The dependency of shipbuilding and steel industry by the shipping industry is obvious: In the period of its apogee the shipbuilding industry absorbed 35% of steel output. See Bunker, S.G. and Ciccantell, P.S. (1995): "Restructuring markets, reorganizing nature: An examination of Japanese strategies for access to raw materials", *Journal of World Systems Research*, Vol. 1, No. 3, 1–63.

83. See Stopford, M. (1997), *op. cit*.

Chapter 2

Globalisation — the Maritime Nexus

Jan Hoffmann[*] *and Shashi Kumar*[†]

1. Introduction: Globalised Business in a Globalised Economy

"Globalisation" means different things to different people. For some, it is the *raison detre* for poverty and global financial crisis; for others, it is a *sine qua non* for economic development and a rise in standard of living. Even "When did globalisation begin?" (O'Rourke and Williamson, 2000) is a disputed topic. For us, in this chapter about maritime economics, it is simply a concept that describes a *trend* in international trade. It means (a) that trade is growing faster than the world's GDP; and (b) that this trade is not only in finished goods and services, but also increasingly in components and services that are used within globalised production processes. Maritime transport is growing because it is required to move traded goods and components, and trade in maritime services is itself taking place on an ever more global scale.

Transport is one of the four cornerstones of globalisation. Together with telecommunications, trade liberalisation and international standardisation, the increased efficiency of port and shipping services has made it even easier to buy and sell merchandise goods, raw materials and components almost anywhere in the world. International standards and homogenous products foster global competition. Trade liberalisation allows the efficient international allocation of resources. Finally, telecommunication and transportation are the necessary tools to transfer information and goods. "Despite all the headlines and political bluster surrounding the World Trade Organisation, NAFTA and other trade pacts, the real driving force behind globalisation is something far less visible: the declining costs of international transport" (*The Journal of Commerce*, 15 April 1997).

At the same time, maritime business itself is probably the most globalised industry. Most maritime transport is provided between two or more countries, and the service providers no longer need to be nationals of the same countries whose cargo they move. In fact, a simple commercial transaction may easily involve people and property from a dozen different countries: A Greek-owned vessel, built in Korea, may be chartered to a Danish operator, who employs Philippine seafarers via a Cypriot crewing agent, is registered in Panama, insured in the UK, and transports German made cargo in the name of a Swiss freight forwarder from a Dutch port to Argentina, through terminals that are concessioned to port operators from Hong Kong and Dubai. International standardisation, an important component of globalisation in general, also affects shipping: without standardised containers globalised shipping and intermodal networks would not be possible. Equivalently, international operators are now in a position to take a concession of a container terminal located in any port in the world, suppliers of port and ship equipment produce and sell globally, and ISO and IMO standards concerning quality, safety and training apply equally on all international waters.

The remainder of this chapter will look at the mutual relationship between maritime business and globalisation. Section 2 discusses how trends in international maritime transport affect globalisation, and section 3 looks at the same relationship, but from the opposite direction, i.e. how the maritime business is affected by globalisation. Section 4 provides summary and conclusions.

2. Maritime Transport and its Relevance for Globalisation

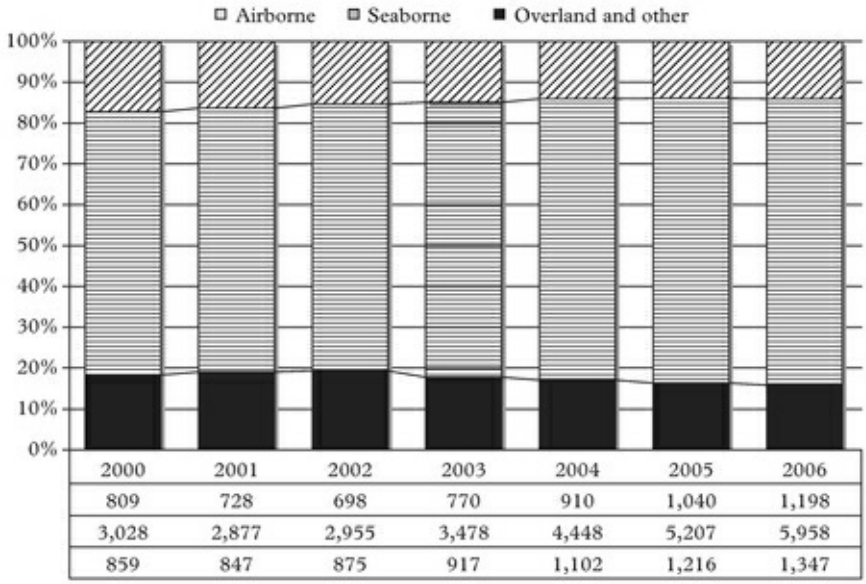
2.1 Global trade, and how it is being moved

2.1.1 The share of the maritime mode of transport

Shipping continues to be the dominant mode of transport for international trade. World seaborne trade has grown almost continuously since World War II, with tonne-miles increasing more than three-fold since 1970 (UNCTAD, 2009).

Seaborne trade accounts for 89.6% of global trade in terms of volume (tonnes) and 70.1% in terms of value. Airborne cargo has a share of just 0.27% of trade volume and 14.1% of trade value, whilst overland and other modes (including pipelines) account for the remaining 10.2% of volume and 15.8% of trade value (See Figures 1 and 2). In 2008, total world seaborne trade, including intra-European Union trade, is estimated to amount to about 8.17 billion tons (UNCTAD, 2009).

The shares of the different modes tend to remain stable in terms of volume, but fluctuate much more when analysing the trade value. During the seven years 2000–2006, the share of seaborne trade volume has fluctuated only between 89.04 and 89.82% (a range of 0.78 percentage points), while its share in trade value fluctuated seven times more – between 64.48 and 70.07% (a range of 5.59 percentage points). The main reason for those differences lies in the fact that the share in trade value is strongly influenced by the price of the traded commodities. In particular, the rising price of oil, but also that of other commodities, has contributed to the rise in the share of sea-borne trade – albeit only its *value* and not its *volume*. Another trend that leads to an increase in the share of maritime trade *value* is the changing composition of global maritime trade, which includes increasingly manufactured and intermediate goods.



	2000	2001	2002	2003	2004	2005	2006
Airborne	809	728	698	770	910	1,040	1,198
Seaborne	3,028	2,877	2,955	3,478	4,448	5,207	5,958
Overland and other	859	847	875	917	1,102	1,216	1,347

Figure 1: Modal split of international trade in goods, $ billion and %, 2000–2006

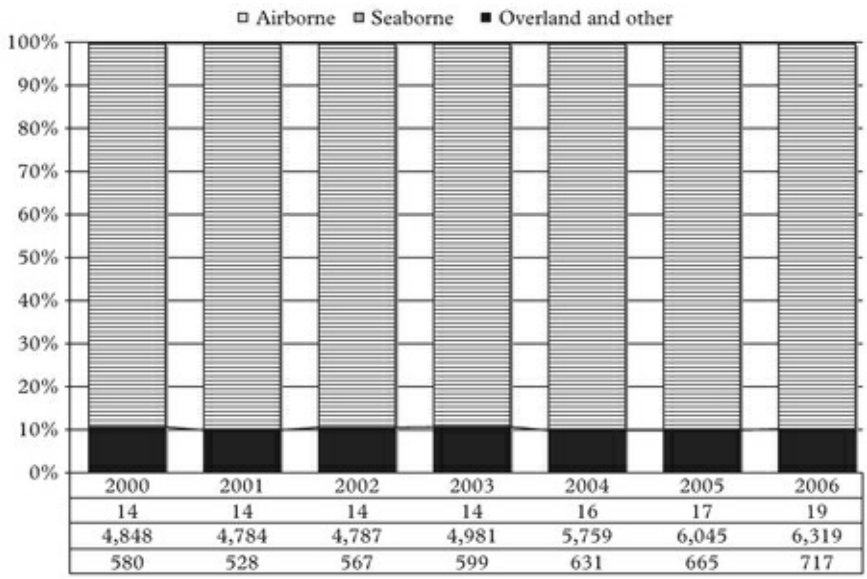


Figure 2: Modal split of international trade in goods, million metric tonnes and %, 2000–2006
Source: Global Insight, not inlcuding intra-European Union trade

As regards the unit values by transport mode, in 2006, the average value per tonne of cargo of seaborne trade was $943, versus $63,184 per tonne of airborne trade and $1,878 per tonne of trade transported overland or by other modes, such as pipelines (Table 1). In other words, a tonne of airborne cargo was on average 67 times more valuable than a tonne of seaborne cargo.

2.1.2 The geography of seaborne trade

The major loading areas for seaborne trade today are developing regions (60.6%), followed by developed economies (33.6%) and countries with transition economies (5.9%). Asia's share of seaborne exports is 40%, followed in descending order by the Americas, Europe, Africa and Oceania (UNCTAD, 2009).

Figure 3 reflects the evolving participation of developing countries in global imports and exports. In 1970, developing countries still imported mostly high-value/low-volume manufactured goods and exported above all low-value raw materials; as a result, they exported almost four times as many tonnes of seaborne cargo than they imported. Today, developing countries participate much more in globalised production processes. Especially China, India and other Asian countries have become important importers of commodities such as iron ore, bauxite and grains, while at the same time increasing their share in manufactured exports. This is an interesting trend, as it illustrates that the classical distribution of trade between developed and developing countries is no longer valid.

2.1.3 The composition of seaborne trade

Approximately two thirds of seaborne trade are dry cargoes and one third liquid bulk (Figure 4). Dry cargoes are increasingly being carried in containers. The majority of containerised cargo is made up of manufactured goods and high-value bulk commodities, such as time- and temperature-sensitive agricultural products. Since 1990, containerised trade has increased by a factor of five – an average annual growth rate of almost 10%. In 2008, global container trade was estimated at 137 million TEUs (UNCTAD, 2009).

Table 1. Average value per tonne of cargo, international trade, 2000–2006

Average value per tonne of cargo ($)	2000	2001	2002	2003	2004	2005	2006
Airborne	56,624	51,241	50,445	54,415	55,503	59,710	63,184
Seaborne	625	601	617	698	772	861	943
Overland and other	1482	1606	1542	1531	1746	1827	1878
All modes	**863**	**836**	**843**	**923**	**1008**	**1109**	**1205**

Source: UNCTAD (2008), based on data from Global Insight, not including intra-European Union trade

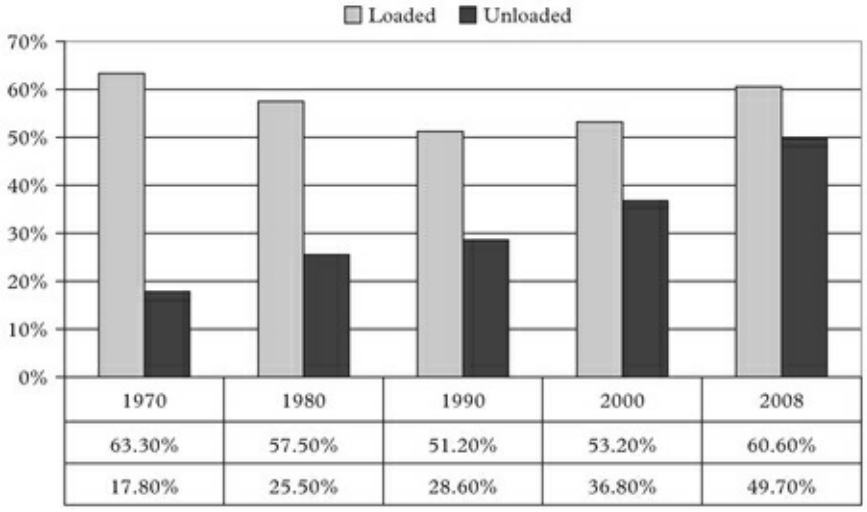


Figure 3: Developing countries' share in seaborne trade (tonnes)
Source: UNCTAD, Review of Maritime Transport 2009, Geneva, 2009

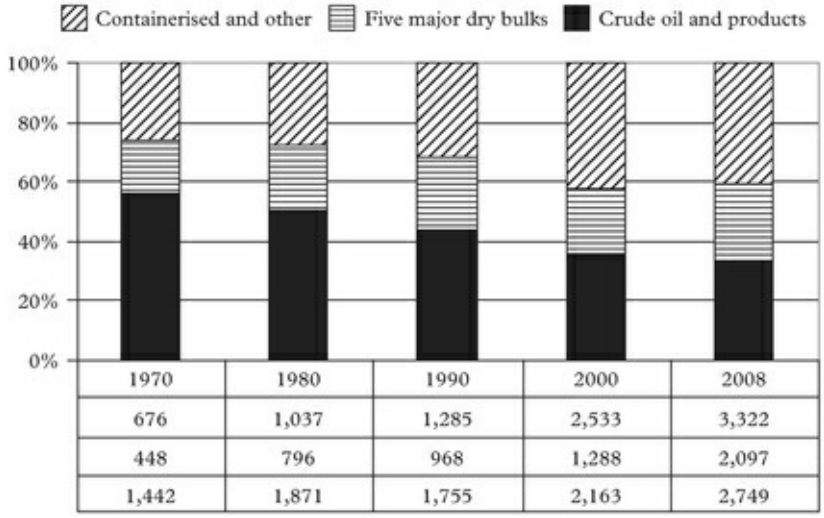


Figure 4: International seaborne trade for selected years – tonnes and % of tonnes
Source: Authors, based on data from UNCTAD, Review of Maritime Transport 2009, Geneva, 2009

Although maritime transport has historically been associated with the carriage of high-volume low-value goods (e.g. iron ore and coal), the share of low-volume, high-value containerised trade has been growing continuously since the container was invented half a century ago. Today, manufactured goods account for over 70% of world merchandise trade by value. They include consumption goods as well as intermediate goods, parts and semi-finished products that have expanded in tandem with intra-company trade, international outsourcing and globalisation.

2.2 Trade and transport in economic theory

2.2.1 International trade and economic growth

Allowing and facilitating trade has obvious positive impacts on economic growth. If Chile can produce bananas only under glass, and Ecuador can grow grapes only on an inaccessible highland, then both countries' populations can eat more bananas and grapes (i.e. achieve measurable economic growth) if they specialise and trade – as long as the shipping services are less expensive than the savings in production costs.

Going a step further, even if one country could produce both commodities with less land or manpower than the other country, according to David Ricardo's (1817) theory of the comparative advantage, it still makes sense for both countries to specialise and trade. Ricardo's example uses the production of cloth and wine, where Portugal has an *absolute* advantage concerning both: It needs 80 man-months to produce X litres of wine and 90 man-months to produce Y metres of cloth, whereas England needs 120 and 100 man-months respectively. England has a *comparative* advantage concerning cloth, and a rational decision of Portugal and England will imply that the first specialises in growing wine and the latter in producing cloth, consequently leading to English exports of cloth to Portugal and Portuguese exports of wine to England. This type of specialisation, and thus also the resulting trade, can partly be explained by the "Factor Proportions Model", which was developed by Eli Heckscher and Bertil Ohlin in the 1920s (Ohlin, 1933). This model expands Ricardo's basic version by including differences in the endowment of resources. Linking both models thus allows to explain trade flows by differences in available technology, capital, manpower and natural resources.

Today, the academic discussion on why and how much countries trade with each other is far developed. The impetus for new trade theories came from the limitations of the classical models because of their relatively simplistic assumptions and also their empirical weaknesses. This was illustrated by the Leontief Paradox (1953) when the Factor Proportions Model, discussed earlier, was applied to the US. The empirical analysis did not support the theory's prediction that a nation's abundance in a particular factor of production would dominate its exports. New contributions in the post-World War II era include Vernon's product life-cycle theory of the mid-1960s, the new trade theory of the 1980s (Krugman, 1981; Lancaster, 1980) and Porter's (1990) national competitive advantage trade theory. The product life cycle theory explained the international trade patterns of the 1960s when the US dominated the global economy and most new products originated in that country (Vernon and Wells, 1986). As demand for the product increased gradually in other developed nations, it was initially met through US exports until the production itself moved to those countries because of higher US labour costs. Furthermore, once the product became standardised, US production was typically replaced with exports from other developed nations first and, in the long-run, exports from developing countries. However, the limitations of this theory are far too many in the contemporary global economy where production is dispersed to different parts of the world simultaneously and no one particular nation is in a position to claim hegemony in international trade.

The new trade theory is based on the increasing returns to specialisation that arise in an industry when it is characterised by high economies of scale. The presence of such economies of scale in production would lead to the existence of only a limited number of global players in the market. Those firms that are *first-movers* may benefit from their early entry and establish themselves, erecting entry barriers for others. It has been argued that to be successful in such an environment, in addition to the firm being lucky, entrepreneurial, and innovative, the nation itself must have a strategic, pro-active

trade policy that facilitates first-mover advantage in key and newly emerging industries (Hill, 2000). Porter's national competitive advantage theory postulates the existence of a diamond that consists of factor endowments, demand conditions, related and supporting industries, and firm strategy, structure and rivalry. The diamond will be favourable when the four components are in place along with an element of luck and favourable government policies as was the case for the Japanese automobile industry in the 1980s (Porter, 1990).

In practice, the different theories of international trade obviously complement each other and make their own contributions. They apply as much to trade in goods as to trade in services – including maritime transport services: Flag registries, for example, surely benefit from economies of scale, shipyards require an endowment of capital and labour, and London was a "first mover" concerning insurance and finance. Later on, we will look in more detail at this specialisation in different maritime sectors.

And what does trade mean for economic growth and well-being? Under almost any model, it is "potentially possible to find a free trade consumption point and an appropriate lump-sum compensation scheme such that everyone is at least as well-off with trade as they had been in autarky" (Suranovic, 2002). And, accordingly, "international economic integration yields large potential welfare effects" (Anderson and Wincoop, 2001). The posterior distribution of these benefits within society is a different matter, beyond the scope of this chapter.

2.2.2 Mainstream economics and its consideration of transport

How does transport fit into this analysis of trade and economic development? Standard Economics text books, if they include it at all, do so by considering it as part of the overall transaction or arbitrage costs. Trade will take place if price differences between two countries are higher than the total transaction costs.

Until the early 1970s, transport and transport-related infrastructure played an important role in location theories and development economics, including the lending policies of the World Bank and bilateral technical cooperation. It was assumed that by simply providing for infrastructure such as ports, roads and bridges, developing countries would soon become more competitive and catch up with the industrialised nations. This changed for two main reasons: first, as transport costs declined and connectivity and efficiency improved, it was assumed that further improvements in transport were no longer relevant for trade and development. Secondly, the relationship between transport and economic growth is quite complex, and impacts of changes were – and still are – difficult to measure. Some of the measurable results of infrastructure investments were actually disappointing or even contrary to the expected and desired impact. For example, if imports suddenly became more competitive, port investments actually led to a closure of local industries (Pedersen, 2001; Hilling, 1996; Simon, 1996).

(Only) once a Nobel Memorial Prize in Economics has so far been given to authors who worked – partly – on transport-related topics; that was in 1993, when the prize was won by Robert Fogel and Douglass North. Fogel's main contributions included research on the role of the railways for the development of the national economy in the United States. Douglass North worked, *inter alia*, on the economic development in Europe and the United States before and in connection with the industrial revolution, including the roles of sea transport and changes in the pattern of regional specialisation

and interregional trade.

Nowadays, most trade models include transport costs or some related variables, such as distance and common borders, to explain the geographical distribution of international trade flows. In empirical research, measurable reductions in transport costs are taken as a given exogenous trend, driven by technological advances, that obviously promotes trade. O'Rourke and Williamson (1999), for example, analyse how in different historical periods trade grew as a result of reductions in freight rates.

Yet still, "there isn't nearly as much trade as standard trade models suggest that there should be. Formal trade barriers such as tariffs and quotas are far too low to account for much of the missing trade while changes in tariffs and quotas in the last 50 years explain too little of the growth in trade. Transport costs help explain the missing trade, but distance and other location variables are far too important in their trade suppressing effects to be accounted for by the effect of distance and measurable transport costs. Fall in measured transport costs do not fully explain the growth in trade. These anomalies have until recently been ignored by the profession" (Anderson, 1999).

Whether transport costs have fallen or not is surely debatable, and we shall briefly discuss this question later on. What is true, however, is that by considering only transport costs and not the other aspects (such as connectivity, safety, security, reliability, speed, or port facilitation), many trade analysts have not been too impressed with the advances in the field of transport and their impact on trade growth. And what has long been ignored altogether is how increased trade influences transport costs.

2.3 Trade and its transport: A mutual relationship

2.3.1 Rediscovering transport as a determinant of trade

Any answer to the question of "why do nations trade (so little)" (Anderson, 1999) needs to look at transport costs and shipping connectivity. Since the late 1990s, in the context of globalisation and the analysis of its causes and impacts, transport has moved back to the mainstream of economics and related sciences. Thompson (2000), from the World Bank, writes he is "delighted to see the general economics profession rediscovering the importance of transportation costs and geography in international trade considerations", and Pedersen (2001) explains that "during the 1990s transport and communication appear slowly to be on their way into the mainstream again, but now transformed into a much broader concept of logistics, which has become an increasingly important element in the organisation and restructuring of the globalising economy. From being an external factor, transport has become an integrated part of the production and distribution system".

Initial empirical research which incorporates transport into trade and economic policy analysis includes Limao and Venables (1999), who conclude that "halving transport costs increases the volume of trade by a factor of five". In a related paper (Venables and Limao, 1999), the same authors highlight that a "theory of trade that ignores transport costs will yield systematically incorrect predictions about trade patterns, industrial structure, and factor incomes".

To redeem such shortcomings, several authors have in recent years incorporated measures of transport costs into trade models. An overview is provided by Korinek and Sourdin (2009), who specifically analyse maritime transport costs as determinants of international trade and conclude that a 10% increase in maritime transport costs is associated with a 6 to 8% decrease in trade, other things

being equal. Wilmsmeier and Sanchez (2009) look specifically at food prices and conclude that any debate on food policy "requires a good understanding of the functioning of transport markets and their role in food transport chains", while Disdier and Head (2008) find a "puzzling persistence of the distance effect on bilateral trade".

Several international organisations are now paying increased attention to this issue, IADB (2009), for example, concludes that "transport costs have assumed an unprecedented strategic importance" for Latin America and the Caribbean. OECD (2008) sets out an ambitious research agenda (a) to examine the impact of transport costs on trade; and (b) to examine the impact of different components of transport. World Bank (2009) analyses transport costs in Africa because "(it) is well known that weak infrastructure can account for low trade performance". UNCTAD (2004) concludes that "Improved transport services for developing countries are key determinants of the new international trade geography, including South–South trade and increased merchandise exports of developing countries. However, not all developing countries are so far benefiting from this new trade geography and further efforts are required to improve transport services and infrastructure especially for least developed and also landlocked countries. The challenge for policy makers is to initiate a virtuous cycle where better transport services lead to more trade, and more trade in turn helps to encourage improved transport services."

2.3.2 What are the determinants of maritime transport costs?

Limao and Venables (1999) and also Radelet and Sachs (1998) not only use transport cost data to explain trade, but also undertake regressions to explain transport costs. The explanatory variables used in their analysis are basically related to distance and connectivity, such as if countries are land locked, or if trading partners are neighbours, and to country characteristics such as GDP per capita. García Menéndez *et al*. (2002) investigate the determinants of maritime transport costs and the role they play in allocating trade across countries for the case of the ceramic sector (tiles). They include a discussion on the sensitivity of trade flows and transportation costs to the existence of back hauling, and suggest that higher distance and poor partner infrastructure increases transport costs notably. Inclusion of infrastructure measures improves the fit of the regression, corroborating the importance of infrastructure in determining transport costs. Higher transport costs significantly deter trade, and distance does not appear to be a good proxy for transport costs, at least not in the ceramic sector. For Latin America, continuing work by Micco and Pérez (2001), Sanchez *et al*. (2002) analyse the impact of port reform on transport costs, and also possible determinants of the port reforms themselves. Hummels (1999a, 1999b, and 2000) discusses if "international transport costs have declined", and he introduces "time as a trade barrier". One of his conclusions is that that "each day saved in shipping time is worth 0.5 percent ad valorem, approximately 30 times greater than costs associated with pure inventory holding" (Hummels, 2000). Fink *et al.* (2001) analyse how liberalisation in trade in transport services leads to further reductions in transport costs, which in turn lead to a further promotion of trade in goods. Although criticised in its methodology and specific conclusions concerning liner shipping's anti-trust immunity (World Shipping Council, 2001), there is no doubt that the liberalisation and globalisation of the maritime business (see section 3 of this chapter), have led to a reduction of transport costs, which is contributing to the globalisation of trade and global production.

What was still missing in the earlier literature was a more thorough consideration of the mutual relationship between trade volumes, transport costs, and the quality of transport services. For example, higher quality of service implies higher transport costs, yet also promotes trade. Economies of scale from high trade volumes have a strong negative (i.e. decreasing) impact on transport costs. Therefore, it appears that the strong relation between trade and transport costs detected by Limao and Venables (1999) quoted above does not only reflect the elasticity of trade towards transport costs, but also almost certainly reflects the economies of scale through which higher volumes lead to lower costs of transport.

Research on the determinants of maritime transport costs has advanced significantly during the current decade. The basic findings of the regressions we first presented in the earlier version of this chapter (Kumar and Hoffmann, 2002) are confirmed by numerous subsequent studies. Based on results from Sanchez *et al*. (2003), Wilmsmeier *et al*. (2006), and Wilmsmeier and Hoffmann (2008) as well as the literature review provided by OECD (2008), six key determinants of freight costs, i.e. the price charged to the shipper, for maritime transport can be summarised as follows.

1. *Distance:* Surely distance plays some role as a longer journey requires more fuel and other operating expenses. This impact is stronger for bulk shipping than for containerised liner shipping. For the latter it is found that doubling the distance increases freight rates by only 15 to 25%, and distance on its own will usually statistically explain just one fifth of the variance of container freight rates.
2. *Economies of scale*: Larger trade volumes and bigger individual shipments reduce unit transport costs. The largest 13,000 TEU container ships cost half as much to build per TEU than vessels of 2,500 TEU, and employ the same number of crew. Larger trade volumes and shipments are also correlated with other determinants of transport costs, such as port infrastructure and competition between services providers.
3. *Trade balances:* On many trade routes, volumes moving in one direction are higher than those moving in the opposite direction. As carriers then have empty ships and containers available for the return trip, freight rates for the return trip may be just half of the rate of the outbound trip. Even if individual countries have a more or less balanced trade (e.g. Chile and Korea), the freight rate from Korea to Chile may still be far higher than the rate from Chile to Korea, because the overall trade balance on the route is determined by the Chinese surplus with the United States.
4. *Type and value of traded goods:* Obviously transport costs vary depending on the type of commodity traded, i.e. dry bulk, oil, containerised cargo, or break bulk. If insurance costs are included in the overall transport costs a higher value per tonne of the commodity will also increase freight charges. Interestingly, it is found that for containerised trade, even if insurance costs are excluded, freight charges per TEU are still higher for higher value goods than for less costly commodities. Carriers used to say that the freight rate is “what the market can bear” – and the market for transporting toys can bear a higher freight rate per TEU than the market for waste paper. Put differently: The demand for transporting low-value waste paper has a higher price elasticity and, hence, waste paper will only be put into a container if freight rates are low.

5. *Competition and transport connectivity:* Competition among carriers and competition between different transport modes reduces transport costs, i.e. the freight rates charged to the shipper. If countries are neighbours and can trade by road, rail or pipeline, freight rates for sea-borne trade are lower. If countries are not connected to each other through direct liner shipping services, but instead containerised trade between them requires as least one transhipment port, freight rates also tend to be higher. Interestingly, it is found that once there are more than four carriers providing direct services, freight rates decrease even further – a possible interpretation is that if there are only up to four providers we are confronted with an oligopoly.
6. *Port characteristics and trade facilitation:* Better port infrastructure, private sector investment, perceived port efficiency and shorter waiting times at Customs have all been found to lead to lower freight rates. Although better infrastructure may actually lead to higher port costs charged to the carrier, the latter will still reduce his freight rate charged to the importer or exporter, because the gained time and reliability more than offsets the possible payments to the port. As regards trade facilitation as measured for example by shorter Customs clearance times, these tend to be correlated with lower maritime freight rates for imports. The efficiency of a port is closely correlated with a country's per capita GDP and it is found that richer countries also tend to benefit from lower freight rates for their exports. A country's "maritime nexus" to globalised trade through its seaports is thus two-fold: better ports help countries to connect and develop – and at the same time more developed countries are better positioned to invest and reform their ports.

2.3.3 A note on transport and regional integration

If it is true that international transport (unit-) costs are declining, and distance has a decreasing impact on these transport costs, why then apparently regional trade is growing (even) faster than inter-regional trade? Intra-Asian container traffic is growing faster than global container traffic. Intra-European or intra-MERCOSUR trade has been increasing at a higher rate than trade between these two regional blocks.

Some of the intra-regional trade growth certainly has less to do with transport but rather with language barriers, historical trends, trade facilitation at common borders, and lower intra-regional tariffs. But some of the reasons do have a relation with transport costs and options: as shown above, due to larger traded volumes, unit transport costs decline (economies of scale) and frequencies and even possibly speed increases. Also, on a regional level, more options (road, rail) are available. This in turn reduces delivery times, allows for more just-in-time delivery, and thus increases the demand for goods and components. In other words, more trade leads to better and less expensive transport services, which in turn again lead to more intra-regional trade.

The impact of better and less expensive transport on trade is equivalent to the impact of lower tariffs, and the relatively faster growth of intra-regional trade does not contradict the previous statement that goods and components are increasingly purchased globally. A large part of the growth of intra-regional trade replaces previous national "trade", i.e. between counties or regions of the same country, and is not a diversion of imports or exports that would otherwise be bought from or sold to countries outside the region. Just as "most analyses of Free Trade Agreements, including most

importantly by far the European Union, conclude that trade creation has dominated trade diversion" (Bergsten, 1997), improved transport costs and services on a regional level are to be seen as a result and a component of the entire process of globalisation.

Just as in the relation between globalisation and international transport, the relation between regional integration and regional transport is also two-fold: Less expensive and better intra-regional transport services lead to further regional integration, and at the same time regional integration also affects the markets for transport services. Within the European Union, maritime cabotage services are liberalised for European registered vessels, trucks from all Member States are at liberty to move national cargo in all other countries, and common standards help to create not only a common market for goods, but also a common market for transport services.

2.4 Outlook

Trade, and its transport, will continue to shape the world's economic development. Historically, when transport costs were prohibitive for most products, each country, or even town, would produce its own goods. Most countries made their own toys, furniture, watches and even cars. Then came the international economy; as transport costs went down and delivery times and reliability improved, many national industries died out and production became concentrated in a few, specialised places, from where world markets were being served. Cars and car parts were made in Detroit; watches, and batteries, in Switzerland; furniture, and the required wood, were made in Sweden.

At present, we are observing how the international economy gives rise to globalisation. As transport costs decrease even further, and delivery times and reliability continue to improve, production is again becoming less concentrated, albeit in a different manner: cars may still be designed in Detroit, yet car parts may be made in Mexico and assembly takes place in Malaysia; watches may still be marketed as "Swiss", yet most components are likely to be imported; and a Swedish producer of furniture will franchise his name and design, to produce local furniture with imported materials and components from wherever these are provided at the best price and quality.

The same applies to shipping. A ship may be registered in Antigua and Barbuda, but its owner can be German, and the "components" of the shipping service, such as insurance, equipment, the work of seafarers, or certificates of classification societies, are very likely to have been purchased in many different countries. "The claim that 'trade follows the flag', often used in the past to justify support for national fleets, has become primarily an argument of special interest groups seeking support for maritime sector enterprises. It is agreed that access to efficient maritime transport is a key variable in economic development. This does not necessarily imply fleet ownership or government control" (Audigé, 1995). The next section will look in more detail at how globalisation affects maritime business.

3. Globalisation and its Relevance for Maritime Business

3.1 The global supply chain

3.1.1 Global supply chain management

Although globalisation is sometimes referred to as being Janus-faced for its inequitable distribution of benefits among nations of the world, the perceptible impact that it has had on international production and marketing are beyond cynicism. Porter (1985) thinks of the firm as a value chain composed of a series of value creation activities, some of them (such as production and marketing) being primary

activities and the others (such as logistics services that include shipping movements) being support activities. As firms tend to focus more on their core competencies and maintain their competitive advantage in the global marketplace, the orientation towards procuring raw materials and sub-assemblies from sources all over the world, based on optimal purchasing arrangements, becomes even more crucial. This, along with the reduction in numerous trade barriers (because of the role of the World Trade Organisation) and the apparent diminution of ideological conflicts between leading nations of the world have led to greater levels of outsourcing and thus, the diffusion of the value chain across the oceans, and hence, the evolution of global supply chains.

Mentzer *et al.* (2001) argue that firms must have a supply chain orientation to effectively manage the supply chain that could result in lower costs, increased customer value and satisfaction, and competitive advantage. Leading edge logistics firms have recognised that it is the supply chain of a firm that is in competition with that of its competitors rather than the firms themselves (Christopher, 1992). The establishment of such a supply chain requires the formation of strategic alliances with channel members that include transportation service providers, shipping companies being one among those. Integration of transport activities is essential for the success of a supply chain and a well-integrated transportation system's contributions to the supply chain could include time compression, reliability, standardisation, just-in-time delivery, information systems support, flexibility and customisation (Morash and Clinton, 1997). Although the emphasis on building supply chain partnerships is a relatively new trend in corporate strategy, it is not a novel concept in the maritime business, two early examples being the evolution of the open registry concept and that of the ship management industry.

The objective of outsourcing non-core activities in search of efficiency and adding value to the end customer is potentially advantageous and adds to societal welfare – as long as the functions are being performed at acceptable levels of quality which in today's lexicon for product standards is one of "zero defects". The ship owner's effort to create a "least cost system" in the maritime business is tantamount to designing a global supply chain based only on least cost channel members.

Whereas this may lead to a loss of market share and corporate profits for the channel members of a supply chain, deficiencies of the least cost maritime system could have more drastic consequences, ranging from loss of life to global climate change and environmental degradation that impacts society at large besides the more traditional commercial losses of the business enterprise. Hence, while the temptations of using the cheapest crew and registering the ship in a lax ship registry might be appealing to the business acumen, the likely catastrophic magnitude of a mishap would make the ship owner think hard before making such choices. Globalisation and its underlying market forces appear to provide some guidance in this regard as there are perceptible specialised markets for virtually any aspect of the maritime business today that parallel the developments in specialisation in a broader context.

3.1.2 Specialisation in maritime business

Readily observable examples of specialisation exist in ship construction, technical management of ships, ship repairs and dry-docking, ship registration, crewing, shipping finance, ship chartering and brokering, and marine insurance. Analogous to the economic philosophy driving the new trade theory in international business, some areas of specialisation in shipping are an outcome of pro-active trade

policies in combination with luck, entrepreneurship and innovation that created a new breed of first-movers in areas like open registries and ship construction and repairs. However, the socioeconomic conditions of the leading nations (in specific areas of maritime specialisation) have also contributed toward their evolution as global leaders.

Examples of this include small service economies that have specialised in open registries (such as Panama, Cyprus, the Bahamas, or Bermuda), and large populous Asian nations that provide seafarers (such as the Philippines, India, and Indonesia). Norway, combining tradition and financing from its oil exports, is strong in shipping finance. London is a leading supplier of insurance and brokering services in general, including shipping. Korea and Japan are highly industrialised countries that build most of the world's shipping tonnage. And then there is China, not only the backbone of global commerce today but also the primary stimulus for the unprecedented shipping boom that we witnessed prior to the worldwide economic meltdown in 2008. China's unique style of unbridled capitalism combined with centralised planning has elevated the nation to a position of extraordinary relevance and abundance in shipping milieu. Overall, there appears to exist a close relation between a country's endowment of resources and general specialisation in services or industrial production and its specialisation in specific maritime sectors, whereas the relation between the different maritime sectors themselves appears to be increasingly weak.

The other side of that same coin is of course "concentration"; as countries specialise, the market share of the major players is increasing (Hoffmann, 1998). Between January 2001 and 2008, Panama's share of the world fleet (Gross Tons, GT) has further grown from 21 to about 23%. Maersk now controls 15% of the world's container carrying capacity, up from around 6% in 1997. One out of every three seafarer in 2008 was an Asian national and one out of every two, either an Asian or an Eastern European. One out of every two ships is registered in one of the top five registries (UNCTAD, 2009).

If the world were still divided into "maritime nations" and others, non-maritime nations that do not participate in the maritime business, then the same countries where carriers are based would also build and register the ships and provide the seafarers. A cross-country comparison based on indicators for these maritime activities would produce very high correlation coefficients. The reality under globalisation, however, is quite different.

3.1.3 Specialisation and clustering: The participation of Asian countries in globalised maritime business

Many Asian countries have become important players in different maritime businesses. Bangladesh and Pakistan have their highest market shares in ship scrapping; Indonesia and the Philippines in the provision of ratings (seafarers other than officers); Republic of Korea in container ship building; and Hong Kong (China) and Singapore in international port operations through Hutchison's and PSA's operations domestically and also abroad. Overall, Asian countries have a greater participation in many maritime sectors than Asia's GDP or international trade would suggest (Figure 5).

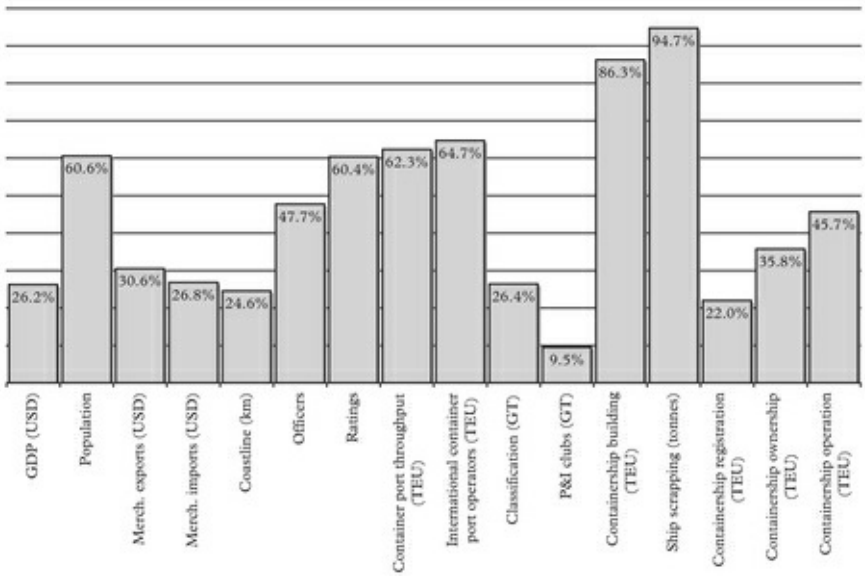


Figure 5: Asian maritime profile – Asia's participation as percentage of world total
Source: Authors, based on data from different sources. Data is estimated for 2004

Different maritime businesses are not necessarily located in the same countries. Table 2 provides the correlation coefficients for different industry sectors. Note that a high and positive correlation should not be confused with a direct causality. The data base includes many small and landlocked countries that have zero participation in most sectors.

As could be expected, port throughput and operation is closely correlated with foreign trade. Ship operation, ownership and registration are also relatively strongly correlated, as are the participation in P&I Clubs and Classification. Seafarers, especially ratings, tend to come from countries with a long coastline, which may be due to a seafaring tradition, which cannot be found in landlocked regions or countries. Ship scrapping takes place in countries that have relatively little participation in other maritime sectors, and thus the correlation coefficients get close to zero or even negative.

What maritime sectors are located in what (type of) countries? As a first preliminary exercise, we have computed the weighted average GDP per capita of the countries that are host to different maritime sectors (Figure 6).

Almost all sectors are more commonly found in countries with a GDP per capita above the Asian average and also above the world average. Only ship scrapping and seafarers (especially ratings) are supplied by countries with a relatively low GDP per capita. Officers are more likely to come from countries with a higher GDP per capita than ratings. The service sectors of classification and insurance are those located in the Asian countries with the highest GDP per capita.

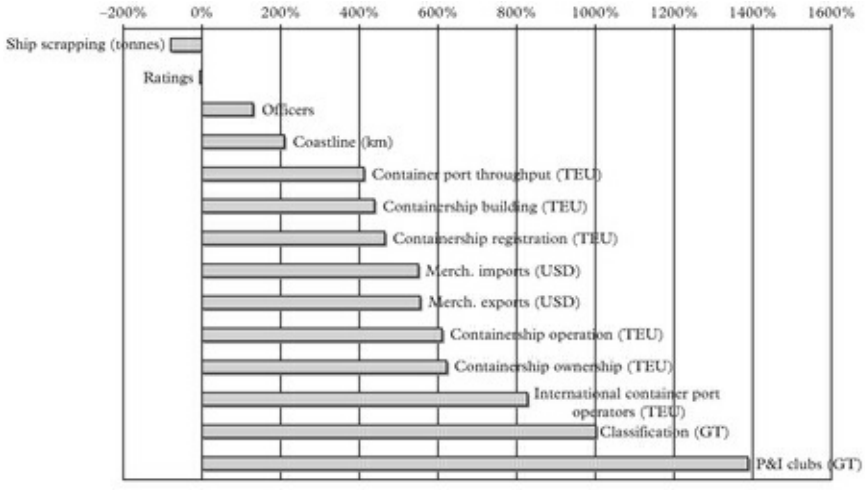


Figure 6: The GDP per capita in relation to different maritime sectors in Asia

Note: The 0% line indicates the average GDP per capita for 51 Asian countries, which is strongly influenced by the GDP per capita of its two most populous countries, China and India. The global average GDP per capita is 131% above the Asian average.

Table 2: Partial correlation between different maritime sectors, per capita indicators

	Exports	Imports	Coast	Officers	Ratings	Port through	Port oper.	Class	P&I	Building	Scraping	Register	Owner	Operations
Imports	0.94													
Coast	0.14	0.07												
Officers	0.08	0.16	0.24											
Ratings	−0.10	−0.03	0.77	0.52										
Port through	0.88	0.94	0.02	0.15	−0.04									
Port oper.	0.85	0.93	−0.04	0.16	−0.05	0.97								
Class	0.00	0.01	0.00	0.13	−0.04	−0.02	−0.03							
P&I	0.00	0.00	0.02	0.09	−0.03	−0.03	−0.03	0.97						
Building	0.06	0.07	−0.06	0.19	−0.03	0.07	0.05	0.29	0.05					
Scrapping	−0.11	−0.10	−0.11	−0.09	−0.06	−0.08	−0.05	−0.04	−0.03	−0.04				
Register	0.14	0.24	0.25	0.02	0.30	0.21	0.16	−0.04	−0.03	−0.02	−0.05			
Owner	0.27	0.39	0.21	0.06	0.27	0.36	0.32	−0.03	−0.02	0.01	−0.06	0.98		
Operation	0.49	0.61	0.14	0.13	0.19	0.59	0.56	0.00	−0.01	0.09	−0.08	0.85	0.93	
Average	0.32	0.35	0.13	0.14	0.11	0.33	0.31	0.12	0.10	0.06	−0.07	0.23	0.28	0.35
Overall average	0.21													

Note: The correlation coefficients are calculated between per capita indicators for 51 Asian economies. To compute the per capita indicators, for each country, its market share in each sector was divided by its share of the world population.

Most port and ship-related business activities are based in countries whose weighted average GDP per capita is five to nine times above the Asian average. There probably exist mutual causalities. A country needs a certain level of income and development to be able to become a strong player in certain industries. At the same time, being able to maintain a high market share in different shipping sectors also contributes to a higher GDP per capita.

Understandably, most countries' policy makers would wish their country's "maritime" market shares to grow. At the same time, the trend of concentration and specialisation in the maritime industry leads to new challenges and opportunities. As the world can no longer be divided into maritime and non-maritime nations, policy makers (and interested researchers and international organisations) should attempt to find out which countries are more likely to specialise in which maritime sectors, and why.

As globalisation in maritime business has led to increasing levels of specialisation in the industry, this has had varying impacts on nations. Along with the traditional maritime nations, a number of new maritime players have evolved, some of which have very little maritime history or even a coastline. A good example is Switzerland, a land-locked nation, which is home to the world's largest freight forwarder and to Mediterranean Shipping Company, one of the top five liner shipping companies in the world. According to UNCTAD (2008), there are 258 Swiss ships – 29 flying the national flag and the rest open-registry – that constitute 1.3% of the world fleet. The meteoric growth of the Chinese maritime enterprise in the new millennium was discussed earlier. The following sub-section discusses

salient policy developments in traditional maritime nations as well as newcomers that have shaped the course of maritime business.

3.2 Policy issues

3.2.1 The decline of traditional maritime nations

The globalised economy and the relatively invisible role played by the maritime sector in facilitating it have led to predictable outcomes for the sector in general. No one attaches the same prominence to shipping today as Sir Walter Raleigh did in the early 1600s when he linked the command of the sea to the possession of the riches of the new world. The irony is that the relative decline of the maritime political power is partly because of the sophistication of contemporary shipping operations wherein a cargo movement from Argentina to Zimbabwe or Mumbai to Marseilles is as predictable as a commute to the suburbs. Thus, shipping operations have become literally invisible in the global chain of commerce, albeit still important and unavoidable. Accordingly, the declining importance given to maritime issues is understandable.

Lovett (1996) provides an excellent discussion of the rise and fall of various maritime empires, from the Greeks and Phoenicians (480 BC) to the British, West European and the US merchant fleet as of the early 1990s, and makes a strong argument for a resurgence of maritime policy-making in the United States. Maritime economists have offered remedial measures to stem the flow of maritime business interests of developed nations like the US (e.g. Kumar, 1994). However, two powerful forces, in combination, have solidified the ongoing decline of traditional maritime nations. One is the power of the market forces driving the global economy and specialisation in general, discussed earlier, and the other, the political reality at the bargaining table.

The political reality in the developed economies today is such that shipping-related issues are subservient to the trade needs of those nations. The balance of power has swung visibly in favour of the cargo owners from that of the transportation service providers (Kumar, 1987) as illustrated by the declining relevance of revered shipping practices like the liner conference system. This has impacted current transport policy-making, in the maritime sector as well as in other modes. Sletmo (2001) captures the contemporary maritime policy-making trend by emphatically placing the supremacy of global trade perspectives over maritime issues. Accordingly, mode-specific transportation policy has become a doctrine of the past in developed market economies, most of who were the major maritime nations of the past. Although one could argue that air movements are still an exception because of the extensive use of bilateral negotiations involved in air transportation, major developed nations today advocate an integrated transport policy that favours seamless multimodal freight movements in general.

These nations have thus assumed a more holistic approach in national transportation policy-making that is conducive to the facilitation of a seamless movement of its commerce. Accordingly, the emphasis today in many developed nations is not in the size of their fleet or their tonnage, but on eradicating barriers to the through movement of cargoes. An excellent example of this is the United States, the world's largest trading nation and the home of many former prestigious shipping companies. Today, it is left with relatively very little presence in the deep-sea fleet, in spite of the Jones Act and other measures that oblige carriers to use US flagged, built and manned vessels for cabotage services.

Figure 7 shows the maritime engagement of traditional maritime nations as of end 2008. It is to be noted that all the traditional maritime nations with the exception of Germany and Japan have a greater share of world trade in value than their percentage share of world fleet in deadweight. Figure 8 (maritime engagement of newly emerging maritime nations) however shows quite the contrary for the newly emerging maritime nations most of who possess higher percentage of owned fleet than their value share in international commerce. For Hong Kong and Singapore, the percentage flag-share exceeds both the value share

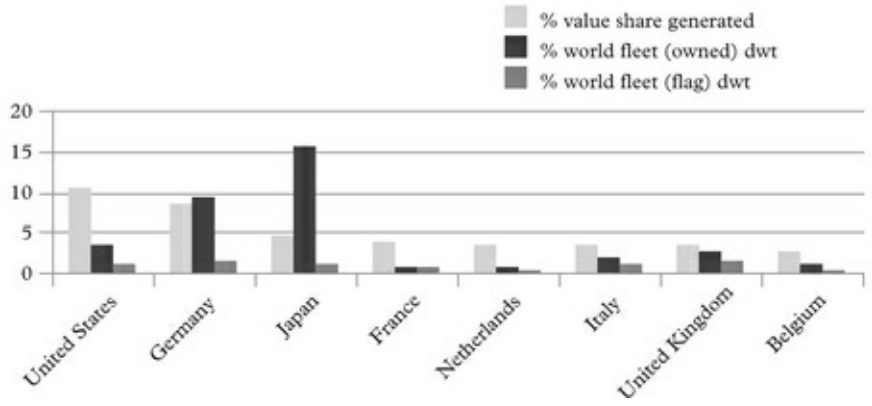


Figure 7: Maritime engagement of traditional maritime nations, 2008
Source: UNCTAD, Review of Maritime Transport, 2009

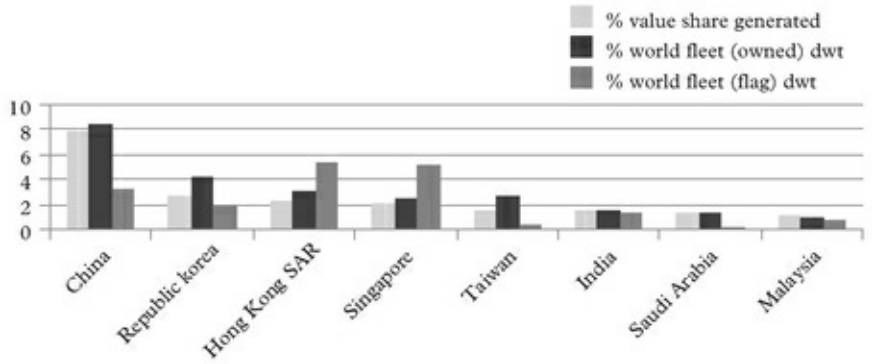


Figure 8: Maritime engagement of emerging new maritime nations, 2008
Source: UNCTAD, Review of Maritime Transport, 2009

and world fleet share in dwt. Figure 9 shows a precipitous decline in the shipping fleet registered in developed market economy nations, most of who also fall under the traditional maritime countries category. The decline in the fleet of these nations during the past 30 years is in direct contrast to the gains made by fleets registered in open registry nations and developing countries. Presently, four out of every five merchant ships are registered either under an open registry flag or in a developing country, and owners from developed countries are more likely to choose a foreign flag than those from countries with a lower GDP per capita (Hoffmann *et al.*, 2005).

Many countries' trade profiles in some way match their fleet profiles. Among the countries with the largest shares of oil exports are Kuwait (93% of its exports are fuels and mining products), Saudi Arabia (90%) Islamic Republic of Iran (88%), Russia (68%), United Arab Emirates (53%) and Indonesia (38%), and all of them also have the highest share of their nationally controlled fleets in oil tankers. Among the countries with the highest shares of agricultural exports are Brazil (29% of its exports are agricultural products), Vietnam (21%), Indonesia (18%), Thailand (16%), India (12%) and Turkey (10%). Among those countries, Thailand, Turkey and Vietnam also have

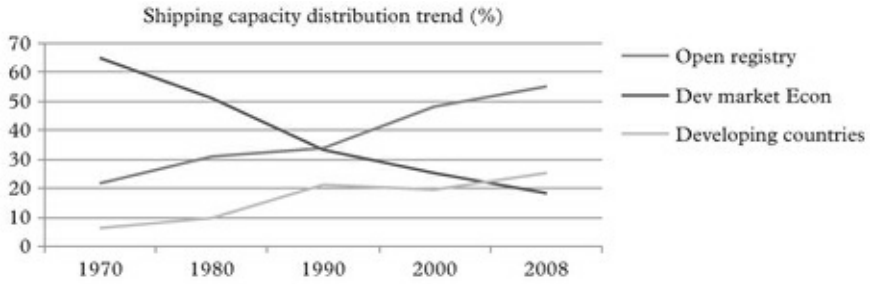


Figure 9: Ship registration trends

Source: UNCTAD, Review of Maritime Transport, 2009

the highest shares of dry bulk carriers, and the other three countries also have important dry bulk fleets. In China, Hong Kong (China), Republic of Korea and Taiwan (Province of China) the dry bulk fleet has the highest share, reflecting the large import demand of iron ore, grains and other dry bulk products (UNCTAD 2008b, pp. 41ff).

A different picture emerges if we look at manufactured goods, which are mostly traded in containerised liner shipping services. These services call in numerous countries' ports, unlike oil tankers and bulk carriers, which are usually employed on direct port-to-port voyages. Many container ships are operated by companies different from the vessel owner (the latter charters the ship to the company that provides the actual liner shipping service). All these aspects may explain why there does not appear to exist a correlation between a country's trade in manufactured goods and its nationally controlled container ship fleet. Even China, which accounts for about 25% of world containerised exports, has only a very small share of containerships among its nationally controlled fleet.

The largest nationally controlled fleets that also fly the national flag include oil tankers from Brazil, India, Kuwait and Thailand; dry bulk carriers from Hong Kong, India, Republic of Korea and Thailand as well as general cargo ships from Indonesia, Russia, Thailand and Vietnam. In several cases, these nationally flagged and nationally controlled ships are employed in cabotage trades that often mandate the use of the national flag, or they are nationally flagged as a consequence of some public involvement in the vessel owning companies.

3.2.2 The rise of a new order in maritime business

While the traditional maritime nations in general are losing their supremacy in the business, a new group of nations have proactively enacted maritime policies that favour their shipping base. A 1996 attempt to classify nations based on their attitude towards shipping in general listed these new centres of maritime business as shipping-friendly whereas the policies of many of the traditional maritime nations were listed under the shipping-hostile category (Lovett, 1996). Examples of the shipping-friendly category include nations such as South Korea, Taiwan and Singapore, all of which appear prominently in Figure 8. The ascendancy of these nations is usually focused on specific aspects of the shipping business, such as ship operation and construction in South Korea, or ship registration in smaller service economies. Some, such as Singapore, Brazil and China, do apparently pursue all-out efforts to build the entire shipping milieu. It is entirely conceivable in the near future that China will not only have the world's largest shipping companies but also the largest shipyards, busiest ports, biggest maritime universities and the most envied maritime infrastructure.

It is noteworthy that despite the efforts by shipping and seafarer organisations from some traditional maritime nations, the open registry fleet has continued its spectacular growth during the last two decades (Figure 9). Furthermore, the open registry nations have also encountered increasing

competition from some traditional maritime nations like Norway and Denmark that have established international ship registers to stem the outflow of their domestic tonnage to foreign registries if not attract some of the previously lost tonnage back to the national fleet.

Governmental interference in shipping has a long history (Farthing, 1993). Ever since the British enacted their restrictive Navigation Acts in the mid-1600s the global maritime business has never operated in so liberal a commercial environment as it exists today. A rational justification for this new wave of liberalism is the impact of globalisation. As maritime policies have become subservient to the overall trade policies of major trading nations, the crux of the issue is not the flag of registration but the overall *fit* of shipping services in the global supply chain. Under such circumstances, the specialisation referred to earlier has led to a new breed of maritime players where nationality is once again irrelevant. As an example, the concept of giving away one's flag to a ship owned by a foreign entity (although not *pro bono*) and staffed by foreign crew is an illustration of high shipping liberalism.

A cursory examination of the current breed of ship owners will show relatively few of the historic shipping families but more so of investment firms, pension funds and business conglomerates, none of which have any significant shipping heritage. Thus, it is ironical that globalisation has led to a certain loss of identity and respectability for the industry. A perfect example of this irony is the high public attention that the industry receives when there is a shipping accident, but the total lack of coverage that it receives from the media when it performs normally. The average citizen today is more aware of the mistakes made by the maritime industry rather than its contribution to the global commerce and our standard of living. The following subsection examines issues related to safety at sea and employment conditions. It suggests that the neo-liberalism in shipping policies has not meant a decline in operating standards but on the contrary, a general improvement in the safety of ships and the environment.

3.3 Safety and employment: the victims of globalisation?

3.3.1 Safety at sea

The increasing environmental awareness of the global community is vividly marked in all aspects of life today including maritime business. Given the inherent operating environment of merchant ships and their propensity to be a major environmental polluter, the increasing safety and environmental regulations imposed on the industry are only to be expected. Major shipping accidents in sensitive locations and the subsequent investigations, such as the ones that followed the *Erica* and *Prestige* incidents have also tightened the maritime operational environment.

The International Maritime Organization (IMO), established under the auspices of the United Nations to promote safety standards in shipping and cleaner seas, has a number of provisions aimed toward these objectives. Although some of these conventions date back to the 1960s and 1970s, they have been amended extensively to enhance the overall safety standards in a globalised operating environment. Two recent developments are particularly noteworthy, those being the *ISM (International Safety Management) Code Amendment to the Safety of Life at Sea Convention* and the *Amendments to the STCW (Standardization of Training, Certification and Watchkeeping) Convention* . *The ISM Code for the Safe Operation of Ships and Pollution Prevention* extends the scrutiny of shipping operations and management to the shore office and the decision makers therein. This is a

drastic change from prior efforts and aims to establish an all-encompassing safety management system in compliance with legislative and company requirements. The amended *STCW Convention* introduced globally accepted minimum standards for maritime training, evaluation criteria and assessment mechanisms. Given the diversity in national origin of seafarers today and their varying levels of skill and proficiency, the amendments have been propitious and timely.

There is a concerted multilateral effort now for ongoing scrutiny of the hardware and software of the maritime business. Some multilateral efforts originated as a unilateral initiative to enhance safety and prevent pollution (such as the US Oil Pollution Act of 1990 that made double-hulls mandatory for oil tankers and certain other ships calling at US ports and was subsequently matched by the IMO through amendments to the multilateral *MARPOL* Convention). The *Prestige* incident off the Spanish coast and the pressure from the EU led to rapid amendments to the MARPOL Convention in 2003. Accordingly, single hull tankers that were to be phased out gradually by 2015 would face an accelerated phase-out scheme by 2010. This does not preclude a flag-state from extending the deadline up to 2015 for tankers 25 years and younger on a case-by-case basis. However, other nations will have the right to ban such ships from entering their ports. The amendments also include new double hull requirement for the transportation of heavy grade oil such as heavy crude oil, fuel oil, bitumen, tar, and their emulsions that came into effect from 5 April 2005. Furthermore, the Condition Assessment Scheme–enacted subsequent to the *Erika* disaster off the Brittany coast of France in 1999 whereby flag-state administration would review and confirm the results of a survey on a single hull tanker conducted by a classification society to assess the condition of the ship concerned–has been expanded. The new CAS requirement would apply to single hull tankers (5,000 dwt and above) when they are 15 years old, in contrast to the previously established 25-year age threshold.

Aside from these, individual nations have signed agreements to enforce safety standards by inspecting the ships that call their ports. Such Port State Control agreements cover all major ship operating areas today and the respective national enforcement authorities arrest ships that do not meet the accepted minimum safety standards. As a further embarrassment (and incentive to scrap unsafe ships), some national authorities (e.g. the UK) publish a list of “rogue” ships in the trade media. Equasis (www.equasis.org) publishes inspection results from many P&I Clubs, classification societies, and port state control organisations on a global level.

Along with the governmental agencies, a number of non-governmental agencies such as labour organisations (e.g. the International Transport Workers’ Federation), ship owners’ association, ship charterers, classification societies, marine insurance firms and others have also raised the barriers and discourage the operation of substandard ships. The overall effect of these multi-pronged initiatives is visible in the following charts that show the trend in maritime casualties, both ships lost as well as oil spilled by ships (see Figures 10 and 11). Despite the increase in global shipping tonnage and maritime activities in general, and despite the diffusion of ship registration (in the neo-liberal maritime environment) to open registry and developing nations, the safety record of the industry is laudable. Even one life lost at sea is one too many, and the authors are not arguing that the current level of safety at sea is beyond improvement, but quite the contrary. However, all numbers strongly suggest that maritime safety is optimistic especially in light of the growing volumes of trade. Another important point to note is that the time lag between the incidence of a shipping catastrophe in a sensitive region with political clout (such as the EU) and the enactment of a new legislation aimed at

preventing such a catastrophe is becoming increasingly short. If such regulatory steps are adopted as expeditiously (as in the

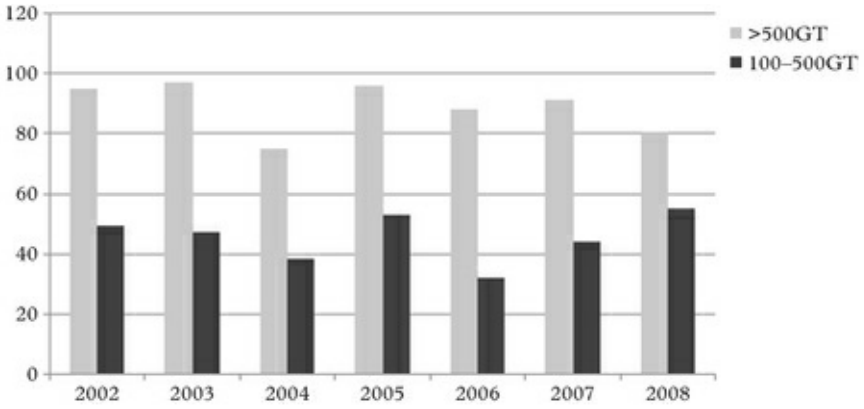


Figure 10: Number of ships lost

Source: Lloyd's Register Fairplay

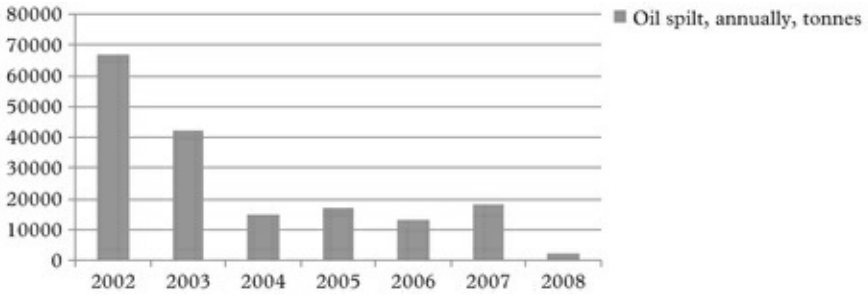


Figure 11: Oil spilled by ships, 2002–2008

Source: ITOPF Annual statistics and Clarksons

Prestige case) regardless of where the next shipping disaster occurs, it would be truly spectacular progress toward safer sailing and cleaner oceans.

3.3.2 The seafarer dilemma

Any discussion of the impact of globalisation on maritime business will be incomplete if the human element is not included. Various technological advances have helped reduce the number of crew required on board a ship compared to the period before the 1980s. This has by no means diminished the role of seafarers in the maritime business; on the contrary, crewing costs still constitute a major component of the operating cost of a ship (Moore Stephens, 2008), and crew-related issues remain relatively complex (IMO – *Globalisation and the Role of the Seafarer 2001*) . The impacts of globalisation on seafaring serve as excellent illustrations of the pros and cons of globalisation in general.

Seafaring is a glorious profession and has no room for error or negligence. Indeed the education of a young sailor is incomplete if it does not include indoctrination for facing calamities at sea or in port. Successful seafarers are unique individuals. The uniqueness comes not from the possession of any extraordinary intellectual capacity but from the possession of simple commonsense (euphemistically referred at sea as behaving in a "seaman-like manner") and from the willingness to subject oneself to the rigors of self-discipline of the highest order and separation from near and dear ones for prolonged periods of sailing. It also comes from the individual's mental and physical aptitude to face the unknown, be that hurricane force winds, pirates, or militant stevedores pilfering cargo in port. The sea is certainly no place for incompetence, negligence or complacency for it can be tranquil one day, and ruthless another. The only way a seafarer can gain respect from fellow shipmates is by knowing

his/her job and carrying it out in the most professional manner. These skills are by no means restricted to any particular nationality, race, religion or creed. On the contrary, well-trained seafarers from a poor country can do the same job as effectively as their well trained, colleagues from a developed nation at drastically reduced cost to the ship owner. Herein lies the dilemma – globalisation has opened up avenues of opportunity for seafarers from developing countries at the expense of those from traditional maritime countries such as the North European nations, the United States and Japan. An example of this is the recent *Maersk* decision to replace 170 Danish deck officers with "foreign competent officers at a much lower price" (*Journal of Commerce*, 1 October 2009).

Today's labour market for seafarers is perhaps the most globalised; standards and minimum wages are agreed globally. These trends have created a schism and ruptured the historic common bondage among seafarers of the world, built over the years based on their professional pride and their wider view of the world that their land-based colleagues often did not fathom. We live in an era today where seafarer organisations in developed nations look upon those from poorer nations as a potential threat to their livelihood, and as a result, lobby for protectionist policies that restrict the mobility of foreign crew members within their national borders.

During the last few decades, we have witnessed a tarnishing of the image of some seafarers, in particular those from less developed countries who crew a majority of the open registry and international registry vessels (*Ships of Shame 1992*). However, it is important to differentiate between the cause and the symptom. How many seafarers truly want to go to sea and work on board an unsafe ship without the expectation of coming back to their near and dear ones? So, the fault does not lie with the seafarers who crew substandard vessels, but with those responsible for putting them on such ships without adequate training and proper quality control in the first place. Furthermore, the argument that seafarers from developing countries are responsible for all maritime disasters does not appear to be true as a number of maritime casualties in the recent past involved ships that were crewed by seafarers from developed nations (an example being the grounding of the *Exxon Valdez* off Alaska in the US).

Another dilemma facing the global seafarer, especially those working on board open registry vessels, can be attributed to the declining number of traditional ship owners discussed earlier. As ship ownership and operation shift from traditional ship owners to pension funds and conglomerates that seek instant gain from the sale and purchase market (for ships) or from certain tax exemption loopholes, the seafarers' roles and functions have been marginalised and their loyalty made meaningless. With the increasing number of open registry vessels and the outsourcing of ship and crew management (discussed earlier), the relationship between the management entity and the ships' crew may sometimes not exceed the length of a contract today unlike the life-long relationship of the bygone pre-globalisation era. Furthermore, ship managers providing the crew for open registry vessels as well as other fleets often find themselves in a highly competitive market where there is little room for the ongoing training of seafarers, especially given the tendency of some of their principals to switch their management companies frequently. This is truly ironic as the challenges of seafaring have never been more than what they are now, despite all the technological advances made by humankind.

Currently there are close to 1.5 million seafarers worldwide of which 44% come from Asian countries. It is estimated that there is a worldwide shortage of 33,000 officers presently and that it will worsen in future years. Recruiting seafarers has become a huge challenge even in traditional seafarer export nations like India where changing macroeconomic conditions have taken away the charm of a

career at sea. Adding fuel to the fire is the tendency to criminalise mariners irrationally. The collision involving *Hebei Spirit*, a VLCC off the coast of South Korea that was hit by an errant heavy-lift crane barge in 2007, is a good illustration of the seemingly *reverse burden of proof* standard imposed on innocent seafarers. Although the actions of the ship's Captain and Chief Officer were endorsed as extraordinarily prudent and seamanlike by virtually every professional association of seafarers, they were given tough jail sentences and released only after prolonged worldwide protest. The Captain of the *Erika*, the infamous 1999 tanker casualty off the Brittany coast, was incarcerated immediately without trial. Nine years later in 2008, he was found innocent and released. Such callous treatment of seafarers does not support initiatives to recruit the younger generation such as through IMO's *Go to Sea* campaign that began in late 2008 or its observing 2010 as the *year of the seafarer*.

3.4 Outlook

The conflicting nature of public arguments regarding the impact of globalisation in general was mentioned earlier. There is a strong sentiment in the media that multinationals and their home nations (typically, developed countries) would benefit more than the developing countries who are likely to suffer from the abuses of globalisation ranging from exploitation to cultural degradation. It is remarkable that the arguments are quite the contrary when one looks at the impact of globalisation on maritime business. The traditional maritime nations appear to be on the losing end in terms of national tonnage and loss of shipping-related jobs, and perceive the new centres of shipping business (and specialisation) as potential threats to their maritime interests. Developing and newly industrialised nations, on the contrary, appear to be the winners with increasing number of ships under their control and better career opportunities for their seafarers. This trend will continue in the neo-liberal era of maritime policies and business environment.

The most encouraging outlook from our perspective is the increasing level of safety at sea which we hope will continue to improve. This means that, so far, the improvements in the quality, frequencies, reliability and costs of maritime transport have not implied an increase in negative externalities. The challenge for policy makers will be to observe and monitor potential future monopolistic abuses in a concentrating industry, and to assure adequate standards of training, working conditions and pay levels for seafarers, the pioneers on the world's most globalised labour market.

4. Summary and Conclusions

As trade in merchandise and unfinished goods increases, so does the demand for maritime transport services. These services form part of the global logistics chain that determines a good's competitiveness.

At the same time, the maritime business is itself strongly affected by globalisation. Trade in maritime services is one of the most liberalised industries, and its "components" such as vessels, flag registration, class inspections, insurance and the work of seafarers are purchased globally.

The results of these two trends are manifold, and some may even appear to be contradictory:

- The market for maritime transport services is growing. Nevertheless the specialisation of countries in certain maritime areas has implied that today there are fewer remaining players in individual maritime sectors.
- A country's national shipping business has ever less to do with its national external trade. Whereas in the past, for historic reasons and due to protectionist cargo reservation regimes,

foreign trade was mainly moved by vessels registered and owned by companies of the trading partners themselves, who employed national seafarers and nationally constructed vessels, today most carriers earn their income transporting other countries' trade, and the trade of most countries is largely moved by foreign shipping companies.

- We observe increased concentration in the maritime industry, yet at the same time the intensity of competition has not declined. This does not mean that fewer suppliers are *per se* good for competition, but the impact of globalisation leads to both - fewer suppliers and more competition.
- Transport unit costs decline, and yet the incidence of maritime transport costs in the final value of a good increases. The value of the final good not only includes its transport costs from origin to destination, but also the transport costs of all the components that have been purchased internationally.
- Lower transport costs are closely related to more trade. This is partly because lower prices (freight rates) obviously encourage demand, and also because economies of scale lead to lower unit transport costs.
- Ever more cargo is being moved across the oceans, benefiting from better maritime transport services and lower costs. This has generally not been at the cost of safety at sea, but, on the contrary, the globalisation of standards by the IMO and ILO help to reduce the negative externalities of shipping.

"Transport undoubtedly belongs to the most complicated, and therewith fascinating economic sectors" (Verhoef *et al.*, 1997). As mainstream economists attempt to tackle the causes and impacts of globalisation, international transport is re-entering the debate on trade models and development theories. As maritime transport is the true nexus between all trading nations, the role for maritime economists (and IAME) in this ongoing debate is clear and beyond doubt.

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References

Anderson, James E. (1999): *Why do Nations Trade (So Little)?*, mimeo, Boston College.

Anderson, James E. and Wincoop, Eric van (2001): *Border, Trade and Welfare*, NBER Working Paper 8515, Cambridge, October.

Audigé, Michel (1995): *Maritime Transport Serving West and Central African Countries: Trends and Issues*, The World Bank, SSATP Working Paper No. 16.

Bergsten, Fred (1997): *Open Regionalism*, Institute for International Economics, Working Paper 97–3.

Christopher, Martin L. (1992): *Logistics and Supply Chain Management* (Pitman Publishing).

Disdier, A.C. and Head K. (2008): "The puzzling persistence of the distance effect on bilateral trade",

Review of Economics and Statistics, Vol. 90, No. 1, 37–41.
DRI/WEFA (2001): Data from DRI/WEFA (www.dri-wefa.com) obtained by email from robert.west@dri-wefa.com.
ECLAC (2009): *Maritime Profile of Latin America and the Caribbean*, United Nations Economic Commission for Latin America and the Caribbean, LC/W.001, www.eclac.cl/transporte/perfil.
Fairplay Newbuildings (March 2002): Supplement to *Fairplay International Shipping Weekly*, London.
Farthing, Bruce (1993): *International Shipping: An Introduction to the Policies, Politics and Institutions* (2nd edn.) (Lloyd's of London Press).
Fink, Carsten, Mattoo Aaditya and Neagu, Ileana Cristina (2001): *Trade in International Maritime Services: How much does Policy Matter?*, World Bank Development Research Group DECRG, Washington, January.
García Menéndez, Leandro, Inmaculada Martínez-Zarzoso, and Celestino Suárez Burguet (2002): *Maritime Transport Costs and Port Infrastructures: Do They Influence Exports?*, Conference proceedings, IAME annual meeting and conference, Panama, November (forthcoming).
Hill, Charles W.L. (2000): *International Business: Competing in the Global Marketplace*, (3rd edn.) (Irwin, McGraw-Hill).
Hilling, David (1996): *Transport and Developing Countries* (London, Routledge).
Hoffmann, Jan, Talley, Wayne and Sanchez, Ricardo (1998): *Concentration in Liner Shipping*, United Nations, LC/G.2027, Santiago de Chile.
Hoffmann, Jan (2005): "Determinants of vessel flag", in Cullinane, K. (ed.) *Shipping Economics*, Research in Transportation Economics, Volume 12 (Elsevier).
House of Representatives, Standing Committee on Transport, Australia (1992): *Inquiry into Ship Safety: Report from the House of Representatives Standing Committee on Transport, Communications and Infrastructure*, Australian Government Publishing Service.
Hummels, David (1999a): *Toward a Geography of Trade Costs*, University of Chicago, January.
Hummels, David (1999b): *Have International Transportation Costs Declined?*, University of Chicago, November.
Hummels, David (2000): *Time as a Trade Barrier*, Purdue University, October.
IADB (2009): *Unclogging the Arteries: The Impact of Transport Costs on Latin American and Caribbean Trade*, Washington.
ILO (2001): Press release 01/05, 26 January, www.ilo.org/public/english/bureau/inf/pr/2001/05.htm, Geneva.
IMO (2001): *IMO – Globalization and the Role of the Seafarer*, mimeo, IMO.
Korinek, J. and Sourdin, P. (2009): *Maritime Transport Costs and their Impact on Trade*, presented at the European Trade Studies Group, Annual Conference, Rome, September 2009.
Kox, H., Lejour, A. and Verweij, G. (2009): *Regulatory barriers in business and transport services trade*, preliminary version, prepared for the First Meeting of Globalization Investment and Services Trade, Milan, June 2009.
Krugman, P. (1981): "Intra-industry specialization and the gains from trade", *Journal of Political Economy* 89 (Oct. 1981), 959–973.
Kumar, Shashi (1987): *The U.S. Shipping Act of 1984: A Scrutiny of Controversial Provisions*

(Castine, Maine Maritime Press).
Kumar, Shashi (1994): "Comparative maritime policies: a U.S. Dilemma", *Transportation Journal* 34.1, 32–38.
Kumar, S. and Hoffmann, J. (2002): "Globalization: the maritime nexus", in Grammenos, C. (ed.) *Handbook of Maritime Economics and Business* (London, Lloyd's of London Press).
Lancaster, K. (1980): "Intra-industry trade under perfect monopolistic competition", *Journal of International Economics* 10 (May), 151–175.
Leontief, W. (1953): "Domestic production and foreign trade: The American capital position re-examined", *Proceedings of the American Philosophical Society* 97, 331–349.
Limao, Nuno and Venables, Anthony J. (2000): *Infrastructure, Geographical disadvantage, and Transport Costs*, World Bank Working Paper 2257, December.
Lovett, William A. (ed.) (1996): *United States Shipping Policies and the World Market* (Westport, CT, Quorum Books).
Mentzer, John T., DeWitt, W., Keebler, J.S., Min, S., Nix, N.W., Smith, C.D. and Zacharia, Z.G. (2001): "Defining supply chain management", *Journal of Business Logistics* 22.2.
Micco, Alejandro and Pérez, Natalia (2001): *Maritime Transport Costs and Port Efficiency*, Inter American Development Bank, Washington, February.
Morash, Edward A. and Steven R. Clinton (1997): "The role of transportation capabilities in international supply chain management", *Transportation Journal* 37.1.
OECD (2008): *Clarifying Trade Costs in Maritime Transport*, OECD, TAD/TC/WP(2008)10, Paris, April 2008.
Ohlin, Bertil Gotthard (1933): *Interregional and International Trade*, Monograph.
O'Rourke, Kevin H. and Williamson, Jeffrey G. (1999): "The Heckscher-Ohlin Model between 1400 and 2000: When it explained factor price convergence, when it did not, and why", *NPER Working Paper 7411*, Cambridge, November.
O'Rourke, Kevin H. and Williamson, Jeffrey G. (2000): "*When did globalisation begin?*", NPER Working Paper 7632, Cambridge, April.
Pedersen, Poul Ove (2001): "Freight transport under globalisation and its impact on Africa", *Journal of Transport Geography* 9, No. 2 85.
Pires, Floriano C.M. (2001): "Shipbuilding and shipping industries: net economic benefit cross-transfers", *Maritime Policy and Management*, Vol. 28, No. 2, 157–174.
Porter, Michael E. (1985): *Competitive Advantage* (Free Press).
Porter, Michael E. (1990): *The Competitive Advantage of Nations* (Free Press).
Radelet, Steven, and Sachs, Jeffrey (1998): *Shipping Costs, Manufactured Exports, and Economic Growth*, Harvard Institute for International Development, January.
Ricardo, David (1817): *Principles of Political Economy and Taxation* (London).
Sanchez, R., Hoffmann, J., Micco, A., Pizzolitto, G., Sgut, M. and Wilmsmeier, G. (2003): "Port efficiency and international trade: Port efficiency as a determinant of maritime transport costs", *Maritime Economics & Logistics*, 5, 199–218.
Simon, David (1996): *Transport and Development in the Third World* (London, Routledge).
Sletmo, G.K. (2001): "The end of national shipping policy? An historical perspective on shipping

policy in a global economy", *International Journal of Maritime Economics* 4.3, 333–350.
Suranovic, Stephen (2002): *International Trade Theory and Policy Analysis*, "e-text" http://internationalecon.com/v1.0/
Thompson, Robert (2000): "The role of transportation in the global food system" in William Coyle and Nicole Ballenger (eds.): *Technological Changes in the Transportation Sector – Effects on U.S. Food and Agricultural Trade*, United States Department of Agriculture, Miscellaneous Publication Number 1566.
UNCTAD (2004): "On the new geography of trade: the role of transport services and their costs", *Transport Newsletter*, No. 25, Third Quarter 2004 (Geneva, United Nations).
UNCTAD (2008): "The modal split of international goods transport", *Transport Newsletter*, No. 38, First Quarter 2008 (Geneva, United Nations).
UNCTAD (2008b): *Review of Maritime Transport, 2008* (Geneva, United Nations).
UNCTAD (2009): *Review of Maritime Transport, 2009* (Geneva, United Nations).
Venables, Anthony J. and Limao, Nuno (1999): *Geographical disadvantage: A Heckscher-Ohlin-von Thunen model of international specialisation*, World Bank, Washington, December.
Verhoef, E.T., Nijkamp, P., Rietveld, P. and Lakshmanan, T.R. (1997): *Benefits and Costs of Transport* (Amsterdam).
Vernon, R. and Wells, L.T. (1986): *The Economic Environment of International Business* (4th edn.), (Prentice Hall).
Wilmsmeier, G. Sanchez, R. and Hoffmann, J. (2006): "The impact of port characteristics on international maritime transport costs", in Cullinane, K. and Talley, W. (eds.), *Port Economics*, Research in Transportation Economics, Volume 16 (Elsevier).
Wilmsmeier, G. and Hoffmann, J. (2008): "Liner shipping connectivity and port infrastructure as determinants of freight rates in the Caribbean", *Maritime Economics & Logistics* 10, 130–151.
Wilmsmeier, G. and Sanchez, R. (2009): "The relevance of international transport costs on food prices: endogenous and exogenous effects", in Gieco, M. and McQuaid, R. (eds.), *Symposium on Transport and Particular Populations*, Research in Transportation Economics, Volume 25 (Elsevier).
World Bank (2009): *Transport Prices and Costs in Africa: A Review of the International Corridors* (Washington).
World Shipping Council (2001): *A Review of 'Trade in International Maritime Services' – a Paper by World Bank Researchers*, May.

Part Two
International Seaborne Trade

Chapter 3
Patterns of International Ocean Trade

Douglas K. Fleming[*]

1. Introduction

In 2007, before the impacts of a global economic recession had been fully realised, nearly 7.5 billion metric tonnes of goods were shipped in commercial oceanborne trade. The ocean transport task for this movement translated to more than 31 trillion tonne-miles.[1] Roughly 59% of the total cargo volume moved in bulk. These impressive dimensions of world seaborne trade leave unrecorded a huge amount of empty space and deadweight lifting capacity of merchant ships steaming in ballast towards their next loading range or leaving their loading range only partly full of revenue cargo. Empty cargo space, like empty seats on passenger airplanes, reflects something lost forever, while vessel operating costs continue inexorably. This lost potential, to an extent inevitable because of basic global patterns and geographic separation of commodity production and commodity consumption, will be a recurring theme in this chapter.

The opening section of this study contains a few reflections on centuries-old trading patterns for ships under sail. Today's bulk commodity trades, which generate many millions of miles of ballast steaming, each year will then be examined. Possibilities for combining different bulk trades in some sort of logical geographic sequence will be considered. The general cargo trades, with particular focus on container line service, will be investigated. The directional imbalances of cargo flow on the main liner routes will be noted and possible network adjustments and service scenarios to cope with the empty space problem will be presented for consideration. Finally, prospects for the twenty-first century will be briefly outlined.

2. Early Patterns Under Sail

Thirty years ago A.D. Couper's "*The Geography of Sea Transport*" appeared on the bookshelves of students interested in ocean trade and transport (Couper, 1972). Professor Couper, master mariner, geographer and head of the Department of Maritime Studies at the University of Wales Institute of Science and Technology (UWIST), was an expert on ocean trade patterns. In his book there is a thought-provoking map entitled "World Wind Systems (January) and ocean routes of European sailing vessels". It is drawn to a cylindrical projection, stretching apart meridians of longitude, as does Mercator's projection. It covers a "world and a quarter" so that the Pacific, Atlantic and Indian Oceans can be seen in uninterrupted form. On it are depicted, with sweeping arrows, the major wind systems encountered at sea in January, and five historic trade routes in the sailing ship era – the Guinea trade triangle, the Dutch East India Co route between Amsterdam and the East Indies, the clipper ship route between Europe and Australia, the transatlantic Anglo-American colonial route and the transpacific Acapulco-Manila Spanish galleon route.[2]

The correlation between the favouring winds and the chosen tracks for the trading vessels stands out clearly on Couper's map. One knows that the chosen tracks shift seasonally as the prevailing winds shift. By summertime, for example, southwest monsoons replace northeast monsoons in the Indian Ocean.

Basically this is a pre-industrialisation, pre-liner service picture. To it one might add many other Portuguese, Spanish, French, Dutch and British "imperial routes" connecting mother countries with their colonies. And many of the routes were controlled by state-franchised trading companies. To be sure, most of these old transoceanic paths of commerce have been displayed in historical atlases,[3] usually in the form of simple lines curving around continents and across oceans, joining points of origin and points of destination with no attention to precise tracks, much less to seasonal variations in ocean tracks. Couper's map suggests much more. Removing his Guinea trade triangle and simplifying his winds to include only the voyage-speeding westerlies and the trades, we have the graphic image reflected in Figure 1. One might add to this image the patterns of favouring ocean currents which all mariners seek.

These old trading patterns were "round voyages", with outbound and homeward legs of the voyage quite often following very different paths, not only because of prevailing winds, ocean currents and weather but also, in the case of the Anglo-American colonial route, to pick up and deposit cargo en route, e.g. in the Caribbean and heading north along the American east coast. Generally, two-way cargo flows were available on the Spanish-controlled Acapulco-Manila route, the Dutch-controlled East Indies route and, later on, the British-controlled Australian route. However, in cargo volume terms, there could be large directional imbalances and seasonal variations. The ships engaged in these trades were, by modern standards, very small and often the cargoes were valuable goods – silver, gold, silks, spices, for instance – that took up little cargo space but generated high freight revenues when rates were *ad valorem*-based. And the "organised" nature of the trade routes mentioned above, since they were controlled by the imperial state or by a powerful state-franchised trading company, meant that the ships serving the trades had fair assurance of onward or homeward cargoes. Empty space on long ballast voyages was not the important consideration it was to become in the late nineteenth and twentieth centuries. It should be noted that these were, by modern definition, at least, tramp trades, however well organised, served by relatively small, multi-purpose sailing vessels adaptable to various cargo types, not excluding human cargoes, slaves or emigrants.

Unfortunately the mercantilist philosophy that was fashionable in Europe in the seventeenth, eighteenth and part of the nineteenth centuries led to highly protected trades in which mother countries paired off with their own colonies, enacted navigation laws which favoured ships of their own flag and often used high tariffs against imports from rival empires. Merchant fleets were really armed merchant navies, commanded to serve the state. When one views these mercantilist systems in global perspective, it is clear that they led to geographically inefficient networks in the form of many shuttle

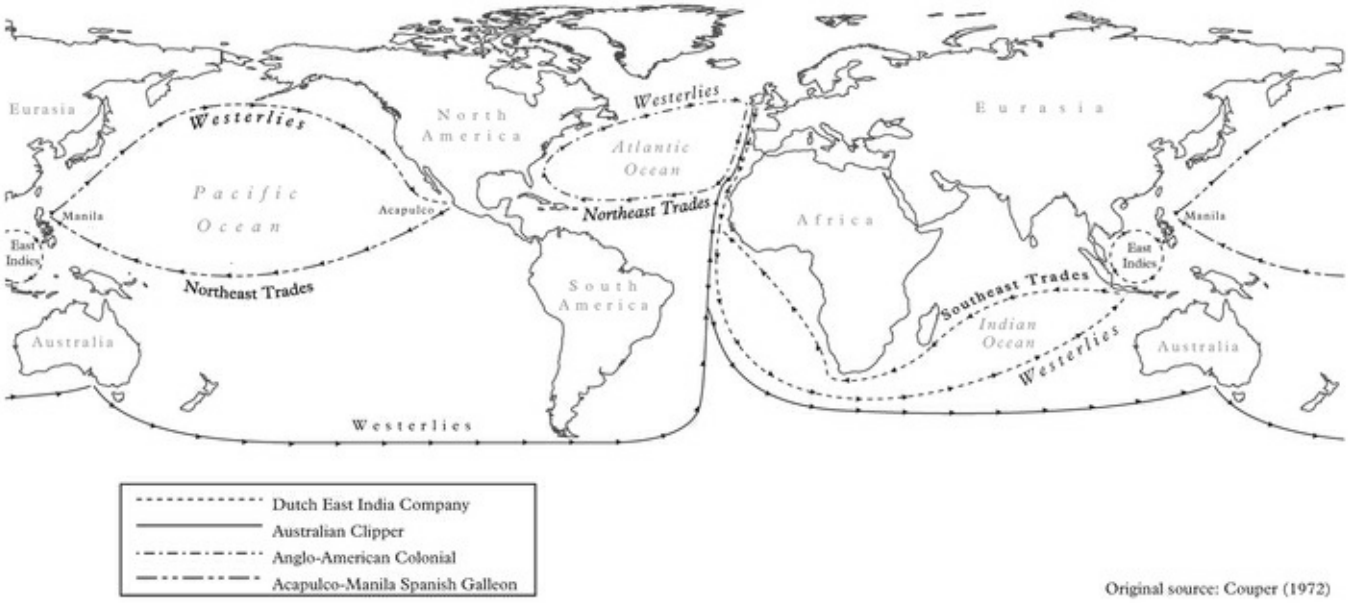


Figure 1: World wind systems (January) and ocean routes of European sailing vessels

services within imperial frames and relatively little "cross-trading" that could have reduced the amount of empty cargo space sailing unproductively across the oceans. Ironically these shuttle service patterns between imperial home ports and distant overseas colonies were somewhat analogous to the much more recent UNCTAD 40–40–20 scheme for splitting cargo allotments and ocean transport privileges 40–40 between trade partners (e.g. a developed and a developing nation) and leaving only 20% for "cross-traders". Of course the political, social and general economic motivations for the two sets of shuttle service patterns were vastly different. Yet the fact remains that the general back-and-forth route configurations were quite alike and there was a consequent accentuation of the empty cargo space problem when there were striking differences in the volumes of cargo flowing in either direction, as there almost always were.

Figure 1 reveals the remarkable clipper ship route in the Australian trade in the 1850s, outbound from Britain via Cape of Good Hope and homeward via Cape Horn. From a point in the South Atlantic, usually closer to South America than Africa, these very fast, fine-lined sailing ships swooped south of Cape of Good Hope into the "roaring forties" zone of westerlies and along a looping approximation of the great circle route to the southern coast of Australia. Homeward bound in an easterly direction, the ships again dipped far into the Southern Ocean, again with following westerly winds, and again approximating a great circle track past Cape Horn. These were ships, both American and British-owned, at the dawn of the free trade era in the 1850s, that took maximum advantage of the winds, currents, navigational aids of the time, and the cargo potentials, to turn profits for their owners.

3. British Impact on Ocean Trading Networks

As the world's front-runner in massive industrialisation, Britain by the mid-nineteenth century seemed to have the world of commerce by its tail. Having abandoned the mercantilist doctrines of the past for the principles and practices of free trade, Britain was a leader in seaborne trade, building what became the world's largest steam-powered merchant fleet and the world's most highly developed banking, chartering, insuring, shipping and other trade related services concentrated in the old City of

London.

The curious thing about Britain's spectacular and, to some extent, unilateral movement toward freer trade was that it took place in the imperial frame, in an empire that spread over the globe. Perhaps it made practical sense to be a free-trading imperialist when you led the world in the production of goods and services. Not to say that Britain traded only within the imperial frame, but the latter certainly had an impact on the networks of ocean trade that were handed down from the sailing ship era, reinforcing the radial patterns emanating from home base. If one added the radial patterns of the French and other European powers to the British hub and spoke pattern and put the whole in global perspective it gave a pronounced Eurocentric impression of world commerce in the latter part of the nineteenth century. And it was not really a false impression. Western Europe *was* the hub of world commerce. However, this set of Europe-based radial networks did not necessarily reflect the most efficient transportation system. Network analysts in the modern era have noted that pure hub and spoke networks have minimal connectivity. There is only one path from any one spoke end to any other and that is via the hub.

A.J. Sargent, British commercial geographer, recognised this network connectivity problem long ago in his unusually perceptive study, *Seaways of the Empire*. From early twentieth century data he traced movements of British shipping in South African, Indian, Australian and other commonwealth trades, finding that ships "disappeared" from one trade and "reappeared" in another. In between was a "hidden" ballast-voyage or half-empty intermediate voyages moving ships to other trade routes. Of course this is common tramp shipping behaviour and not infrequent liner behaviour, and it shows that British steamship lines before World War I had ways of coping with the radial networks and directional imbalances of trade volumes on specific routes. It reminds us, too, that, for British shipowners then, and most shipowners today, "ocean lines are not worked for purposes of philanthropy but to pay dividends" (Sargent, 1930, p. 15).

Although we may have heard more about their spectacular passenger liners, the British merchant fleet in the two decades prior to World War I contained a large number of multi-purpose freighters in the 7,000 to 8,000 deadweight tonnage range. These could be used either in tramp or liner service. Quite often there would be outbound cargoes of coal from Britain to coaling stations around the globe and return cargoes of the various products of the colonies or other overseas areas the British lines were willing to and allowed to serve. The versatility of most of these vessels was an important attribute, enabling the steamship lines to adjust to directional imbalances on trade routes, ballast to other trades, if necessary, and, in general, minimise the empty cargo space problem by reducing the amount of non-paying ballast steaming.

The British coal-burners were the forerunners of the thousands of oil-burning "10,000 tonners", the American Liberty, Victory, and C2 types built during World War II. These vessels had the built-in flexibility and adaptability for the carriage of various bulk and break-bulk cargoes in various trades. The prototype of the slow but amazingly serviceable American Liberty ship was, by the way, British-designed. Sixty of them were contracted to be built in American yards for the British early in World War II (Gibson and Donovan, 2000, p. 166). The thousands of Liberty-size vessels built between 1942 and 1945 became an essential component in Allied wartime convoys and supply chains.

In retrospect, the British, controlling a large portion of the world's pre-World War I merchant fleet, had a remarkable impact on the patterns of nineteenth and early twentieth century ocean shipping.

Americans must concede, also, that it was the British who selected New York as the main distribution point for goods that had accumulated during the War of 1812 awaiting entry into the American market. This gave New York's port its great leap forward (Albion, 1939, chap. 1). It was a small group of expatriate British textile merchants, originally from Yorkshire, who formed Black Ball Line to provide the very first transatlantic liner service between New York and Liverpool. Black Ball booked baled cotton diverted to New York from southern US ports for their eastbound transatlantic voyages and then lined up Yorkshire and Lancashire textile goods for their westbound voyages (Albion, 1939, pp. 99–100). It was the British, again, who propelled world shipping into the use of iron-hulled, propeller-driven steamships. And it was Britain that gave the world the theories and, especially from 1850 to 1875, the practices of free international trade (Ellsworth, 1958, chap. 4).

4. Bulk Commodity Trades: 2007

A.J. Sargent remarked, long ago: "The ultimate determining element in the employment of shipping lies in the sum of the geographical conditions of each region in relation to those of other regions of the world, though the effect of such conditions may be modified greatly by economic or political policy on the part of individuals or Governments." (Sargent, 1931, p. 25). Sargent's comment pertained to *any* seaborne commodity trade. It certainly would apply to bulk commodity shipping today, perhaps with the insertion of "or corporations" between "individuals" and "Governments".

The tonnage imbalances between exports and imports for regions of the world and for individual ports are most striking in the bulk commodity trades. Very seldom are there two way cargo flows between regions for the bulk movement of oil, coal, iron ore or grain, even though these four broad commodity categories contain different sub-types and grades. However, there *are* two-way movements of the ships that carry these materials. One way they are laden with cargo. The other way they are ballasting, very often returning to the original loading range, signifying that half the voyage steaming is in ballast, a regrettable but seemingly inevitable waste of cargo space. This, of course, reflects the basic commercial geographic reality that raw material supply sources and the markets for these materials are often separated by large transoceanic mileages. It also suggests that both shippers and carriers have been somewhat resigned to shuttle service itineraries.

Over the past half century the rise of proprietary carrier fleets – oil companies owning, or controlling by long-term charters, fleets of tankers; steel making companies controlling dry bulk carrier fleets for the movement of their inputs of coking coal, iron ores, etc. – seems to accentuate the long ballast voyage problem. The ships engaged in these proprietary carrier trades are often very large and specially built for the carriage of one commodity type. There is a built-in inflexibility when such vessels are employed. Their operations may be confined to a back-and-forth shuttle service. The primary purpose of the fleet is to serve the transport needs of the corporation; therefore the emphasis has been on transport timing, cost, and reliability, in other words on the production function. The focus, understandably, is not on revenues from shipping since shipping is viewed by the firm as an "in house" and "at cost" service. Unless the normal intra-firm movements of materials are in some way disrupted, the proprietary carrier fleet is not inclined to move from one trade route to another. It stays in the trade for which it was designed and built, or for which it was chartered.

The independent tramp operator of the past and a dwindling number of owners of multi-purpose or combined carrier fleets, today, might be inclined to move from one trade route to another, seeking

efficient geographic patterns that maximise their rate of utilisation on paying cargo and minimise ballast steaming.[4] Whether this results in profit, assuming profits are desirable, depends also, of course, on the revenue side of the equation.

4.1 Market locations

In the last half of the twentieth century many scholars in a variety of social sciences became enamoured with concepts of "cores and peripheries". Geographers struggled to define, in precise and mappable terms, the core industrial regions of the world. The unevenness of industrial development in the spatial sense makes this difficult. Very often the available statistical data pertained to the nation, not to the regions within it. And, as one famous historian observed, "*All* advanced economies have their 'black holes'", their local pockets of backwardness (Braudel, 1984, p. 42). Economists identified the processes and stages of economic growth, the leading sectors in specific countries, the industrial concentrations and industrial linkages. They even assigned time frames to the stages of growth (Rostow, 1962, chap.13) but they were not particularly concerned with the precise geographic dimensions. However, scholars in the field of regional science (e.g. August Losch, Edgar Hoover, Walter Isard) have recognised some of the intra-national changes in industrial location which continually re-shape cores and peripheries.

It is well supported statistically that the world's most massive industrial developments over the past two-and-a-half centuries took place in Western Europe, eastern North America and eastern Asia, setting a pattern that profoundly shaped ocean trade flows. The early industrial cores experienced rapid growth of the manufacturing sector, originally fuelled by coal and given great economic momentum by ferrous metallurgy and metalusing industries. These regions still contain very large markets for seaborne shipments of oil, iron ore, coal and grain. They are densely populated, too. To conform to today's realities, however, one could expand those three economically advanced and populous regions to include all of Europe, all of North America, and an Asia that extends from Vladivostok to Singapore to the Indian subcontinent, parts of the Middle East and includes the islands and archipelagoes of eastern and southeastern Asia. This, of course, amounts to a gross, mostly northern hemispheric, geographic generalisation, but it does identify three continental *loci* for industrial concentrations and economic growth that generate a huge portion of world trade today. To be sure there are "black holes", rust belts, regions of economic decline. There are also new industries, new technologies, new communications, new linkages and new industrial and service locations. Modern industrial globalisation and corporate outsourcing strategies complicate the patterns of industry and commerce. Networks have become more extensive and intricate. The southern hemisphere and emerging economies are definitely part of the present and future commercial picture.

It is noteworthy that the world's largest markets for seaborne bulk shipments of oil, iron ore, coal and grain are still in the northern hemisphere. It should be noted, too, that a relatively small number of very large oil companies and mining and steel-making enterprises have a great deal to do with three of the four major bulk commodity trades.

4.2 Crude oil

Crude oil seaborne shipments exceed those of any other bulk cargo movements, constituting nearly 24% of total world seaborne trade in 2007.[5] This tanker-borne crude oil trade totaled 1,775 million metric tonnes. Figure 2 depicts origins and destinations and directions of movement of 75% of the

total seaborne volume of crude oil shipments in 2007.

The major destinations for these crude oil shipments were the oil refineries of eastern Asia, western and Mediterranean Europe, and the east, west and Gulf coasts of North America. The largest crude oil importers were the United States, Japan and China. It is worth noting that the Europe that contains the enlarged 27-member European Union which, if considered a bloc, is a very important crude oil importer.[6] The Middle East is the primary source of supply for these crude oil shipments but the Caribbean (Venezuela and Mexico, especially) and both West African and North African supply sources are important too. Compared to these major sources, southeast Asian oilfields, the North Sea offshore fields, oil piped to Near East terminals on the Mediterranean coast for tanker shipment onward, and Russian oil piped to Black Sea terminals generate minor, but regionally significant, tanker trades. Russia was the world's largest crude oil producer in 2007 but domestic consumption and pipeline deliveries to points west in Europe cut back seaborne exports.

Both the United States and China have been important crude oil producers as well as consumers. Once self-sufficient, they now find themselves alarmingly dependent on

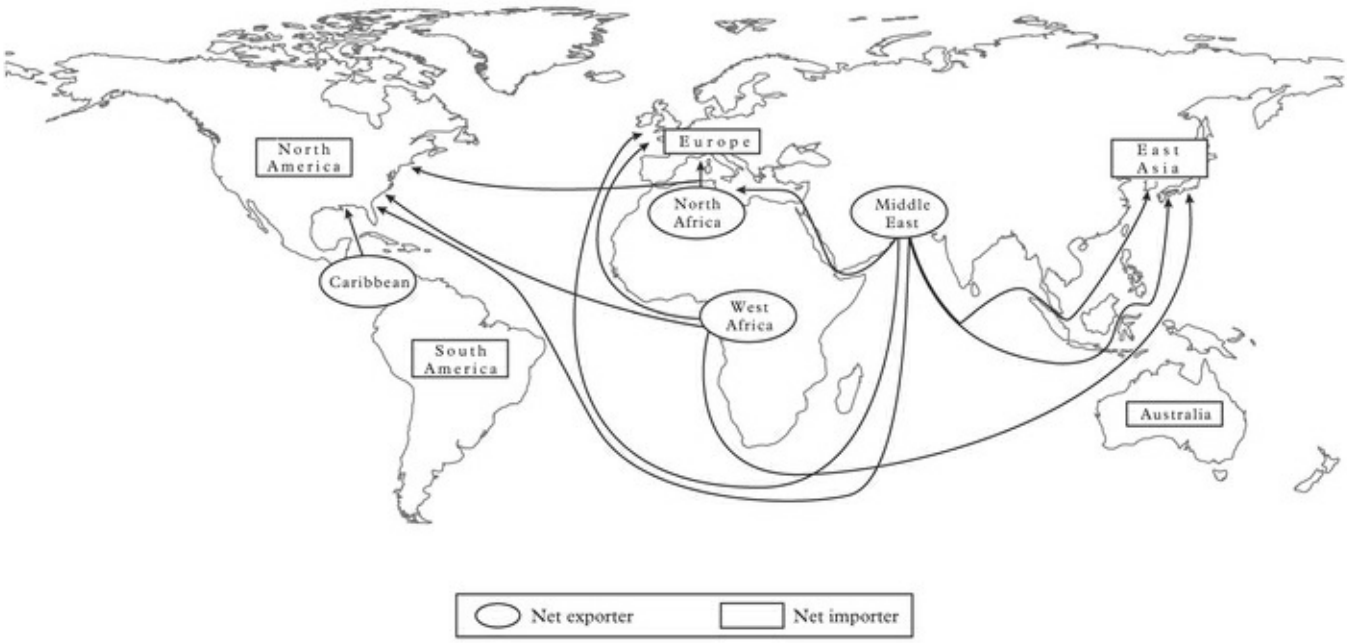


Figure 2: Major crude oil trade routes, 2007

oil imports. Industrial development and a recently surging economy plus, so far, negligible domestic oil production have placed India in the same boat as the US, China and Japan as significant importers of tanker-borne oil.

Tanker itineraries depend in part on the size and loaded draft of the vessels. Very large crude carriers cannot transit the Suez Canal or the Malacca and Singapore Straits, fully loaded, and must round the Cape of Good Hope on their laden voyages to Europe, and the Lombok and Makassar Straits on their laden voyages to East Asian destinations.

Not depicted on Figure 2 is the sizeable crude oil flow from Valdez, Alaska by tanker to western US termini and refineries. This has been an US domestic, "protected" trade. Also not depicted are the refined products shipped in smaller tankers, usually on shorter voyages, for instance from Caribbean

refineries to US Gulf coast and US east coast markets; and from Southeast Asian refineries to East Asian markets. The total tonnage of the oceanborne refined oil products trade amounted to 553 million metric tonnes in 2007, an impressive volume of seaborne trade, almost a third as much as the volume of the crude oil trade. Also omitted from the picture in Figure 2 is the quite significant movement of liquefied natural gas which requires specialised and expensive vessels and terminal facilities.

4.3 Iron ore

Iron ore in crude, sintered or pelletised form is shipped by sea transport from sources on all the world's inhabited continents to metallurgical regions which have been located predominately in the northern hemisphere.

The arrowed lines of Figure 3 depict origins, destinations and directions of movement of the main oceanborne flows of bulk iron ore in 2007, representing major high volume routes and 83% of total volume of seaborne iron ore shipments in that year. Total sea-borne iron ore shipments in 2007 measured nearly 800 million tonnes, generating more than 4.5 trillion tonne-miles in ocean transport. East Asia and Europe were the big recipients. In recent years, the two countries exporting the highest volumes of iron ore have been Australia and Brazil. Australia has been a big supplier for Japanese steelworks but China has emerged in recent years as the world's largest importer of Australian iron ore. Brazil ships large tonnages on notably large bulk carriers to European, Chinese, Japanese and other East Asian (e.g. South Korean, Taiwanese) market destinations. Again, China is the leading importer. South Asian (especially Indian) exports of iron ore have climbed steadily. Once again the Chinese market beckons. There are numerous iron ore sources in Africa but, in total, they generate comparatively small volumes for export mainly to Europe and East Asia. Canadian and Swedish mines produce quite impressive volumes of iron ore for export usually in rather short-distance seaborne trades to near neighbours such as the US, Germany, UK, etc.

The size of the dry bulk vessels carrying the ore affects the exact itineraries and limits the ports that can be used in the ore trades, although not quite as remarkably as in the crude oil trades. It should be noted that long-distance ore trades, as on the Brazil–Far East route, generate large annual tonne-mile totals. Very large ore carriers, some of more than 300,000 deadweight tonnes, have performed well on an itinerary that swings south of the Cape of Good Hope and through the Indonesian archipelago via the Lombok and Makassar Straits.

Metallurgical enterprises in the heavily industrialised regions of the northern hemisphere have drawn for a long time on their own iron ore deposits as well as on imported

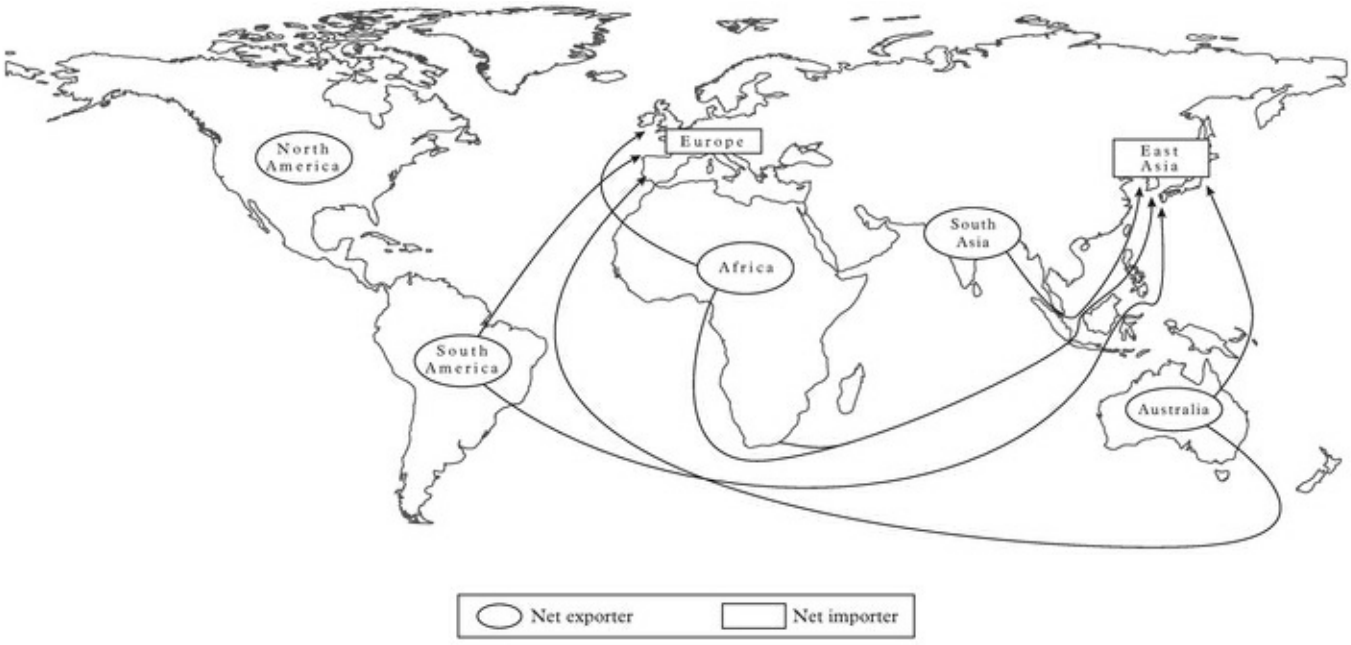


Figure 3: Major iron ore trade routes, 2007

ores. Four of the world's five largest steel producers – China, Russia, the US, India – have been large iron ore producers in the past but China has emerged as the world's largest iron ore importer. This relates to her needs as the world's largest steel producer. Japan, Germany and South Korea now rely mostly on seaborne ore imports. The anticipated twenty-first century scale of steel production will require supplementing the old and, in some cases, depleted or uneconomically low grade, northern hemispheric sources of iron ore supply. The southern hemisphere possesses the richer and more abundant supply sources.

4.4 Coal

"Hard coal" includes steam coal, an important industrial and thermal power plant fuel and the somewhat higher grade coking coal, heavily used in its beneficiated form (i.e. coke) as blast furnace fuel in iron and steel works. These were the primary energy resources of the Industrial Revolution. There were abundant coal deposits in the European and North American industrial regions, fueling their rapid nineteenth and twentieth century growth. In more recent times north Chinese coal mining spurred massive Chinese development of heavy industry. Today China is both the world's largest producer and the largest consumer of hard coal.

Total seaborne movements of hard coal in 2007 measured slightly over 800 million tonnes, generating almost 3.8 trillion tonne-miles of ocean transport. Figure 4 depicts the major routes accounting for 65% of the total seaborne movement of hard coal in 2007. Close to three quarters of the total seaborne coal shipments are steam coal; therefore only one quarter, the coking coal, is directly dependent on the state of the iron and steel industry.[7]

Australia has recently outstripped all other coal exporters and the Japanese market has been particularly important to them. Chinese and Indonesian steam coal exports have recently cut into Australia's East Asian markets, however. South African steam coal exports to Europe and Asia constituted quite steady volumes over the last decade. Quite a few years ago an interesting shipping pattern was developed, combining US coal exports from Hampton Roads with South African exports

to the East Asian market. The coal was loaded to the maximum allowable vessel draft on large bulk carriers at Hampton Roads and the carriers "topped off" with coal in South Africa proceeding on to Japanese or other Asian destinations. Other notable sources for coal exports include Colombia which favours the European market for steam coal shipments and western Canada which has directed coking coal shipments towards East Asia. Poland mainly serves European markets on short-distance shipping routes to northwestern and Mediterranean Europe.

US coking coal exports, which were so prominent in early post-World War II times and vital to the rebuilding of European and Japanese industrial economies, have dropped off noticeably in the last decade. However, the US, Russia and China remain huge coal producers and consumers, and still have net surpluses for export.

4.5 Grain

Grain shipments including wheat, barley, rye, oats, maize, sorghum and soybeans make up the most inconstant patterns of the four major bulk commodity trades.[8] There have been large seasonal and year-to-year fluctuations in the volumes and directions of the oceanborne grain trade. Weather, politics and transport costs can be notoriously

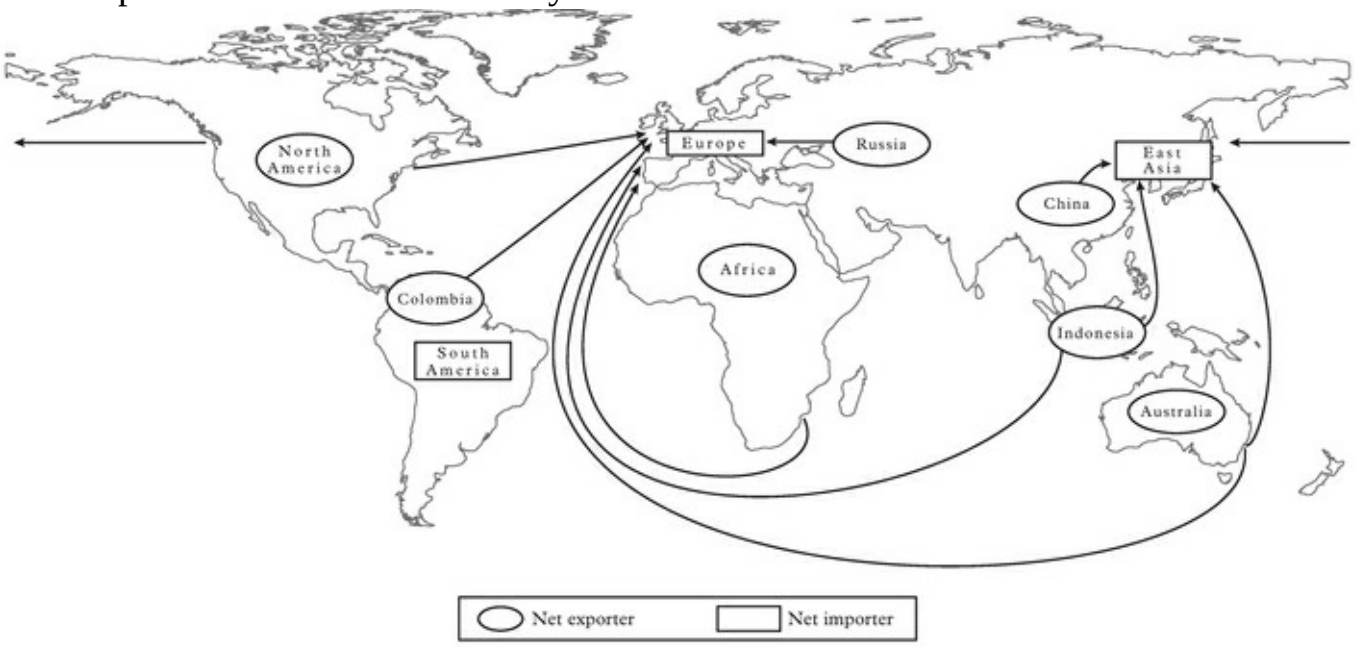


Figure 4: Major coal trade routes, 2007

variable factors. Even so, grain shipments have been a significant component of world seaborne commerce since ancient times. The grain trade typically attracts tramp shipping which can adjust to the inherent variability. A few very large grain companies such as Cargill, Continental Grain, Bunge, and Dreyfus have had a large influence on the patterns of grain trade, too (Morgan, 1979).

In 2007 seaborne trade of the grain types mentioned above totaled 341 million tonnes, generating over 1.9 trillion tonne-miles in ocean transport. Despite the year-to-year fluctuations of the volumes and directions of the ocean trading routes there have been source countries that, year after year, have been net exporters. These include the US, Canada, Brazil, Argentina and Australia. The North American continent has provided the largest volume of oceanborne grain exports.

South America, especially Brazil, has become a prominent grain exporter with soybeans and

soybean meal exports rising in importance. In recent years some of the regions producing the grains in Australia have suffered from persistent drought conditions and grain exports were at a low point in 2007.

Figure 5 shows the major grain trade routes on which 73% of the world's seaborne grain shipments moved in year 2007. Intercontinental flows of grain are complex and, as mentioned, vary from year-to-year. Parts of Europe, e.g. France, are net exporters; other parts, e.g. several East European countries, have often been net importers. The northern countries of South America are net importers whereas Brazil, Uruguay and Argentina are exporters.

The markets are different in different countries for different types of grains, some of which are domestically produced; others of which are not.

East Asia, notably including Japan, South Korea, China and Taiwan, with their large populations and, in some cases, relatively limited available arable land, exerts the strongest market demand for imported grains. To a certain extent, the "green revolution" has rescued parts of South Asia, especially India, from what had become an overdependence on grain imports. Other parts of the developing world have not been as fortunate. Africa, for example, has some alarming agricultural problems ranging from desertification and drought in the Sahel, to the dreadful impacts of civil wars on farming, to ruinously low, artificially-set crop prices, to the chaotic land-holding "reforms" in Zimbabwe, once a land of great grain-producing potential. Africa, with these problems and its fast-growing population, has been forced to become a rather large grain importer. The grain shipments are often, of necessity, enabled by foreign aid and relief programs.

Despite variations from year to year in the grain production of each of the major supply sources, and variations also in market procurement programmes, the total annual volume of the seaborne grain trade took no wild fluctuations in the last two decades, rising at a fairly steady pace to a high point in 2007.[9] Actually the percentage of world grain production that enters ocean shipping channels is comparatively small. Most of the world's largest grain producers, for instance Russia, China, India and the United States, consume domestically a large proportion of their annual grain production.

4.6 A composite picture

Visualising the four major bulk commodity ocean trades in geographical perspective, as rather crudely sketched in Figure 6, a composite picture, one recognises immediately that a large portion of the cargo flow has been aimed at what should be carefully

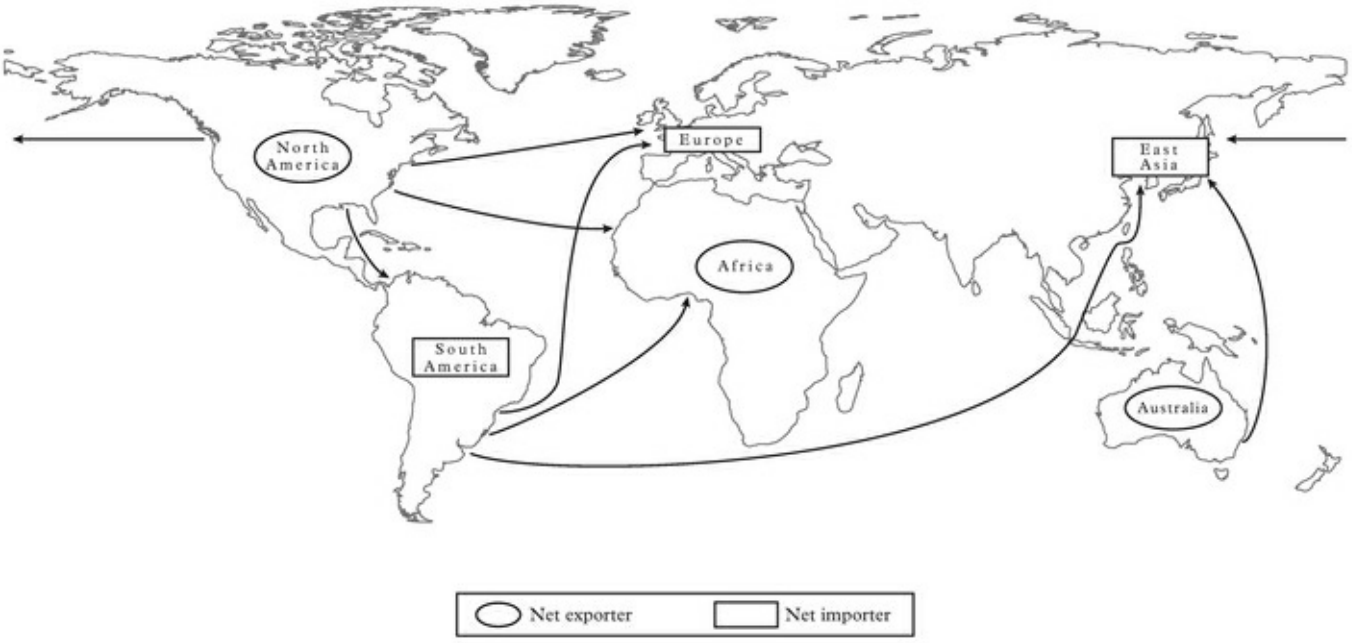


Figure 5: Major grain trade routes, 2007

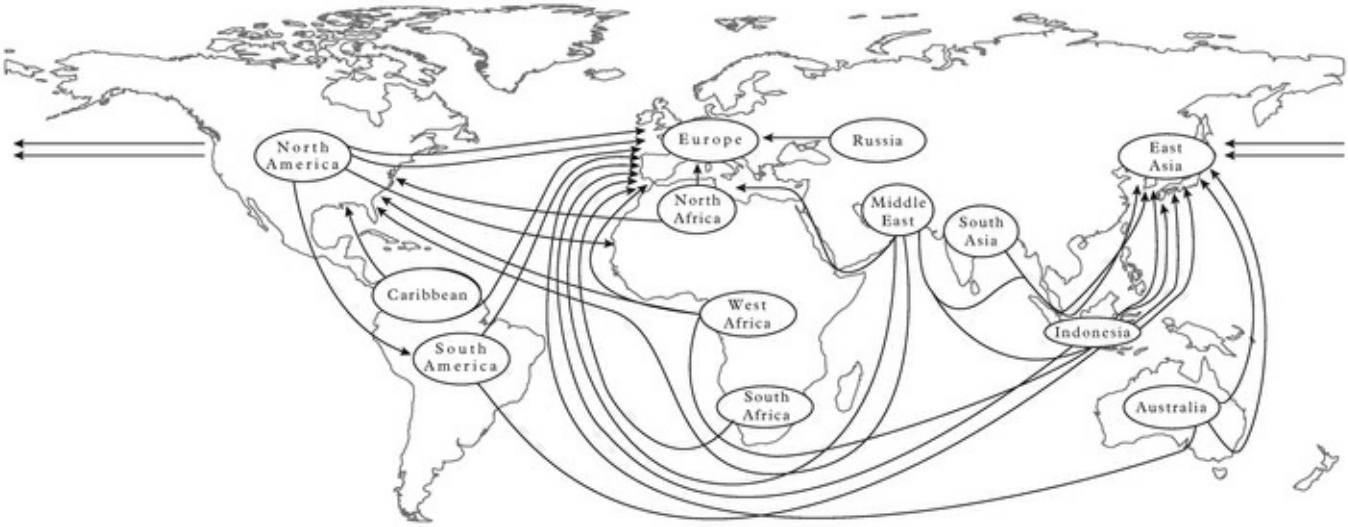


Figure 6: Major bulk trades, composite picture, 2007

branded as industrialised core regions *within* East Asia, Europe and North America. Europe and East Asia have been the two greatest bulk commodity importers. North America, while a net exporter of coal and grain, is, however, the recipient of huge quantities of crude oil from the Caribbean (esp. Venezuela), Africa, the Middle East and lesser sources. A sizeable portion of the coal and grain trades has been *between* North America and Europe and between North America and East Asia, trades entirely within the northern hemisphere.

The world's greatest oil producing region, the Middle East, is also in the northern hemisphere and practically athwart the main ocean shipping corridor from East Asia across the Indian Ocean, through the Red Sea and Suez Canal, to the Mediterranean and Western Europe. The largest tankers, however,

must dip into the southern hemisphere rounding the southern edge of Africa to perform their transport task of carrying oil to Europe or to the US. (Figure 6 takes graphic liberties by assuming that the main volumes of bulk commodity ocean trade are not shipped via either the Suez or Panama Canals.) The southern hemisphere is not "neglected" by bulk carriers because South American, African, Indonesian and Australian supply sources are a very significant factor in bulk commodity ocean trade.

When one considers Venezuelan oil, Brazilian iron ore, Colombian coal, and Brazilian and Argentine grain, not to mention other somewhat smaller supply sources, South America has been an important contemporary exporter of all four major bulk commodities entering ocean trade. Australia, with its abundant mineral reserves and its grain fields, has been a significant supplier of three of the four main bulk commodities – all except oil. The commercial ties between Australia and Japan, enabling the shipments, especially of iron ore, were consolidated by long term contracts on purchases and shipments and Japanese participation in infrastructure developments to facilitate these trades (Manners, 1971, p. 317). China has more recently entered the Australian picture to become the most important iron ore procurer of all.

Figure 6 depicts origins, destinations and directions of seaborne bulk commodity movements which constituted 75% of the total volume of the crude oil, iron ore, coal and grain bulk trades and an even greater percentage of the tonne-miles in ocean transport. The voyage lengths in the oil and ore trades are apparent simply by noting the number of routes rounding the Cape of Good Hope on Figure 6 and understanding the limitations created by the mammoth size of some of the largest tankers and ore carriers. Of course, there are counterbalancing scale economies in transport which have made the mega-ships appealing to vessel operators. There is no visual expression in Figure 6 of the comparative tonnages of cargo flow on the various routes, nor is there a precise picture of ocean tracks taken by the carriers. Most of the Suez and Panama transits have been "assumed away", whereas, in fact, these canals have been on the itineraries of many smaller-size bulk carriers and have figured importantly on ballast voyages.

The composite picture is essentially a "laden voyage" picture. That is to say, ballast voyage segments are not shown and, of course, ships in ballast have contributed almost as much to the congestion of traffic lanes and to the incidence of accidents at sea as fully laden ships, although the latter are more of an environmental hazard if accidents do take place. One can deduce from available traffic data, much of which has been used above in composing the picture, that the main approaches to western Europe, Japan and the eastern coast of the US have been very heavily trafficked by ships, full or empty, serving the industrial core regions of the northern hemisphere that generate so much of the world's oceanborne bulk trade. One can deduce, also, that there are traffic convergences at straits such as Malacca, Lombok, Hormuz, Gibraltar and Dover. One can imagine that there are convergences of full and empty ships rounding Cape of Good Hope and other promontories where the dangers of "hugging the coast" to shorten voyages can never be completely removed by traffic separation schemes.

The rough tracings of global bulk commodity trades reinforce the impression that the northern core industrial regions have been the main focus of market demand. And this might also reinforce the impressions conveyed by dependency theorists a few decades ago and voiced by the UNCTAD Committee on Shipping in the 1970s and 1980s, suggesting that not only the *control* of world merchant fleets, under whatever flag, but also the relevant supply and demand elasticities for the

products exported favor the developed nations in the industrial core regions. As Alexander Yeats wrote almost 30 years ago: “The incidence (that is, the question of who pays transport costs in a trading transaction) of freight rates depends on the relative elasticities of supply and demand for the goods transported. Theoretical analyses show that the relevant elasticities are such that developing countries have borne a major portion of increased transport costs for both exports and imports” (Yeats, 1981, p. 2).

The patterns graphically presented in Figures 2, 3, 4, 5 and 6 suggest that there has been a great deal of empty space on ships steaming about the oceans, fully manned, consuming fuel, as they ballast to their next loading range. There may be no way to eradicate this problem, but the next section of the chapter explores possible strategies by independent ship operators to ameliorate it.

5. Feasibility of Combining Bulk Trades

In the late 1970s, when the world energy crisis was acute, Deeds (1978) and Fleming (1978) both addressed the issue of reducing ballast steaming as a percentage of total voyage steaming. Both considered patterns in the bulk commodity trades. The use of combination carriers (e.g. OBOs) offered a flexibility that allowed the accommodation of any of the four main oceanborne bulk commodities. The ballast leg, in Deeds’ words, “ties together many of the world’s shipping routes in a world where complete reciprocal specific complementarity does not exist” (Deeds, 1978, p. 87). In other words there are almost always regional imbalances and ballasting becomes a necessity. Careful routeing can reduce the percentage of ballast steaming if an OBO, for instance, can move from one commodity trade to another. Deeds examined the regional imbalances in some detail and experimented with different combinations, alternatives and scenarios, arriving at a routeing model, using OBOs, that would reduce ballast steaming, vastly reduce annual fuel oil consumption for the fleet, increase the rates of vessel utilisation and annual work capacity of each vessel, thereby reducing the necessary size of the bulk carrier fleet.

Deeds constructed his final model using recorded bulk commodity trade data at a high level of geographical generalisation. Fleming’s model that combined four different bulk commodity trades in logical geographic sequence was even more abstract. A comparison of the four trades using specialised bulk carriers in back-and-forth shuttle service on each route with an OBO fleet moving progressively from one bulk trade to the next showed the theoretical cost and efficiency benefits of combining the trades. Both researchers were impressed by the potential of the modern-day combined carrier but both were skeptical that the actual geographic configurations of global bulk commodity shipments would ever match their idealised models.

What has prevented the combined carrier from catching on? More than two decades of decline in the size of the combined carrier fleet in numbers of ships and total deadweight capacity left only 99 ships totaling 9.3 million deadweight capacity in 2007 (*Fearnleys Review 2008*, p. 64). One might begin by asking who controls the oil, ore, coal and grain trades. Obviously the big oil, steel, and grain trading companies have huge shipping influence and often have had large proprietary fleets of vessels under their ownership or firm control. Understandably, these companies have been primarily interested in the transport of their own basic raw materials or energy resources. Tying together diverse commodity trades has not been their first priority, although the flexibility inherent in the combined carrier may have had some appeal when their own trade was in the doldrums. In normal times,

however, the industrial carrier, controlling and securing the transport requirements for the firm, serves the production and marketing divisions of the larger corporation and tries to provide an efficient, reliable, timely, transportation service. Routeing efficiency and low fuel consumption are not likely to be ruling considerations, although annual work capacity of the fleet is a significant long-term concern.

Proprietary carriers, especially in the oil trades, have been wooed by the dramatic economies of scale derived from mega-ship transport despite the inflexibility in routeing that large size adds to the inherent inflexibility of specialised single-purpose vessels. Extremely low costs per tonne-mile seem to magnify the advantages of the supertanker, for example, and assuage the disadvantages of longer-distance voyages. (One sometimes forgets that the cost per tonne of carrying a bulk commodity in a ship of given size and specifications is *always* going to be higher on a long voyage than on a short voyage). The costs per deadweight tonne of capacity of building a combined carrier are, to be sure, considerably higher – some estimate 25% higher – than the costs of building a single purpose vessel of the same cargo carrying capacity. Admittedly, also, scheduling ships on back-and-forth shuttle service between the company's own terminal facilities, as is the case on many of the oil company trade routes, is less complicated than arranging more elaborate and time-consuming itineraries that combine different trades and different commodities. Moreover, there are "time economies" that come from ballasting straight home for the next outbound voyage.

When governments or government agencies develop industrial or shipping policies that allow them to intrude in the development of shipping networks and merchant fleets, the complexion of the issues, objectives and priorities, with respect to the transport function, may change. The careful bulk commodity-routeing strategies of BISCORE when British Steel was a nationalised venture, and in the 1960s the use of combined carriers by SIDERMAR, the shipping wing of Finsider, the Italian state-owned steel combine, are cases in point. Perhaps there was less attention to the immediate "bottom line" of the bulk commodity shipping operation, but more attention to longer-term planning of voyages and voyage combinations, usually resulting in a more efficient and productive use of the fleet. SIDERMAR, for a while, combined coking coal cargoes eastbound from the US to Italian steelworks with iron ore cargoes westbound from West Africa to the US, the westbound shipments for the account of an *American* steel company (Fleming, 1968, p. 31). Of course, this sort of tramp-like service was easier in those days when multiple-purpose "10,000 tonners" were still being used. The government agencies in such cases had a proprietary interest in the transport function. One supposes that, beyond their transportation service to the national steel company, certain general principles of fuel conservation, environmental safety and even the implementation of national political objectives could have come into play.

There is another major component in bulk commodity ocean trading and that is the independent shipowner, or the modern version of the tramp shipping operator. Some of these shipowners, whose names have become legendary in shipping circles, built enormous fleets of tankers or dry bulk carriers. Also, many of the owners were serious students of the patterns and trends of the bulk commodity trades. Most of their vessels were "ships for hire". Their fleets were fixed on charters of various durations, from spot voyage charters to long-term bareboat charters. Quite often the long term charterers were "big oil" or "big steel" or "big mining" concerns and, for all intents and purposes, the ships became part of the proprietary carrier fleet.

One of the most successful steamship operators of the twentieth century was Erling Naess, a

Norwegian who pioneered the financing, building and operating, under charter contracts, of fleets of OBOs and other versatile bulk carriers. In Naess' own words: "For owners of large bulk carriers the secret of operating a profitable shipping business is to a large extent one of arranging trading patterns in such a way that the time at sea in loaded condition exceeds the time at sea in ballast condition." Later, "I spent much of my time dreaming up 'combination trades' in which the individual market rates might appear uneconomic but in combination with return trades a satisfactory return might be secured." And, still later, "I was strongly in favour of 'combination carriers', later known as OBOs, which could carry liquid or alternatively dry cargo." (Naess, 1973, p. 191). By clever choices of trading patterns Naess was able to reduce ballast steaming dramatically. On an 89-day voyage, for instance, loading coal at Norfolk for Japan via the Panama Canal, ballasting to the Persian Gulf, loading crude oil for Portland, Maine and ballasting back to Norfolk he calculated only 19 days in ballast or 25% of the total steaming days (Naess, 1977, p.150).[10]

One concludes that it is not necessary to have official government collaboration in the shipping programs or even official agreements between the different commodity trades to make combination trades work. The independent steamship operator with a fleet of combined carriers should be able to discover the efficient geographic patterns, latch on to them for as long as the commodity flows last and the transport service is providing mutual benefit to carrier and shipper, and retain the flexibility to move all or part of the fleet elsewhere when contracts expire. *Theoretically*, it's appealing.

To be realistic, contemporary evidence suggests that neither combined carriers nor combined bulk commodity trades have caught on with the big shippers or with proprietary carrier fleets. Nevertheless, there are many independent ship operators today who combine bulk and break-bulk cargoes on smaller, versatile, multipurpose vessels that still make combinations work, serving parts of the world that may not yet generate huge cargo volumes and often do not yet have harbours and port facilities that can handle mega-ships. There are a multitude of smaller bulk trades and trade routes that do not appear on Figures 2 through 6. There are many possible combinations and there are many tramp operations of modest size that involve much more than one bulk commodity trade on one trade route. It is not unrealistic to suppose that combinations of trades do more than accommodate "demand for spot transit of bulk commodities" and go beyond the "derived and marginal character of the demand for tramp shipping services", therefore beyond some of the usual theoretical explanations of the rationale for these services (Metaxas, 1971, pp. 4, 41, 230).

One could hardly expect the tramp operator to adopt highly idealistic policies of ballast reduction to help the world in an energy crisis, or of combining trades for the sake of international good will. However, more efficient patterns of movement can be more profitable patterns of movement and *that* should appeal to most tramp operators and independent shipowners.

The trade-offs between ship size and ship versatility have been a constant concern for commercial shipping lines whether in tramp or liner service and whether they carry bulk or break-bulk commodities, containers, roll on/roll off items, reefer cargoes, or passengers. There are physical geographic limitations for mega-ships – shallow waters, harbours without sufficient maneuvering room, restrictive canal dimensions, etc. And there are market limitations – insufficient or irregular cargo flows, etc. One remembers the disastrously low passenger complement on the first eastbound transatlantic voyage of the Great Eastern, a "ship before its time"; and one recalls the bankrupting

experience of an American container line unable to achieve break-even load factors in their round-the-world service in the 1980s.

6. General Cargo Trades: 2007

The seaborne cargo flows in the bulk commodity trade are obviously unidirectional, from supply sources en route to market locations, as depicted graphically in Figures 2, 3, 4, 5 and 6. This creates a ballasting necessity, either to return to the original loading range or to move “onward” to a different trade route and, if combined carriers are used, a different commodity to carry. General cargo trades, those served by container lines, for example, nearly always have bidirectional cargo movements. The need for ballast legs without *any* paying cargo aboard is not as important a concern for liner shipping on the major general cargo routes as it has been for tramp shipping.

Yet there remains a problem that cannot be eliminated. Seldom are the liner trades directionally in balance in size of cargo flows. This means that a container ship very often has a high achieved load factor, in percentage of slots filled with revenue-paying containers, in one direction and a low load factor in the opposite direction, with many slots filled with empty containers being “positioned” for the heavier flow direction. Furthermore, the directional imbalances can vary for many different reasons, economic and political. One of the big challenges for the liner operator is to cope with these imbalances that create unused revenue cargo space if the vessels are used in simple bidirectional shuttle service.

6.1 Network strategies

As in the bulk trades, one of the ways to cope with empty space involves routeing strategies that discover the most appropriate itineraries, port sequences, transhipment junctions and methods of tying one liner route to another so that vessels can avoid the weak cargo flow direction of one liner route by slipping into an adjoining liner route with stronger cargo prospects. In attempts to handle the directional imbalance problem and elevate the achieved load factors (i.e. capacity utilisation percentage) for the extended voyage, some of the major container lines, Evergreen, for instance, constructed elaborate globe – encircling network systems, choosing strategically located hubs for transhipment purposes as they coordinated schedules of main line and feeder services. Naturally they tried to select ports of call with the most powerful cargo-generating local and regional hinterlands. Unfortunately round-the-world service with its itinerary, network, and timing complexities, has proved difficult to operate and difficult to market. There always seemed to be weak links in the globe-encircling chain. Several container lines, instead, developed pendulum systems which allowed them to serve all three of the major industrial core regions leaving out *one* ocean: Atlantic or Pacific or Indian, and using coordinated intermodal connections, overland, to penetrate or sometimes cross large landmasses like North America. The pendulum networks and itineraries needed to be flexible enough, and the size of the container line fleet needed to be adjustable enough to adapt to changing market conditions in a competitive environment.

Doctoring a liner network for maximum operating efficiency needs to be a constant consideration, but doctoring it for maximum freight revenue generation is very important too. And the two types of doctoring may conflict with one another. In recent years the container lines, having rushed headlong into the acquisition of mega-ships, scheduled these vessels on long voyages on the heavy-volume *inter-core* routes calling at relatively few ports, transhipping frequently to extend their market reach.

Some gravitated towards hub-and-spoke systems. The latter offer strong market-penetrating potential but one should remember that pure hub-and-spoke networks have, in graph theoretical terms, minimal connectivity. This means that there is only one path, and no alternatives, between any two points in the system, and that path is either to or through the hub. This translates, in fact, to lower rates of vessel utilisation and lower annual work capacities for the fleet if both main line and feeder services are under the same corporate roof. It could also amplify the directional imbalance problem by shifting it to the feeder services. However, both the network connectivity problem and the directional imbalance problem are not without solutions when the large container line shifts focus from main line to feeder line and does the necessary network-doctoring.[11]

The arguments for hub-and-spoke networks are much stronger on the revenue side of the voyage proforma than on the cost side. Andrew Goetz, in an article on the US airline industry, commented, "The widespread adoption of hub-and-spoke networks conferred tremendous economies of scope to airlines, as the costs of adding each additional spoke to a hub are generally quite small in comparison to the benefits of increased traffic feed." (Goetz, 2002 p. 3). Are there parallels to this in the container trades? Generally speaking, yes. The carriers are willing to incur the cost inefficiencies inherent in hub-and-spoke operations if the "traffic feed" to and from their main line service is sufficiently enhanced and the freight revenues sufficiently compensatory. Remember, however, that hub-and-spoke operations entail transhipments, and potential cargo can be lost to competitors who offer direct port calls rather than transhipment service.

6.2 Northern latitudes

The impact of the East Asian, European and North American industrial core regions on general cargo trades and, more specifically, on container trades is even more spectacular than their impact, largely as a market destination, on bulk commodity seaborne shipping. More than 70% of global seaborne container trade is "inter-core"[12] (see Figure 7). Periphery-core ocean shipping connections (see Figure 6) have had more significance in the bulk trades; however there have been notable increases in break-bulk cargoes on smaller multiple purpose as well as special purpose (e.g. heavy lift) vessels. South American and African container line trade with the industrialised regions of the northern hemisphere has trended upward but is still impeded by inadequate infrastructure for container logistics. In some parts of the south it has been recently estimated that less than half of the containerisable commodities are yet containerised.

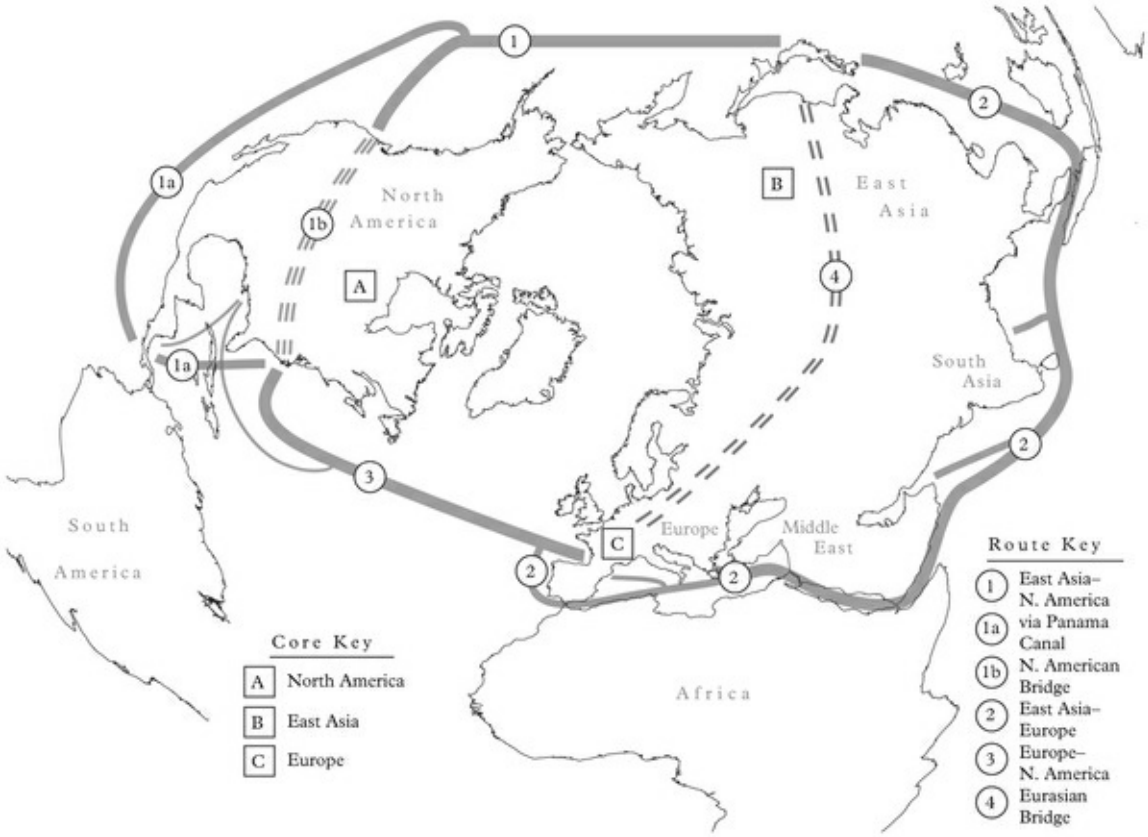


Figure 7: Global inter-core container trade

Container lines have not abandoned the rest of the world but there is no doubt that they have found most of their freight in northern latitudes. In the developed nations of the north and neighbouring rapidly developing economies it is estimated that roughly 80% of the containerisable general cargo is now being containerised although an estimate of 65% for India was recently noted.[13] The world's largest container lines with the world's largest container ships have gravitated to the heavy volume east–west inter-core routes. They offer transatlantic, transpacific and Asia–Europe via Indian Ocean services, all north of the equator. These are heavy volume routes that, together, ring the globe with cargo flows in both directions, east–west and west–east. The traditional all-water routes via the Panama Canal and Suez Canal have been supplemented by continental overland bridge routes (sketched in Figure 7), notably in and across North America. There are now three options for container flows from Asia to eastern North America: (1) transpacific, then transloading to the overland bridge; (2) all-water transpacific eastbound via Panama Canal (with present ship size limitations); and (3) all-water westbound, using the Suez Canal, then transMediterranean and transatlantic. All these options are used by container lines today. In recent years, there has been a remarkable rise in intra-Asian seaborne container trade on Route 2 and beyond.

The three major transoceanic routes and the intra-Asian as well as intra-European seaborne container trades have attracted feeder traffic from the southern hemisphere at strategically located points such as Singapore, Colombo, Dubai, Algeciras, Freeport (Bahamas) and at transhipment terminals at either end of the Panama Canal. At these points the container transfer is often between medium-sized container ships on medium-volume trade routes and the 8,000 TEU mega-ships that have been seen more and more frequently on the ring of main-line routes. Recent deliveries of Maersk's 12,500 TEU vessels and the dampening effects of economic recession, not to mention the escalation of bunker prices, certainly accentuate the vessel assignment and vessel routeing problem.

The economies of scale measured by (low) slot costs of the megaships need to be accompanied by economies of scope increasing traffic feed, thereby increasing the percentage of slots filled with revenue-paying containers.

Large container lines operating large container ships need to have a carefully designed global intermodal strategy. There are certain clearly defined physical geographic constraints. Vessels with sufficient beam to load more than 13 containers abreast have been too wide for the Panama Canal locks and this generally means vessels of more than about 4,800 TEU capacity cannot (yet) get through. The widening and deepening of the Panama Canal is a project expected to be completed by 2014. This should allow transit for all but the very largest fully laden container ships and should enhance assignments of vessels to route 1a, one of the East Asia-eastern North America connections mentioned above (see Figure 7) . Important connections between southeast Asia, India, Pakistan, Middle East and eastern North America via the Suez Canal can be served by large container vessels but there are still many ports without adequate water depth to accommodate fully-laden container ships in the 5,000–8,000 TEU capacity range; and these large ships require terminal cranes with enough reach to handle containers lined up on the ship 16 or 17 abreast.

6.3 Directional imbalances

Another area of concern is the directional imbalance of cargo flow on virtually all container routes. The large container lines, with large ships in their fleets, need to be especially sensitive to "weak directions" and "weak segments" in their extensive networks. Sometimes these are created by extraneous factors of global geopolitics or global economic trends like economic recession, or major currency exchange fluctuations. Periodic adjustments need to be made to respond to changes in market demand – e.g. adjustments of network configuration, itineraries, schedules, alliances, fleet capacity, vessel sizes, not to mention freight rate adjustments. This is part of a global strategy that each line constructs and modifies.

From Table 1 one can construct three general scenarios for container line service:

Scenario 1: Shuttle services

- Container lines offer back-and-forth shuttle services on Routes 1.2 and 3.
- There are no special physical geographic constraints except on Route 1 where only Pacific Coast North American ports can be used for mega-ships until the Panama Canal project is completed (est. 2014 or later).
- The least empty space and the best directional balance in year 2007 occurred on Route 3 (transatlantic) where the westbound to eastbound cargo volume ratio was 4.5m TEUs to 2.7m. The west/east ratio on route 1 (transpacific) was 4.2m. to 14.5m. The west-east ratio on Route 2 (Far East-Europe) was 14.7m. to 5.1m.
- The highest total TEU traffic occurred on Route 2 which also has the best en route cargo prospects to/from South Asia and Middle East plus cargo transshipped from the southern hemisphere and ongoing traffic transatlantic along Route 3 to/from eastern North America.

Scenario 2: Round-the-world (RTW) services

- RTW services offered in both directions.
- Complete all-water service limits vessel size to about 4,800 TEU capacity enabling Panama Canal transit.

Table 1: Inter-core container traffic in the year 2007

	TEUs
Route 1 North America–East Asia (westbound)	4,213,489
Route 1 East Asia–North America (eastbound)	14,497,668
Route 2 East Asia–Europe (westbound)	14,704,162
Route 2 Europe–East Asia (eastbound)	5,112,961
Route 3 Europe–North America (westbound)	4,464,206
Route 3 North America–Europe (eastbound)	2,711,037

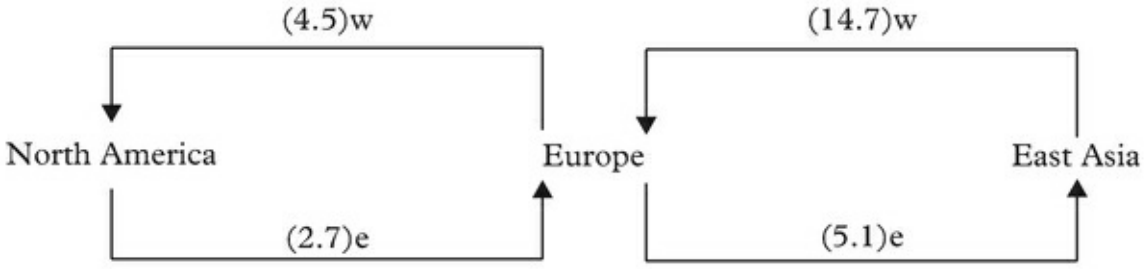
Notes:
North America includes Canada, USA, Mexico
Europe includes all European coasts, Black Sea, Russia and North Africa
East Asia includes all northeast and southeast Asia
Route 2 totals do not include en route cargo generated in South Asia or Middle East on vessels not providing end-to-end service in either direction between Europe and East Asia.
Source: Containerisation International, September 2008 pp. 5, 7. and October, 2008, p. 4.

- Using the data from Table 1, an eastbound globe encirclement starting in Europe progressing from Route 2 to 1 to 3 would have accumulated 22.3m TEUs (intra-Asian, South Asia and Middle Eastern traffic omitted) whereas a circumnavigation starting in Europe, progressing westbound from Route 3 to 1 to 2 would have accumulated 23.4m TEUs. The balance between eastbound and westbound cargo volumes in 2007 was quite close. However, there would have been a great deal of empty space circling the globe on containerships unless the operators were astute in their choice of transhipment ports, feeder service arrangements, etc. and unless they made the most of Route 2 by tapping into the rapid growth of intra-Asian and South Asian cargoes which have not been included in the above statistical calculations.

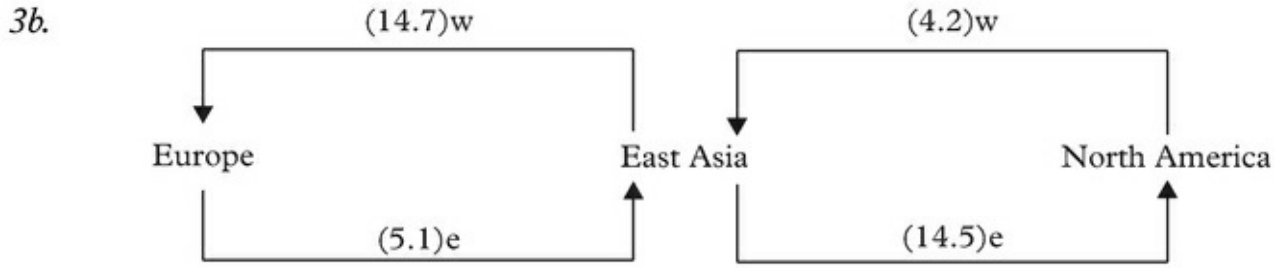
Scenario 3: Pendulum services

- Container lines can construct three types of pendulum service, one centered on Europe, one centered on East Asia and one on North America.
- The diagrams below indicate 2007 TEU volumes in millions; e = eastbound, w = westbound.

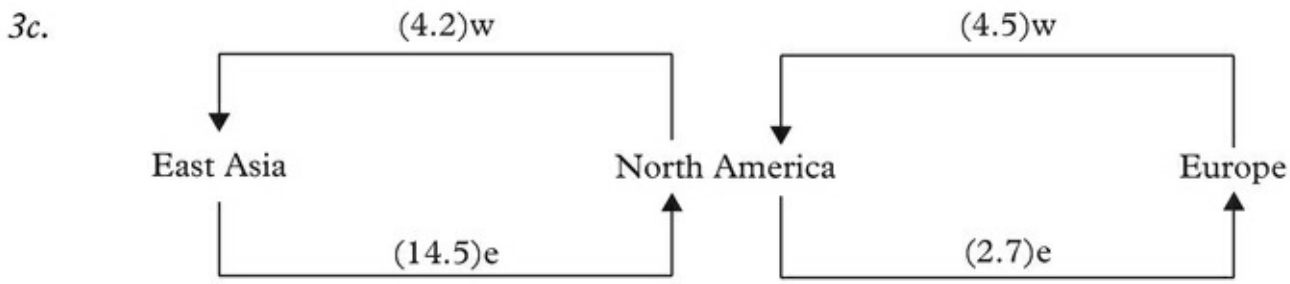
3a.



- no special constraint on vessel size; mega-ships use east coast North America ports;
- the least empty space of the pendulum services;
- lowest total traffic potential.



- no special constraint on vessel size;
- the most acute directional imbalances of the three scenarios;
- heaviest total traffic potential, especially if Indian and Middle Eastern traffic feeding in to or out of Route 2 is counted;
- presence on the two heaviest volume routes: transpacific eastbound and East Asia-Europe westbound.



- all water service via Panama Canal limits size of vessels to about 4800 TEU capacity;
- presence on heavy cargo volume transpacific eastbound route;
- most comprehensive access to North American intermodal system.

These scenarios suggest some of the general geographical factors of network structure, traffic densities and favoured directions of movement that enter into the container line's thinking as global strategies are constructed. It should be emphasised that there are many other factors in the decision equation, for instance the revenue yields per filled slot which vary from one route to another, the break-even load factors for ships of different sizes on different routes, the degree of competition on the various routes, the amount of traffic feed that might be expected at well-chosen transhipment hubs. And, for each container line, there are always the possibilities of finding "special niches" to enhance market share.

There is no fail-safe scenario. Each requires reevaluation as market conditions change, for better or for worse. The empty space problem engendered by "weak directions" and weak route segments can sometimes be softened by moving from one scenario, or form of service, to another. Every one of the big container lines has used shuttle services and pendulum services in the past. A few of the largest lines have tried RTW services, some like US Lines in the 1980s very unsuccessfully (Lim, 1996). Evergreen, the huge Taiwanese carrier, whose competition really precipitated US Lines demise, announced, not much later, the cessation of their RTW services, replacing them with pendulum services, one centred on North America using 4,200 TEU vessels and Panama Canal transit, and the other centred on East Asia using new 5,600 TEU vessels.[14] The need to accommodate mega-ships, recently of 8,000 TEU capacity or more has become a vital consideration in network decisions.

Apparently the promise of low slot costs outweighs the fears of overcapacity, leading to cut throat competition, low yields per slot, and the inherent inflexibility in the operation of these huge vessels.

7. Summary and Prospects

Analysing the empty-space phenomenon, whether from bulk carriers in ballast or from container ships with low achieved load factors, one can certainly find flaws in some of the network efficiencies. However, much of the empty space problem for the world merchant fleets, in aggregate, stems from unavoidable commercial geographic realities, namely the spatial separation – by oceans – of regions of production and regions of consumption and the directional imbalances of cargo flows on each trade route. “Overbuilding” in the 1990s and 2000s has added to the problem. There is very little prospect of correcting the flaws in global network efficiencies by any sort of comprehensive governmental “edict”. There is every reason to hope, however, that individual steamship operators in both bulk and liner trades will use their own ingenuity to fashion networks and patterns of operation that will enhance their capacity utilisation, annual fleet work capacity, and, on the revenue side, annual fleet yields. There is no general prescription for success; however, each carrier, serving a geographical domain that is somewhat unique in its specifics, with a fleet that is somewhat unique in vessel sizes and specifications, should be able to differentiate itself from its competitors in some “attractive” way. Yet there have been many recent indications of “copy-cat behavior” in the liner trades – not a good sign, perhaps, if it leads to indiscriminately competitive efforts, overbuilding, overcapacity, bankruptcies, emergency mergers, and the like.

The trend towards using mega-ships in both bulk and liner trades complicates network strategies and, unless market demand is really robust, compounds the empty space problem. There is, as mentioned, an inherent inflexibility from large size although, of course, the ship operators count on this being outweighed by scale economies, measured in unit costs of transport.

Unfortunately the combined carrier for bulk trades, while conceptually appealing, has not lived up to its former promise or, in Erling Naess’ case, its former success. (Naess, 1977, chap. 21). Many operators have complained that dry and liquid bulk commodity trades just do not mix, not only because of expensive vessel design, cleaning costs when shifting trades, etc., but also because of difficulties coordinating trades between two or more “masters,” each absorbed with own-company needs. Many of the remaining combined carriers still in operation have reverted to the carriage of one commodity type, liquid or dry. So much for flexibility!

There is little doubt that the twenty-first century will bring more development of southern hemispheric trade routes, especially for container lines. It has been estimated that only 50% of the containerisable commodities in the developing economies are, in fact, containerised for ocean transport whereas the percentage in the developed economies approaches 90. It is predictable that as (or if) trade itself grows, and as the infrastructure for container handling and intermodalism continues to develop, the volumes of containerized cargo in all parts of the world will increase. Clearly they *have* increased for China, India, Brazil, Mexico, Malaysia and others.

China and India are special cases, both with enormous growth potential in the container trades. Well over half the containerised cargo imported by North America and an estimated third of global seaborne container exports involve China and these fractions may well increase in size, despite the recent recessionary slump in trade, as more and larger vessels offer direct calls in China. Both China

and India are on the main pathway from Japan and Korea to Europe, so their burgeoning ocean transport needs will accentuate the east–west northern hemispheric ring of inter-core trade routes. The data that appears in Table 1 for year 2007 traffic on the East Asia–Europe route, as mentioned, do not include the sizeable "intermediate" movements, for instance South Asia and Middle Eastern containers westbound to Europe (2.5m TEUs) and European containers eastbound to the Middle East and South Asia (5m TEUs). South Asia and the Middle East exported 1.2m. TEUs to East Asia and imported an astounding 6.5m. TEUs from East Asia in 2007. Add to this a heavy volume of short-haul intra-Asia cargo (e.g. China–Japan, Japan–South Korea, China–South Korea). And, part of the heavy use of Route 2 of Figure 7 is by ships serving the North America–South Asia and Middle East connection and North America–Southeast Asia connection. This en route traffic potential provides rationale for the use of mega-ships on the East Asia–Europe inter-core route and for the development of en route transhipment terminals.[15]

There is much reason to expect the filling out of networks to and in the southern hemisphere, especially if the South American and African economies rise to their true potential. However, it is unlikely that the dominant inter-core pattern in northern latitudes will disappear. It is too firmly etched on the mercantile maps of the globe.

A final prediction relates specifically to the container trades of the future. There has been much talk of intermodality, total logistics chains, seamless movement of containers, electronic data interchange, and so forth. These are good ideas but not ideas that have yet been fully and perfectly implemented. There always seem to be weak, often time-consuming, links in the chain. One trend, however, that has been notably strong and growing stronger in recent years has been the service contracting between carriers and shippers based on time-volume freight rates. On American container trade routes, the North America–East Asia route, for instance, a large proportion of the total trade falls under these service contracts. The latter seem to reflect a true partnership between shipper and carrier, unlike the more confrontational shipping arrangements of the past. It is hoped that the partnership philosophy based on perceived mutual benefit will prevail in the twenty first century.

Container line operations have grown spectacularly in the last half century as Levinson describes vividly in his recent account of "how the shipping container made the world smaller and the world economy bigger" (Levinson, 2006, front cover). There is still, however, a large volume of baled, crated, bagged, palletised, wheeled, lashed down, loose and "other" general cargo on ships of various size in both tramp and liner service on all our seas and oceans. They have many of the same empty space, ballast requirements, directional imbalances in cargo movements that have been mentioned above and it seems certain that there are commodities that will never fit into a container. In a real sense this makes the maritime scene more interesting.

8. Conclusion

As mentioned at the beginning of this chapter, an important focus was to be on empty cargo space steaming across the oceans. In the bulk commodity trades very often there are shuttle services with half the steaming time for the round voyage in ballast. This can be perceived as lost cargo lifting potential but there are, of course, extenuating circumstances such as the unavailability of return cargoes, and, on a more positive note, the time economies of a ballast run compared to time expended on a slow voyage in a nearby trade at a low freight rate.[16]

Tramp operators undoubtedly search the globe for efficient and profitable patterns of operation and there are ways that they can improve on engaging in shuttle services if they have a fleet of versatile multi-purpose bulk carriers. As mentioned, however, the combined carriers have not been an unqualified success in an age when vessel size and single purpose specialization offer the cost benefits most appreciated by the proprietary carriers.

In the container trades we have noted the most important trade routes and the directional imbalances of cargo flow on those routes. A few strategies were mentioned, including moving back and forth from shuttle services to pendulum services to round-the-world services, or vice versa, to tailor the supply of vessel space more evenly to the demand for it when market conditions change. Of course, this requires a certain amount of operational flexibility. And the carrier's flexibility needs to be weighed against the shippers' usual need for reliable and uninterrupted service.

All told, "flexibility" enters the picture of both tramp and liner shipping in many different shades and colours. It can be a general characteristic and expectation of tramp-shipping operations. It is a built-in quality of a steamship line's network that interlocks various trade routes and services. Its opposite, inflexibility, can be inherent in the operations of single purpose mega-ships.

Flexibility can relate also to a philosophy or grand strategy of company operations which favours a thoughtful adaptability to market conditions and customer needs.

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Endnotes

1. See *Fearnleys Review 2008*, tables on world seaborne trade, p. 48.
2. Actually, there is a span of almost three centuries between the first Spanish galleon transpacific round trip, Acapulco to Manila and return, and the mid-nineteenth century US-built clipper ships plying the Australia-Britain route.
3. See, for instance, the three "flow maps" depicting colonial trades, circa 1775, on pp. 198–199 of *The Times Atlas of World History*.
4. Despite the potential for shifting from one trade to another and despite the fact that the OBO was designed for that very purpose, the combined carriers, today, tend to stick exclusively to one type of bulk commodity trade and the fleet has dwindled in number.
5. As calculated from *Fearnleys Review 2008*. Most of the statistics that are the basis for the analysis of the bulk trades in this chapter come from *Fearnleys Review 2008* and from *SS&Y Monthly Shipping Review*, January, 2009.
6. On paper today it is an institutional bloc, however, there are still quite a few unintegrated parts.
7. See *SS&Y Monthly Shipping Review*, January 2009, p. 5, which differentiates between coking and thermal coal in the seaborne coal trade data.
8. Rice is not included in the data on which this analysis of the grain trade is based. Soybeans, technically not a grain, are included, however, in the calculations by Fearnresearch.
9. See *Fearnleys Review 2008*, p. 48.
10. Of course, the Panamax-size, or smaller OBO vessels used in these earlier days (mid-1960s) were easier to route; shifting trades was easier, too.
11. In fact, some of the feeder line carriers move progressively from one "spoke-end" port to another, adding connectivity to the network. Some of the ports in these "loops" are favoured

with faster cargo-transit times than others.

12. 70% is not, of course, a full indication of the traffic on this route. There are container ships, large and small, serving only segments of the route. Calculations of the 2007 inter-core container volumes are drawn from the trade statistics section (numbers provided by MDS Transmodal) of the September, October and November issues of *Containerisation International* (2008).

13. Evergreen, Maersk, and other container lines have taken delivery of even larger ships recently, creating for the time being an excess capacity for which there is no short-term, pleasant (in cost terms) panacea in sight for the carrier, and unease for the shipper who needs steady, reliable, reasonably priced service.

14. See *Containerisation International*, May, 2008, p. 55.

15. See *Containerisation International*, September, October and November, 2008, Trade Statistics sections. Heavy intra-Asia traffic and containers moving in and out of *segments* of the end-to-end Far East–Europe route (e.g. bidirectional container flows on the Europe–South Asia and Middle East, and North America–South Asia and Middle East routes) add to the Far East–Europe end-end-to-end traffic and make Route 2 (see Figure 7) the most significant connection of all.

16. Assume that a combined carrier is fixed on a dry bulk 30-day voyage, laden outward and ballast return, promising a net profit of $150,000 or $5,000 daily. That might appeal more to the operator than combining the dry bulk trade with a ballast-reducing oil trade back to the original loading range if the combination of the two trades results in a 50-day voyage with a net profit of $200,000 or $4,000 daily. The daily profit is, in a sense, a “running bottom line”.

References

Albion, R.G. (1939): *The Rise of New York Port, 1815–1860* (New York, Charles Scribner’s Sons).

Barraclough, G. (ed.) (1978): *The Times Atlas of World History* (London, Times Books Ltd.).

Braudel, F. (1984): *The Perspective of the World*, Vol. III of *Civilization and Capitalism 15th–18th Century*, trans. Siân Reynolds (New York, Harper & Row).

Couper, A.D. (1972): *The Geography of Sea Transport* (London, Hutchinson University Library).

Deeds, C.L. (1978): “Fuel conservation as a regulation of vessel routeing”, *Maritime Policy & Management*, 5, 75–88.

Ellsworth, P.T. (1958): *The International Economy* (2nd edn.) (New York, The Macmillan Co.).

Fleming, D.K. (1968): “The independent transport carrier in ocean tramp trades”, *Economic Geography*, 44, 21–36.

Fleming, D.K. (1978): “A concept of flexibility”, *Geo Journal*, 2, 111–116.

Fossey, J. (2002): “Trans-Pacific Outlook”, *Jo C Week*, March 25–31, 38.

Gibson, A. and Donovan, A. (2000): *The Abandoned Ocean, A History of United States Maritime Policy* (Columbia, SC, University of South Carolina Press).

Goetz, A.R. (2002): “Deregulation, competition and antitrust implications in the US airline industry”, *Journal of Transport Geography*, 10, 1–19.

Hoover, E. (1948): *The Location of Economic Activity* (New Y ork, McGraw-Hill).

Isard, W. (1956): *Location and Space Economy* (Cambridge, MA, The MIT Press).

Levinson, M. (2006): *The Box* (Princeton, NJ: Princeton University Press).
Lim, S.M. (1996): "Round-the-world service: The rise of Evergreen and the fall of US Lines", *Maritime Policy & Management*, 23, 119–144.
Losch, A. (1953): *The Economics of Location* (2nd edn. trans. Woglom, W. and Stolper, W.) (New York, Science Editions, John Wiley & Sons).
Manners, G. (1971): *The Changing World Market for Iron Ore, 1950–1980, An Economic Geography* (Baltimore, The Johns Hopkins Press).
Metaxas, B.N. (1971): *The Economics of Tramp Shipping* (London, The Athlone Press).
Morgan, D. (1979): *Merchants of Grain* (New Y ork, The Viking Press).
Naess, E.D. (1977): *Autobiography of a Shipping Man* (Colchester, Seatrade Publications Ltd.).
Rostow, W .W . (1962): *The Process of Economic Growth* (2nd edn.) (New York, The Norton Library).
Sargent, A.J. (1930): *Seaways of the Empire* (2nd edn.) (London, A & C Black Ltd.).
Yeats, A.J. (1981): *Shipping and Development Policy, An Integrated Assessment* (New York, Praeger).

Chapter 4

International Trade in Manufactured Goods

*Mary R. Brooks**

1. Introduction

Shipping, on the scale we see today, would not exist were it not for globalisation, and the evolution and restructuring of the world's economies after World War II. The increasing specialisation of the world's economies, and the desire for goods or food made or grown elsewhere, along with increasing urbanisation, has altered the demand for transport. In this chapter, the focus will be on global trade in manufactured goods and the role that shipping plays in this market.

Cargo transported by ship falls into two broad categories – bulk and unitised. The former usually travels via tramp vessels and includes both liquid bulk – mostly crude oil and oil products – and dry bulk, the largest of these being iron ore, grain and coal. As the ocean transport of unitised cargo is the subject of this chapter, bulk cargoes will only be discussed where it is necessary to supply context.

In the bulk sector, the world of shipping has followed a traditional growth pattern. Based on tonne-miles, crude oil, oil products and dry bulk commodities are the most important trades in ocean shipping (Figure 1). Unitised cargo (predominantly containers, and included in other in Figure 1) is not dominant in terms of tonne-miles demanded; it accounted for 25 to 28% of tonne-mile demand in the 1990s, up from 19.9% in 1970, and it continued to grow in importance until 2007.[1]

However, shipping demand in tonne-miles is only one measure of importance. In value terms, trade in manufactured goods drives world prosperity, as manufactured goods account for about 70% of world trade in value terms. This chapter provides an overview of world trade in manufactured goods, the primary user of containerised liner shipping. It begins by identifying the key manufactured goods traded globally, the leading trading nations and the accompanying trade flows. As air cargo is the principal competitor of maritime transport for inter-regional trade in manufactured goods, the role of air cargo is examined briefly. To complete the picture, the trader's view of shipping as a mode choice is discussed and conclusions drawn about what the future may hold for the transport of manufactured goods.

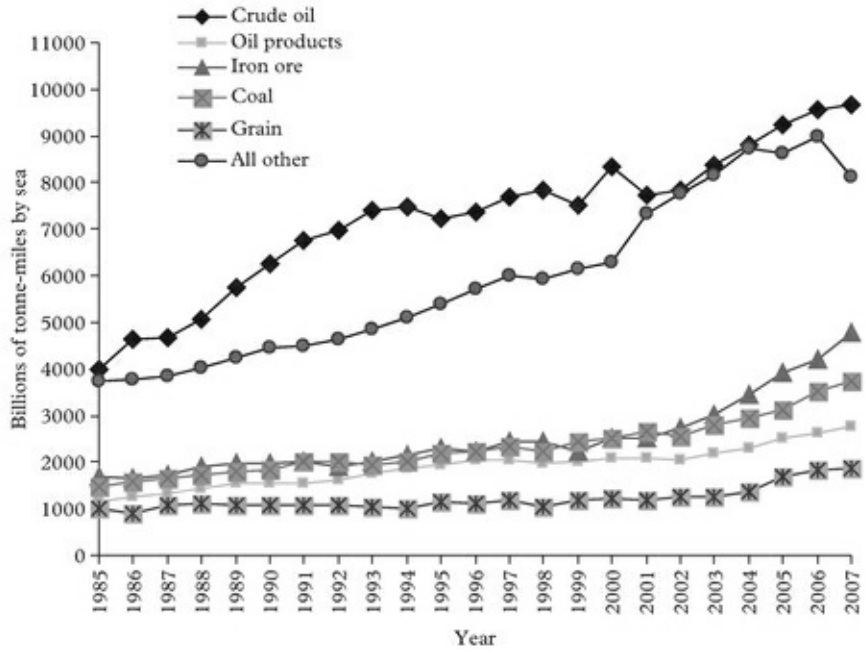

Figure 1: World seaborne trade 1985–2007

Source: Created with data cited by UNCTAD (2009), *Review of Maritime Transport 2008*, Table 5, p. 15 and equivalent tables from prior years' editions.

2. The Key Manufactured Goods Traded Globally

The world in the early days of general cargo shipping looked nothing like the world of trade today. The heyday of trade in tea and silk financed by opium sales to China is long gone. By 1900, China's imports had become more diversified, with cotton goods and yarn replacing opium. While tea and silk may have been China's key exports to Europe in 1870, by 1890 they too had diversified, giving way to shipments of seeds, oil, beans, hides and "all other items" on the westbound leg from Asia.[2]

Product development departments 40 years ago were only beginning to contemplate many of the manufactured goods critical to business today, such as personal computers, mobile phones and wireless devices. However, post-war consumerism was well-established by the late 1950s when Malcolm McLean, in an effort to address inefficiencies in goods transport, conceived the seminal idea of what has now become containerisation. In 1956, he shipped the first "boxes" (really truck chassis) on the *Ideal-X* from New Jersey to Houston, irrevocably changed the way most manufactured goods are transported[3] and laid the foundation for the next wave of globalisation. Mattel's "all-American" Barbie, to use one of Levinson's insightful illustrations, was anything but all-American; her plastic body, clothes and hair all came from various factories in Japan, Taiwan and China.[4] Barbie was conceived in 1959 and this inexpensive item, relatively speaking, could withstand the cost of transport, be made half-way around the globe and still be affordable for a generation of female baby boomers. Transport costs had been dropping steadily since the end of World War II, and no longer offset the cost advantages of Asian labour. Asia continued to compete on wages and became the heart of the manufactured goods sector over the balance of the century. From 1985 to 1990, the average annual growth in containerisable trade on North America/Far East and Far East/Europe trade legs exhibited double-digit growth rates and, after a brief slowdown in the early 1990s, growth in trade production in many Asian nations resumed its former pace. Since then, the rate of growth in merchandise trade has consistently outstripped the rate of growth in world GDP and commodity output.

According to the World Trade Organisation (WTO), trade in manufactured goods accounted for 74.9% of all merchandise exports by value in 2000, significantly higher than the 70.5% recorded in 1990.[5] It included iron and steel, and chemicals, both of which may be carried as bulk commodities, although the chemicals make up a significant component of containerised trade. If these two categories of manufactured goods are discounted, the remaining manufactured goods still made up 63.3% of merchandise exports by value in 2000. Then, by far the largest category of internationally traded manufactured products in 2000 was machinery and transportation equipment, even after the highly visible automotive category was extracted. The WTO reported that growth in 2000 was 6% in manufactured goods, 14.5% in manufacturing exports and only 4% in world GDP.[6] Much of the 1990s' growth had been driven by enhanced labour productivity. However, growth in global sales for office equipment and production machinery was expected to slow, if not stagnate, as the technology revolution completed its restructuring of both the office environment and the shop floor. The growth for the 2000–2007 period was 7.5% in manufactured goods and the forecast for the office and telecom equipment sub-sector had been realised as it was the slowest growing of all export sectors reported.[7]

In 2006, the WTO discontinued reporting machinery and transportation equipment exports separately so Figure 2, which reports the latest available 2007 data, includes this traded good in the Others (semi and manufactures) category. The decline seen for office and telecom equipment was also reflected in other manufactures, although not to the same extent, as the exceptional rise in energy and commodity prices (and hence the fuels and mining products sector) over the seven years took a significant bite out of the share held by most manufactured goods.[8] The share of manufactured goods in world merchandise exports has declined a full 5% since 2000.

As the 2008 data have not yet been released by the WTO, the impact of the economic downturn on the mix of trade is not yet known but is anticipated to be much worse as US and European consumers slowed their spending on consumer goods and energy prices hit a 30-year high in the summer of 2008.

Looking ahead, the world continues to move towards a service economy and, in general, service production activities do not use sea transport. Job growth is in economies and industries that do not contribute to shipping tonne-miles – software, pharmaceuticals, education services, bio-technology, eco-tourism and leisure recreation, and business services. The conversion of world trade from predominantly goods-led to service-led growth is mostly complete.

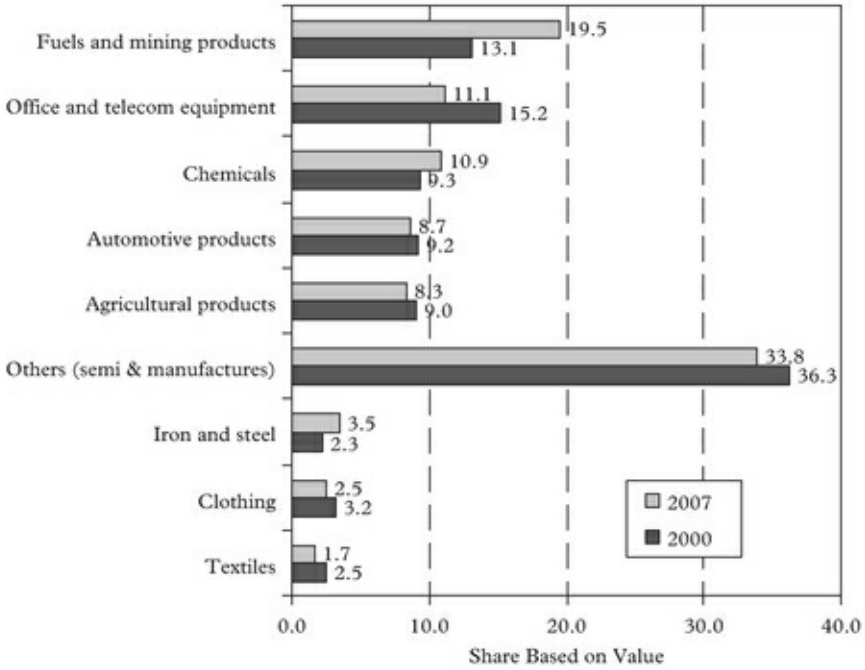

Figure 2: World merchandise exports by product 2000 and 2007 (in US$ billions)

Note: 'Others' includes machinery and transport equipment but excludes both office and telecommunications equipment and automotive products.

Source: Created from data provided by World Trade Organisation (2002), *International Trade Statistics 2001*, Table IV.1, p. 95 and World Trade Organisation (2008), *International Trade Statistics 2008*, Table II.2 from www.wto.org

3. Who are the Leading Traders?

As already noted, export growth in the 1990s was phenomenal in Asia and this continued throughout the economic recovery in the post-2001 period. North American trade was disappointing, as it did not grow at a rate approaching that of Western Europe, let alone Japan and the developing countries of Asia. By 2007, the top 10 world traders are all, with the exception of China, members of the Organisation for Economic Co-operation and Development (Figure 3).[9] Belgium and its neighbour the Netherlands are key gateways for Europe's trade in manufactured goods, supporting Germany's role as the world's second largest consumer and the leading goods producer.

Since the late 1990s, the four BRIC countries – Brazil, Russia, India and China – have captured the imaginations of trade observers and warrant closer attention. While the exports of Brazil have grown at an annual average rate of 17% since 2000, the country ranked twenty-fourth in exports still only accounts for just over 1% of global trade and has not yet recovered its 2% share of world merchandise exports recorded in 1948. More important, Russia's growth 2007 over 2006 was similarly dramatic; Russian exports

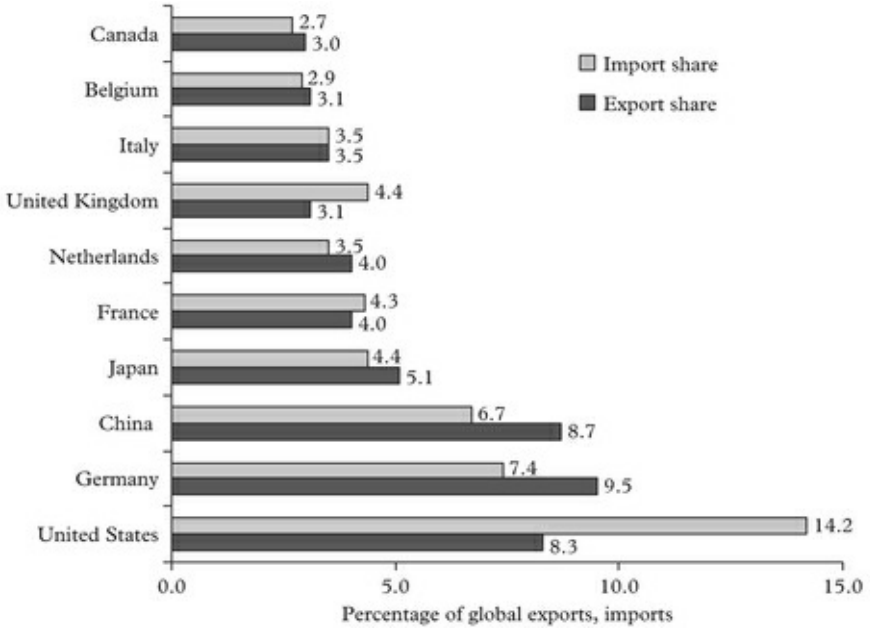

Figure 3: Leading goods traders in 2007

Source: Created from data provided by World Trade Organisation (2008), *International Trade Statistics 2008*, Table 1.8, p. 12 of World Trade Developments section.

grew at 17% over the previous year, moving it to twelfth place among exporters while imports grew 36% over the previous year, to confer the rank of sixteenth. However, both countries continue to play significant global roles in supplying energy, raw materials and food, with manufactured goods being of less importance. India, like Brazil, accounts for just over 1% of global trade and it too has not recovered its post–World War II prominence; it is currently ranked twenty-sixth in merchandise exports, playing a substantial role in IT, office and telecom products. China has been outstripping these three. Since 2001, China's export trade has grown by four times. Its growth has been sufficiently fast to wedge it into the top 10 traders, firmly in third place after the United States and Germany by the end of 2007 in terms of total trade, and in second place from an export perspective.[10] In 2008, Paul Bingham presented Global Insight's conclusions that the top four countries with the capacity to buy global products (measured in terms of GDP rank in real dollars) by 2050 will be China, the US, India and Japan, in that order.[11] Brazil and Russia will be in the Top 10. Therefore these countries, and others in close proximity, may well benefit from the transportation demands such growing wealth and resultant spending on consumer goods will encourage.

Before drawing any conclusions about geographic interests in the trade in manufactured goods, and what that might mean for those with an interest in shipping, it is important to examine the major trade flows of manufactured goods and how much of

Table 1: Intra-regional merchandise trade 2007

Origin	Destination	Share of origin's world trade in %
Europe	Europe	73.5
North America	North America	51.3
Asia	Asia	49.7
South and Central America	South and Central America	24.4
Commonwealth of Independent States	Commonwealth of Independent States	20.2
Middle East	Middle East	12.3
Africa	Africa	9.5

Note: The share in North America is down from 56% in 2000 (p. 3).
Source: Created from data provided by World Trade Organisation (2008), *International Trade Statistics 2008*, Table 1.4, p. 9.

that trade is intra-regional. Throughout the last two decades, trade liberalisation and the development of the World Trade Organisation as a multilateral forum to encourage such liberalization, when coupled with the global restructuring of supply chains, encouraged intercontinental trade growth. However, the 1980s and 1990s also bore witness to an explosion of regional trade agreements – the European Single Market and the subsequent broadening of the European Union; the *Canada–US Trade Agreement* and later the *North American Free Trade Agreement*; Mercosur in South America– encouraging continental trading patterns. By the end of the 1990s, approximately half of world trade was intra-regional.

The seven regional trade flows in manufactured goods presented in Table 1 account for a significant share of world trade. As shipping best supports intercontinental and inter-regional trade, rising intra-regional trade has a dampening effect on growth in shipping demand. The intra-regional flows of the three largest trade blocs (Europe, Asia and North America) are particularly significant, and account for about half of all trade in manufactured goods. The most integrated market is Europe, with 73.5% of its trade classified as intra-regional.

"[T]rade flows within regions account for a higher share of world trade than flows between regions. Since 2000, this share has fluctuated from between [sic] 55 to 58 per cent. Relatively large differences have occurred in the growth of trade within regions: North America and Asia show a relative [sic] balanced growth between inter- and intra-regional trade; Europe's intra-trade is growing much faster than its external trade due to the deepening of its economic integration while South and Central America, Africa, the Middle East and the CIS have recorded higher growth in inter-regional exports than in intra-regional."[12]

Should the trend of trade integration continue along its current path, a prospect not unlikely given US preoccupation with homeland security and its focus on tighter border controls (resulting in a greater administrative burden), how much trade growth will

Table 2: Top trade enabling countries and transport competitiveness indicators

	Subindex		Pillars			
	Transport and communications infrastructure		Availability and quality of transport infrastructure		Availability and quality of transport services	
Country/Economy	**Rank**	**Score**	**Rank**	**Score**	**Rank**	**Score**
Germany	1	5.77	8	5.28	3	5.85
Netherlands	2	5.64	14	5.12	2	5.91
Singapore	3	5.64	12	5.14	1	5.96
Sweden	4	5.63	6	5.35	11	5.3
Hong Kong SAR	5	5.57	11	5.15	6	5.55
Austria	6	5.55	9	5.20	5	5.76
France	7	5.54	1	5.83	10	5.33
Denmark	8	5.50	5	5.44	17	4.97
Switzerland	9	5.49	18	5.04	12	5.17
United States	10	5.48	3	5.54	14	5.08

Note: The rank in the first column is based on one of the four sub-indexes. The ranks in the remaining two columns are component pillars.
Source: Lawrence, Robert Z., Margareta Drzeniek Hanouz, and John Moavenzadeh (2009): *The Global Enabling Trade Report 2009*, Geneva: World Economic Forum, Extracted from Table 4, p. xxii.

be available for ocean transport? The likely answer is a smaller share than is now available. In other words, any rise in protectionism will dampen the demand for shipping more so than already seen from the economic downturn.

This then raises the question of how focused countries are on supporting their future trade to take advantage of global trading opportunities. The World Economic Forum has undertaken to assemble a new report on this issue. The *Global Enabling Trade Report* assesses factors, other than tariffs and quotas, that become barriers to trade, such as border administration, infrastructure, logistics and the business environment traders must contend with in the foreign market. Four indices are created (Table 2) based on nine "pillars" that encourage the development of trade,[13] of which two reflect strong transportation competitiveness inputs (Table 3).

If the top 10 trading nations by value in Figure 3 are compared with the top 10 in transport and communications infrastructure from Table 2, there is only an overlap of four countries – Germany, the Netherlands, France and the United States. However, it should be remembered that Figure 3 represents a "size of economy" construct that Table 2 does not. The remaining six are all smaller economies without the significant home markets that allow them the luxury of trade-destroying protectionism. Even more noticeable is the openness of Europe, which has fostered growth in container trade with Asia (noted previously) as well as rising intra-regional trade.

Table 3: Trade enablers – The two transport-related pillars

Indicator	Best Performer
5th Pillar: Availability and quality of transport infrastructure	
Airport density	Norway
Transshipment connectivity index	United Kingdom
Paved roads	Multiple Economies
Road congestion	Bangladesh
Quality of air transport infrastructure	Singapore
Quality of railroad infrastructure	Switzerland
Quality of roads	France
Quality of port infrastructure	Singapore
6th Pillar: Availability and quality of transport services	
Liner Shipping Connectivity Index	China
Ease and affordability of shipment	Netherlands
Competence of the logistics industry	Netherlands
Ability and ease of tracking	Singapore
Timeliness of shipments in reaching destination	Singapore
Postal service efficiency	Switzerland
GATS commitments in the transport sector	Moldova

Note: This table only has 2 of 9 pillars of trade-enabling indicators. Best performers are extracted from Albania's table, p. 105.
Source: Lawrence, Robert Z., Margareta Drzeniek Hanouz, and John Moavenzadeh (2009): *The Global Enabling Trade Report 2009*, Geneva: World Economic Forum.

4. How are Manufactured Goods Carried?

In some measure, the choice of transport mode for manufactured goods is dictated by shipment characteristics – the value to weight ratio, the value to volume ratio and the size of the shipment. However, it is not quite this simple.

From its inception to the late 1980s, much of the growth in container shipments could be attributed to conversion of breakbulk and general cargoes to a container "format" (penetration). By the late 1990s, that process was mostly complete. While some commodities like scrap and specialty grains made the switch to containers from breakbulk or dry bulk vessels, the value to density ratio of most general cargoes not yet containerised means there will always be some general cargoes carried conventionally. An excellent example of this is project cargo. Often bulky, high-value but high density, this cargo is seldom aligned dimensionally to make the container a suitable option. This means of acquiring traffic growth for liner companies has mostly run its course.

In finished goods trade, a very small percentage of the delivered value of the goods is attributed to transport. A dated Canadian study notes that, in 1986, transport costs

Table 4: Modal split for Canada's export markets 2007 (in thousands of C$)

Destination	Eastern Provinces	Western Provinces	Total exports	Main modes used (percent of total value)
United States	244,748	109,461	354,210	Road (49), Rail (20)
Other Countries	56,521	37,834	94,355	Marine (64), Air (27)
West Europe	30,536	8,514	39,050	Marine (58), Air (38)
Asia	10,569	20,676	31,245	Marine (83), Air (15)
Latin America	7,466	4,121	11,587	Marine (44), Road (23)
Middle East	3,023	1,778	4,800	Marine (63), Air (27)
East Europe	2,004	847	2,851	Marine (51), Air (34)
Oceania	1,437	771	2,208	Marine (50), Air (36)
Africa	1,457	1,120	2,578	Marine (59), Air (23)
Other	30	6	36	Marine (66), Air (32)
Total	293,263	145,667	438,931	

Source: Statistics Canada (2009) *Shipping in Canada, 2006*. Ottawa: Statistics Canada. Cat. No. 54-205-X, http://dsp-psd.pwgsc.gc.ca/collection_2009/statcan/54-205-X/54-205-x2006000-eng.pdf, last accessed 15 June 2009. Table EC-12.

consumed only 2–3% of the export sales value of furniture and fixtures, and motor vehicles, but accounted for 45% of the export sales value of coal.[14] A 1983 US study put the transport cost component at 4% for electronic machinery and instruments, 8% for transportation equipment, 12% for furniture and fixtures, but 24% for petroleum products.[15] A UK study of manufacturing and services industries reported transport costs at 3–6% of production costs.[16] In the 20-plus years since these studies were undertaken, the sheer size of vessels and improvements in speed of cargo handling technologies has dramatically reduced transport costs to nearly negligible in the total price paid by the end consumer. To quote a 2006 International Chamber of Shipping video, "shipping a can of beer costs about one cent".[17]

Therefore, as the value of the goods rises, the importance of transport cost as a function of delivered price diminishes and the value of transport time rises (inventory carrying costs are a function of time and interest rates). Because of this, high-value goods of low density and small shipment volumes become targets for air cargo providers. Hummels attributes the rise in air freight share of global trade to 2000 to technological advances in jet engines and the resultant reduction in air cargo costs; he also attributes the loss of share for air freight after 2000 to rising input costs, particularly fuel.[18]

It is difficult to allocate various commodities to the type of transport they will demand. The trade statistics, while indicating the relative value of flows between countries, provide very little indication of what moves by what mode of transport. In the world of increasingly proprietary data, only a superficial assessment is possible.

Table 4, for example, indicates that modal split is not common across export markets, but that a significant share of Canada's international modal split by value can be

Table 5: Modal shares of US international merchandise trade by value and weight: 2000 and 2001

	Value %		Weight %	
Mode	**2000**	**2001**	**2000**	**2001**
Imports to the United States				
Water	44.4	45.5	78.1	78.7
Air	25.4	23.4	0.4	0.3
Other modes	30.2	31.1	21.5	21.0
Total, all modes	100.0	100.0	100.0	100.0
Exports from the United States				
Water	25.5	27.2	75.5	75.1
Air	36.4	34.4	0.6	0.6
Other modes	38.1	38.4	24.9	24.3
Total, all modes	100.0	100.0	100.0	100.0

Source: Bureau of Transportation Statistics (2003), US International Trade and Freight Transportation Trends, www.bts.gov/publications/us_international_trade_and_freight_transportation_trends/2003/html/table_08.html, last accessed 15 July 2009.

attributed to air, particularly for Western and Eastern Europe and Oceania. The representation of modal split is quite accurate; the remainder of traffic moves by surface transport (road, rail or pipeline), and is generally intra-regional in nature. In the case of North America, the dominance of surface modes is therefore clear. Even so, data errors in "mode of transport" are quite common. Many exporters only know the origin of the goods, not how they were transported to their destination; this may be because the price they charge is based on FCA or EXW terms of sale or because they have outsourced transport decisions to a third party logistics service supplier. Given the sheer volume of transport services outsourced, it is not surprising that a significant number of manufacturers do not know the mode of transport used for the international leg of the journey; they may only know that a truck picked it up.

It has already been noted that significant trade in manufactured goods is intra-regional in nature, and therefore there is a potential target market for ship operators – the short sea market. However, encouraging cargo interests to switch from land transport options to regional shipping is not easy. Where there are very good land-based transport systems in place, particularly Western Europe and North America, short sea development has been a struggle, whereas where regional seas exist (Eastern Europe/Baltic States/Scandanavia and the Mediterranean) that has been less the case.

The case for short sea is particularly market-specific. For example, a Spanish study investigated a road versus short sea discrete mode choice, drawing conclusions about buyer requirements, including cost considerations; it found that shippers' choice of short sea transport is more sensitive to changes in road transport prices than to changes in sea transport costs, and concluded that modal switching to short sea could be induced by imposing an 'ecotax' on road transport.[19]

Although severe congestion in road transport is a widespread problem, short sea or tug/barge transport options are not viewed as positive solutions by many shippers.[20] While it has an image problem in both Europe and the US, in Canada this is not the issue; lack of adoption by Canadian cargo interests has been traced to its failure to meet specific shipper requirements in the current operating cost environment. In particular, short sea shipping has difficulty responding to shippers' need for specific delivery windows required of just-in-time systems, and the usual evaluative criteria of transit times, departure frequencies and costs continue to drive the choices made in favour of more

flexible land routings.[21] While short sea shipping adoption languishes in North America, it has reached a traffic volume in Europe similar to that carried by trucks.

In conclusion, modal splits between truck and sea in manufactured goods are more likely based on the product characteristics and seller/consignee preferences for fast transit time and time-definite delivery. The financial crisis may have changed the value proposition of each of these modes and the modal splits of the future are more likely to reflect the value proposition of the mode more closely attended by the cargo interest.

5. Competition from Air Freight

In the early 1980s, interest rates and the cost of capital increased the likelihood of traders evaluating the carrying costs associated with in-transit inventory in assessing their transport options; efforts to address these costs contributed to tremendous growth in the air cargo industry. Air's share of total trade in 1985 was 13.7% and was forecast by Sclar and Blond to grow to 18.2% by the year 2000;[22] much of the growth was expected to come at the expense of ocean transport, and it did. Air cargo growth in the 1990s was attributable to the growth in product sectors like pharmaceuticals, electronics (office and telecom products in particular) and automotive parts. Because these products have a high value to weight ratio and tend to be time-sensitive, shippers favour air as a mode of transport. Furthermore, the just-in-time nature of time-managed manufacturing and the slimming of retail inventories to the barest necessary enhanced the shift to air cargo in general; the consumer's desire for mass-customised products required the speed and agility that ocean transport is often incapable of delivering. Until the 2008 financial crisis, shippers of high-value, low-density manufactured goods were willing to incur higher transport costs to reduce risk in making and holding inventory. Time-based competition became a new logistics necessity in the 2003–2007 period, and air cargo thrived in these circumstances.

In 2001, the air cargo sector was severely tested by the collapse of the technology sector in early 2001.[23] With 20–25% of air cargo being high- or information-technology products, there was a significant decline in the volume of air cargo by the summer of 2001. The World Trade Center tragedy in September had a further chilling effect on consumer spending that also had to be absorbed by the industry. Air freight volumes were low in 2002 but from 2003 to 2007 growth in air freight volumes recovered, with growth exceeding 15% in early 2004. Volumes deteriorated severely in 2008 in advance of the financial crisis of the fall of 2008. The industry projects recovery in 2011.[24]

As Figure 4 reveals, the largest international air cargo providers are well-established airlines, some with passenger services, but all with substantial cargo-handling capability. With the quality of service provided by air cargo operators to trading interests, the use of air cargo resumed its very high growth rate throughout the 2000s as higher value

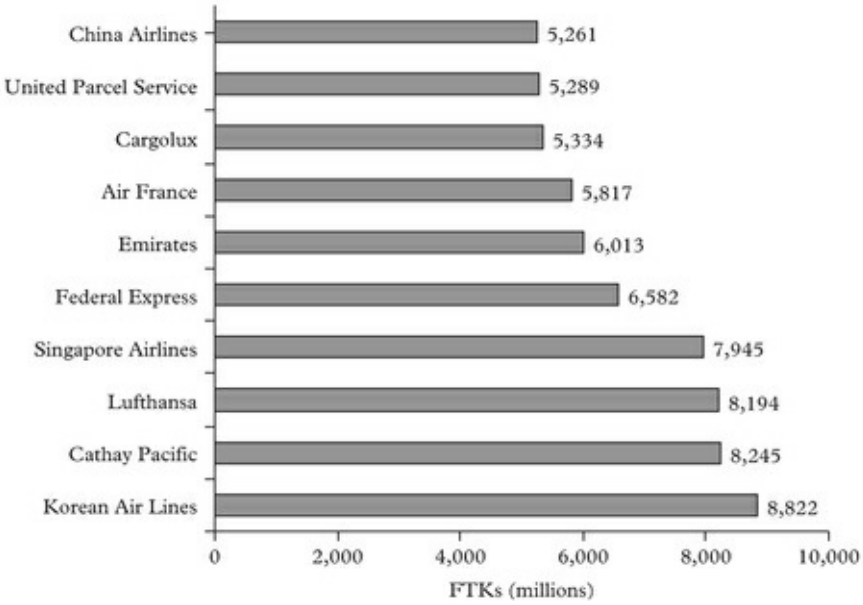

Figure 4: Top 10 International scheduled air cargo carriers 2008
Note: FTK = scheduled freight tonne-kilometre flown
Source: Created from data provided by IATA, World Air Transport Statistics, downloaded from www.iata.org/whatwedo/economics/index. Accessed 15 July 2009.

perishables established even stronger global supply chains, and those decision-makers worried about cargo damage, just-in-time delivery and cargo security switched to air where the economics made sense. According to Mike Tretheway of InterVISTAS, new planes, engines and technologies enabled the air cargo industry over the past decade to attract lower-value-per-kilogram cargos, moving these air carriers into competition for the premium end of the marine container business.[25] Air cargo, for example, had always dominated the high-fashion clothing industry, but in the last five years has established a stronger presence in the seafood market.

The US market provides a good illustration of the air cargo versus liner shipping relationship, and obvious evidence of air cargo's dominance in the transport of high-value but light-density products. In dollar terms, the ratio of US exports using ocean to those using air was 58.8% to 41.2% in 2000 and 55.8% to 44.2% in 2001. On the import side, water transport fares better, with a ratio in 2000 of 63.7% to air's 36.3%. In 2001, air cargo lost some traffic to marine, dropping to 34.0% of the two-mode total.[26] On the other hand, in weight terms, air cargo has a two-mode share of less than 1% (Table 5).

Over the past few years, as the air freight industry has continued to innovate and reach ever further into the premium end of the marine container cargo market, air cargo carriers have come to see ocean carriers as key competitors for the manufactured goods market. Updates on ocean rates and competition from marine cargo options are now featured in IATA economic briefings and market research documents. Particularly noticed in the second quarter 2009 briefing was that marine container cargo demand had fallen by 15%, less than the market loss experienced by air freight carriers.[27]

Of particular interest is the relationship between air freight and marine cargo over the economic cycle and the recent economic downturn. According to the International Air Transport Association, air freight volumes drop four to five months before economic softening, as shippers switch to cheaper but slower forms of transportation, like the marine mode. The drop in volume is faster than the drop in world trade, but the air freight recovery mode also features a faster rebound as manufacturers restock

source components in anticipation of the recovery.[28]

While shipping will never compete with air cargo in the perishables or emergency goods markets because the consequential loss caused by any delay, these are not products targeted by shipping in the first place. The problem for shipping is that many high-value, low-density manufactured goods are the high-yield business of shipping lines and quite easily switched to air cargo. This is particularly true if just-in-time systems have reduced the shipment size to that manageable by the air carrier. The existence of the air cargo option has the ability to keep transport prices for high-value goods depressed; without sufficient cross-subsidisation potential, lower-value, high-density product volumes will be of less interest to the shipping lines and the total volume traded will be less.

The recent financial crisis, however, has hit air cargo volumes hard, and sea has attracted some of that business back. New cooling technologies that enable the shipment of live lobster and premium seafoods by sea (lobster formerly only had a 24-hour life span in transport) hold promise for wider application and restoration of some lost traffic for the marine mode. Furthermore, it is likely that full costing of the environmental impacts of air freight will enhance the attraction to ocean shipping activity once the economic downturn has passed.

6. The Trader's View

Today’s trading perspective can be traced to the post-war rise in consumer demand. By the 1960s, trade in manufactured goods had reached new heights. The dramatic increase in oil prices in the 1970s, however, brought unacceptable rises in interest rates. As a result, traders turned their attention to extracting inventory carrying costs from the system. Those selling the goods sought new ways to ship that improved transit time and allowed them to restructure their operations to diminish time-to-purchase at retail. They also began to reconsider where they produced goods, expanding their horizons to include servicing more than just domestic markets. The seeds of globalisation of production and distribution were planted.

By now, it should be evident that the future transport of manufactured goods by sea is dependent on a pro-marine modal split decision by traders. Clearly, for some high-value, low-density products, the choice will continue to be air cargo. At the other end of the continuum, for awkward, bulky and unconventional machinery there will also be no choice but non-unitised ocean transport. In the middle lies the largest share of manufactured goods. For these, renewed focus on regional trade may encourage defection to surface modes. At the moment, it appears that the air mode is not cost-competitive with sea and surface modes in the China–Western Europe corridor (See Table 6). While road does provide a faster alternative to sea (about one week), the cost is three to four

Table 6: The transit-time trade-off in the China–Western Europe corridor

Mode	Cost (in USD) per 40′ container	Transit time in days
Sea	3,000	28
Road	11,000	19
Rail	7,500	36
Air	45,000	5

Source: US Chamber of Commerce (2006), *Land Transport Options Between Europe and Asia: Commercial Feasibility Study*, July, presented to the Overcoming Border Crossing Obstacles Joint ITF/UNECE/World Bank Seminar, 5–6 March 2009, Paris, p. 31.

times the ocean container rate and security concerns about the route are ever-present. For most inter-continental markets, the two primary competitors are air and ocean container. The choice of mode

depends on which meets the customer's needs better and provides the superior value proposition when carrying costs and product characteristics are considered.

Research has shown that traders' transport decisions are multi-criteria ones. They take into account product and customer requirements and specific attributes deemed desirable in making route- and product-specific decisions. Over a period of 20 years, the author has examined this decision-making process for the liner industry, identifying a number of key purchase determinants for a liner company's services, and illustrated that different criteria can be identified for different customer segments, but that these criteria are dynamic over time.[29] As the industry evolved, emphasis on price diminished and other factors like transit time grew in importance. The last paper in the series concluded that shippers, consignees and freight forwarders all have significantly different decision criteria when it comes to choosing a carrier; these factors are also distinct geographically.[30] Furthermore, some customers clearly buy a package of attributes for the rate paid while others evaluate individual attributes separately. The research also confirmed the move away from transaction-specific carrier decisions towards relationship-building through agreements with carriers and logistical service suppliers. The heavy use of professional logistics firms and the outsourcing of these functions are two directions traders took in the 1990s, both serving to concentrate decision-making power over shipments in fewer hands.

The 2001 "peak" shipping season serves as a useful illustration of the ramifications of traders' decision-making on ocean carriers. The growth in trade in manufactured goods is partly driven by consumer demand for holiday gifts, particularly in North America and Europe. As large retailers tie up shipping capacity in the period of August to November each year on the Asia/North America eastbound and Asia/Europe westbound routes, the full impact on all manufactured goods trade capacity is felt. The 2001 peak season was particularly interesting to watch. A slowdown in the US economy through the early summer months meant many US retailers delayed placing orders for Christmas merchandise for as long as possible. This, coupled with increasing supply from vessel deliveries over the year, resulted in severe difficulties for carriers with capacity well in excess of demand. Add the tragedy of 11 September 2001 to the mix, and consumer demand plummeted. The impact on available ocean capacity and transport prices was immediate, devastating and exacerbated further by those who took advantage of excess air cargo capacity to cover any shortfall. The economic slowdown could have been predicted, although not far enough in advance to address the additional vessel capacity being delivered, but the tragedy could not.

7. Looking Forward

Over the past two decades, the nature of transport of manufactured goods has changed as many consumer products sectors have globalised. Manufacturers can buy components in many places, distribute somewhere else for assembly and the final products end up in a third location to be sold. Sometimes some component parts have been moved seven or eight times in the process of getting on the retail shelf or to the automotive showroom. Declining real transport costs, increasing value of goods transported, a declining weight to volume ratio, along with diminishing costs of telecommunications and computing all encouraged a concentration of specialised production.

However, recently companies producing products requiring customisation have moved the customisation location as close as possible to the end market. All this means, in an era of supply chain

management, that these multiple moves are dependent on continuous improvement activities, regular and frequent performance monitoring and re-evaluation of the network of manufacturing and distribution partners. With a global perspective, the conclusion for container shipping is one where large volume routes will continue to dominate but, at the level of the trader, the product mix and route will be less predictable. Direct delivery, via air cargo, is now the norm for many high value-to-weight segments, such as personal computers, particularly those where products are customised to order.

Furthermore, with the trend to mega-retailers in North America and Europe, and the use of fewer and fewer distribution points, the network for warehousing and distribution has become very dynamic. Companies now have the capacity for creating just-in-time systems of distribution and that has been accompanied by an intense focus on performance monitoring. Constant re-evaluation of the entire supply chain has meant frequent changes to the network as continuous performance improvements are sought. If system performance does not measure up, not only can manufacturers choose to re-route the traffic, but they may also decide to relocate their production or assembly facilities, thus shifting trade flows. The mergers and acquisitions trend of the 1990s led to industry consolidation in many sectors; the result is fewer, larger production facilities and those "relocation" decisions are now in the hands of fewer and fewer "global" shippers.

Will world trade in manufactured goods continue to grow in future? There will be some growth attributed to rising population, and significant growth due to the expanding middle class in many of the world's more populated countries. As already noted, growth in container transport demand arising from the penetration of containerisation is less probable, as containerisation will soon reach maximum penetration except on low-volume routes. Furthermore, continued incursion of air cargo into traditional ocean shipment markets is possible as manufacturers continue to squeeze buffer time out of the transport chain and to favour time-definite transport over the vagaries of weather-influenced shipping. Most important is the issue of whether or not the growth of the past decade resulting from manufacturing supply chain management and national economic specialisation has run its course. Most industrial sectors have undergone a decade of consolidation; the accompanying strategic merger and acquisition activities were intended to prepare surviving companies for global reach in defined niches or global domination. Any economic or financial crisis brings with it the opportunity for corporate restructuring; how international merger and acquisition activity will affect both traders and transport suppliers remains to be seen. We can only speculate on what the market will look like in two years.

Therefore, the future demand for sea transport of containerised goods is unlikely to reflect the demand patterns of the past for three critical reasons. First, in serviceled economies, growth in demand comes largely from the rise in wealth and greater consumer spending, in addition to greater demand from rising population; here, the likelihood is that demand for consumer products will continue to drive growth where new wealth is being generated for an expanding middle class. Therefore, it is likely that increased demand will come from BRIC and Eastern European markets, as the rising middle class seeks to enjoy consumer products now taken for granted by developed-country consumers. Secondly, it is not clear how the financial crisis will play out in terms of which key manufacturers of these products and which providers of marine container services will survive the economic downturn and emerge as healthy businesses. Finally, it is also not clear how the United Nations Framework Convention on Climate Change will affect the economic value proposition offered

by transport companies to their customers; carbon taxes or cap and trade approaches to incorporating environmental costs into the supply chain will influence traders' mode choices in future.

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Endnotes

1. UNCTAD (2009): *Review of Maritime Transport 2008*, Geneva, United Nations Conference on Trade and Development.
2. Jennings, E. (1980): *Cargoes: A Centenary Story of the Far Eastern Freight Conference*, (Singapore, Meridian Communications (South-east Asia) Pte Ltd).
3. Levinson, M. (2006): *The Box: How The Shipping Container Made The World Smaller and the World Economy Bigger* (Princeton NJ, Princeton University Press).
4. Levinson, n 3, discusses this in Chapter 14.
5. World Trade Organisation (2002): *International Trade Statistics 2001*, www.wto.org.
6. World Trade Organisation (2002): Note 5.
7. World Trade Organisation (2008): *International Trade Statistics 2008*, Table II.2 from www.wto.org.
8. For a more detailed discussion, see www.wto.org/english/res_e/statis_e/its2008_e/its08_merch_trade_product_e.pdf.
9. The Organisation for Economic Co-operation and Development is a multilateral grouping of 30 developed economies comprising the countries of Europe, North America (including Mexico), Australia, New Zealand, Japan and Korea.
10. Growth data for all four countries have been taken from World Trade Organisation (2008). Note 7, pp. 3–14.
11. Bingham, Paul (2008): Macroeconomic View of Trends in Global Trade and Transportation, presentation to the Transportation Research Board Annual Meeting, Washington, DC, 14 January.
12. Page 3 of WTO (2008), Note 7.
13. The pillars of enabling trade are: 1. domestic and foreign market access, 2. efficiency of customs administration, 3. efficiency of import-export procedures, 4 . transparency of border administration, 5. availability and quality of transport infrastructure, 6. availability and quality of transport services, 7. availability and use of ICTs, 8. regulatory environment, and 9. physical security.
14. NTA (1992): *An Integrated and Competitive Transportation System: Meeting Shipper and Traveller Needs*, Ottawa, National Transportation Agency of Canada, March.
15. Anderson, D.L. (1983): "Your company's logistic management: An asset or a liability?", *Transportation Review*, Winter, 111–125.
16. Diamond, D. and Spence, N. (1989): *Infrastructure and Industrial Costs in British Industry* (London, Her Majesty's Stationery Office).
17. International Chamber of Shipping (2006), *International Shipping: Life Blood of World Trade* (London, Videotel Productions).
18. Hummels, David (2009): "Globalization and Freight Transport Costs in Maritime Shipping and Aviation", Background Paper for the International Transport Forum 2009 on *Transport for a*

Global Economy: Challenges and Opportunities in a Downturn, Joint Transport Research Centre of the Organisation for Economic Co-operation and Development (Leipzig, May 26–29, 2009). www.internationaltransportforum.org/2009/workshops/pdf/Hummels.pdf

19. García-Menéndez, L., Martinez-Zarzoso, I. and Pinero De Miguel, D. (2004): "Determinants of mode choice between road and shipping for freight transport: Evidence for four Spanish exporting sectors", *Journal of Transport Economics and Policy*, 38, 3, 447–466.

20. Paixão, A.C. and Marlow, P. B. (2002): "The strengths and weaknesses of short sea shipping", *Marine Policy*, 26, 167–178; Commission of the European Communities (2004), *Communication from the Commission to the Council, The European Parliament, the European Economic and Social Committee and the Committee of the Regions on Short Sea Shipping* (Com (2004) 453 final). Brussels: Commission of the European Communities; and GAO (2005), *Short Sea Shipping Option Shows Importance of Systematic Approach to Public Investment Decisions* (05–768) (Washington, United States Government Accountability Office, July).

21. These are well-documented in Brooks, Mary R., J.R.F. Hodgson and J.D. Frost (2006): *Short Sea Shipping on the East Coast of North America: An Analysis of Opportunities and Issues* (Halifax, Dalhousie University). www.management.dal.ca/Research/ShortSea.php; and Brooks, Mary R. and Valerie Trifts (2008): "Short sea shipping in North America: Understanding the requirements of Atlantic Canadian shippers", *Maritime Policy and Management*, 35, 2, 145–158.

22. Sclar, M.L. and Blond, D.L. (1991): "Air cargo vs. Sea cargo trends", DRI/McGraw-Hill Conference *World Sea Trade Outlook*, London, 25 September.

23. *Air Cargo Yearbook 2002* (London, Air Transport Publications Limited).

24. International Air Transport Association (2009): *IATA Economic Briefing*, April. www.iata.org/economics, Accessed 15 July 2009.

25. Tretheway, M. (2008): Personal communication with the author, August 25.

26. This study by BTS on value by mode used 2001 data and is the latest published on the BTS website as of July 2009; Bureau of Transportation Statistics (2003): *US International Trade and Freight Transportation Trends, Modal Shares of US International Merchandise Trade by Value and Weight: 2000 and 2001*, Table 8, www.bts.gov/publications/us_international_trade_and_freight_transportation_trends/2003/html Accessed 15 July 2009.

27. See for example, International Air Transport Association (2009): *Cargo Market Analysis (Cargo E-Chartbook Q2*). www.iata.org/whatwedo/economics/index.html, Accessed 15 July 2009.

28. International Air Transport Association (2009): *IATA Economic Briefing*, April. www.iata.org/economics, Accessed 15 July 2009.

29. Brooks, Mary R. (1985): "An alternative theoretical approach to the evaluation of liner shipping, Part II: Choice criteria", *Maritime Policy and Management*, 12, 2, 145–55; Brooks, Mary R. (1990): "Ocean Carrier Selection Criteria in a New Environment", *The Logistics and Transportation Review*, 26, 4, 339–55; Brooks, Mary R. (1995): "Understanding the ocean container carrier market – A seven country study", *Maritime Policy and Management*, 22, 1, 39–50.

30. *Ibid*.

Chapter 5
Energy Economics and Trade

*Michael Tamvakis**

1. Introduction

It is a well known fact that the international maritime industry is driven by the movement of goods and people. Maritime economists have long established that the demand for shipping services is derived from the demand for international trade and awareness of what drives the latter is the aim of this chapter.

Within the space and scope of the next few pages, it is impossible to cover all trades and factors that affect demand for maritime services. We will focus, instead, on the economics and major trade patterns of the most important commodity group, energy, which encompasses three very important commodities: crude oil and products, gas and coal.

2. Energy

2.1 Demand for energy

Energy is what drives modern economic development and for the last couple of centuries at least, human societies have relied on hydrocarbons for the supply of that energy. Despite continuous research and initiatives into the development of renewable, sustainable and ecologically friendly energy resources, we very much rely on three major forms of hydrocarbons – oil, coal and gas – for effectively 90% of the world's primary energy consumption (see Figure 1).

With the widespread use of hydrocarbons in all aspects of economic activity, consumption of energy commodities has been closely linked with a nation's development and its transition from a traditional, agriculture-based economy, to a developed, industrialised one. A recent poignant example is that of China, which from the 1990s onwards has transformed itself into the world's industrial powerhouse. On an aggregate basis, it is reasonable to assume that energy consumption is directly related to the level of gross domestic product (GDP). Figure 2 shows a proxy of this relationship by

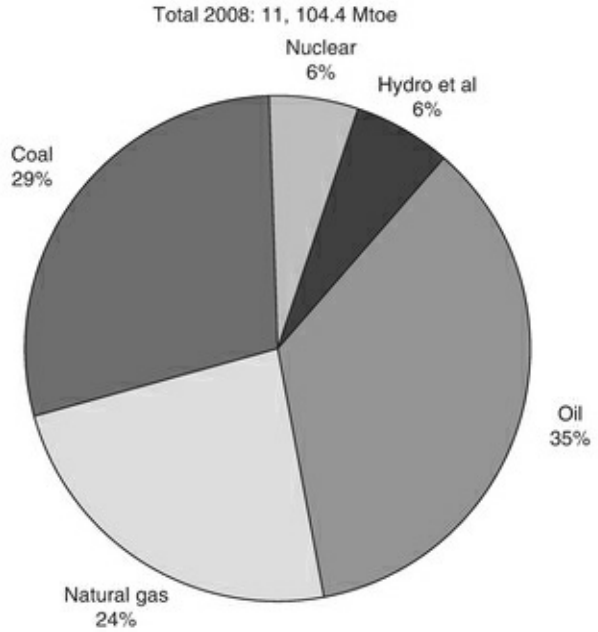

Figure 1: World primary energy production

Source: BP Statistical Review of World Energy, 2009

looking at the development of industrial production and primary energy consumption in OECD countries since 1973. Notice the fundamental change in the relationship between the two indices after 1980. For comparison, the price of oil is also plotted on the same chart, and highlights the effect it has had on energy consumption.

The notion of a straightforward relationship between energy consumption and GDP is quite appealing, but rather simplistic. One has to look at the disaggregated picture of energy consumption to get a more accurate idea of the underlying demand parameters. Primary energy consumption is usually classified into four broad categories: industrial; transport; other (incl. residential and agriculture); and a fourth residual category encompassing all non-energy uses. Figure 3 shows the OECD estimate of energy usage in the world, by fuel, in 2007.

2.1.1 Residential consumption

Like for any other good, demand for energy depends on the price of the commodity and the total disposable income of households. Any change in the price of the commodity will affect the quantity purchased by consumers. For example, if the price of oil falls, its consumption is expected to increase *ceteris paribus*. The total change in consumption is usually split between the *income* and the *substitution* effects. The first is attributed to the fact that with the new, lower price the same amount of income will buy more units of the commodity; the second effect is due to the switch from other, more expensive substitutes to the lower-priced commodity.

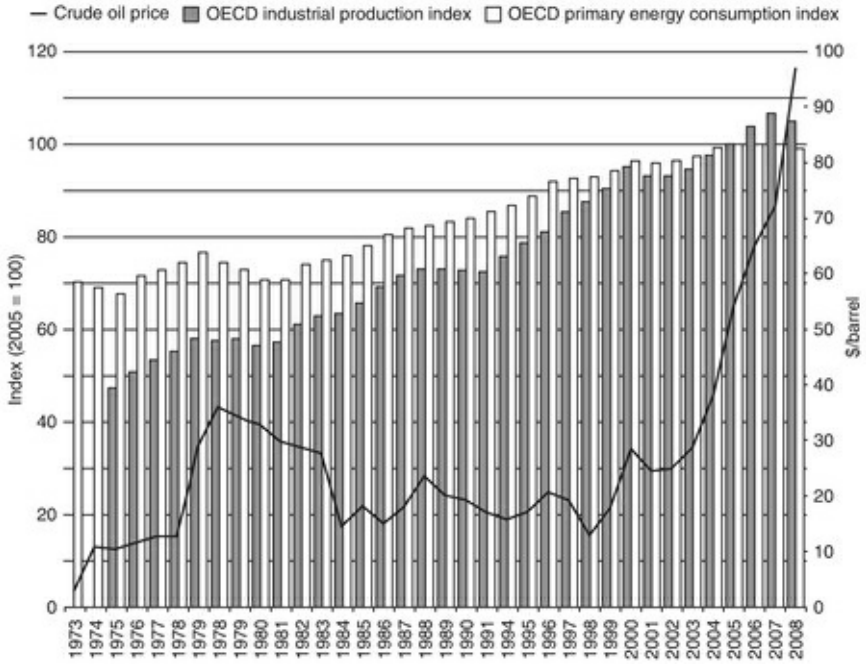

Figure 2: Industrial production and energy consumption in OECD

Source: OECD Key Economic Indicators, BP Statistical Review of World Energy; Datastream

When analysing the demand for specific energy commodities, it is always useful to know their responsiveness to changes in their own price, changes in disposable income and changes in the price of substitutes. This responsiveness is measured by the own price – or demand – elasticity, the income elasticity, and the cross-price elasticity. The usefulness of these three parameters was eminently demonstrated during the two oil price shocks in 1973 and 1979. While the first shock put pressure on household incomes, which had to accommodate a larger expenditure for energy, it did not tamper demand for oil substantially. This was not the case with the second oil price shock, however, when

income and price elasticities of oil experienced a structural change and led to a dramatically reduced demand for oil. In yet another demonstration of the change in these fundamental relationships, demand for energy in recent years seems to grow unabated despite the persistent ascent of oil prices.

2.1.2 Industrial consumption

The production cost of an industrial process depends – in the short to medium term – on the cost of its inputs and a set of fixed costs; in the long term, of course, all costs are variable. The production cost function can be formally written as $C = f(X_1 \ldots X_n, E, FC)$, where $X_1 \ldots X_n$ are production inputs, E is energy and FC is fixed cost. This function

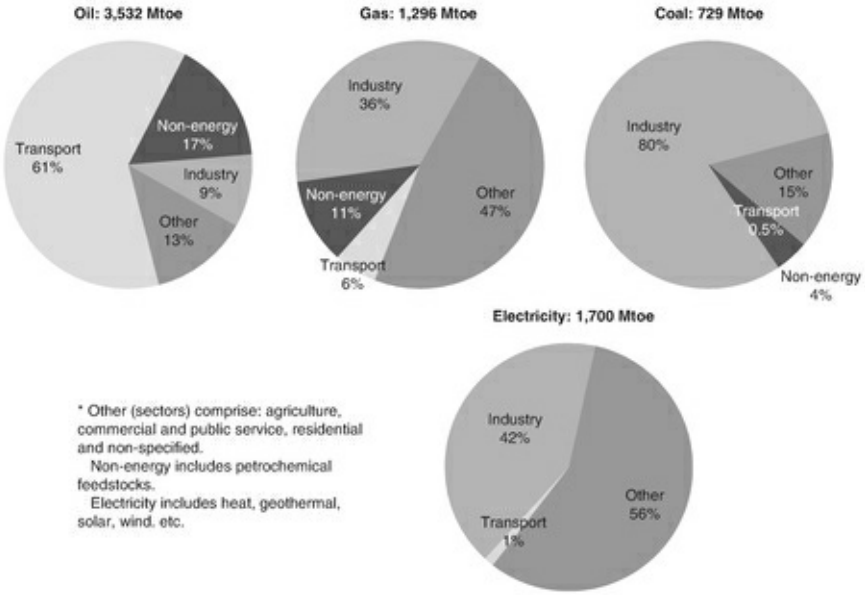

Figure 3: World energy consumption by fuel and sector, 2007
Source: IEA Key World Energy Statistics, 2009

represents a slight deviation from the usual norm of depicting production costs as a function of capital and labour, and is more suitable for our purposes.

The total demand for industrial energy can be viewed as an aggregation of all production cost functions like the one given above. The effects of price changes on energy demand will depend on the *rate of technical substitution*, which represents the rate at which one input of production can be replaced by another, in order to achieve the same cost.

In practical terms the rate of technical substitution shows how easily energy can be replaced by other input factors, and how easily different sources of energy can substitute one another in the same production process. Once again, a suitable example can be taken from the two oil price crises. The first price shock took industry by surprise, as no cost-effective alternatives to oil were available. The second shock, however, came after considerable restructuring in energy usage and efficiency had been implemented, with the result that total energy requirements were reduced and alternative sources of energy – predominantly coal, but also natural gas and nuclear power – replaced oil.

2.1.3 Transport consumption

Energy consumption in transport is dominated by oil, which displaced coal earlier or later in the history of different transport means. In the car industry, for example, gasoline was used since the very beginning, as it was the most appropriate fuel for the internal combustion engine. At sea, coal was dominant until after the end of the World War I, but was rapidly replaced by oil afterwards. On land, coal persisted slightly more

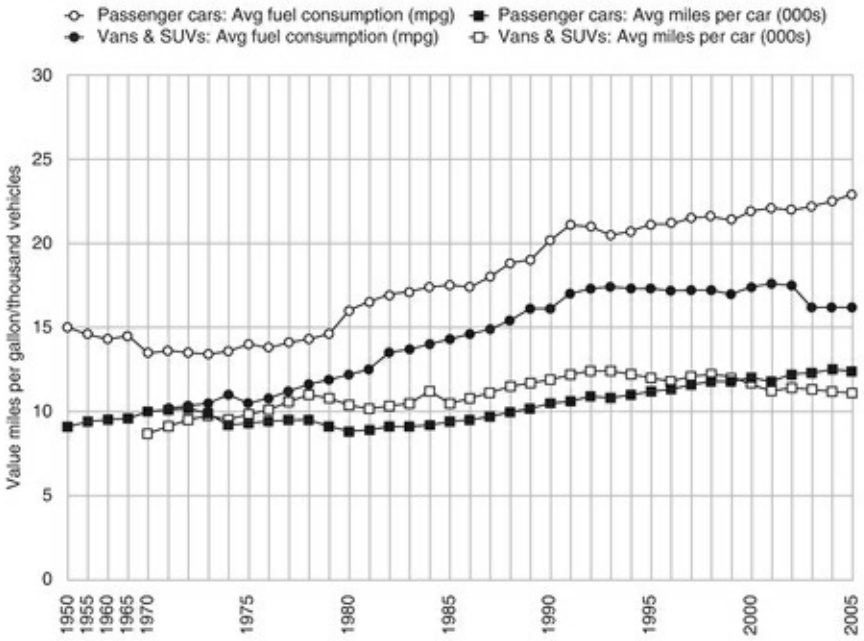

Figure 4: US car efficiency development

Source: Energy Information Administration, US Department of Energy, 2006

as a source of energy for locomotives, but eventually had to give in to oil's undisputed superiority.

Today, oil is used in transport almost exclusively; perhaps the only notable exception is that of Brazil, which has promoted the extensive use of sugar-derived biofuel in the 1970s and, again, in current times. Setting aside the past and possible future use of biofuels, very few other oil substitutes have been used in transport; notably natural gas and liquid petroleum gas (propane).

Because oil has virtually no – commercially viable – substitutes in transport, demand for it depends very much on income and efficiency of use. The latter is probably more important, as is shown in Figure 4, which graphs the development of car efficiency in the United States. Two indicators are used: the rate of fuel consumption expressed in miles per gallon; and the car usage expressed in average miles per car. Two types of vehicle are also shown: passenger cars and vans and SUVs (sports utility vehicles). As one can see, mileage was not affected substantially, despite the oil price hikes in 1973 and 1979. The rapid increase in car fuel efficiency, assisted by the mass introduction of Japanese cars in the American market, helped sustain the great love affair of US consumers with the automotive industry and provide endless material for 'road movies' to Hollywood scriptwriters.

Transportation is not of course limited to road only. The other two major consumers are air and seaborne transportation. The former has risen to prominence, due to the general increase in passenger and cargo air-miles travelled and due to the fact that the fuel used (aviation turbine fuel or jet kerosene) is one of the most valuable refined petroleum products. However, the importance of shipping fuel consumption (in the form of either heavy fuel oil of marine diesel) cannot be underestimated, given that an estimated 75% of the world merchandise trade is seaborne.

2.1.4 Other consumption

This category encompasses all the remaining sectors of the economy, primarily energy consumption for agricultural use and commercial buildings. Parameters affecting this segment of consumption include fuel efficiency and the degree of mechanisation of agriculture.

2.2 Supply of energy

Energy can be generated by both exhaustible and renewable resources. The latter have amassed

considerable scientific attention and certainly have ample potential, but their share of primary energy consumption remains very modest and is dwarfed by the dominant position of exhaustible hydrocarbons. In this chapter we will focus only on these very hydrocarbons: oil, gas and coal.

Like other minerals, energy commodities fall in the category of exhaustible resources. Available reserves, rates of extraction and economic rents are some of the parameters governing the usage of exhaustible resources. The theory behind this was explored as early as 1929 by Hotelling who built a basic economic framework for the exploitation of non-renewable natural resources.

Basic economic theory anticipates that each additional unit (the "marginal" unit) of a natural resource will be extracted as long as the economic cost of extraction – which includes marginal[1] cost and user[2] cost – is lower or equal to the price[3] paid for the resource plus the marginal utility of present consumption.[4] Like in most production processes, extractive firms benefit initially from increasing returns to scale, then their average total cost curve stays flat for some time after reaching the minimum efficient scale, and if they decide to increase output further they are usually faced with decreasing returns to scale. In the long-run, production tends to stabilise along the bottom of their long-run average total cost curve (see Figure 5).

The theory, as it stands, implies that high-cost producers – which usually also have limited reserves – should be the first to be squeezed out of the market when energy prices fall and operating costs are not covered. It also implies that large low-cost producers should be relatively immune to price downswings, and continue to produce under all – but the most extreme – market conditions.

Alas, real life is not as clear-cut as this model suggests. To take yet another example from the oil industry; although Arab OPEC countries are indisputably the lowest-cost producers, it is high-cost producers that seem to be operating at full capacity, while low-cost competitors seem to play the role of "swing' producer"[5] balancing demand and supply.

The picture becomes even more complicated when government economic policies are taken into account. Energy supplies are of strategic importance to every government worldwide. If they are in abundance, they will be used to cover domestic needs and the balance will probably be exported; if they are in short supply, the government will resort to imports and a certain amount of stockpiling for security reasons.

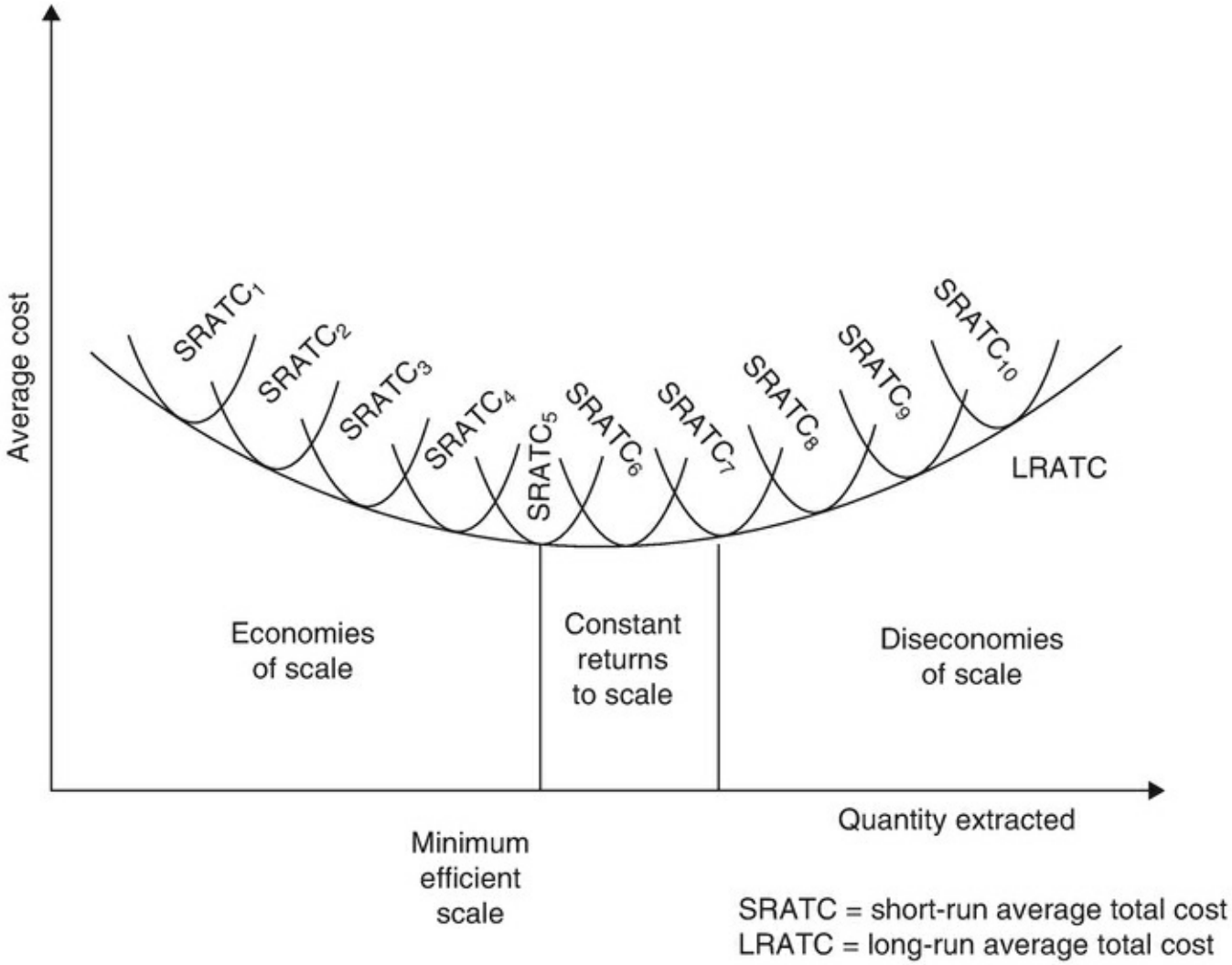

Figure 5: Long-run average total cost curve

If security of supplies is a major issue on the energy agenda, demand will tend to be biased towards certain (perhaps low-cost) producers, and "secure" (perhaps high-cost) suppliers will realise this and step up their production. Finally, if financial flows from exports and/or export taxes are considered as well, national fiscal and monetary policies may distort the picture even further.

In any project for the extraction of mineral resources there are three main stages: exploration, development, and production. Exploration may last a few years, until proper geological surveys point with high probability to the existence of reserves. Several exploratory wells/shafts may have to be drilled in order to assess the quality and extent of the deposits. Costs at this stage can be substantial and are sunk. The development stage involves extensive drilling in the case of oil and gas, and construction of an open pit or underground mine in the case of coal. Again, costs at this stage are sunk, and further costs might have to be incurred at later stages of a project, in order to improve and/or extend capacity.

At the production stage, most of the costs are operating costs, which tend to increase as reserves are being depleted and more effort is required to extract them. This is particularly true for coal, especially when underground mining is the method of production.

Energy projects use capital quite intensively and embody a substantial amount of risk. Even when adequate reserves are found, the high rate of discount applied to such projects makes the extraction of the commodity more desirable sooner rather than later. This argument is often used to explain the

intensive exploitation of high-cost oil

Table 1: Comparative oil and gas finding (exploration) costs

Region	2002–4 average $/boe*	2003–5 average $/boe
United States		
Onshore	7.18	6.67
Offshore	27.66	42.74
Total US	10.33	9.79
Other world		
Canada	26.07	16.46
OECD Europe	12.16	9.66
Former Soviet Union and Eastern Europe	4.30	13.00
Africa	7.55	15.25
Middle East	6.76	4.67
Other Eastern hemisphere	6.18	8.98
Other Western hemisphere	4.98	25.06
Worldwide	9.18	10.73

* boe: barrel of oil equivalent
Source: Performance profiles of major energy producers 2005, Energy Information Agency, US Department of Energy, DOE/EIA-0206(05), December 2006

reserves like the ones in Alaska or the North Sea, in order to maximise oil recovery as quickly as possible.

Another important characteristic of the energy sector – and the mineral sector in general – is the large extent of heterogeneity in production costs. Depending on the geomorphy of the field and local climatic conditions costs can vary considerably from one region to the next. In the oil sector, for instance, capital expenditure for field development may range from “low-cost” to “frontier areas”, as it is shown in Table 1.

A similar situation is evident in the coal industry, with Venezuela, Indonesia and South Africa in the low to medium-cost producers, while countries like USA, Germany, UK and France are at the other end.

3. Oil

With a share of 35% in world primary energy consumption, oil remains the leading energy commodity, and has been so for at least the past four decades. Oil reserves currently amount to just over one and a quarter trillion barrels, over half of which are located in the Middle East. Latin America is the second largest reserve holder, with deposits mainly in Mexico, Venezuela and, more recently, Brazil. The other dominant reserve holder is the former Soviet Union, particularly Russia and Kazakhstan.

What is remarkable about the oil sector is its imbalance in terms of reserves. It has to be noted, however, that production by different countries has never been proportional to their reserves, as technology, investment capital, and finance are not freely available to all producers, and political conditions have often distorted economic principles of production.

3.1 Geology and extraction

Oil is one of a number of hydrocarbon compounds that can be found in the earth’s crust. In fact four-fifths of the world’s sedimentary basins provide suitable geological conditions for the formation of crude oil. On several occasions, parts of the earth’s crust move against each other to form an *anticline*,

which creates a *reservoir* of impervious rock, where organic material is trapped and broken down by enzymes over a period of several million years. A reservoir usually contains several oil *fields*, some of them grouped together in *provinces*. The organic material contained in the fields is a mixture of oil, water and gas. Oil floats on top of the water, while gas provides pressure in the field, which is invaluable for the extraction of the precious fuel.

Oil exploration is the part of the oil industry that has always caught the imagination of the masses, as it contained a huge element of risk, but offering the possibility of extremely good returns. Modern oil exploration does not rely that much on luck any more. A number of scientific methods are used for the location of possible oil reservoirs and the estimation of their reserves. These are usually grouped in three main categories: geophysical analyses; geophysical surveys; and drilling and well logging.

Geological analysis includes a number of alternative – and often complementary – methods, ranging from traditional field geology (examining surface rocks), to the use of orbiting satellites. Geochemical analysis is also used, in order to establish the presence of suitable material for the formation of oil deposits. The aim of all the above techniques, is to understand the geological structure and history of an area, and decide whether it is worthwhile to spend more money on exploring it.

The main geophysical technique used nowadays is the seismic survey, although gravimetric and magnetic surveys can also be used to identify underlying structures that are possibly oil-bearing. Seismic surveys involve the artificial generation of shock waves, using a variety of techniques, like controlled explosions, dropping of weights and vibration generators (see Figure 6). The aim is to record the reflections of those waves by the various geological strata. The data are recorded by geophones, which are similar to seismographs, and then transmitted and recorded.

The *recording* stage is followed by the *processing* of the data collected, which involves their enhancement by computers. Finally, the results are *interpreted* by experts, who build an image of the underground formations and the likely location of deposits. All three stages (recording, processing and interpretation) have been immensely improved by the use of enhanced computer technology. The latter has allowed the advance from 2D to 3D seismic surveys, which use a lot more signal recorders and provide a far more accurate picture of underground formations. A traditional 2D seismic survey, until a few years ago, was shot along individual lines, at varying distances, producing ‘pictures’ of vertical sections of the underground formations. A 3D seismic survey, on the other hand, is shot in a closely spaced grid pattern and gives a complete, more accurate, picture of the subsurface.

The next stage in oil exploration is well drilling. To collect more accurate survey data, *boreholes* are drilled on top of the area suspected to contain oil reserves. Many of these *wildcat* drills end up as dry holes. The purpose of the boreholes is not only to extract the

Figure 6: Seismic vibrators in the desert
Source: Satellite Imaging Corp., www.satelliteimagingcorp.com

oil. For the purposes of *well logging*, rock cuttings, core samples and geophysical data are extracted from boreholes, giving scientists an idea of the local geological structure and, if any oil does exist, the history, nature and extent of the reservoir.

The boreholes that are successful eventually become oil *wells*. Neighbouring wells are normally grouped together to define an oil field. To date, there are over 30,000 known oil wells. Of these, 330 produce just over 50% of the world's oil output, while just 17 of them produce over 30% of the same. Some of the wells are classified as giants – each holding over 0.5 billion barrels of reserves – while the biggest of wells and/or fields are also known as *elephants*. The largest of all oil fields, Ghawar, is located in Saudi Arabia, and is estimated to hold approximately 70 billion barrels of oil reserves. To put this in perspective, the Ghawar field accounts for more than a quarter of Saudi reserves (estimated at 260 billion barrels in 2006).

The discovery of oil deposits and the drilling of oil producing wells is not, of course, the end of the story. The entire production process has to be organised properly. This involves a detailed reservoir management plan; the well layout and design; design of production and evacuation facilities; and an implementation schedule covering the drilling of wells and construction and installation of facilities.

The next step is to ensure that oil can be extracted in the most efficient way. The reservoir's own pressure is usually sufficient, at least initially, to drive the oil or gas to the surface. When recovery levels are low, however, secondary recovery enhancements can be used, whereby the reservoir's natural drive is supplemented with the injection of water or gas. Finally, where both natural drive and secondary recovery are not producing the desired production levels, enhanced oil recovery (EOR) methods can be used. These techniques are considerably more expensive and must be justified by oil market conditions. EOR methods include: the heating of oil by injecting hot water and/or steam, in order to increase its viscosity and flow; mixture of oil with a suitable gas or liquid solvent to reduce or eliminate residual oil trapped in the displacement process; and use of chemical additives, which modify the properties of the water that displaces the oil and which change the way water and oil flow through the reservoir rock.

Oil is not the only fuel produced by oil wells. Natural gas liquids (NGLs) are byproducts of oil extraction. NGLs include: a type of light oil called *natural gasoline*; a mixture of petroleum – or 'wet' – gases, like butane, propane and ethane; and sometimes natural – or 'dry' – gas, which is methane.

There are also "non-conventional" sources of oil. These include: kerogen, which consists of hydrocarbons not yet developed into oil; tar sands, which are impregnated with oil; and synthetic petroleum, which can be produced – rather expensively – from coal. Non-conventional hydrocarbons have remained largely unexploited due to the large costs involved in their processing. However, in recent years (since the early 2000s), the industry has shown renewed interest in developing them, especially tar sands, as their production becomes more economically viable in the light of oil prices fluctuating between $60–70 per barrel.

3.2 Physical characteristics

Oil has three physical characteristics which have significant economic importance. The first one is specific gravity. Crude oils are classified as: light, or paraffinic; medium, or mixed-base; and heavy, or asphaltic. Light crudes have lower specific gravity and are easier to refine. Specific gravity is measured in "degrees API", which were introduced by the American Petroleum Institute. The lighter the oil, the more degrees API attributed to it. The baseline is the specific gravity of water, which is 10° API. Crudes below 22° API are considered heavy, while those above 40° API are considered light.

The second characteristic is viscosity, which is sometimes measured in centistokes. The more centistokes, the more viscous (thick) the crude, and the harder it is to burn. Two common grades of crude oil, typically used for vessel bunkers, have viscosities of 180 CST (intermediate fuel oil – IFO) and 380 CST (heavy fuel oil – HFO). One more detail: the centistoke value of a crude oil changes with temperature. Hence, a typical assay will contain viscosity measurements at several different temperatures.

Finally, a crude's quality also depends on its content in sulphur. Crudes with high sulphur content are known as "sour" crudes, while the rest are known as "sweet".

3.3 Reserves

As with any non-renewable natural resource, it is important to be able to establish the stock of reserves available for future extraction. The total reserves worldwide are known as *ultimate* reserves, but their estimation is of little practical use. It is more interesting to estimate the amount of *oil-in-place*, which is an indication of recoverable reserves. Reserves, for which there is conservatively reasonable certainty of production under existing economic and operational conditions, are called *proved* reserves (see Figure 7).

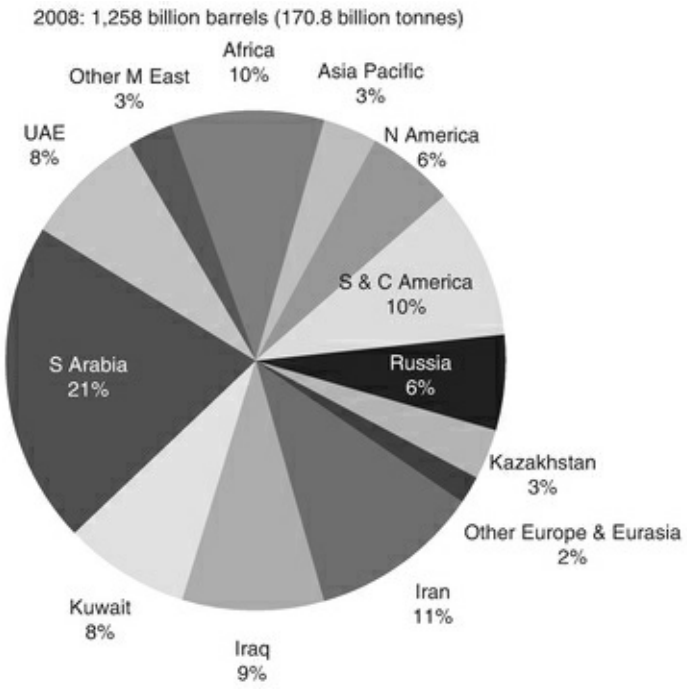

Figure 7: Proven oil reserves

Source: BP Statistical Review of World Energy, 2009

In contrast, *probable* reserves are those whose production would be achievable as a result of further exploration and development, or changed economic and operating conditions.

Frequently, the *reserves:production ratio* is used as an indicator of the future life of existing reserves. The ratio shows the number of years that reserves will last, if production (see Figure 8) continues at the current rate. The R:P ratio, however, only offers a view of the future, extrapolated from the present, and assuming that technology and prices remain unchanged.

3.4 Trade in crude oil

From a total of approx. 3,900 million tons (or nearly 82 million bpd) of oil produced in 2008, some 2,700 million tons (54.6 million bpd) were traded internationally. Of these, over 75% was carried by sea. Throughout oil's turbulent history, international trade has played an important role. In fact, one of the biggest integrated oil companies – Royal Dutch Shell – started life as a trade and transport company.

Despite the political uncertainty associated with the region, the Middle East remains the world's top oil exporter, supplying approximately 37% (in 2008) of the world's crude oil exports (see Figure 9). The vast majority of flows are directed towards three man areas: North America, Northwest Europe and Asia Pacific. These flows coincide

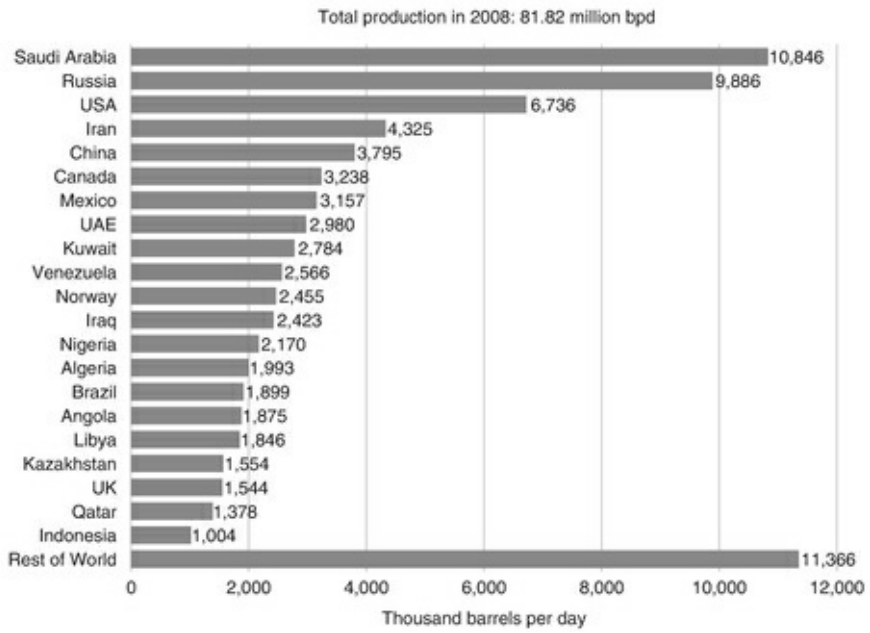

Figure 8: Crude oil production

Source: BP Statistical Review of World Energy, 2009

very much with the main trade routes for VLCCs and some of the larger-size tanker tonnage. Following Middle East, Africa and FSU come a distant equal second. Western (mainly Nigeria and more recently Angola) and North (mainly Libya and Algeria) Africa are very important suppliers to the European Union and Nigerian crude is also very comp etitive in transatlantic trades to the USA.

FSU exports are dominated by Russia, the world's second largest exporter after Saudi Arabia, and Kazakhstan. The importance of Russian exports to the European Union cannot be overestimated and the supply routes start from West Siberia through the Baltic Sea (Primorsk), and from the Caspian Sea through the Black Sea (Novorossiysk). Smaller suppliers, like Azerbaijan, generate less exports, but they strive to disengage from their dependence on the Russia oil pipeline system and gain direct access to the export markets through alternative routes.

Latin America (mainly Venezuela and Mexico) are the most important short-haul supplier to the USA (after Canada which largely exports to the USA via pipelines) and are the first recourse for short term demand upsurges (e.g. due to cold weather). The rest of the demand generated by the world's largest consumer of oil is satisfied either by medium-haul (West Africa and North Sea), long-haul (Arabian Gulf) or domestic (Alaska) supplies. Pacific Rim countries are still largely dependent on the Middle East for their imports, although some of their demand is satisfied by regionally produced crudes in Indonesia, Australia and Vietnam.

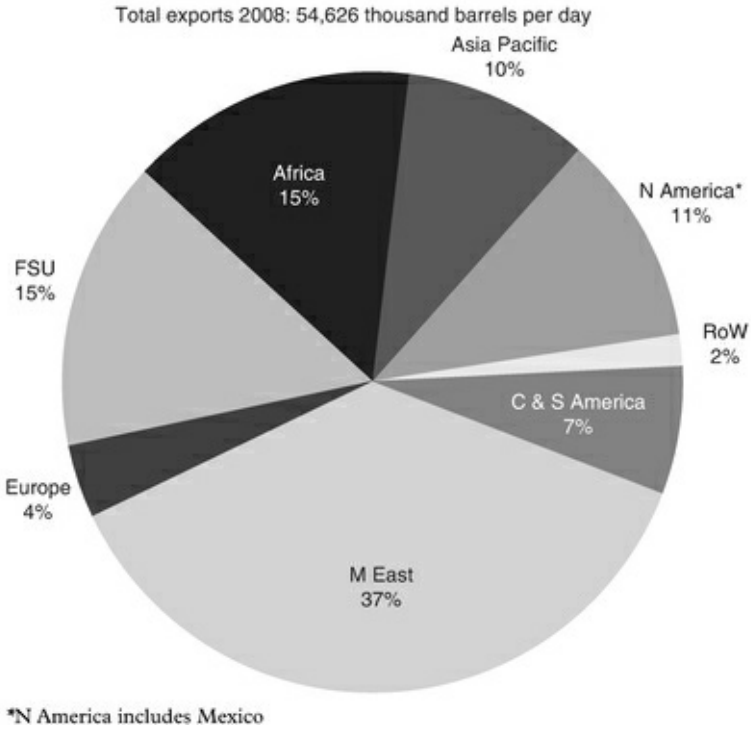

Figure 9: Oil exports (crude and products), 2008
Source: BP Statistical Review of World Energy, 2009

4. Oil Products

Much of the discussion up to now has dealt primarily with crude oil, although trade figures referred to both crude and products. In this section, I will begin with a brief description of the refining process, continue with the main categories of refined products and, finally, discuss production, consumption and trade patterns for major regions, like the United States, Western Europe and South East Asia.

4.1 Refining process

Although much of the economics of the oil industry revolves around crude oil, it is the final products that are used by the end-consumers. Crude oil is rarely usable and has to be refined and broken down into products adequate for final consumption.

The fundamental principle on which oil refining is based has not changed since the nineteenth century: crude oil is heated until it is vaporised and then the vapours are condensed separately, according to the boiling points of their constituent molecules; the procedure is called distillation. Crude oil is stored into large tanks and from there it is pumped continuously through a series of steel tubes into a furnace. From there it is pumped to the bottom of a tall cylindrical tower, usually 8–24 feet in diameter and 100–150 feet in height. This is called a “fractioning” tower, as it is divided into “floors”, with perforated trays, which allow vapours to pass from lower to higher floors. The hydrocarbon vapours with highest boiling points condense first, on the bottom floors, and those with the lowest boiling points condense last, higher up the tower. The most volatile product – petrol – comes off at the top of the tower and is then condensed separately.

This simple distillation procedure yields about 20% light distillates from an average crude, and usually falls short of the commercial needs for petrol. At the same time, the process yields heavier products in quantities that exceed consumption requirements. To redress this imbalance, some of the heavier oil distillates are further processed, using methods such as *thermal cracking* and *catalytic cracking*. Both these procedures allow enhanced recovery yields of petrol from crude: the first

procedure used high temperature and pressure to “crack” the large hydrocarbon molecules of heavier products into smaller molecules of petrol and petroleum gas; the second process uses catalysts to facilitate cracking under milder and more easily controlled conditions. Reverse procedures are also available, which reform lighter gas molecules into heavier products, such as petrol. Finally, several of the gases are used as feedstocks for the petrochemicals industry.

The outputs of the refining process are classified into three broad categories: *light*, *middle*, and *heavy* distillates. Light distillates – also known as *white* or *top-end* cuts – include ethane, propane, butane, naphtha (all used as feedstock for petrochemicals), aviation turbine fuel (ATF), kerosene, petrol and other industrial spirits.

Middle distillate (or middle cuts) include gas oil, diesel, marine diesel, and medium and high grade fuels. Finally, heavy distillates – also known as *black* or *bottom-end* cuts – include heavy fuels, paraffins, lubricating waxes and greases.

4.1.1 Refining: capacities and throughputs

The supply of oil products is very much dependent on the available refining capacity around the world. In fact, refining capacity sets the upper limit to the supply of distillates. What is more interesting in terms of production, however, is the refinery *throughput*, i.e. the quantity of oil being processed by refineries per annum. This also allows the calculation of refinery utilisation rates, a figure most important for the profitability of a refiner. Figure 10 shows the development of refining capacity through the mid-1970s, 1980s and 1990s and in the late 2000s. Taking a closer look, one can see that North America – and this is mainly the United States – was head and shoulders above the other two important refining regions: Western Europe (which excludes Russia, labelled ‘Eurasia’ in Figure 10), and Asia Pacific. However, Asia Pacific caught up fast and is now on par with the whole of Europe and Eurasia and above North America. These three regions are top in the league of refinery throughputs as well. In 2008, United States alone produced almost 14.6 Mbpd of oil products, with Europe and Eurasia (i.e. Russia) standing at 20.6 Mbpd, and Asia Pacific at 21.5 Mbpd. Within the latter region, the largest refiner used to be Japan (3.9 Mbpd in 2008), but has now been overtaken by China (6.8 Mbpd in 2008), with Singapore accounting for most of the remaining throughput in the region as it is a huge transhipment and refining centre.

Refinery throughputs and consumption of oil products give a broad framework for the study of patterns in international trade in oil products. As we are going to see later, however, trade flows are much more complicated, and there is often exchange of similar

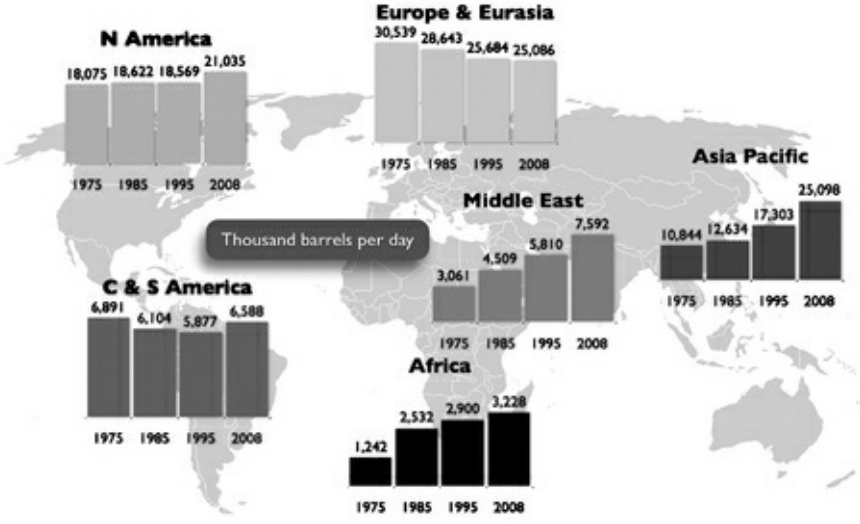

Figure 10: World refining capacity by region
Source: BP Statistical Review of World Energy, 2009

products between countries which produce all distillates, but in varying proportions. This is, in fact, a classic case of intra-industry trade. It is, therefore, essential to look at the composition of the typical barrel of oil – known as crude oil *yields* – when studying trade patterns.

Oil yields depend on the distillation technology available to the refinery, the grade and quality of the input crude, and also seasonal and consumption parameters of the region in question.

Table 2 lists representative crude yields in a sophisticated and a typical refinery in the US Gulf, during the winter and summer periods. Notice how, in both cases, yields for unleaded gasoline increase during the summer, the season when most Americans travel around the country by car. Figure 11 shows the products yielded by three representative types of crude in refineries in the US Gulf and Northwest Europe.

4.2 Consumption patterns

It is consumption patterns, of course, that influence both the short and the long-term balance of the market. Different regions have different tastes for oil products, depending on their economic activities, climatic conditions and other consumption habits. Although refinery yields can change to match demand, imbalances do arise, and trade flows are generated in order to cover them.

Figure 12 shows consumption patterns in 2008. The United States is a heavy consumer, with the emphasis on gasolines. Western Europe is the second largest consumption area, with the emphasis on middle distillates, while Japan shows a slightly more balanced picture.

Table 2: Representative crude yields

US Gulf sophisticated upgrading refinery % yields		
Winter Basis	**Arab Light**	**UK Brent**
Sep–Mar		
Unleaded Regular	51.6	54.6
Gasoil/No.2	36.2	35.4
Fuel Coke	4.9	3.1
Fuel Oil	5.1	5.1
Summer Basis		
Apr–Aug		
Unleaded Regular	59.0	60.9
Gasoil/No.2	28.0	28.4
Fuel Coke	4.9	3.1
Fuel Oil	6.0	5.9

Source: PMI

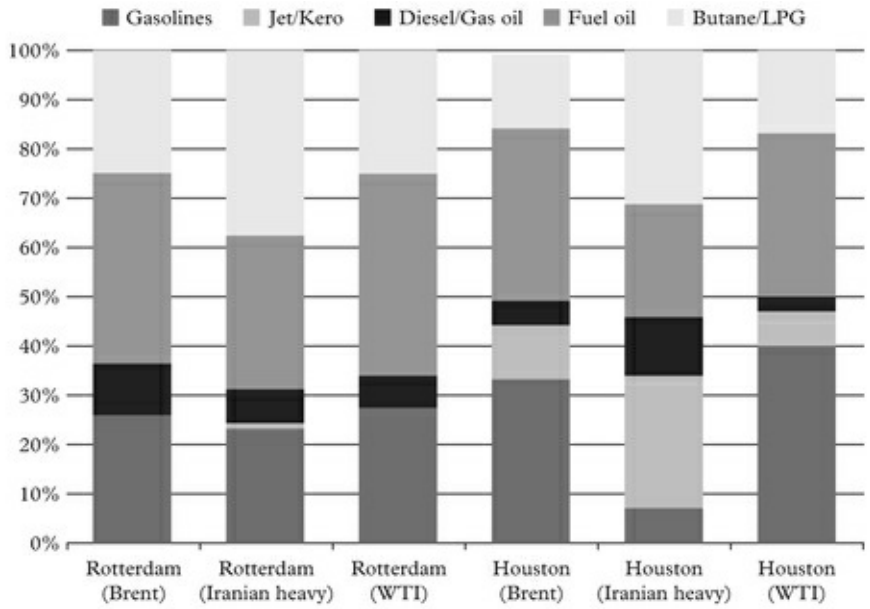

Figure 11: Yields for three types of crude in Houston and Rotterdam
Source: Platts

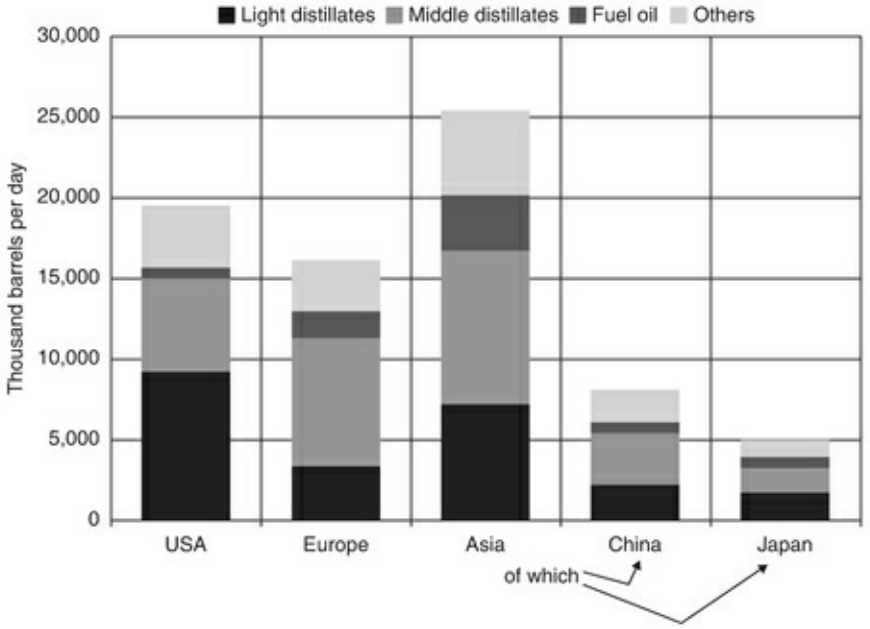

Figure 12: Regional products consumption, by type of product
Source: BP Statistical Review of World Energy, 2009

4.3 Trade in products

Trade in oil products is older than trade in crude, but with increasing scale economies in the transportation of crude oil, products trade has shrank to about a third of total trade in oil.

Figure 13 depicts the development of crude and products trade since 1975. As one can see, products have fluctuated a lot less than crude oil trade, and in recent years they have increased as a proportion of crude trade, to about 36%.

Figure 14 shows the importing and exporting activity of major regions worldwide, and their relative deficit or surplus positions. In terms of regional patterns, United States, Western Europe, and Singapore are the most active exporters and importers of oil distillates. The Pacific Rim as a whole is a very important product trading region, with China, Japan and now India being also very important players. From the rest of the world, Russia and the Middle East are large net exporters of products.

The combination of factors that were discussed earlier, makes the international trade in oil products fairly complicated, and its study long enough to be the subject of a separate treatise. Partly due to this

complexity, there is a very active market in oil products, both on the floor of major commodities' exchanges, and over the counter.

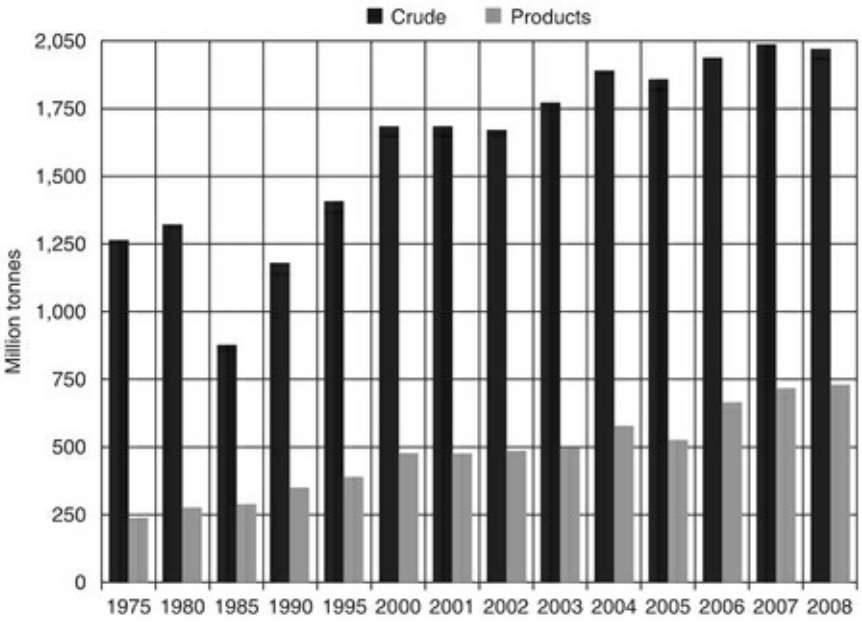

Figure 13: Crude and products trade
Source: BP Statistical Review of World Energy, 2009

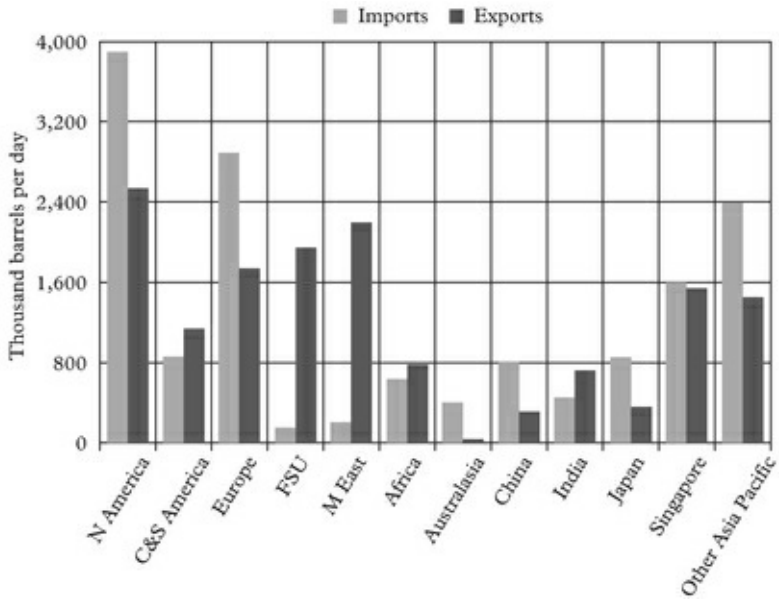

Figure 14: Trade in oil products
Source: BP Statistical Review of World Energy, 2009

5. Brent Crude and Oil Pricing

There is a large variety of crude oils and oil products available in the open market, many of which are priced on a purely competitive basis. One such market which developed and matured in the 1980s is the market for Brent crude, which is extracted in the UK sector of North Sea. The presence of Brent crude prices in the pricing formulae of several crudes around the world, emphasises its international character and importance.

Brent is named after one of several fields, whose output is used to create a standard blend. In fact, there are two distinct pipeline systems – Brent and Ninian – which contribute towards the production. In 1976 the first consignments of Brent crude were loaded at Brent Spar, and in 1979 the terminal at Sullom Voe became operational. In the early 1990s, the production of Brent blend amounted to about 850,000 bpd. In the early 2000s this figure has down by more than half, and was deemed so low that

the industry decided to launch a parallel crude oil index reflecting four different North Sea crude oils: Brent Blend and Forties (from the UK sector) and Oseberg and Ekofisk (from the Norwegian sector).

Brent blend is denominated as a light, sweet crude, with a specific gravity of 38° API. Its constituent crudes, however, have a specific gravity in the range of 30°–40° API, and a sulphur content of 0.2–1%. Standard quality is of course important, since market participants expect at least some security in terms of the blend's properties.

Brent is very much an international crude, with about three quarters of it being exported. It is mainly, though, an Atlantic basin crude, with most of the exports to the United States, Canada and Germany. Flows to the US are primarily received in Gulf ports, where Brent's main competitor is Nigerian crude, which has similar physical characteristics, and other domestic sweet, light crudes. In the UK the main users are Shell's refineries at Stanlow and Shellhaven, Texaco's at Pembroke, and Total's at Milford Haven.

In addition to being an important pricing benchmark for a number of internationally traded crude oils, Brent really drives a multi-layer market, consisting of a number of derivative instruments, traded both on exchange floors, electronically and over the counter.

5.1 Price reporting

With the collapse of OPEC prices in the mid-1980s, there was a move towards market related pricing. This trend was already evident due to the introduction of Brent crude in the world markets, and was accentuated with the resort of some OPEC countries to netback pricing, which made the availability of reliable and up to date spot prices crucial. As the market for financial oil derivatives also took off, the need for reliable and transparent price setting and reporting became crucial.

Today there are several oil price reporting agencies, which are used worldwide for pricing spot and derivatives deals. One of the most well known is probably Platt's. The agency was founded very early, in 1924, and originally concentrated on products. It started reporting crude prices in 1983 and is currently owned by McGraw-Hill. Petroleum Argus is another well known reporting agency, which was the first to start quoting crude oil prices in 1979. ICIS-LOR started in 1978 as London Oil Reports, publishing a weekly newsletter with price assessments. In 1985 it merged with Independent Chemical Information Services which provided price quotations for chemicals and petrochemicals. There is also a number of screen services, which provide up-to-date prices, such as Reuters and Bloomberg.

Prices are quoted on a minute-by-minute basis for Brent and most other crudes. Sometimes agencies report high/low price assessments, but they mostly tend to quote bid/ask ranges, which show the difference between the highest offer to buy (bid) and the lowest offer to sell (ask). Table 3 reproduces an excerpt from 'Platt's Crude Oil Marketwire', with some of the most commonly quoted crudes. Price quotations are also *time stamped*, especially when they are near the opening and closing times of the markets. Naturally, the most interesting price quotation is at the closing of a market, since closing prices are often used for settlement of contracts.

Although individual crudes have their own quotations, it is not uncommon that these prices are calculated as differentials from a few *benchmark* crudes. Brent and WTI are such *marker* crudes and are used extensively around the world.

As far as Brent and WTI are concerned, the most liquid forward month is usually assessed first;

then quotations for other forward months and from dated deals are also used to compile the daily settlement price. Once this process is completed, other crudes are priced on a differential basis and so are inter-crude spreads and inter-month spreads for other crudes. Differentials themselves are not *ad hoc* stable; in fact, they do fluctuate, but markedly less than absolute prices.

5.2 Other crude markets

Up to now I have focused on the Brent market and instruments. Despite the market liquidity and importance for pricing of crudes around the world, one should also bear in mind that Brent is only a small fraction of the world crude oil production and exports. The bulk of oil exports comes from countries which have their own pricing formulas, but look to the Brent market in order to assess the true supply and demand situation. This section will discuss briefly some of the other available crudes and their main characteristics.

5.2.1 North Sea

Brent is one of a number of crude oils produced in the North Sea. In the UK sector blends from the Forties and Flotta sectors are also competing for export shares, although they are priced as Brent spreads. Of the two, Forties seems more likely to take Brent's place as an international crude, when the latter is exhausted. This is reflected in the inclusion of Forties in the BFO composite index.

In the Norwegian sector, the most prominent fields are Ekofisk, Oseberg, Statfjord and Gullfaks. All of them enter the international market, as most of the Norwegian production is exported. Most of these crudes are priced against Brent, although there is a small proportion priced against WTI.

5.2.2 United States

The most prominent crude in the United States is West Texas Intermediate. Like Brent, it is a blend of several crudes with specific gravities between 34°–45° API and sulphur content below 0.5%. The par grade is 40° API and has 0.4% sulphur content, which

Table 3: Sample of Platts' crude oil marketwire

PLATT'S CRUDE OIL MARKETWIRE					January XX 19XX
BRENT (FEB)	+14.49-15.00+	DUBAI (FE)	13.77-13.851-	WTI (MAR)	15.50-15.52
BRENT (MAR)	+14.42-14.46+	DUBAI(MA)	13.52-13.56-	WTI(APR)	15.49-15.51
BRENT(APR)	14.23-14.29+	DUBAI (AP)	-13.27-13.36-	P-PLUS	+1.51-1.53
BRENT (DTD)	+15.01-15.08+	OMAN (FEB)	-14.07-14.12-	WTI (MID)	+15.5515.60+
FORTIES	+15.14-15.21+	MAR "MPM"	0.05-0.06	WTS	+14.55-14.62+
EKOFISK	+15.31-15.38+	URAL	+14.45-14.54+	EUGENE I	14.70-14.79+
STATFJORD	+15.28-15.35+	ILT (SIDI)	+14.45-14.54+	LLS	15.78-15.82
OSEBERG	+15.32-15.41+	IHVY (SIDI)	+13.82-13.91+	HLS	15.55-15.60
FLOTTA	+14.51-14.58+	SUEZ BLEND	+12.71-12.78	WYO SWT	15.50-15.52
BQ	+15.80-15.89+	ES SIDER	+14.81-14.88+	ANS (FEB)	+14.15-14.17+
FORCADOS	+15.67-15.77+	CABINDA	+14.12-14.22+	ANS (MAR)	+14.15-14.17+
CANO LIMON	+13.90-13.92+				
CALIFORNIA CRUDE ASSESSMENTS					
ANS/LOMG BEACH	+12.95-12.97				
LINE 63/HYNES	+12.60-12.62+				
THUMS/LONG BEACH	+9.56-9.61+				
KERN RIVER	+8.38-8.43+				
PACIFIC RIM SPOT CRUDE ASSESSMENTS			**SPREAD VS ICP**		
TAPIS	16.65-16.70	MINAS	+14.90-14.95+	+ -0.35-	-0.30+
PAP.TAPIS (FEB)	16.50-16.55	ATTAKA	15.80-15.90	-0.15-	-0.05
PAP.TAPIS (MAR)	16.57-16.62	ARUN	15.45-15.55	0.00-	0.00
LABUAN	16.75-16.80	ARDJUNA	15.55-15.65	0.10-	0.25
MIRI	16.45-16.50	HANDIL	14.55-14.60	-0.60-	-0.50
GIPPSLAND	15.70-15.75	CINTA	14.05-14.15	-0.55-	-0.50
JABIRU	16.65-16.70	DURI	11.98-12.05	0.05-	0.10
SALADIN	16.65-16.70	WIDURI	13.92-14.00	-0.10-	0.00
KUTUBU	15.40-15.55	BELIDA	15.75-15.85	0.15-	0.20
DAQING	+14.20-14.25+				
SHENGLI	12.15-12.20				
CANADIAN CRUDE ASSESSMENTS					
	CD/CM	**USD/BBL**			
PAR CRUDE	114.75-116.75	-13.78-14.02-			
MIXED LT SR	93.27-35.27	-11.20-11.44-			
BOW RV/HDSTY	84.05-86.05	-10.09-10.33-			

Source: Platt's Crude Oil Marketwire, McGraw-Hill Inc

is slightly lighter and can be slightly sweeter than Brent. The physical base consists of crude deliveries at the end of the pipeline at Cushing, Oklahoma. Shipments are usually 50,000 or 100,000 bbls.

Like Brent, WTI has an active forward market. However, the futures market is even more active and forward looking, with months open until nine years ahead. More specifically, consecutive months are listed for the current year and the next five years; in addition, the June and December contract months are listed beyond the sixth year. WTI contracts are also more flexible than Brent contracts, in that they allow a considerable number of alternative crudes to be delivered. Specific domestic crudes with 0.42% sulfur by weight or less, not less than 37° API gravity nor more than 42° API gravity. The following domestic crude streams are deliverable: West Texas Intermediate, Low Sweet Mix, New Mexican Sweet, North Texas Sweet, Oklahoma Sweet, South Texas Sweet. Also, specific foreign crudes of not less than 34° API nor more than 42° API are deliverable. The following foreign streams are deliverable: U.K. Brent, for which the seller shall receive a 30¢-per-barrel discount below the final settlement price; Norwegian Oseberg Blend is delivered at a 55¢-per-barrel discount; Nigerian Bonny

Light, Qua Iboe, and Colombian Cusiana are delivered at 15¢ premiums.

Another important US crude is that produced in Alaska. Alaskan North Slope (ANS) is extracted from the fields at Prudhoe Bay and then carried by the Trans-Alaskan pipeline to Valdez. From there, it is shipped by tankers to US West Coast and US Gulf. There is also a forward market on ANS, but it is primarily priced as a spread on WTI.

Other US crudes include: West Texas Sour and Light Louisiana Sweet, both of which are priced as differentials of WTI.

5.2.3 West Africa

A substantial amount of international oil trade is generated from the west cost of Africa, where the producer countries are Nigera, Angola, Gabon, Congo, and Cameroon. Their target markets are primarily transatlantic, notably the US. There are several types of crude, but three are the most commonly known: Bonny light; Forcados; and BBQ, a blend of Brass River, Bonny light and Qua Iboe. All of the above crudes use mainly Brent as a marker crude, but pricing on WTI is not uncommon.

5.2.4 Middle East and Mediterranean

Middle East is the biggest exporter of crude in the world and plays, therefore, a key role in regulating the supply side of oil trade. The role of the Middle East was extensively discussed in the previous chapter and was recently reaffirmed during the Gulf Crisis.

One of the commonly quoted crudes for many years was Arab light, and it is still used as a benchmark for Middle East OPEC members. A relatively newer entrant in the market is Dubai Fateh. This is a medium crude of 31° API and containing up to 2% sulphur. It is often considered as the equivalent of Brent in the Middle East and seems to dominate the spot market. Oman and UAE are two very active participants in the spot crude market as well, but their grades are relatively sour. Pricing formulas in the region are quite complicated, often involving retroactive pricing. Some of the often quoted prices are OSP, and MPM or PDO,[6] the latter, however, seems to be priced as a spread of Dubai.

In the Mediterranean the main producers participating in the spot market have traditionally been are Libya, Egypt, Syria, and Algeria. Iran and Russia are also very active and important despite not having a Mediterranean coast; the former from Sidi Kerir and the later from the Black Sea. For a long time Libya was disadvantaged by the US embargo, but continued to have considerable transactions with other Mediterranean countries, Italy in particular. Spot prices are quoted for most of these crudes, and a sample of these prices is given in Table 2. Brent and Dubai prices are often involved, directly or indirectly, in the pricing formulas of Mediterranean crudes.

Russian crude has gained particular significance in the last eight to ten years, with the rise of the country to the top of oil exporting nations. The bulk of Russian crude from the Caspian Sea is transferred via pipeline to Novorossyisk and from there it is shipped in tankers through Bosporus and on to its final destination. In addition to Russia (Urals), Kazakhstan (CPC blend) and Azerbaijan (Azeri light) also ship through the same route, although alternative pipeline routes became operational in the early 2000s which bypass both Russia and the congested Bosporus channel. The most important of these pipelines is the Baku-Tbilisi-Ceyhan (BTC) pipeline which delivers its cargo to the port of Ceyhan in Southeast Turkey, where it is lifted by tankers for delivery to international clients.

5.2.5 Far East

The situation in the Far East is far from clear-cut. There are several crude grades available, coming primarily from Indonesia and Malaysia, but also from Australia, China and Vietnam. There are, however, essentially only two prices: APPI and ICP.[7] The first is assessed weekly by a panel of traders, producers and refiners. The second is assessed monthly and is based on a basket of crudes, including Oman, Dubai Fateh, Gippsland (Australia), Minas (Indonesia), and Tapis (Malaysia). Both pricing system have been criticised as too slow in responding to changing circumstances; APPI is produced twice weekly and ICP monthly.

5.2.6 Products

Up to now we have concentrated exclusively on crude oil. The fact is, however, that there are active spot markets for products as well, which have been in existence well before the spot market for crude. The products market tends to concentrate around several main areas. Four of them, Rotterdam, Houston, New York Harbor and Singapore, have considerable refining, storage and shipment facilities, and usually offer the most competitively priced products. Other areas include the Mediterranean, Caribbean, Arabian Gulf, New York Harbor and Japan.

Prices are quoted for a wide array of products, including gasoil, heating oil, marine bunkers, jet fuel (kerosene), diesel, unleaded gasoline, RBOB (reformulated gasoline blend stock for oxygenated blending) gasoline and naphtha, among others. Products in the A-R-A[8] range are commonly quoted as "barges f.o.b. Rotterdam" and are usually quoted on an f.o.b. export basis. Contracts are typically traded in parcels of 1–5,000 mt. For shipment purposes, cargoes are normally bundled in consignments of 10–30,000 mt.

Some fundamental products also have an active futures market operating alongside the spot market. The products contracts traded on NYMEX, ICE and TOCOM (Tokyo

Table 4: Product futures contracts around the world

Contract	Specs
NYMEX Heating oil	42,000 US gl (1,000 barrels); tick = $0.0001/gl ($4.20/contract)
NYMEX NYH RBOB Gasoline	42,000 US gl (1,000 barrels); tick = $0.0001/gl ($4.20/contract)
NYMEX Gulf Coast Gasoline	42,000 US gl (1,000 barrels); tick = $0.0001/gl ($4.20/contract)
NYMEX Gulf Coast Diesel	42,000 US gl (1,000 barrels); tick = $0.0001/gl ($4.20/contract)
NYMEX NYH Diesel	42,000 US gl (1,000 barrels); tick = $0.0001/gl ($4.20/contract)
NYMEX 380cst Fuel Oil	100 metric tonnes; tick = $0.01/tonne ($10/contract)
ICE Gas oil	100 metric tonnes; tick = $0.25/tonne ($25/contract)
ICE NYH RBOB Gasoline	42,000 US gl (1,000 barrels); tick = $0.0001/gl ($4.20/contract)
ICE Heating oil	42,000 US gl (1,000 barrels); tick = $0.0001/gl ($4.20/contract)
TOCOM Gasoline	50 kl (kilolitres); tick = JPY10/kl (JPY500/contract)
TOCOM Kerosene	50 kl (kilolitres); tick = JPY10/kl (JPY500/contract)
TOCOM Gas oil	100 kl (kilolitres); tick = JPY10/kl (JPY1000/contract)

Commodity Exchange) are shown in Table 4, together with their sizes and minimum price fluctuation per contract (tick). Heating oil has been trading on NYMEX since 1979, and is the second most active

energy contract after crude oil. Gasoline contracts are more recent and are continuously changing to reflect the new environmental legislation in each country. So in the USA, for example, the phase-out of MTBE (methyl tertiary-butyl ether) as a gasoline additive, meant that NYMEX introduced the trading of RBOB gasoline, which conforms to the most recent US government environmental regulations.

6. Natural Gas

Natural gas is the newest of hydrocarbons and, many people believe, the future of energy, at least its medium-term future. In the last 20 or so years, natural gas has experienced an impressive growth in terms of reserve discovery, field development and production. On the demand side, gas consumption has rapidly expanded to contest coal's second place as a source of primary energy. Although not a serious threat to oil yet, it certainly is a weighty contender, and the most promising source of energy due to its excellent burning properties.

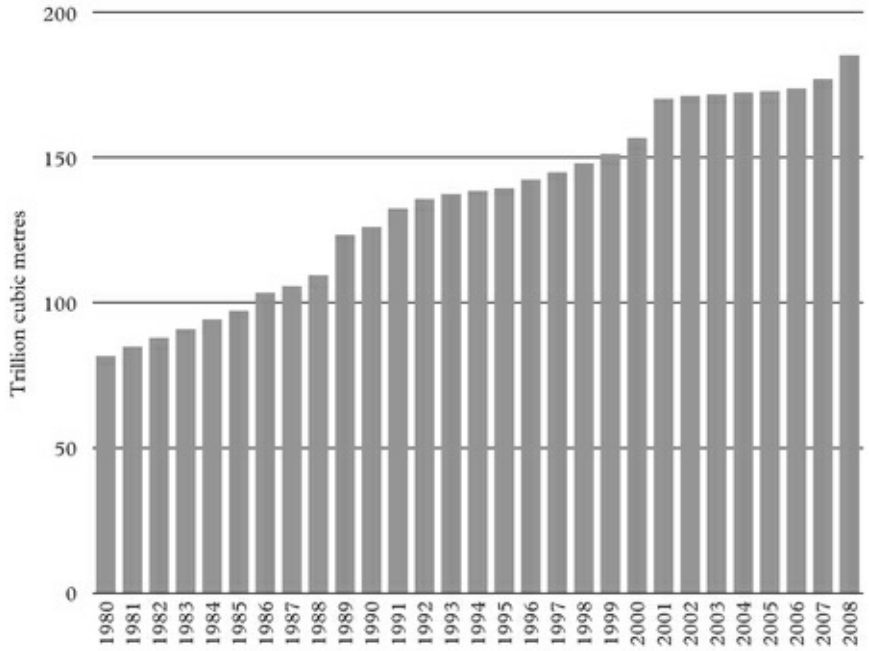

Figure 15: Development of proven natural gas reserves

Source: BP Statistical Review of World Energy, 2009

Gas formation is similar to that of oil. Organic matter which has been compressed and heated for a very long period of time is the source of hydrocarbons, especially oil and gas. At greater depths both higher pressure and higher temperatures favour the production of gas over oil. This is why gas is normally associated with deep oil deposits and the depth increases so does the probability of finding fields which contain almost pure methane. Most gas comes from 'conventional' fields, which allow the extraction of the commodity using existing cost-efficient technology. There are, however, additional "non-conventional" gas reserves, which are currently either uneconomical or technically difficult to exploit.

Although often a by-product of oil production, most of the world's natural gas production comes from dedicated gas fields. In its "dry" form, natural gas consists primarily of methane (often up to 90%), small amounts of other hydrocarbons such as ethane, propane and butane, and even smaller amounts of carbon dioxide, oxygen, nitrogen, hydrogen sulphide and rare gases. Gas exploration is similar to, and associated with, oil exploration. Once found and extracted, it is normally refined to remove impurities and separate methane form other gases, which can then be further processed and

marketed separately. What remains is then channelled into the distribution network, which normally consists of pipelines, but often involves a liquefaction plant and the use of specialised LNG carriers to carry the liquid gas to the export markets.

6.1 Supply determinants

Like oil, a substantial amount of gas reserves are held by those who don't consume them heavily. The picture is similar, but not identical, to that of oil. Reserves are concentrated in a few regions and are controlled by relatively few governments. In 2008, there were just over 185 trillion cubic metres (tcm) of gas reserves in the world (see Figure 15). Of these, 43 tcm (23%) were located in the Russian Federation, and 76 tcm (41%) in the Middle East. Within the latter region, two countries hold the majority of reserves: Iran and Qatar. In fact, combining the reserves of these two countries with those of Russia, they amount to over half (53%) of the world's total. It is no wonder then that when these three, together with several more medium-size and smaller producers decided to found the Gas Exporting Countries Forum (GEFC) in 2001, they sent jitters to all major gas consumers, especially Europeans. Although just a "forum" for the time being, it will be interesting to observe whether it could ultimately turn into a "gas-OPEC".

Relatively smaller reserves are located throughout the world (see Figure 16), but the regions who use it most – North America, Western Europe and Asia Pacific – control a mere 20% of the world's reserves. There is always, of course, the exciting prospect of non-conventional gas reserves, but there may be quite a few years before these can be developed in an economical way.

When it comes to production figures, however, the picture is somewhat changed. The world's two largest producers of gas, by far, are Russia and the USA, followed by Canada, Iran, Norway, Algeria, Saudi Arabia, Qatar and China (see Figure 17). The presence of the USA is of course justified as the world's largest consumption market,

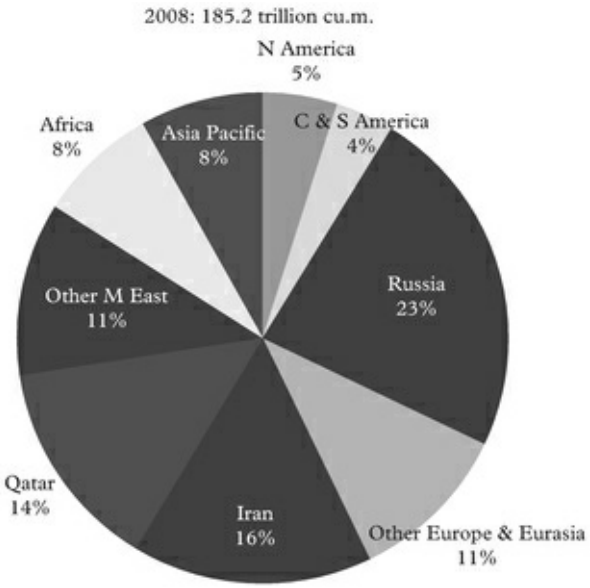

Figure 16: Distribution of world gas reserves

Source: BP Statistical Review of World Energy, 2009

which is also ahead of the game in terms of competitiveness and deregulation. The salient feature of production, however, is once again the dominance of Russia, which produced nearly one-fifth of the world's output in 2008. Of the remaining producers, Canada directs large quantities of its gas to the US market, while all other important producers, perhaps with the exception of Iran, market their production internationally.

Once gas is produced at the wellhead, it goes through a purification process which removes NGLs ("wet" gases), water vapours, carbon dioxide, sulphur and oil (if the gas is associated with an oil well). This is required for the "dry" gas to be of suitable quality for pipeline transportation and further distribution. A sophisticated network of pipelines[9] is used to collect the gas from the wellhead, channel it through the processing plant for purification and distribute it to its final destination; or channel it to a port facility for cryogenic liquefaction, load it on a specialised LNG carriers, unload it at a regasification facility at the other end and deliver it again by pipeline to its final destination.

As it is evident from the short description, the existence of a technically competent, cost effective and low-risk transportation network is vital for the commodity to flow in either domestic or international markets. This is much easier said than done, however.

Pipelines are expensive and time-consuming to lay. The decision to invest requires a host of factors to be taken into consideration: technical (e.g. pipeline diameter, route, sourcing of materials, safety aspects, sourcing of skilled staff); political (e.g. obtaining licences and approvals, adhering to national and international regulations, crossing or

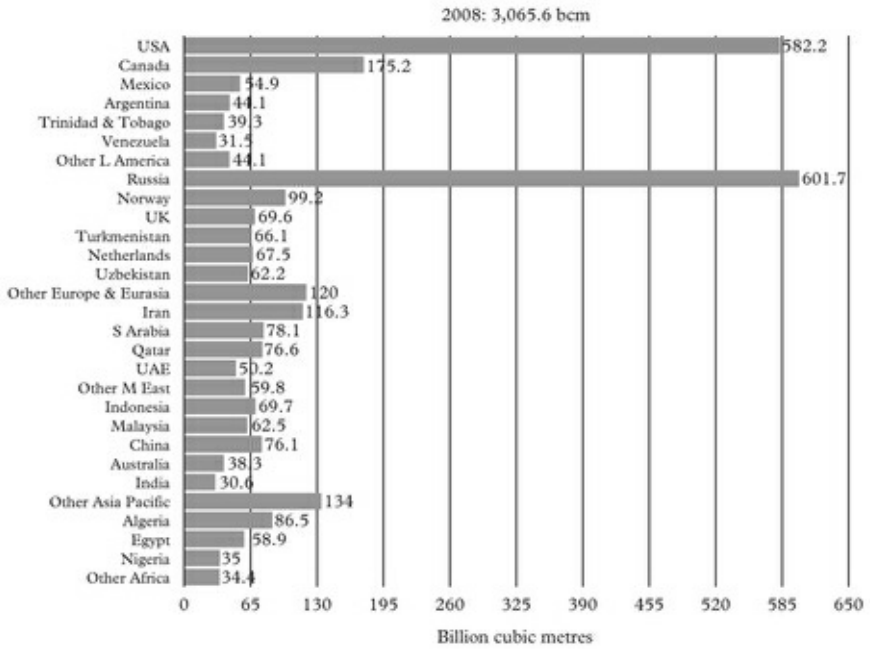

Figure 17: Gas production
Source: BP Statistical Review of World Energy, 2009

Figure 18: Gas pipelines in Europe

by-passing country borders); and economic (e.g. supply flow from reserves and their duration,

existence of adequate demand at the receiving end) are but a few of the obstacles (or “opportunities”) created by a pipeline project. The decision to build a pipeline of use seaborne transportation is itself complex. Broadly speaking pipelines are more suitable when the distance is below 5,000 km. LNG transportation, on the other hand is more efficient in bringing ‘stranded’ gas reserves to distant markets.

Probably the most interesting aspect of the supply side of gas, as indeed of oil, are the geopolitics and the resultant effects on security of supplies. We have already seen how gas reserves are concentrated in Russia and the Middle East. To complicate matters even more, the supply corridors from producers to consumers are often ridden with problems. Pipelines are the most effective means to move gas from A to B, but they typically have to cross one or more countries, which can often be a headache for all parties involved. A textbook case is that of Russia, most of whose gas production is channelled to the EU via other countries, including Ukraine and Belarus (see Figure 18). The stand-offs between Ukraine and Russia in late 2005 and again in 2008, whose Druzhba (Friendship) pipeline crosses through the former, are well documented and exemplify the type of political tensions created. And this is not counting extremist groups who want to blow up the pipeline installations!

Another example, in the same vein, is Russia’s decision to lay its new major pipeline to West Europe on the seabed of the Baltic, rather than through the territories of old foes. This refers of course to the Nord Stream pipeline project (jointly owned by Russia’s Gazprom and Germany’s Wintershall and E.On Ruhrgas), which is scheduled to start construction in 2010. The project will directly link Vyborg in Russia to Greifswald in Germany using a twin pipeline, 1,280 km-long, 48-inch wide, with a total capacity of 55 bcm per annum.

6.1.1 Storage

Just like oil, gas also has storage requirements. There are various regulatory and economic reasons for doing so. Demand fluctuations has traditionally been one such reason. Increasingly, gas is being used for power generation; uninterrupted power supply requires a steady supply of gas and stored gas helps avoiding disruptions. Typically, two types of storage are required: base-load and peak-load. Base-load storage is designed to address long term demand patterns through the consumption year; for example, higher demand in winter months, which implies that gas is injected in the storage during the summer months and retrieved at slow and predictable rates during the winter. Larger depleted reservoirs tend to be used for this storage, which are slower in responding to sudden demand surges. Peak-load storage, on the other hand, are designed for exactly this purpose: sudden demand surges, which they can cover with quick delivery or relatively smaller amounts of gas. Salt caverns tend to be used for this type of storage, as well as storage in LNG form.

6.2 Demand determinants

Natural gas consumption has experienced remarkable growth; since 1980, its consumption has doubled, from just under 1,500 bcm to just over 3,000 bcm (see Figure 19). The average growth rate during these years was a seemingly modest 2.5% per annum, but still far better when compared to the 1% recorded by oil. A host of factors have contributed to this development. The rapid increase in reserves, noted above, certainly provided a springboard for this. The clean-burning properties of natural gas, in the face of increasingly urgent environmental concerns was another factor. Practically all new power gene ration projects these days rely on CCGT (combined cycle gas turbine) technology.

Increased affluence (at least in developed and rapidly developing economies) combined with an environmental conscience make gas an ideal choice for the modern consumer.

Gas was first marketed in the United States, in the late nineteenth century. It was not until the 1930s, however, when technological improvements made possible the laying of high pressure pipes over long distances, that it was extensively marketed throughout the country. This started the very long history of gas in the country which makes it the world's largest consumer of the commodity; 657 bcm of gas were consumed in the USA in 2008, a staggering 22% of the world's total (see Figure 20).

In Europe gas was discovered in small quantities at Lacq (France) and the Po Valley (Italy) in the 1950s. The first substantial discovery came about in 1959 at Groningen in the Netherlands, while Britain made the first commercially exploitable discoveries in its sector of the North Sea in 1965. Since then gas has had a predominant position in domestic consumption. In the EU, UK still remains the largest consumer of gas with 94 bcm consumed in 2008. It is followed closely by Germany and then Italy, France and the Netherlands. The EU(27) as a group consumes a total of just over 486 bcm, more than Russia, but still well behind US consumption. In Russia, gas overtook oil as the main source of primary energy consumption in the early 1980s. Since then it has remained firmly at the top and Russia is today the second largest gas consumer in the world, behind USA.

In the Middle East the most prominent consumer is Iran with 118 bcm in 2008, practically absorbing all its indigenous production. It is a surprise that one of the biggest reserve holders is not a prime exporter, but Iran has been struggling for years to

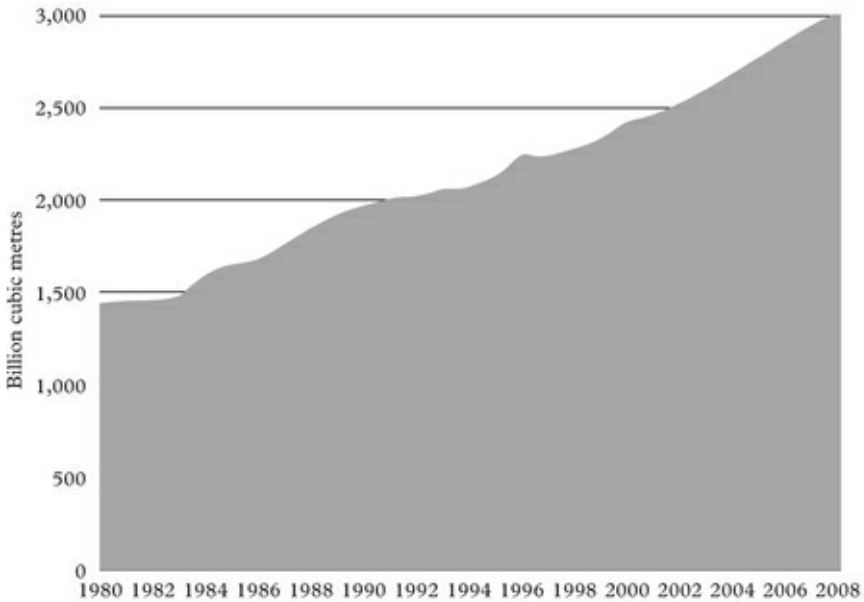

Figure 19: Gas consumption development
Source: BP Statistical Review of World Energy, 2009

put the investment in place necessary to become an influential exporter. In Asia Pacific, Japan and China are the two largest consumers, with China being the most rapidly increasing as its economy, especially manufacturing, continues its rapid growth.

Having seen the leading consumers in absolute terms, it is also worth observing the degree of penetration natural gas has achieved in primary energy consumption. Figure 21 shows the relative shares of the main fuels in broad regions around the world. The picture presents us with some obvious contrasts, but there are a few hidden ones as well. In North America (which includes Mexico), South & Central America and Europe gas accounts for a quarter of consumption. Africa is a bit lower at

around one-fifth, although what is not shown here is the very low level of consumption compared to, say, North America or Europe.

The contrast is between Russia and Asia Pacific: in the former gas has assumed an even more commanding position, accounting for 55% of total consumption; in the latter gas has a very modest share, with coal still having a stronghold, especially in China and India. Given that this is the key growth region currently and in the foreseeable future, it will be interesting to observe how gas consumption will develop, given that the region as a whole is in deficit, i.e. has to rely on gas imports, particularly from the Middle East. The region is already showing a voracious appetite for any type energy, but as environmental concerns assume urgency, gas becomes a more palatable choice. The development of the Sakhalin II project (LNG) on Russia's Pacific coast shows how well aware the Russian government and IOCs (international oil companies) are of the huge growth potential of Asia Pacific in gas consumption. And returning to our earlier

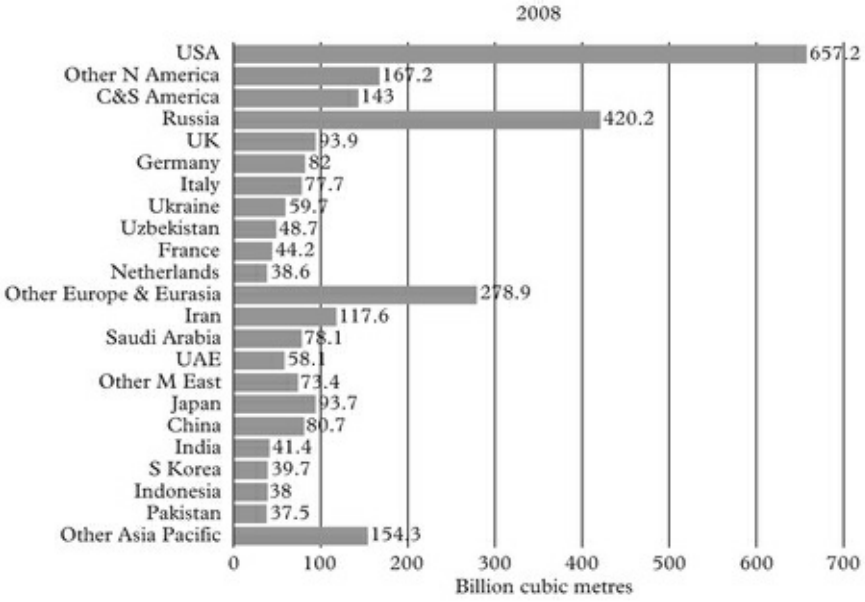

Figure 20: Key gas consumers

Source: BP Statistical Review of World Energy, 2009

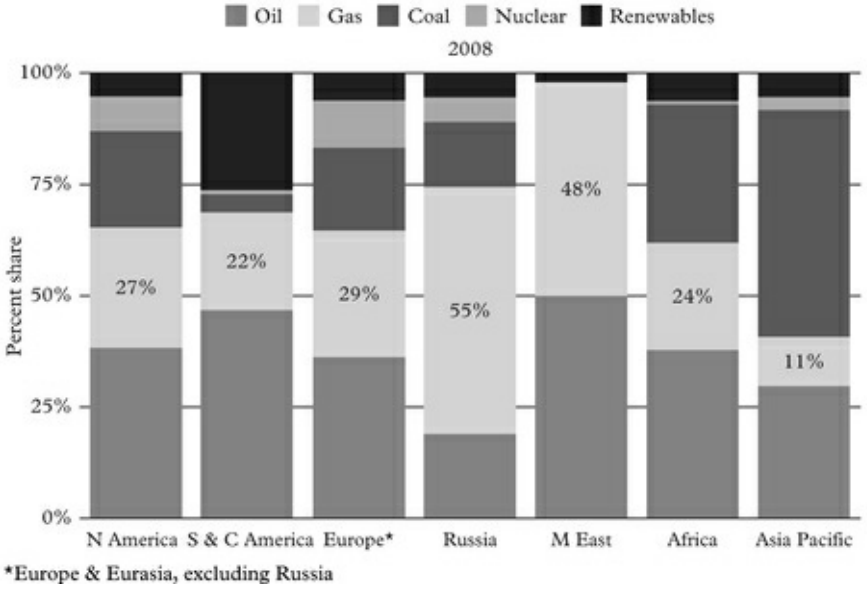

Figure 21: Regional Gas Shares in Primary Energy Consumption

Source: BP Statistical Review of World Energy, 2009

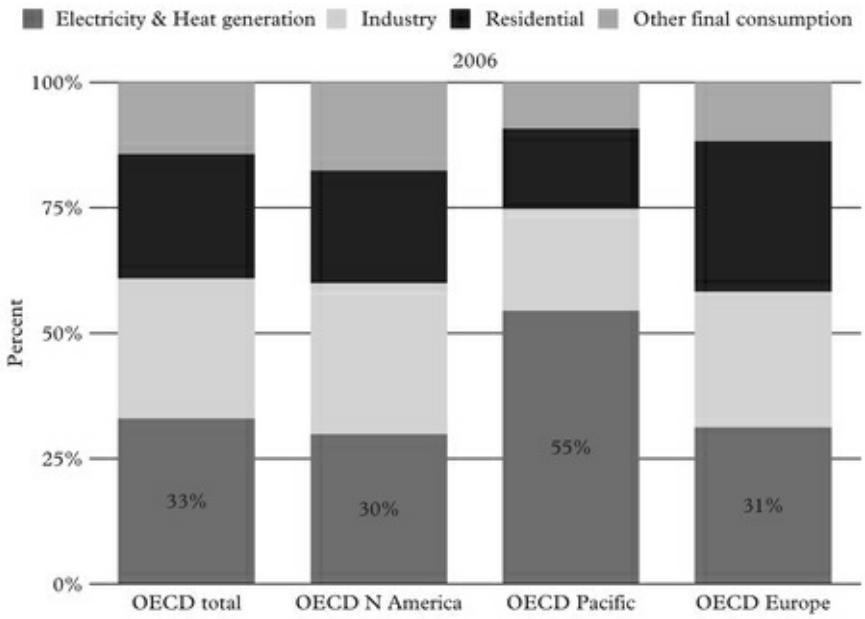

Figure 22: Gas consumption by end use in the OECD
Source: IEA, Natural Gas Information, 2006

geopolitical theme, Russia's expansion to the lucrative Asian markets shows how diversification of consumer markets has become a strategic priority for the country.

Another important aspect of gas consumption is its end use. Figure 22 shows how gas is used in OECD countries, as a total and also in various OECD country groupings. A third of the gas used is for generating electricity and heat in combined cycle plants. This figure changes dramatically when one looks at OECD Pacific, however. What the graph does not show is that this figure is dominated by Japan, which uses substantial amounts of imported LNG for power generation. The remaining two-thirds find their way to "final consumption", an aggregation of gas's use by households (for heating and cooking), industry (for power generation and as feedstock to other industrial processes) and transportation. For the moment, gas absorption by power plants is set to grow, with more CCGT plants being developed. It will be interesting to observe how growth in other sectors, especially the rather negligible transportation, will change the map of how gas is utilised by final consumers.

6.3 Marketing and pricing

Natural gas is not as extensively traded as oil and coal. Its physical characteristics make it more difficult to handle and its high flammability makes precision and care imperative. In 2008, just over one quarter (26%) of the world production entered international trade; the remaining (74%) was consumed domestically. Of the 26% which was exported, nearly 19% was by pipeline and the remaining 7% in liquefied form

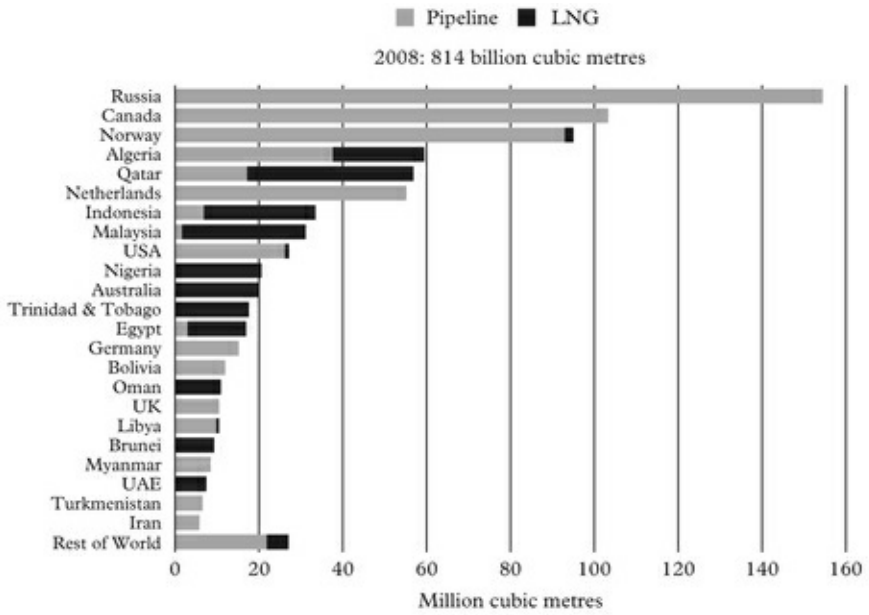

Figure 23: Top gas exporters (pipeline and LNG)
Source: BP Statistical Review of World Energy, 2009

(see Figures 23 and 24). Pipeline exports are predominant between Canada and the United States (100 bcm), and between Russia and the rest of Europe (150 bcm, of which 60 bcm were exported to Germany and Italy alone). Pipeline gas also flows in large quantities from Norway (85 bcm), Netherlands (48 bcm) and Algeria (37 bcm) to Europe. The other growing force in pipeline exports is Turkmenistan, This former Soviet republic exports to Russia and Ukraine. However, this is set to increase, as the country has recently (April 2007) signed a 30-year contract to supply gas to China, starting in 2009.

LNG trade accounted only for just over 7% of world natural gas production (and 28% of total gas trade) and is rather small compared to trade flows of other energy commodities; but because of the complexity of its transport logistics, LNG flows have been meticulously documented on a voyage to voyage basis, since the very beginning in the 1960s. The carriage of the liquid itself is only one of several steps of a carefully planned procedure, which includes carriage of gas from the point of production to the port liquefaction facility; loading; regasification at the port of destination; and transport to the point of consumption. LNG contracts have been extensively documented and are being regularly quoted in special publications by Cedigaz and BP. Examples of existing contracts are given in the following table, which records long term contracts by exporting country.

As mentioned earlier, natural gas entered international trade in a very modest way in the 1960s. The first experimental voyages with LNG carriers were carried out in the

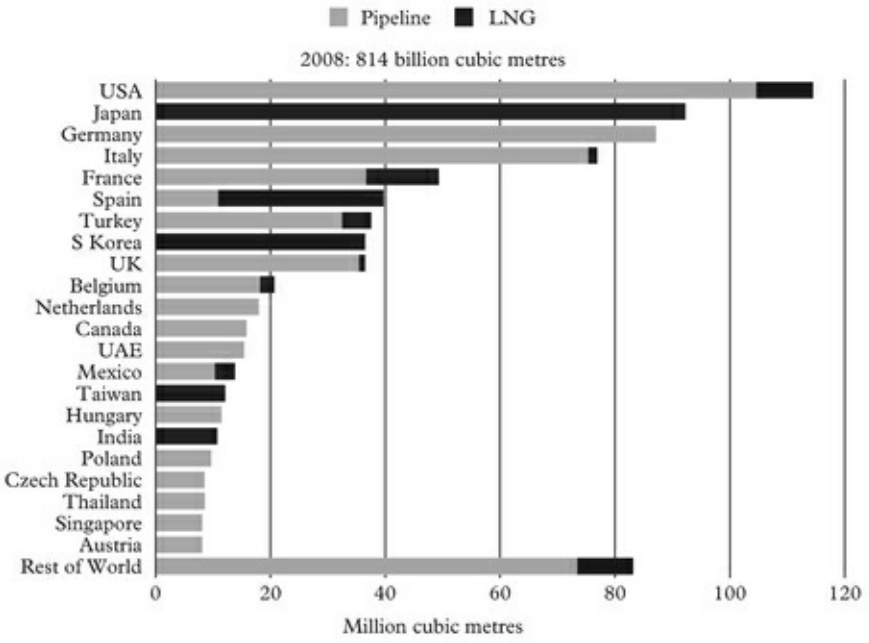

Figure 24: Top gas importers (pipeline and LNG)
Source: BP Statistical Review of World Energy, 2009

1950s, but the first commercial trip was in 1964, between Algeria and the UK. A year later LNG cargoes began flowing from Algeria to France, while in 1969, trade between Alaska and Japan was initiated.

In the 1970s gas entering world trade increased to 13% of total production and new countries appeared in the scene, like the Netherlands, Norway, Soviet Union, Iran and Mexico. The 1980s saw the opening of the submarine pipeline between Tunisia and Italy, the beginning of trade between Malaysia and Japan and the expansion of Soviet gas exports. The most challenging issue for the economics of the industry in that decade was the relation of gas and oil prices (see Figure 25). Traditionally, gas prices were determined on the basis of its calorific equivalence to oil. The 1986 oil price collapse increased pressure for a reassessment of gas pricing formulae, and many countries resorted to hybrid pricing mechanisms, often incorporating one or more petroleum products, like gas oil or gasoline. This trend is still being followed, with gas prices tracking oil prices quite closely, although gas prices do follow the prices set in the two main energy exchanges which list gas contracts: NYMEX and ICE.

With the emergence of China as the world's powerhouse of manufacturing, the much-talked-about depletion of oil reserves and environmental concerns on the ascent, interest in gas trade was also boosted; even more so for LNG, whose growth has been unstoppable since the beginning of the new millennium.

Table 5: Examples of LNG Contracts

Purchaser	Amount (million t/y)	Contract length (years)	Start	Signed
Algeria				
Gaz de France	0.79	21	1992	1991
Botas	2.96	19	1994	1998
BP/Sonatrach	3.30	20	2005	2003
Australia				
Shell Gas and Power	2.00	20	2008	2003
Tokyo Gas	1.20	25	2010	2005
Osaka Gas	1.50	25	2011	2005
Brunei				
Kogas	0.70	16	1997	–
Indonesia				
Tokyo Gas	1.00	17	2006	2002
Fuijan LNG (CNOOC)	2.60	25	2008	2003
Qatar				
Exxon Mobil	15.60	25	2009	2003
Gas Natural	1.50	20	2005	2004

Source: Petroleum Economist; Cedigaz

6.3.1 LNG projects

An interesting characteristic of the LNG market is the fact that the transport element is only the last in a long chain of planning decisions that have to be made for any individual project.

LNG ships are probably among the most sophisticated and technology-intensive in the world, with prices in the region of $220 million for a ship with a typical capacity of 147,000 cu.m., built in the Far East.

LNG projects are extremely capital intensive, usually requiring billions of funds, of which a substantial part has to be provided by equity holders. Projects are usually set up as joint ventures between developed and developing countries and involve long lead times, usually between seven to ten years. Some of the factors that need to be in place for a project to be successful are:

- a big enough reserve of gas which is unlikely to be consumed domestically for the next 20 years at least;
- one or more buyers willing to enter long-term purchase contracts;
- a host government willing to be flexible on fiscal issues;
- expertise in technical and safety areas; and
- willingness of all parties to view the projects on a long-term, cooperative basis.

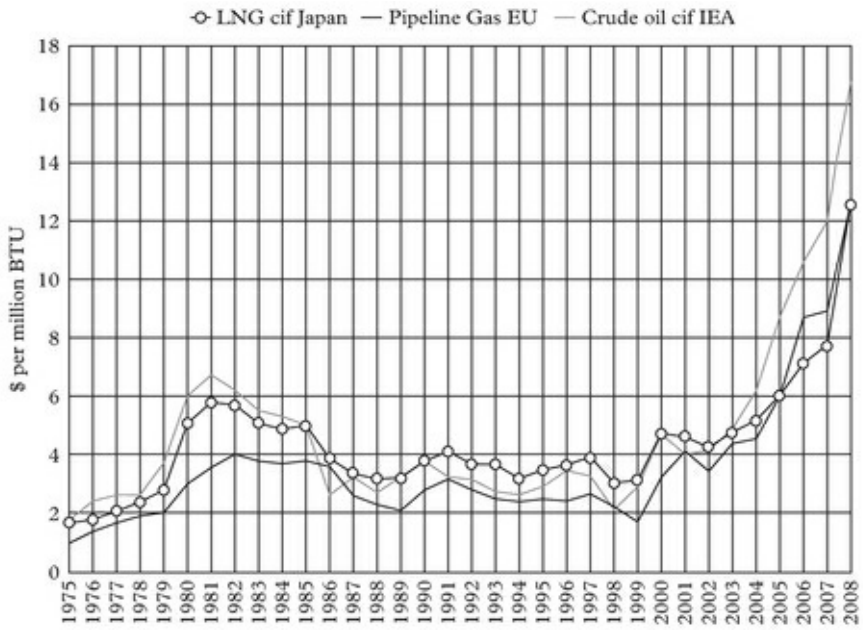

Figure 25: Indicative gas prices

Source: BP Statistical Review of World Energy, 2009

With a lot more buyer interest and more governments willing to export their production, LNG projects took off since 2000. Japan stands out as the country with most import projects (25) in operation; USA as the one with the most import projects under construction (6) or planned/proposed (9); Algeria as the one with the most export projects in operation (4); and Qatar as the one equalling Algeria's operational exports projects and with the most planned/proposed export projects (6).

As mentioned just above, an LNG project consists of several distinctive stages, namely production, liquefaction and storage, transport and trading, storage and regasification, and end-market distribution and sales. Until 2006, technological advances and and economies of scale had kept the construction costs of liquefaction plants in check, usually below $200/t/y (per ton per year) capacity. Reports in 2007, however, estimated a sharp increase in these costs, rising to over $500/t/y, sometimes reaching as much as $1000/t/y capacity. To put this in perspective, Russia's Sakhalin II project, estimated at $9.6 billion originally is now facing construction costs of $20 billion. Statoil's Snøhvyt project has experienced 50% cost inflation, to $9.5 billion.[10]

To spread the scale of costs and the overall project risk, there is usually a divide in ownership between the first three phases, which relate to sales, and the final two, where buyers take over. In some cases – in projects related to the Japanese market – trading houses provide the bridge between buyers and sellers.

The transport element of the project comes at a later stage, usually a couple of years before launching a new project. Depending on the project, sales might be on a c.i.f./f.o.b. basis in which case the seller/buyer is responsible for transport costs.

Once the project, including the transport element, is in place the buyer and seller face the risk of operating a successful and profitable venture. Notwithstanding any technical or operational issues, the key risk is profitability. The buyer requires a long-term, steady stream of income; the seller requires a competitively priced, highly marketable, easily transferable commodity. Long-term contracts (LTCs) have, therefore, been the obvious choice for LNG partners (see Table 5). This is not a novelty; iron ore and other mineral commodities have been traded for decades on the back of LTCs. In this contractual arrangement, the buyer normally takes the price risk and the seller assumes the volume risk. LTCs

normally have take-or-pay (TOP) clauses, whereby a buyer is obliged to pay for a certain amount of cargo, even if he does not lift it. Often there are destination clauses: the cargo can only be destined to certain markets, it cannot be sold further on, to more lucrative markets.

On the other hand, pricing is equally challenging. With rapidly and constantly changing markets in substitutes like oil and coal, gas prices need to be flexible, in order to be representative of true market conditions, and hence competitive. It is not surprising, therefore, that *indexing* or *formula* pricing is used in most, if not all, cases. Oil products, more than crude oil, are used as benchmarks. Most North European, North African and Caribbean LNG projects price their gas on a combination of different refined products, such as gas oil, low-sulphur fuel oil (LSFO), high-sulphur fuel oil (HFSO), as well as crude oil benchmarks, such as WTI and Brent/BFO.

7. Coal

Coal is a solid mineral, composed primarily of carbon; other components of coal are volatile hydrocarbons, sulphur and nitrogen, and the minerals that remain as ash when the coal is burned.

Most of the coal in the earth's crust was formed during the Carboniferous period – between 280 to 345 million years ago. At that time much of the world was covered with luxuriant vegetation growing in swamps. Many of these plants were types of ferns, some as large as trees. This vegetation died and became submerged under water, where it gradually decomposed. As decomposition took place, the vegetable matter lost oxygen and hydrogen atoms, leaving a deposit with a high percentage of carbon. As time passed, layers of sand and mud settled from the water over some of the carboniferous deposits. The pressure of these overlying layers, as well as movements of the earth's crust and sometimes volcanic heat, acted to compress and harden the deposits, thus producing coal.

Coal is classified in several sub-types, primarily according to its carbon content. Peat, the first stage in the formation of coal, has a low fixed carbon content and a high moisture content, but it does not have the same uses as commercial coal.

Commercial coal is usually classified in two broad categories – brown and hard. The first category includes lignite – the lowest rank of coal – and sub-bituminous coal. Both of these types are invariably used for power generation and, because of their low quality, they are consumed in domestic markets. Lignite is usually brownish-black in colour and often shows a distinct fibrous or woody structure. Lignite is inferior in calorific value to ordinary coal because of its high (43.4%) water content and low (37.8%) carbon content; the high (18.8%) content of volatile matter causes the lignite to disintegrate rapidly upon exposure to air.

The term "hard coal" comprises all the remaining high-quality types of coal, from bituminous coal to graphite. Bituminous coal has more carbon than lignite and a correspondingly higher heating value. It is primarily used for generating power, although coals closer to anthracite are suitable for further processing into coke for steel production.

Anthracite is a hard coal with the highest fixed-carbon content and the lowest amount of volatile material of all types of coal. It contains approximately 87.1% carbon, 9.3% ash, and 3.6% volatile matter. Anthracite is glossy black, with a crystal structure; although harder to ignite than other coals, anthracite releases a great deal of energy when burned and gives off little smoke and soot. Anthracite is ideal for reduction into coke, which is then used to fire iron ore in order to produce molten iron.

Coke is a vital input in the steelmaking process. Coke is the name given to the hard, porous residue

left after the destructive distillation of coal; it is blackish-grey, has a metallic lustre and is composed largely of carbon – usually about 92%. It has excellent burning properties, with a heating value of 13,800 Btu/lb, which makes it appropriate for use as a reducing agent in the smelting of pig iron.

Coke was first produced as a by-product in the manufacture of illuminating gas. The growth of the steel industry, however, produced a rising demand for metallurgical coke, making it inevitable that coke should be manufactured as a chief product rather than as a by-product.

The earliest method of coking coal was simply to pile it in large heaps out-of-doors, leaving a number of horizontal and vertical flues through the piles. These flues were filled with wood, which was lighted and which, in turn, ignited the coal. When most of the volatile elements in the coal were driven off, the flames would die down; the fire would then be partly smothered with coal dust, and the heap sprinkled with water.

A later development was the coking of coal in the beehive oven, so named because of its shape. As in open-air coking, no attempt was made to recover the valuable gas and tar that were by-products of the process. Beehive ovens have now been almost entirely supplanted by the modern by-product coke ovens. These ovens, usually arranged in batteries of about 60, are narrow vertical chambers with silica-brick walls, heated by burning gas between adjoining ovens. Each oven is charged through an opening in the top with anywhere from 10 to 22 tons of coal, which is heated to temperatures as high as 1,482°C for about 17 hours. During this period the gases from the oven are collected through another opening in the top. At the end of the coking period the red-hot coke is forced by a ram, out of the oven, directly into a car that carries it to the quenching hood, where it is sprinkled with water. The emptying process takes only about three minutes, so that the oven is ready for recharging with little loss of heat.

Although we are mainly concerned with coal for power generation and steelmaking, it is worth taking note of another form of coal – graphite; and a coal by-product – coal tar; both of which have a variety of industrial uses.

Graphite is one of the three allotropic forms of carbon; the other forms are diamond and amorphous carbon. It occurs in nature as a mineral invariably containing impurities. It is widely distributed over the world; important deposits are found in Siberia, England, Madagascar, Mexico, Sri Lanka, Canada, and numerous localities in the United States. Graphite is made artificially by baking a mixture of petroleum coke and coal tar pitch at 950°C for 11 to 13 weeks, then transferring the baked product to electric graphitising furnaces and heating it to about 2,800°C for four or five weeks.

Although graphite is chemically the same as diamond, it differs greatly from that mineral in most of its physical properties. Graphite is black, opaque, metallic in lustre, and has a specific gravity of 2.09 to 2.2. Graphite is extremely soft, it smudges anything with which it comes into contact, and it feels greasy or slippery to the touch. It is the only non-metal that is a good conductor of electricity; unlike other conductors of electricity, it is a poor conductor of heat.

The cores of “lead” pencils contain no lead but are made of graphite mixed with clay. Graphite is used as electrodes in electrochemical industries where corrosive gases are given off, and for electric arc furnaces that reach extremely high temperatures. It is used as a lubricant either by itself or mixed with grease, oil, or water. It is also used in crucibles that must withstand extremely high temperatures, and in certain paints.

Coal tar is a viscous black liquid produced in the destructive distillation of coal to make coke and

gas. Coal tar is a complex mixture of organic compounds, mostly hydrocarbons. Its composition varies with the coal, the temperature at which it is formed, and the equipment used. Coke is usually produced at about 1,000°C, and coal tar formed in that temperature range consists mostly of aromatic hydrocarbons, plus phenols and some compounds containing nitrogen, sulphur, and oxygen. The variation in composition means that most of the compounds in coal tar are formed during the coking process and are not present, as such, in the original coal. Some 300 distinct compounds have been identified in coal tar, of which about 50 are separated and used commercially. Separation is achieved through distillation, which produces benzene, toluene, naphthalene, xylene, anthracene, phenanthrene, and other valuable products. The processing may be varied to give different proportions. Left, after distillation, are residues of pitch used in making roads, in roofing mixtures, and in electrodes for the production of aluminium.

Coal tar was once regarded as a useless nuisance. Since then, however, it has led to a whole new field of chemistry and its compounds are indispensable to a vast number of products, including dyes, drugs, explosives, food flavourings, perfumes, artificial sweeteners, paints, preservatives, stains, insecticides, and resins. Coal tar is also the chief source of creosols, a group of chemicals used in antiseptics, creosote oil, paint removers, and plastics.

As noted earlier, coal normally contains a number of other compounds, mainly sulphur and metallic elements, which form the ash. When burnt, coal generates a number of undesirable by-products, which have largely contributed to the image of coal as a “dirty” source of energy. Carbon reacts with oxygen to produce carbon monoxide (CO) and dioxide (CO_2). Increased emissions of these two gases are have contributed to the greenhouse effect on the earth’s atmosphere, with detrimental long-term consequences for global climate. When burnt, the sulphur contained in coal reacts with oxygen to form sulphur dioxide (SO_2), a gas which has several useful industrial applications. If the gas is released in the atmosphere, however, it mixes with water (H_2O) in a lethal combination - sulphuric acid (H_2SO_4) – which returns to earth as acid rain. Finally, coal burning also produces a number of nitrogen oxides (NO_x), which also have detrimental effects on earth’s atmosphere.

As the coal industry is trying to improve the image of the commodity, several attempts have been made to improve its combustion, with the aim to reduce emission of impurities, such as sulphur and nitrogen oxides, and increase the efficiency of energy production. Clean coal technologies (CCTs) are a relatively new, but now more established, generation of advanced coal utilisation processes, some of which may be increasingly commercially viable in the 21st century. In general, these technologies are cleaner, more efficient, and less costly than conventional coal-using processes. A wide variety of CCTs exist, but all of them alter the basic structure of coal before, during, or after combustion. CCTs include: improved methods of cleaning coal; fluidised bed combustion; integrated gasification combined cycle; furnace sorbent injection; and advanced flue-gas desulphurisation.

7.1 Supply characteristics

The supply determinants of coal have essentially been discussed earlier in this chapter, under the section on oil. One definite advantage of coal over all other fossil fuels is its sheer abundance. World coal reserves were estimated at 826 billion tonnes at the end of 2008, with an R/P ratio of 122 years. With R/P ratios of 60 years for natural gas, and 42 years for oil, coal maintains the advantage of supply security. Another very interesting statistic is that while just between 6–8% of oil and natural

gas reserves are located in OECD countries, over 40% of coal reserves are located in the OECD area, which makes coal a “politically safe” source of energy (see Figure 26).

With such obvious advantages then, why is coal not the most popular source of energy in most countries around the world? The answer lies very much in the economics of coal mining and the challenge to coal by the ‘new’ fuels – oil and natural gas.

As in any project for the extraction of mineral resources there are three main stages in coal recovery: exploration, development, and production. Exploration may last a few years, until proper geological surveys point with high probability to the existence of reserves. Several exploratory shafts may have to be constructed in order to assess the quality and extent of the deposits. Costs at this stage can be substantial and are sunk. The development stage involves the construction of an open pit (if the developer is lucky enough to find coal near the ground surface) or the digging of an underground mine. Again, costs at this stage are sunk, and further costs might have to be incurred at later stages of a project in order to improve and/or extend capacity.

At the production stage, most of the costs are operating costs, which tend to increase as reserves are being depleted and more effort is required to extract them. This is particularly true when underground mining is the method of production. Another important difference of coal mining from oil and gas extraction is that coal has to be moved at every stage, whereas oil and gas flow naturally; coal requires a lot more effort to break and extract, while oil simply requires a steady pressure which will keep it flowing out of the well, naturally.

Another important characteristic of the coal industry, which is also evident throughout the mineral sector, is the large extent of heterogeneity in production costs. Depending on the geomorphy of the field and local climatic conditions, costs can vary considerably from one region to the next. Indonesia, South Africa and Colombia, for example, are low to medium-cost producers, while countries like Germany, UK and France produce coal at such high costs that it is often cheaper to import the commodity from distant, low-cost exporters.

Apart from regional differences, one should also expect different production costs between surface and underground coal mines. Intuitively, one would anticipate lower production costs for open pit mines; this, however, is not always so. Underground mining does suffer from increased costs for tunnelling, roof and wall supports, adequate ventilation, and a transport system to move coal to the surface. However, because of the extent of these costs, many high-cost producers – particularly European mines – have developed increasingly mechanised, and more cost-efficient, ways of extracting

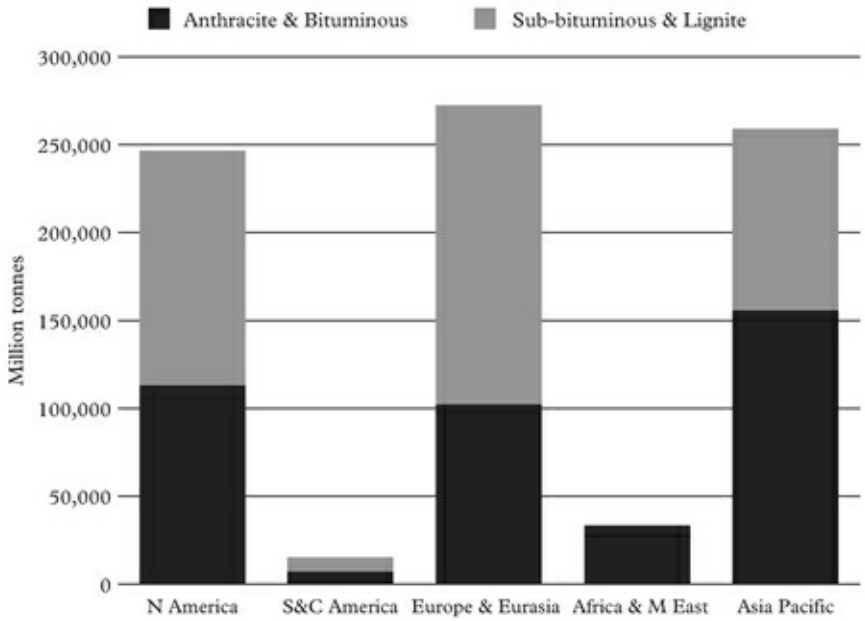

Figure 26: Proved coal reserves

Source: BP Statistical Review of World Energy, 2009

coal. These technologies have been largely adopted by medium-cost producers – like US mines, for instance – resulting in lower costs for underground mines and increased competitiveness with surface mines.

On the other hand, surface mines can do little to improve their earth-moving equipment, except perhaps by using a continuous transport system, like a conveyor belt. No matter how efficient the movement of coal is, however, it cannot compensate for the fact that there is a lot of waste material that has to be moved as well. The overall effect is, of course, that the cost per tonne of coal increases, often making surface mines more expensive than underground mines.

Although capital and land are the most important contributors to extraction costs, one should not underestimate the role of labour in coal production. Taking into account the fact that coal is largely produced in OECD countries, labour costs become quite sizeable, and labour relations are central to the uninterrupted running of a coal mine; one has only to recall the huge disruption caused, in the UK economy, by the long strike of coal miners at the beginning of the 1980s.

7.1.1 Reserves and production

Coal is found in nearly every region of the world, but deposits of present commercial importance are confined to Europe, Asia, Australia, and North America (see Figures 27–31). Great Britain, which led the world in coal production until the twentieth century, has deposits in southern Scotland, England, and Wales.

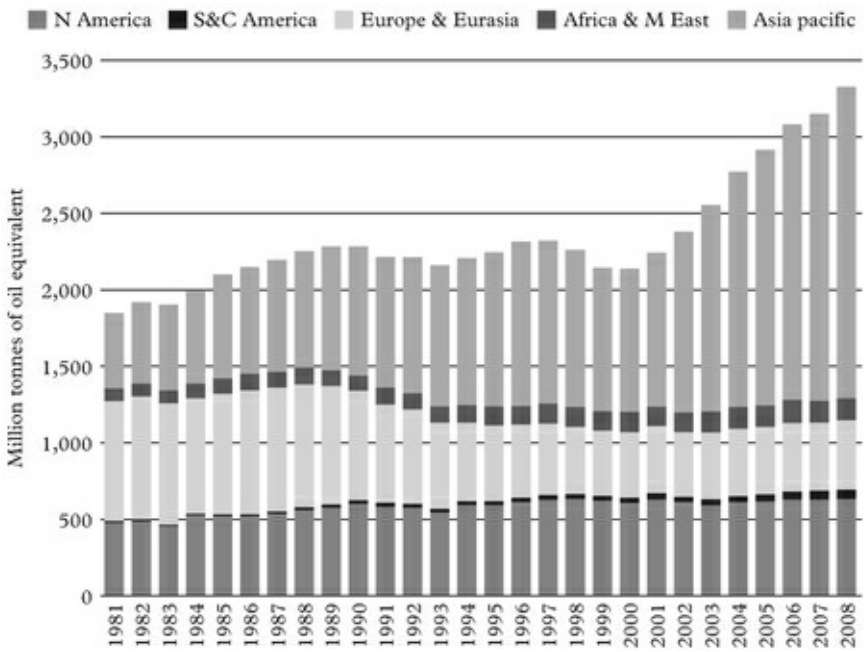

Figure 27: Development of coal production by region

Source: BP Statistical Review of World Energy, 2009

In western Europe, coalfields are found throughout the Alsace region of France, in Belgium, and in the Saar and Ruhr valleys in Germany. The French and Belgian production is rather small, with the latter disappearing altogether, after 1993. Germany is still the most important Western European producer, but its production has been falling steadily for the last 10 years. Most of Germany's deposits contain brown and sub-bituminous coal, which are of lower calorific value and, hence, decrease total German production in oil equivalent terms.

Eastern European deposits include those of Poland, the Czech Republic, Romania, Bulgaria, and Hungary. The most extensive and valuable coalfield in the former Soviet Union is that of the Donets Basin between the Dnepr and Don Rivers; large deposits have also recently been exploited in the Kuznetsk Coal Basin in Western Siberia. The Russian Federation holds the world's second largest reserves of coal, with some 157 billion tonnes in 2008, which was behind US deposits of 238 billion tonnes. Apart from Russia, Ukraine and Kazakhstan are the other two former Soviet republics to hold substantial reserves. As in Western Europe, coal production in Eastern Europe experienced a declining trend through the 1990s. This trend, however, started a reversal in the late 1990s, with coal production showing an increase as we have moved into the twenty-first century. Unlike Germany, the former Soviet republics – especially Ukraine and Kazakhstan – produce primarily hard coal.

The coal reserves of the United States are divided into six major regions. Only three of these regions, however, are mined extensively. The most productive region is the Appalachian field, which includes parts of Pennsylvania, West Virginia, Kentucky,

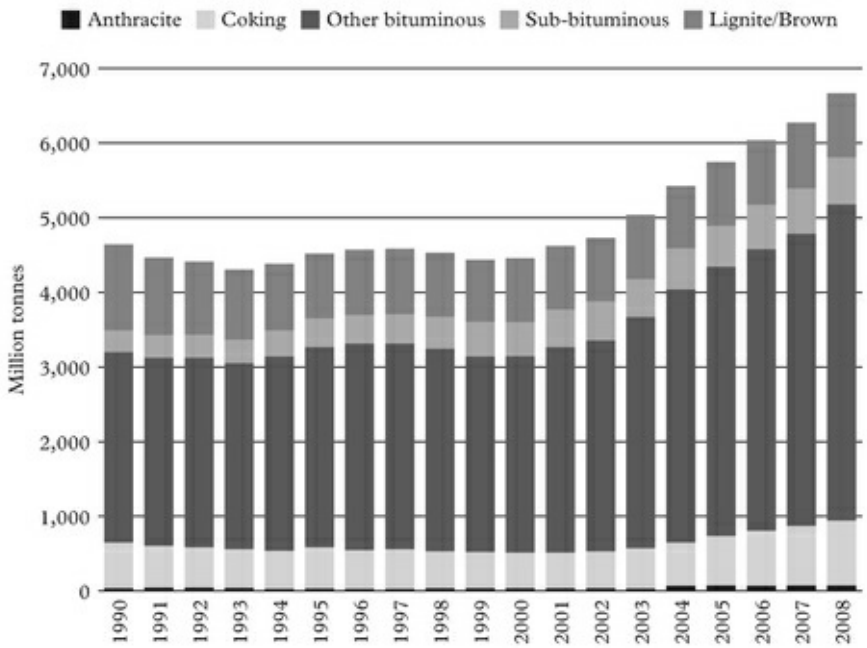

Figure 28: Development of coal production by major type
Source: IEA Coal Information, 2009

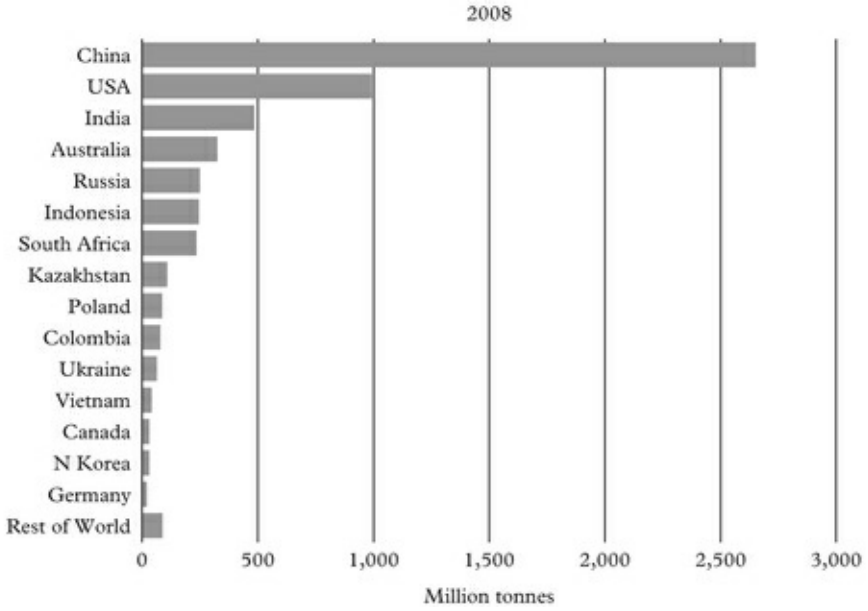

Figure 29: Top hard (steam & coking) coal producers
Source: IEA Coal Information, 2009

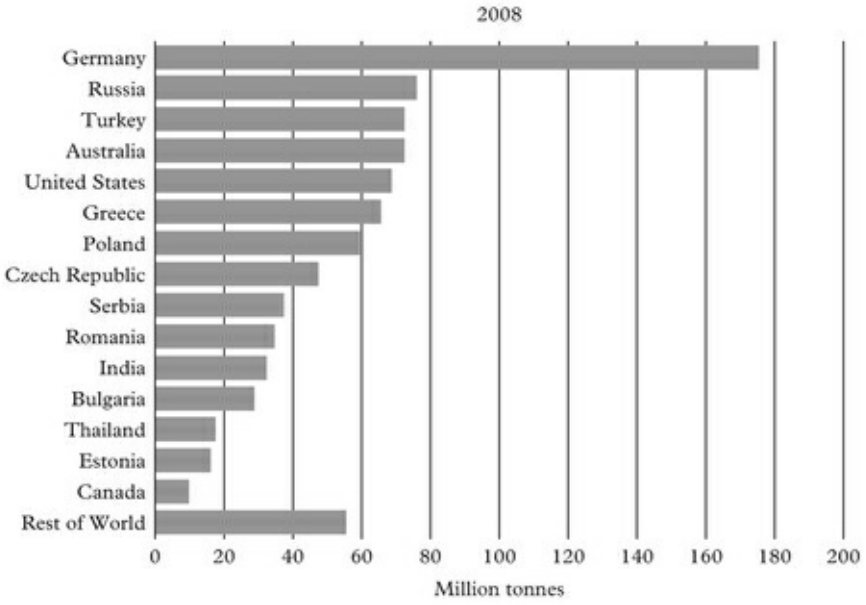

Figure 30: Top brown coal producers
Source: IEA Coal Information, 2009

Tennessee, Ohio, and Alabama. In the Midwest one large field covers most of Illinois and sections of Indiana and Kentucky. A thick field extends from Iowa through Missouri, Kansas, and Oklahoma. These three regions produce the majority of the coal mined in the United States. There are large deposits of lignite and sub-bituminous coal in North Dakota, South Dakota, and Montana. Sub-bituminous and bituminous coal deposits are scattered throughout Wyoming, Utah, Colorado, Arizona, and New Mexico. The Pacific Coast and Alaska have small reserves of bituminous coal. Almost all the anthracite in the United States is in a small area around Scranton and Wilkes-Barre, in Pennsylvania. The best bituminous coal, for coking purposes, comes from the Middle Atlantic states.

Canada does not have the massive coal reserves of the United States, but it produces very good quality anthracite, large quantities of which it exports to Japan, as well as Western Europe. Most of Australia's coal reserves are located in Western Australia, close to the large iron ore reserves. Australia is a substantial producer, and a very important exporter, of coal, particularly to the Pacific Rim.

The coalfields of north-western China, among the largest in the world, were little developed until the twentieth century. Today, however, China is the world's largest coal producer, although its reserves are only about half those located in the United States; the Chinese economy is a very intensive user of the commodity.

Finally, the most important producer in Africa and the Middle East is South Africa, with reserves of over 30 billion tonnes. The country is essentially the only significant producer of coal in the African continent, with a production of 250 Mtoe in 2008, all of which was hard coal.

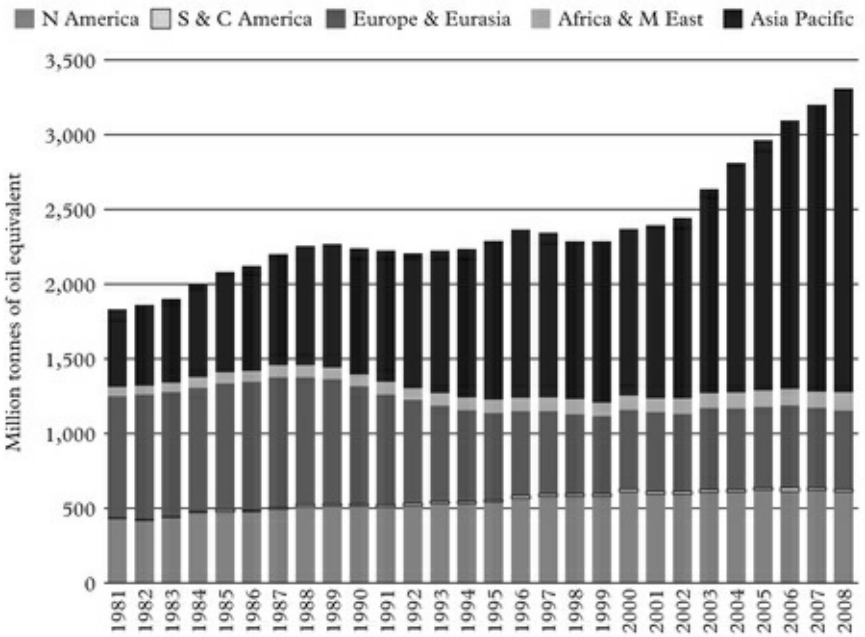

Figure 31: Development of coal consumption by region
Source: BP Statistical Review of World Energy, 2009

7.2 Demand characteristics

All types of coal have some value; as an old saying in the coal industry goes "anything pale brown will burn". This, of course, does not necessarily mean that it will burn efficiently. Although peat is frequently used as a fuel in rural communities and, more recently, peat and lignite have been made into briquettes for burning in furnaces, it is brown and hard coals that are consumed extensively; and,

of these two, only hard coal is traded internationally.

If one were to point at a single factor that has tremendously affected the fortunes of the coal industry, this would be its cross-substitutability with oil and natural gas. We saw earlier that energy is needed for residential, industrial, transport, and "other", consumption. Although oil fits very well into all types of consumption, this is no longer the case for coal. Coal has been substituted by oil and natural gas in domestic consumption; in transport, coal burns inefficiently and is quite bulky to carry around; in industry, however, it is still used extensively.

Coal has two main uses – power generation, and as a fuel in the production of other industrial materials (see Figure 32) . Coal is used extensively in power plants with coal-fired electricity generators, as well as in other industrial processes that use coal-fired generators. In industry, coal is used in the production of steel and cement. For the latter, coal is mixed with limestone and other materials, and fired to produced *clinker* – the raw material which is pulverised to become cement. In steelmaking, the procedure is not that simple; coal has to be carbonised – i.e. purified – in special furnaces, in order

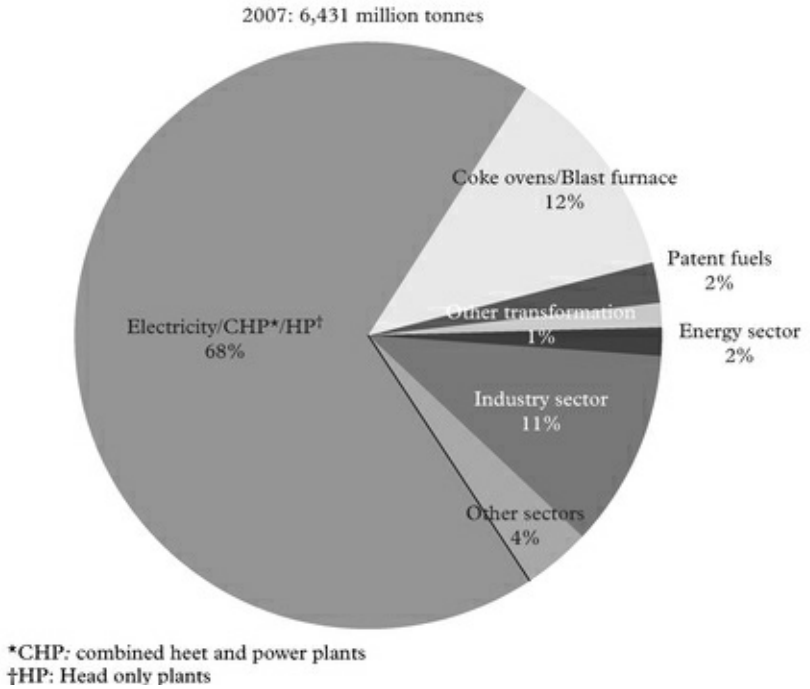

Figure 32: Consumption of steam coal by end use
Source: IEA Coal Information, 2009

to produce coke, a coal of a quality very close to that of graphite. Coke is then mixed with iron ore and a flux, and fired in a blast furnace, to yield pig iron, as we will describe in chapter 6.

Only anthracite and high-quality bituminous coal can be used for coking; coal with such attributes is known as *coking* coal. All other coal is used for power generation, and is known as *steam* coal. These two new groupings of coal should not be confused with brown and hard coal. By definition, all lignite and sub-bituminous coal is steam coal, and so is the lower-quality bituminous coal; anything of higher quality is suitable for coking.

Steam coal is a very important input in power generation, accounting for about 80% of the variable cost of producing coal-fired electricity. Demand for steam coal depends on the price of the commodity itself, the price of other substitutes – like oil and natural gas – and the ease with which a power plant can switch between different fuels. After the first oil price shock, although coal became affordable, it was rather difficult for coal to capture a large market share, because most power generators were

geared to use oil as fuel. During the 1970s, it became evident that oil was getting too expensive and too unsafe to be relied upon; the result was increased popularity for coal, which was readily available from politically safe areas. With electricity companies and other industries changing their generators to accommodate coal, it was little surprise to see a massive boost in coal consumption and trade, after the second oil price shock.

While steam coal is by far the most important cost contributor in electricity generation, this is not the case with coking – or metallurgical – coal, which is estimated to

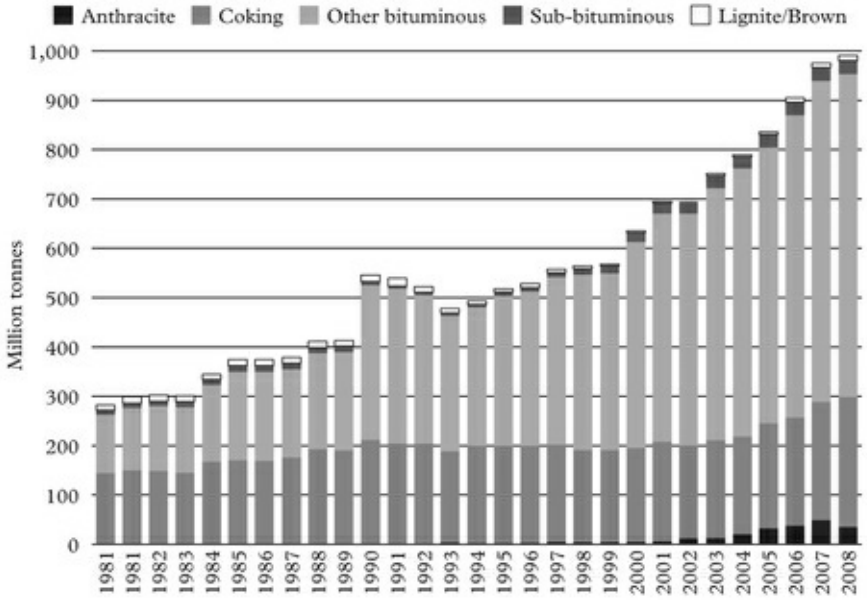

Figure 33: International hard coal trade
Source: IEA Coal Information, 2009

account about 10% of the finished cost of steel. There is no substitute for coal in blastfurnace steel production; instead, the whole steelmaking process has to be replaced with an electric arc furnace. The increased popularity of EAFs has curtailed the share of blast furnaces in crude steel production and has, therefore, undermined the demand for coking coal, as well. While this is true, however, new smelting reduction techniques for making steel utilise coal[11] once again and, thus, increase the demand of coal.

Power generation steelmaking and cement production, are not the only uses of coal, however. Coal was also used, from the early nineteenth century to the World War II era, for the production of fuel gas, just as coal liquefaction techniques were used to produce liquid oil products. In the 1980s, several industrialised nations showed interest in developing CCTs, but the popularity of the environmentally-friendlier natural gas and the availability of cheaper oil after the mid-1980s has hampered the rapid development of such technologies. With the rapid increase in crude oil prices since late 2005, however, CCTs experience a newly found popularity once again. Finally, coal has a number of additional minor uses. For example, it is used as a raw material for the manufacturing of carbon electrodes; also in pulverised form it is directly injected in blast furnaces for steel production.

7.3 Marketing and trade

Not all coal that is produced, is marketed internationally. Brown coal has a high humidity content, which makes it susceptible to spontaneous combustion and, therefore, difficult to transport. Moreover, its low carbon content makes brown coal uneconomical to export (see Figure 33).

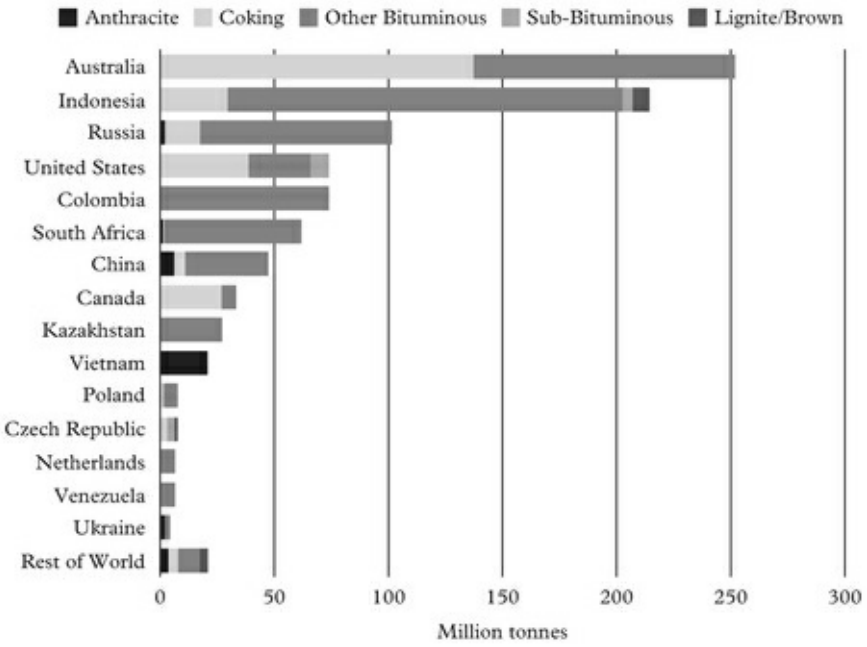

Figure 34: Major hard coal exporters

Source: IEA Coal Information, 2009

Hard coal, however, is quite actively traded, and a total of over 950 million metric tonnes of coal were traded in 2008. Hard coal traded is made up of steam coal (Bituminous and sub-bituminous) and coking coal (plus anthracite). Steam coal trade is the larger of the two, but coking coal is actually the most actively traded.[12]

The list of top exporters of coal differs somewhat from that of top producers (see Figure 34). Some of the most important producers of coal use it domestically; the case of China is an extreme example, whereby only a tiny portion of the country's production (ca. 3%) is exported. At the other extreme, Australia channels over 75% of its production in the export market, while the United States presents a mixed picture, with substantial quantities of coal disappearing through domestic demand.

Overall, the most prominent exporter of coal is Australia, controlling just under 20% of steam coal exports, and over 45% of exports of coking coal. Other important exporters of coal include the Indonesia, Russia, South Africa, China, Colombia, United States, Canada, Poland, and India.

Focusing on steam coal trade now, Indonesia and Australia are the largest exporters, followed by South Africa, and then by Russia, South Africa, Colombia and China. The direction of most steam coal trade flows is Asia (especially Japan, S. Korea and Taiwan), which receives over 50% of world imports. Japan is the single most important importer of steam coal, absorbing 18% of world trade. The second largest importing

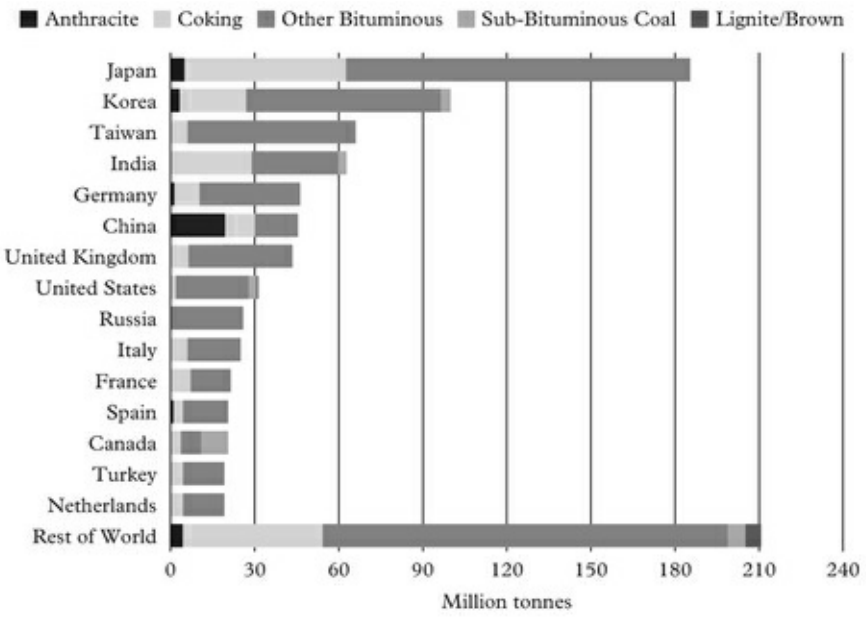

Figure 35: Major hard coal importers
Source: IEA Coal Information, 2009

region is Western Europe, with Germany, UK, Italy and France the top four European importers (see Figure 35).

The situation in metallurgical coal is quite different. Both exports and imports are dominated by a few large players. Coking coal is not abundant, and there are only a few countries that have adequate reserves. Australia, the United States, Indonesia and Canada, are the four most important exporters of coking coal, accounting for nearly 80% of total trade. Other exporters include Vietnam, Russia and China.

Coking coal imports are directed primarily to Asia and Western Europe. Once again, Japan is the largest single importer of coking coal, absorbing nearly a quarter of world exports and sourcing most of its needs from Australia. Because of this interdependence, it is no surprise that both Japanese steel mills (JSMs) and Australian coal producers enter negotiations every year, in order to determine quantities and prices for coking coal exports. These negotiations parallel those for iron ore, and they usually involve the same companies. Following Japan at a distance are China, India and S. Korea, each one importing 27–29 million tonnes in 2008.

The steam coal market is not as concentrated as the market for coking coal. There are several suppliers of coal in each of the large producers: in Australia the key players are BHP Billiton, Xstrata, Rio Tinto and Anglo American. In South Africa most of the production and exports are generated by Ingwe, Anglocoal, XCSA[13] and the local companies Sasol[14] and Exxaro.[15]

Table 6: Top US Coal Producers

Rank	Company	2005 production (000 short tons)	Percent of total production
1	Peabody Coal Co	201,410	17.8%
2	Rio Tinto Energy America, Inc	123,876	10.9%
3	Arch Coal, Inc	117,402	10.4%
4	CONSOL Energy, Inc	65,626	5.8%
5	Foundation Coal Corp	64,071	5.7%
6	A.T Massey Coal Co, Inc	42,272	3.7%
7	North American Coal Corp	30,909	2.7%
8	Westmoreland Coal Corp	29,911	2.6%
9	TXU Corp	23,158	2.0%
10	Alliance Coal, LLC	21,897	1.9%
	Total Top 10 Production	720,532	63.7%
	Total US Production	1,131,498	100.0%

Source: Energy Information Administration, Major US Coal Producers, 2005

In the United States there are many producers with producing capacities from as low as 2–4 million (short) tons per annum to as high a few hundred million tons per annum, making the US one of the most competitive markets in the world. This said, however, its top ten producers control more than half of the country's total production (see Table 6).

Like steel producers, power plants need reliable supplies of adequate quality of coal that will make electricity generation as efficient as possible. Power plants usually enter their own negotiations with coal mines and/or traders, and any respectable procurement manager of a power plant concentrates on four main aspects of the negotiations:

- physical characteristics of the coal;
- the reliability of the supplier;
- contract specification; and
- pricing.

Coal quality is determined by a number of parameters, like its calorific value (measured in kcal/kg), percent content of volatile matter, moisture, ash, and sulphur; hargrove; and initial deformation point. Coal quality is important, because low-quality coal results in: energy losses; excessive waste material that has to be disposed of; increased corrosion and, hence, increased maintenance costs; and increased expenses for desulphurisation.

As far as the supplier is concerned, a power plant needs a counterpart with adequate infrastructure, in an area of relative political stability, with a healthy financial position, a long-term attitude to doing business, and commitment to quality development, and

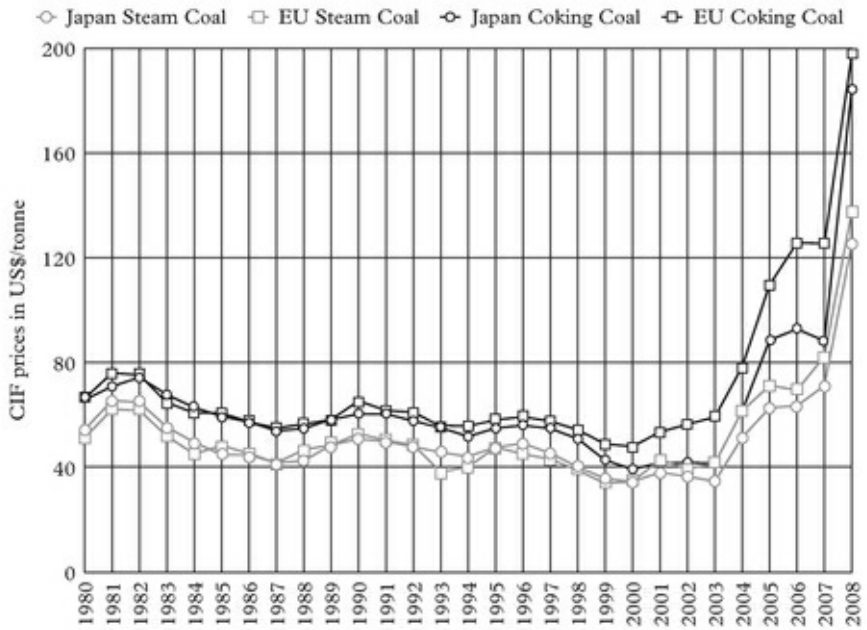

Figure 36: Coal import prices

Source: IEA Coal Information, 2009

cost control. Moreover, the supplier should preferably have prior export experience, which will help overcome any difficulties that may arise.

The contract is, of course, the most important part of the agreement, and should be fair and equitable, which will keep both partners happy throughout its duration. After all, the contract provides security of supplies for the buyer, while income security is the main benefit for the coal producer, together with the ability to use the contract as a loan collateral. Although contracts usually include long lists of clauses for every eventuality, it is always preferable to keep them simple, since arbitration is expensive and time consuming. Finally, contracts also make proper arrangement for the transportation of coal from source to destination. Approximately 80% of the world trade in coal is carried by sea – just under 800 million tonnes in 2007. Coal is in fact – with iron ore – the largest seaborne dry bulk commodity, providing employment for all sizes of dry bulk carriers, but particularly for Capesize and Panamax vessels.

Pricing is the last stage of the agreement between buyer and seller. Prices are usually set every year, in a process that is called *annual price nomination*, and are usually based on the average cost of operations plus a profit component. This method is called *cost-plus* and is the most popular – but not unique. Another, very similar method uses a base price, which is estimated from the cost-plus price, and an escalation term is attached to it. Finally, market prices can also be used although, due to the large heterogeneity of the commodity, such prices are quite difficult to determine. Coal prices reflect, of course, the conditions in the energy and steel markets. An increase in the price of oil (like the

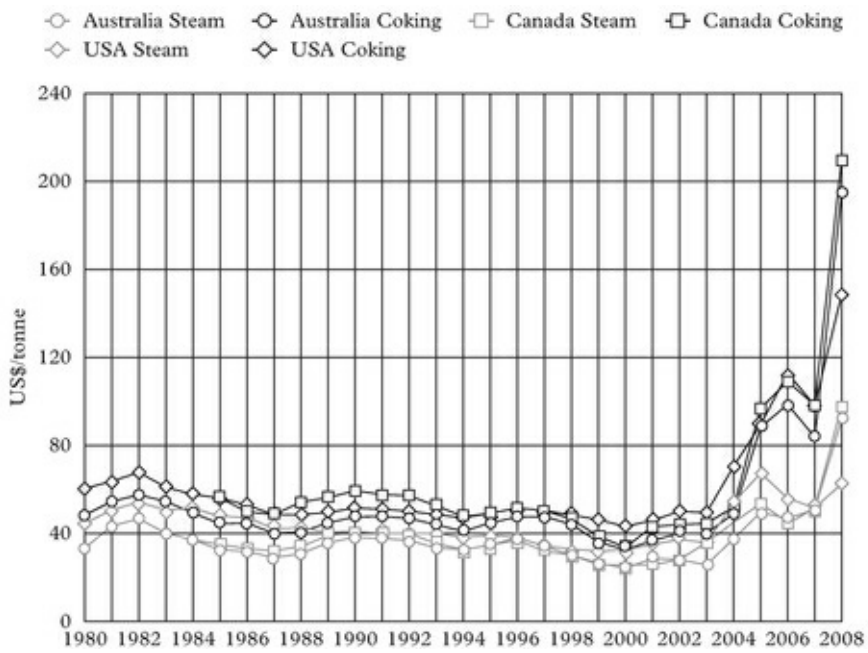

Figure 37: Coal export prices

Source: IEA Coal Information, 2009

ones in 1973 and 1979) will increase demand for oil substitutes – like coal – and will, thus, push prices upwards (see Figures 36 and 37).

8. Conclusion

Concluding the discussion on energy commodities, we focused first on the history and current markets for crude oil, refined products and natural gas. After the oil price collapse of the mid-1980s, the world witnessed a notable switch to open market pricing. This led to the emergence of some crudes, like Brent and WTI (and more recently Dubai), as marker crudes. Although not commanding an important part of world production or trade, the markets (spot, forward, futures and other traded or over-the-counter derivatives) of these crude grades provide competitiveness and transparency and are used for two very important activities in commodity trading: price discovery and hedging. Few could have predicted the roller-coaster ride of these prices in the early 2000s. Strong economic growth, an apparently insatiable appetite for energy my new industrialising economies and continued political turmoil in the Middle East pushed oil prices a historic record high of $147/barrel, followed by a sharp decline down to nearly $40 and then a continuous fluctuation between $60–70 up to now (autumn 2009).

Natural gas remains a dynamic contender in the energy sector. After experiencing a rapid growth of reserves and production, it has stabilised its share in global primary energy consumption. The most notable development in this market, especially in the new millennium, is the increasing complexity of the trade flows. With new LNG projects becoming operational, the possibility of a deeper and more competitive spot market for LNG cargoes and new gas pipelines being constructed or planned, this industry continues to offer exciting opportunities for growth.

We also discussed the supply and demand economics of coal. Not long ago, not many people believed that coal could withstand the onslaught of natural gas on its market share. Yet, this commodity never ceases to surprise. Coal production and trade continued to increase through the 2000s and still enjoys a commanding position in global primary energy consumption, particularly so in heat and power generation. With the strong growth in steel production, driven by China, coal

remained the world's largest bulk commodity, together with iron ore.

Coal is still considered a politically safe commodity. It is also the heaviest contributor to carbon emissions. Although coal has managed to overcome this shortfall by being quite cost effective for power generation, the fact remains the coal industry is facing an urgent and major overhaul. Clean coal technologies, such as carbon capture and sequestration, offer possibilities for the industry to clean up and reduce the burden on greenhouse gas emissions. However, these technologies are still an experimental stage and require time, money and perhaps the right legislative force to implement them on a large scale.

For the foreseeable future and until one or more commercially viable clean and renewable energy substitutes come to the mainstream, hydrocarbons will continue to dominate the world energy industry and will continue to generate the trade flows which provide the livelihood to a substantial part of the world's merchant fleet.

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Endnotes

1. Marginal cost is the cost of extracting one additional unit of the commodity. This often includes the operating cost, a fixed cost element, and possibly an allowance for the cost of capital investment required to achieve extra production.
2. User cost is usually defined as "the present value of the resource foregone when a unit of the commodity is produced today rather than tomorrow". Although a more "academic" concept of cost, it becomes quite relevant when environmental concerns become of substance.
3. The price may also include a "normal" rate of return on the investment undertaken.
4. The utility/satisfaction gained by bringing production forward, i.e. producing an additional unit today rather than tomorrow.
5. The term will be explored in the next chapter.
6. OSP stands for Official Selling Price; both MPM and PDO are acronyms for official Omani prices.
7. APPI stands for Asian Petroleum Price Index; ICP stands for Indonesian Crude Price.
8. Amsterdam–Rotterdam–Antwerp.
9. This network includes associated compressor, metering and control stations, all necessary for a seamless operation and all adding to the cost.
10. According to *Petroleum Economist*, April 2007.
11. Coal is substituted for coke in these techniques.
12. In 2008, about a third of coking coal production was traded, as opposed to only about an eighth of steam coal production.
13. Ingwe is owned by BHP Billiton; Anglo Coal is owned by Anglo American and XCSA is owned by Xstrata.
14. Sasol is the world's largest producer of synthetic oil from coal.
15. Exxaro, which formed in late 2006, started life as Kumba Resources, then took over Eyeswize Coal, then unbundled its iron ore business as Kumba Iron Ore and rebranded itself keeping the coal operations, mineral sands and zinc.

Chapter 6

Modal Split Functions for Simulating Decisions on Shifting Cargo from Road to Sea

*Manfred Zachcial**

1. Introduction

This chapter deals with modal split models and compares the classical binary mode choice approaches with practical decision situations of shifting cargo from road to sea and tries to quantify the qualitative factors influencing the split between modes in addition to pure financial determinants. In a first section the classical modal split models are briefly reviewed, to be followed by two different examples for the application of modal split models on European freight transport problems.

For a long time, the system-immanent disadvantages of inter modal transport including maritime or rail transport compared to direct trucking have not been quantified in monetary terms. There have been only certain tentative estimates available assuming advantages of transport cost of 15–30% in favour of sea transport to be necessary to shift a certain amount of cargo from road to sea or to avoid shifts from sea to road. Among others scientists, the author has dealt with this problem since years.[1]

2. Binary Mode Choice Models

The basis of the empirical modal split functions tested in the following is the classical interchange modal split model. This modelling approach was dominated by post-distribution models. The advantage of this procedure is the principle inclusion of the characteristics of the trip and the modes performing it. The first models included only one or two characteristics of the trip, almost vehicle operation cost and travel time. As found by several researchers, a S-shaped curve seemed to represent this kind of behaviour adequately. This hypothesis is shown in the following Figure 1.

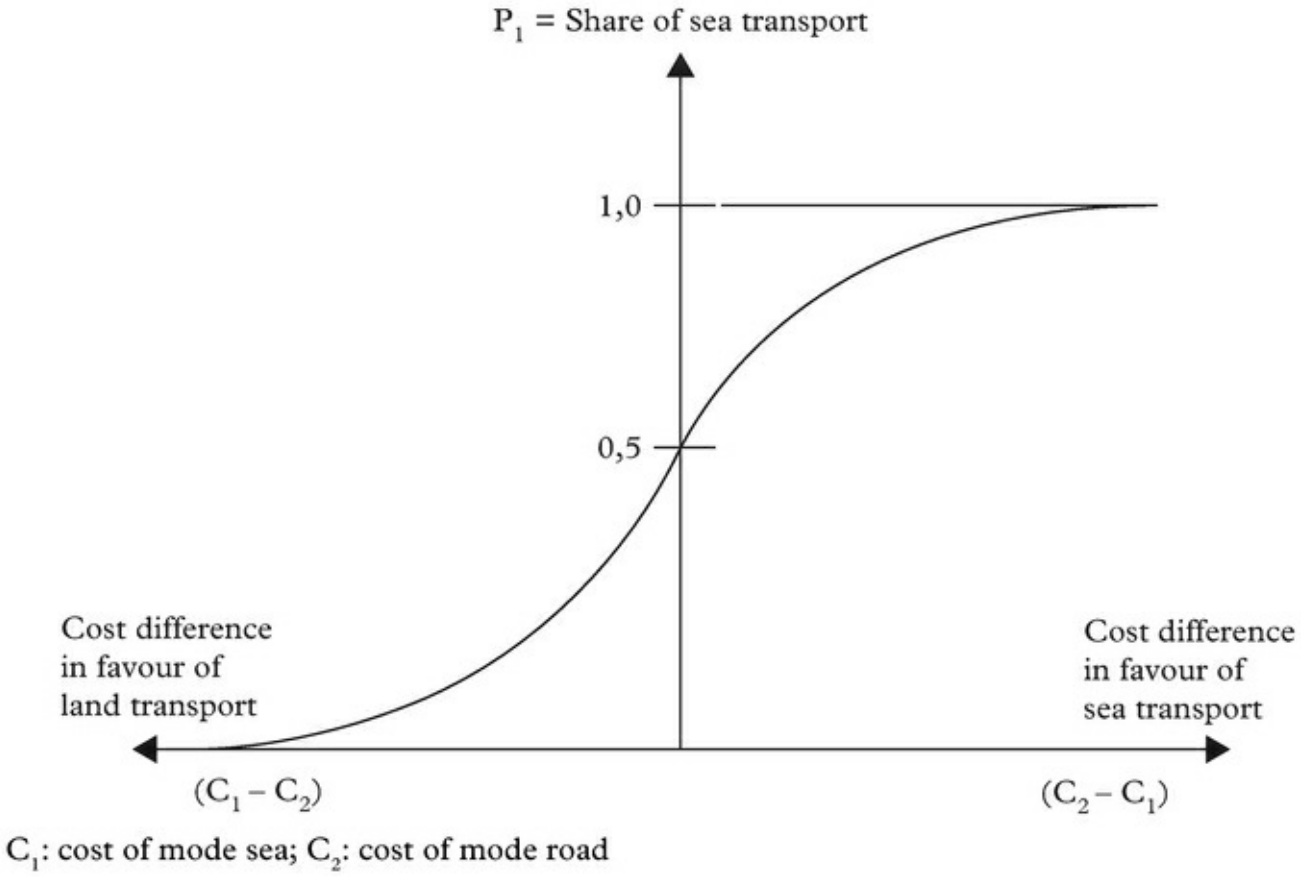


Figure 1: The classical modal split function

Empirical tests have shown that the forecasting ability is doubtful due to missing explanatory parameters. Among others such as qualitative factors they ignore a number of policy-sensitive variables. Therefore it seems to be necessary to modify this type of model.[2]

3. Modelling Approach and Empirical Tests

Since some of the determinants of mode choice are not possible to be quantified and expressed in monetary terms, it seems to be necessary to apply a modal split model which estimates system-immanent disadvantages of inter modal transport compared to pure road haulage.

$$\frac{P_1}{1-P_1} = \frac{1}{\exp\{-\lambda(C_2+\delta-C_1)\}} = \exp\{\lambda(C_2+\delta-C_1)\}$$

The ratio of the proportions or transport shares of both modes is equivalent with the probability to choose the one or the other mode. The components of the formula are defined as follows:

P_{ij}= market shares of O/D pairs

λ = dispersion parameter

δ = modal disadvantage (penalty)

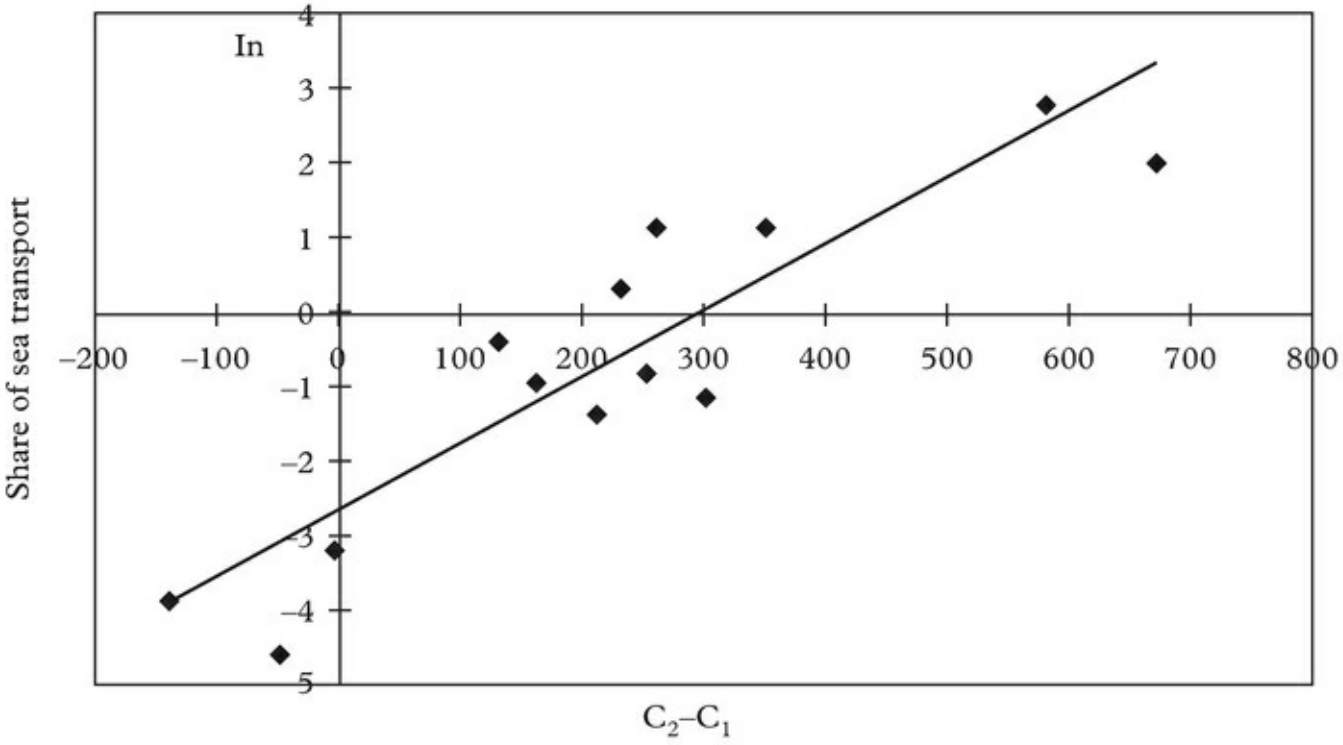


Figure 2: Linearised regression line of mode choice assuming 0.90€/km for trucking cost

Linearisation by using logarithms results in the following formula was used for linear regression:

$$\ln\left\{\frac{P_1}{(1-P_1)}\right\} = \lambda(C_2 - C_1) + \lambda\delta$$

The values of λ and δ as the regression‘s unknown parameters have been calibrated by regression analysis with ($C_2 - C_1$) as the independent one. The term λδ equals the regression's constant and λ the slope of the function.

The theoretical modal split function implies that both modes will have 50% market share if the difference between total costs of both modes including all relevant qualitative factors is zero.

3.1 Test of split functions for trade data between Portugal and Germany

In a first example for the application of a modified type of modal split models, the freight traffic situation of land and sea transport between Portugal and a number of German metropolitan areas was analysed (for example Hamburg, Bremen, Berlin, Düsseldorf, Frankfurt, Munich, Stuttgart, Cologne etc.). Figure 2 shows that the market shares between land and sea related to each of the origin/destination pairs follow the theoretical modal split function.[3]

However, the y-axis (indicating the cost difference of zero) is not crossed at the 50:50 distribution between sea and land, but at about the 40:60 distribution. This means that there are determinants of demand in the market which influence the split in addition to pure transport cost.

$$y = \ln\left(\frac{P_1}{1-P_1}\right) = 0{,}0095\ (C_2 - C_1) - 7{,}4826$$

$$(5{,}402) \qquad (-5{,}689)$$

The function is satisfactory from the statistical point of view with a rate of determination of $R^2 = 81\%$ and high values for the t-statistics (number in brack ets below the regression coefficients). This holds for the fact that the regression has been calculated based upon cross section data which per se show

lower values compared to time series.

The numerical result can be interpreted as follows: the regression line crosses the x-axis at about €134. This means that with regard to this transport relation (Lisbon-Germany cities) sea transport achieves 50% of the market if the pure transport price (including port handling charges) is by €134 cheaper than trucking (on average). If the price differential is zero or even negative, the share of inter modal land/sea transport is zero or close to it.

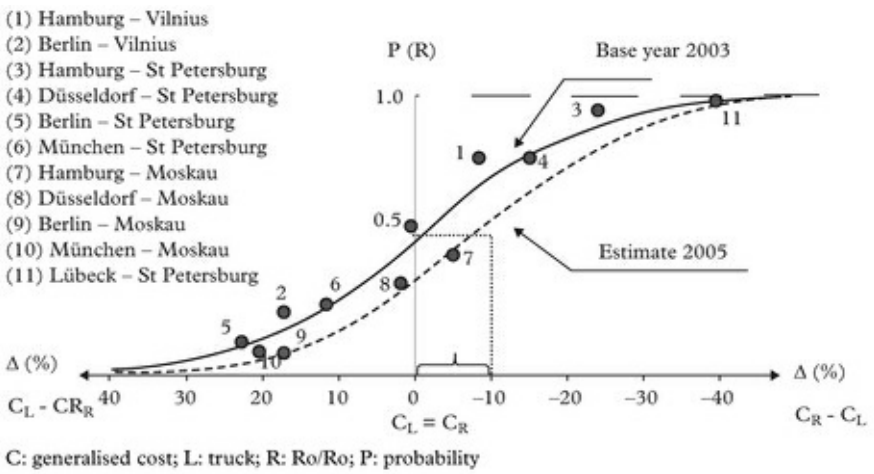
This means also that the market share of inter modal transport could be increased if on a certain route the price difference could be extended (for example by lower handling cost or lower freight rates by using economies of scale) and/or if the qualitative disadvantage of shipping including time cost, capital binding cost and others would be reduced.

3.2 Land/sea trade flows between Germany and Poland

In contrast to the modelling case presented in 3.1 where possibilities for shifting cargo from road to sea have been analysed with respect to trade flows between Portugal and Germany, now a different planning case is presented with respect to estimates of cargo shifts from sea to road within and along the Baltic Sea between Germany and Russia/ Finland. This topic became relevant because of the full EU membership of Poland and the Baltic Republics and the opening of the borders, especially of that between Germany and Poland.

The new situation of free trade flows had several impacts, especially the absence of the former long waiting times at the German/Polish border of up to 16 hours. This shortened the total transit time between Germany and Russia (St Petersburg) substantially and gave the land connection respective benefits compared to Ro-Ro traffic between the German Baltic sea ports of Kiel, Lübeck and Rostock. In addition, there have been some other aspects in favour of road compared to sea, especially the possibility to use large quantities of cheap fuel, partly stored in special tanks below the truck body of up to 1,300 litres for running across Germany further in transit to other European countries. Another aspect favouring road instead of mixed land/sea traffic across the Baltic Sea was the problem of partly missing controls of the travelling time of truck drivers.

These factors caused a substantial shift of former Ro-Ro cargo to the land corridor along the Baltic Sea with negative financial impacts on the ferry and Ro-Ro operators. They claimed for stronger regulations of land transport and financial assistance by the German Government and the EU-Commission. In the meantime most of the market biases have been resolved. Nevertheless, this former change in competition seems to be an interesting case for testing this type of modal split models. In order to help to



C: generalised cost; L: truck; R: Ro/Ro; P: probability

Figure 3: Empirical modal split function with and without changes of transport and time cost in Baltic Sea Trades 2003/2005

clarify the interactions between the changed road transport conditions and the lost of freight on the ferries, the Institute of Shipping Economics and Logistics, Bremen, tried to simulate the impacts by financial terms.

The function applied is the same as used before, where in addition to the qualitative improvement of land transport and lower freight rates also some effects of disturbed competition due to timely illegal behaviour in trucking are used as inputs to the model.

The following Figure 3 shows the split function for the market shares of Ro-Ro shipping across the Baltic Sea including hinterland traffic and pure land transport by truck. The dots are staying for origin/destination flows, for example between St Petersburg and Moscow in Russia on one and Lübeck as Baltic Sea port location and Hamburg, Berlin, Düsseldorf and Munich as locations in the German hinterland. The traffic flows from/to the latter metropolitan areas imply hinterland trucking to/from a German Baltic port and then Ro-Ro shipments compared to exclusive land transport by truck.

The straight line indicates the modal split situation "Ro-Ro shipping to road haulage" for the base year 2003, i.e. before the opening of the Polish land border, and the broken curve the situation after the opening and free cross-bordering traffic. In principle, the market share of Ro-Ro transport is the higher, the shorter the distances between the origins and/or destinations and the ports are. Consequently, the Ro-Ro shares are very low for the flows between Munich and Moscow as well as Berlin and Moscow (about 5%), while the these shares are very high for the flows between Hamburg and especially Lübeck and St Petersburg (close to 100%).

For the year 2005, there was a significant downward shift of the split function towards lower market shares expected due to the improved traffic situation in the land corridor along the Baltic Sea. This was simulated earlier to the opening of the border being indicated by the lower curve. In the changed conditions, the Ro-Ro market share was anticipated to reach only 40% on average, given equal transport cost for both transport means. This is especially true for all German origins and destinations not being located close to the coast. For Lübeck and also Hamburg this effect is not relevant. After 2005, the introduction of adequate regulations concerning fuel transport and social rules led to a certain shift back to Ro-Ro traffic.[4]

4. Summary and Conclusions

A short description of a classical modal split approach and two modifications has been presented. It could be shown that such models are suitable for deriving a better insight into the inter-modal markets and to simulate necessary cost reductions and/or quality improvements to realise a certain market share for coastal shipping compared to land transport and especially road haulage.

The precondition for an adequate assessment of effective measure is a clear knowledge of market shares and cost structures. The modification of the classical modal split model has been applied not only in the two planning cases presented here, but also in transport planning studies dealing with the competition between road and rail and between rail and shipping.[5]

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Endnotes

1. Zachcial, M. (1995): "From road to sea", in: *Logistik*, Vol. 48.
2. Ortuzar, J. and Willumsen, L. (2004): *Modelling Transport* (3rd edn) (New York).
3. Zachcial, M. (2002): "Establishment of Europe-wide maritime flows by origin/ destination", in Grammenos, C.T. (ed.), *The Economics and Business* (London) pp. 147–154.
4. Institute of Shipping Economics and Logistics *Trade Flows along the Baltic Sea*, (Bremen/Bonn, 2005).
5. Dornier/DEC/GTZ: Railway Development Study for the UAE, Abu Dhabi 2007 – GTZ: Saudi Arabian Transport Development Plan (III), Riyadh 2005.

Part Three
Economics of Shipping Markets and Shipping Cycles

Chapter 7

The Economics of Shipping Freight Markets

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1. Introduction

The purpose of this chapter is to provide analysis of the many economic changes that have occurred in freight markets in recent decades. Whereas great technological leaps in container, bulker, tanker and Ro-Ro shipping were already well in train by the 1970s the three decades since have witnessed less evident, but equally forcible changes in the shape and composition of freight market supply and demand. The intention here is to build on the solid theoretical foundations of freight markets that the blossoming discipline of maritime economics had already provided by the 1970s. From this position, the critical changes that occurred in freight markets will be discussed and their impact on freight markets analysed. Additionally, the intention is to focus on the new trends already taking place in the freight market, including the increasing impact of environmental issues on the market.

The freight market can be defined as the place where the buyers and sellers of shipping services come together to strike a deal. Categorisation may be made in a number of ways. The charter market can be divided up into the following four main sectors: First, the *Voyage Charter Market;* under this type of contract the charterer hires the ship to carry his cargo for usually an agreed rate per ton. Most of the problems are for the shipowners with the major points of negotiation being the freight rate and the laytime (the time the charterer wants for cargo handling). For obvious economic reasons charterers will opt for this market when freight rates are high and when the expectations are that they will fall and when the demand of the commodity markets seems unstable. Second, *The Contract of Affreightment Market (COA);* this is a variation of consecutive voyage chartering or in other words a contract between owner and charterer to move so much cargo on a regular basis. No ship is named, which is an advantage to owners with large fleets or to owners who are members of a "pool". Third, *Time Charter Market;* this market can be split into short, medium and long period of times. Prior to 1970 many tramp owners would have a good percentage of their fleet under long-term (say 15-year) charters. This gave stability to their business as they could estimate their income for long periods of time. However when many accepted long-term charters in the boom year of 1970 they suffered financially in the period of inflation that followed in 1973. Since then the majority of the market has been in short- and medium-term charters. In this type of contract the charterer becomes the disponent owner and has to accept many of the problems that might arise, so the negotiations will usually be more complex. Finally, *Bareboat Charter Market*; under this contract the shipowner will lease the bare ship to the charterer who for practical purposes will operate the vessel as his own. However, in this market often standard contract forms are seldom used so the actual conditions will vary, though the contract can be for a long period of time, often for the life of the ship. It can be used as a way of financing a ship, particularly in a period when shipowning enjoys certain tax advantages, as in such situations financiers can enjoy the benefits of shipowning without the problems of having to operate the vessel. In addition the charter market manufacturers and traders with significant annual volumes to move may express a preference for directly owned, vertically integrated tonnage.

The plan of work provided here outlines the nature and composition of shipping freight markets in the 1970s and the theoretical framework constructed by the new school of maritime economists in this era. The dramatic technological and operational changes to freight markets in the 1970s were well in train. Oil markets were becoming a dominant force in global shipping as the seemingly insatiable oil demand by developed industrial nations was accelerated by unin terrupted world growth (up until the late 1970s), post-World War II. The increased demand, coupled with increasing tonne-mile factors brought about by growth in long-haul oil trades, proved conducive to radical developments in vessel size. Economies of scale were the economic *zeitgeist* of this period as tanker and bulker sizes soared upwards. Equally dramatic changes were occurr ing in the cargo liner sector, with capital intensive fully cellular and Ro-Ro ves sels replacing the traditional labour intensive cargo liner. During this period the dominance of North America and Europe in world trades was being supple mented by the dynamic industrial growth of Japan, with Korean industry begin ning to register as a world force.

Building on the theoretical framework which was well established in the 1960s by the burgeoning school of maritime economists, this chapter considers new developments in freight markets. Whereas great technological leaps in design – containerisation, massively increased sizes in the tanker and dry-bulk and tanker sectors, Ro-Ro shipping - accompanied by a revolution in operational practice, occurred in the decade post-1960, later decades have been much less dramatic. However a number of areas in the freight market have under gone significant change. The intention is to explain the change process by analys ing the shifts in the demand and supply of shipping within the context of freight market changes. Though it is perhaps too early to determine what the effects of the EU banning the liner conference system will have on the liner and general cargo shipping market.

This is followed by a statistically based analysis of the principal changes to aggregate freight markets in the past four decades. The fundamentals of derived is revisited within the context of these changes. Whilst it is not proposed to challenge the main precepts of demand, it is important to recognise that important new developments have affected specific freight markets. Trends of industrialisation and de-industrialisation have wrought changes to the pattern of demand. Additionally unforeseen events shaping the global political economy have impacted on the freight market.

Finally, the concept of “green shipping” is discussed within the context of eased environmental concern during the last few decades. Empirical evidence drawn from the operations (and accidents) of contemporary shipping will be analysed within the context of the fast evolving green agenda, as well as the economic pressures of the post-credit crunch market. The intention is to explain the change process via the utilisation of a broad-based range of economic and organisational theory. This should not only contribute to the understanding of change but also endorse the value of theory which will deepen analysis of the dynamics of restructuring and strategy in the industrial transi tion process.

2. The Theoretical Framework

The key determinants of demand for sea transport were clearly defined by Chrzanowski.[1] These are:

1. the volume and quantity of cargoes to be transported;
2. the distance of transport.

The basic tools for meeting this demand were met by a mixture of charter market and directly owned tonnage. The essential question this raises is what type of allocative process was best suited to meeting these demands. The market mechanism was clearly favoured by leading maritime

economists. By the 1970s the economic principles determining freight markets had been rigorously defined by the new wave of maritime economists. From this period a strong tradition of neo-classical economic analysis has been maintained in maritime economics. With the emphasis on cost competitiveness in open freight markets, maritime economists have argued for the efficacy of market forces. Svendsen's 1958 work[2] provided a seminal analysis of the neo-classical micro economics of freight markets, stressing the essential comparative costs of shipping and their importance in attaining competitiveness in the global market. Thorburn[3] effectively employed supply and demand analysis to develop a detailed model of shipping freight markets, identifying some 36 supply and 24 demand conditions to be found in the working marketplace. Goss[4] reflected the emerging macro factors which were beginning to affect shipping markets by the late 1960s. The changes in the world political order during this period led to the market model of open freight markets being challenged. The once colonial nations were beginning to pressurise for more economic independence which included the ownership and management of merchant shipping. Additionally, open registry tonnage was becoming a major force in the world fleet. Both trends were to prove difficult for traditional owners in the USA and in Northern Europe. Protectionism in the freight market was seen as an effective response to these difficult conditions. Goss was to question the efficacy of resorting to protectionism, particularly where it negated the benefits of the competitive markets.[5] Goss' position on the open market has been a consistent feature of the maritime literature. In 1993, he was to counter calls for interv ention in the freight market:

"International shipping services are commonly bought and sold in competitive markets which lead to the survival of those with the lowest private costs... the relevant principle is that of comparative advantage."[6]

Gilman[7] heralds the great leap in technology and innovation "that facilitated the container revolution. Focusing on such major liner routes as the North Atlantic and Transpacific, Gilman credits the great economic gains of con tainerisation on the competitive process which ensured that leading lines would strive for ever-increasing efficiency. Jansson and Schneerson identified the benefits of a rigorously competitive shipping liner industry, one optimises the most economic use of the global supplies of capital and labour:

"The best division of labour in international sea transport is obtained when the most efficient operators become price leaders."[8]

3. Changes in Freight Markets

3.1 World trade from 1840–2000

World trade in the form we know it today started in the middle of the nineteenth century as global communications developed. Before that what the ship brought back from her voyage depended on the commercial ability of the master or the discretion of the owner's agent. As London became the communication centre of the world it became the trading centre of the world.

Figure 1 shows that although world trade has faltered from time to time it has continued to grow. Note also how after World War II from the mid-1950s growth in demand dramatically increases and the modern trend of maritime transport can be considered to have started.

Figure 1 also shows the general increase in world trade since World War II apart from a plateau in the 1980s caused by a slight decline in the oil trades in that period. Since then the growth has followed

the same buoyant trend established in the 1960s.

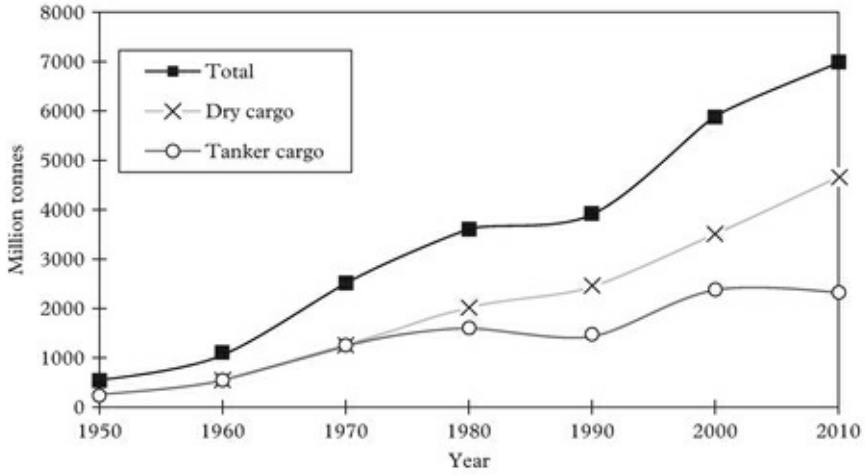

Figure 1: Growth in world seaborne trade

3.2 Main specific markets post-1970s

Figure 2 shows the growth in the world container traffic from 1970–2005 and illustrates that although the global growth has been consistently increasing (until mid-2008), the growth has varied in the three main trading regions. In 2000 World Container Ports handling increased by 8.7% but in South-East Asia and South America growth would be nearer 25%. Note that some 20% of container traffic is empty containers.

Figure 3 indicates the percentage of general cargo that is containerised in the global situation. At many of the major ports in the developed countries that percentage may be well into the 90s.

3.3 The dry bulk trades

In 1937 total seaborne trade of all mineral ores was 25m tonnes.

Demand due to post-war reconstruction caused trade to boom during the 1950s helped by re-armament, the (Korean war) and increased consumer demand, in particular by the motor car industry. During the 1960s the bulk carrier fleet increased from seven to 70m dwt. During the last few years iron ore, coal and grain have accounted for some 65% of seaborne dry bulk cargo movements. Other important bulk cargoes include bauxite, sugar, wood, wood pulp, wood chips, fertilisers and cars (full cargoes such as cars and packaged lumber are sometimes referred to as neo-hulk cargoes). See Table 1.

3.4 Tanker cargo

Following the 1973 oil price rise it became economic to develop indigenous sources of supply which is reflected in Figure 5.

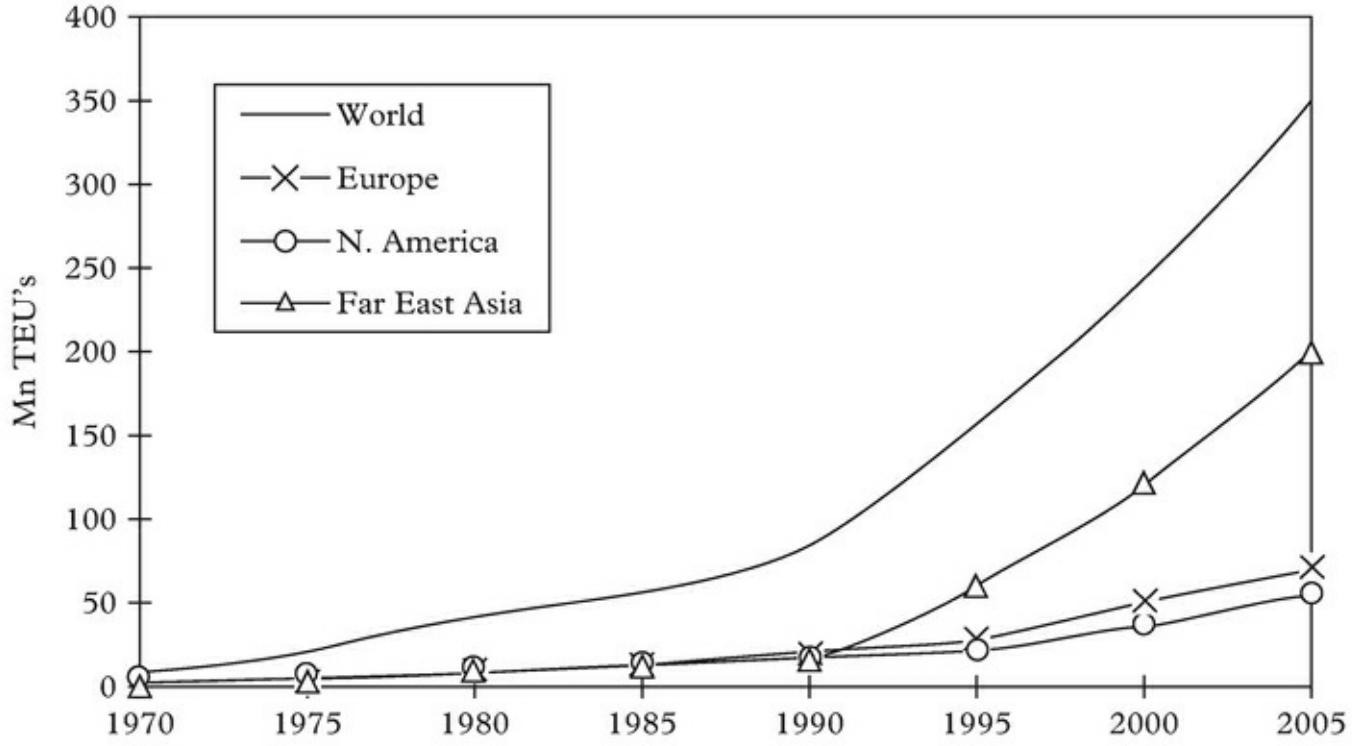

Figure 2: Growth in major containerised trades

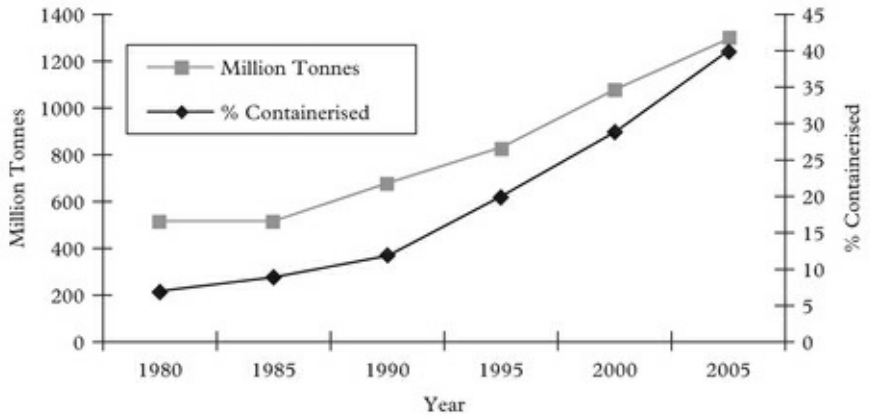

Figure 3: Growth of general cargo

Table 1: World dry bulk trade

World trade in million tonnes							
Year	**Crude Oil**	**Oil Prods**	**Iron Ore**	**Coal**	**Grain**	**Other**	**Total**
1975	1,263	233	292	127	137	995	3,047
1980	1,170	262	314	188	198	1,255	3,387
1985	871	288	321	272	181	1,360	3,293
1990	1,190	336	347	342	192	1,570	3,977
1995	1,415	381	402	423	196	1,870	4,687
2000	1,612	412	455	520	225	2,150	5,374
2005	1,820	488	650	690	242	2,894	6,808
2007	1,888	535	799	798	322	3,220	7,572
2008	World trade peaked in mid-2008 and then dropped substantially						
Average Growth 1975-2000	1.1%	3.1%	2.2%	12%	2.6%	4.6%	3.1%
World trade in billion tonne-miles							
1970							11,000
2000	8,180	2,085	2,545	2,590	1,244	6,440	23,251
2007	9,685	2,755	4,790	3,750	1,857	10,095	32,932
Average Growth 1975-97	-0.7%	4.1%	2.3%	6.1%	2.1%	3.5%	1.5%

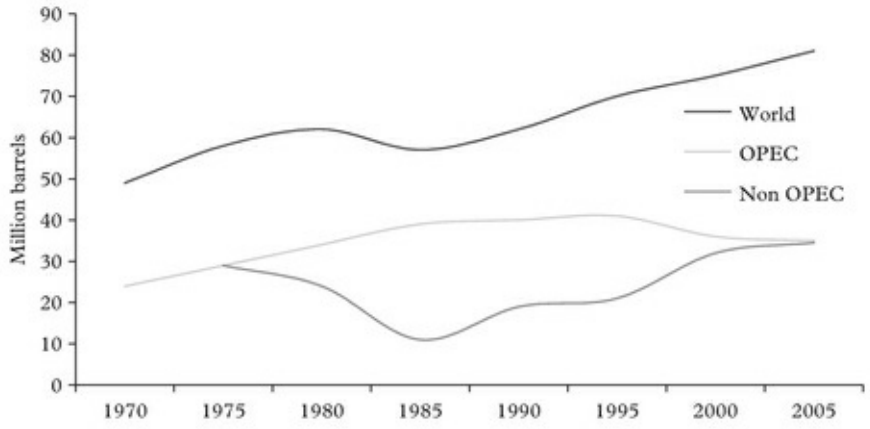

Figure 4: World crude oil production
Source: BP Statistical Review of World Energy

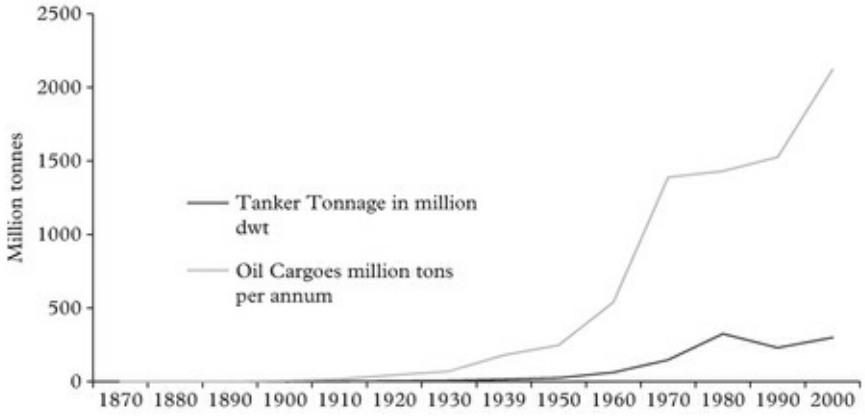

Figure 5: Tanker supply and demand
Source: Compiled from a variety of sources from the oil industry for the *Oxford Encyclopaedia of Maritime History* by author

If India and China increase their energy per capita to only half that of say Europe or Japan the demand in this sector will be tremendous. See Table 4.

3.5 Derived demand revisited

The intention now is to consider some of the specific demand factors that have altered the freight market in recent decades. The concept of derived demand serves to define and predict the nature and pattern of demand for shipping. Key determinants of

Table 2: Oil consumption at the end of the twentieth century

India	2	0.8
China	4.4	1.3
Korea	28.5	17.2
Japan	29	16.4
UK	27.6	10.7
Germany	29.1	12.6
USA	58.6	24.6

Source: Poten & Partners

Table 3: Freight costs as a percentage of import values

Country group	**1980**	**1990**	**2000**
World total	6.64	5.22	5.06
Developed countries	5.49	4.4	4.07
Developing countries of which in:	10.44	8.6	8.06
Africa	13.42	11.05	
America	8.85	8.17	
Asia	10.41	8.19	
Europe	8.23	8.96	
Oceana	12.84	12.26	

Source: UNCTAD Review of Maritime Transport.

demand have been clearly identified by maritime economists. These include: the level and location of economic activity, distance factors, population levels and trend factors. In the last three decades derived demand has been affected by the pattern of deindustrialisation in the mature economies. This has been reflected by changes in such staple trades as coal, iron ore and steel. The run down of the coal mining industry in Northern Europe has created a heavy demand for the deep-sea carriage of steam coal. Australian, Chinese, Columbian, South African and North American coal exports have benefited by the new international division of labour. The economics of such long haul trades are facilitated by the comparative costs of sea transport. Table 4 and Figure 6 illustrates the cost competitiveness of sea transport over long distances. The assumptions made here are based on representative cost between the three transport modes:

1. Imported South African Coal: Voyage Chartered Capesize Vessel, 180,000 dwt Richards Bay-Clyde, >6,000 nautical miles.
2. UK Mined Coal: Rail Central Scotland-Central England Merry-go-round train. 15 trucks, 200 miles approx. Payload 45 tonnes per truck.

Table 4: Comparative tonne-mile costs

Mode	**Sea**	**Rail**	**Road**
Rate per tonne	$6.5	$7.7	$9.0
Rate per tonne-mile	.001	.002	.007

Source: UNCTAD Review of Maritime Transport

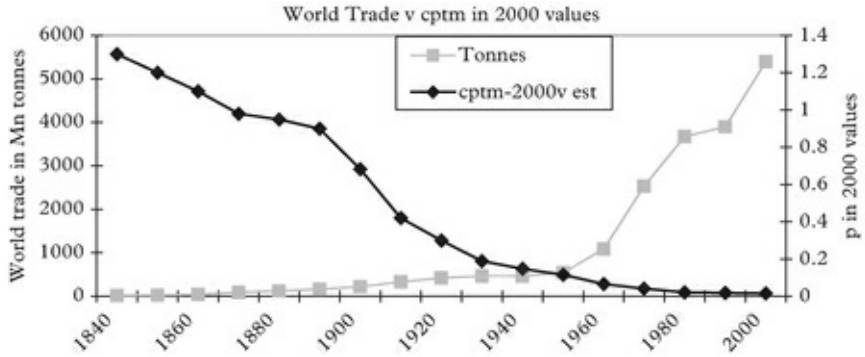

Figure 6: World trade v cost per tonne mile

Source: Data collected from several sources

(3) UK Mined Coal: Road Central Scotland-Central England Tipper Truck, 200 miles approx. Payload 25 tonnes.

Developments in the inland German Port of Duisburg clearly reflect the deindustrialisation process. The run down of the giant Krupp steel complex not only reduced demand for regionally produced coal but also the import of iron ore via the ports of Rotterdam and Antwerp. The transformation of Duisburg into a centre of logistics now emphasises the growth of container flows through the port.

The switch of heavy industry to the Far East has also had a similar impact on the demand for coking coal. See Tables 2 and 3.

3.6 The impact of changes in the political economy

Freight markets have also been affected by unforeseen changes in the political economy. The impact of the ending of the Cold War, the welcoming of South Africa back into the world trade network and the inexplicable decline of the industrial giants of Japan and Korea.

In the 1970s the growth of the Soviet bloc fleet posed some concern for Western Defence strategists. Fearful that the low cost of the socialist ships would enable them to penetrate crucial freight markets, it was argued that the socialist ship-managers did not have to pay insurance charges and benefited from low cost East European labour and fuel supplies. On some key liner routes socialist ships were charging rates up to 65% lower than con ference rates.[9] The rapid collapse of Communism following the periods of Glasnost and Perestroika in the late 1980s has led to a drastic reduction of consumer power as the ex-command economy struggled to achieve a market mechanism. An obvious casualty has been the market for North American grain imports. The normal shortfalls in the Soviet wheat harvest provided a sizeable market for American and Canadian grain. The impoverishment of the economy means that there is little consumer purchasing power and that the state lacks the hard currency to make large scale bulk purchases, regardless of the poor state of the nation's diet.

Another unanticipated outcome of the collapse of the ex-Soviet economy has been the relinquishment of large volumes of merchant shipping into world trade routes. Additionally, the collapse of the Soviet bloc economies in the late 1980s saw large amounts of ageing tonnage and low cost crews entering into the open market. Particularly noticeable has been the incursions of' the Russian Volga barges into the trades. These vessels usually named Lagoda were originally intended for the calmer waters of the Volga these vessels can now be seen in the less clement waters of the North Sea, the Irish Sea and the Bay of Biscay. Whilst the Eastern bloc seamen had hitherto enjoyed a sound world wide reputation for professionalism, the substandard conditions and ships they now find

themselves has diluted their craft status. Typical of the plight of these seamen is the example of the 20 crew of the 740 TEU vessel, *Hannes C.* Composed of a mix of Russian, Romanian, Ukrainian and Filipino, the feeder vessel's crew found themselves dependent upon the Antwerp Port Chaplains and their Seafarer Centre. The lay-up of their vessel, following the financial collapse of the vessel's owners, stranded the crew without pay, food and fuel, resulting in extreme conditions on board. Emergency supplies of clothing, blankets, food, water and fuel were supplied to the vessel by the Antwerp Seafarers' Centre.[10] This is just one example of numerous incidents occurring in ports around the world involving the impoverishment and marginalisation of seafarers in the global market.

The impact of changes in the international political economy is currently being felt in the Far East, particularly the impact of China's trade liberalisation and the transfer of Hong Kong to the Peoples' Republic of China as a Special Economic Region.

3.7 Supply

The supply of shipping is made up of the carrying capacity of ships to move cargo. This is made up of three main factors.

Ships Ships have consistently grown bigger over the last century. The growth was slow from 1880 to 1955 but from 1955 to 1975 it was spectacular, as owners realised the possibilities of new technologies and trade routes. In 1975, the last of the ships ordered before the oil crisis ended the boom of the early 1970s, were being constructed. Since then the situation has stabilised – tankers, for instance, have not grown any bigger, but ferries have. The number of ships: over the last century the num ber of ships which carry things has declined but the total tonnage of ships has greatly increased. The reason for this is *their size.* See Figures 7 and 9.

Figure 8 indicates that the depth of water was not a major issue until the 1960s. Even in 1950 Rotterdam still had only ten metres. In 1970 there were only eight ports in Europe which could accept the new class of VLCC tankers and there were no ports with sufficient depth of water on the east coast of North America. By 1975, following a period of energetic dredging there were 22 ports in north-west Europe which could accept such ships. Dredging is a very expensive activity and the question facing port

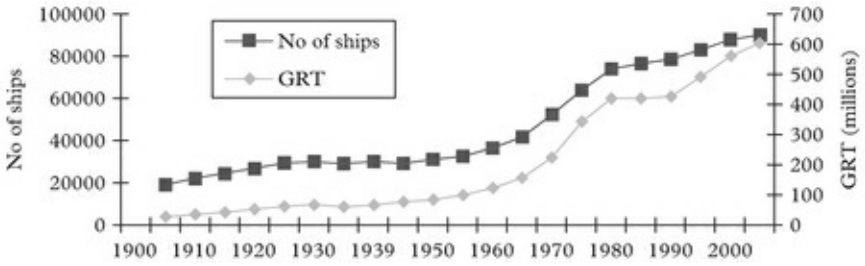

Figure 7: Growth of the world fleet

managers is: "Will ships continue to get bigger?" Figure 8, showing average ship size since 1850, does indicate a levelling off in average ship size after 1980. If the average of the *five* largest tankers are considered for each year it can be seen tanker size peaked around 1975. If the same exercise is considered for dry bulk carriers their size seems to have peaked around 1985–1989. If so, should one dredge the old channel or develop a new terminal in an area which enjoys deeper water?

Port time The less time ships spend in port the more cargo they can carry in a year – hence reducing port time increases the supply of ships.

Speed Increasing speed obviously increases the supply of ships and vice versa. This is the only way

supply can be adjusted in the short term apart from laying ships up and reactivating them. Few marine engines allow wide variations of speeds, but reducing speed two or three knots can show significant economies, so “slow steaming” can be a valid strategy in the attempt to balance supply and demand or to reduce propulsion costs in periods of high hunker costs, as seen in the late 1970s and early 1980s.

Perhaps a more useful analysis is to consider the supply from the different types of vessels.

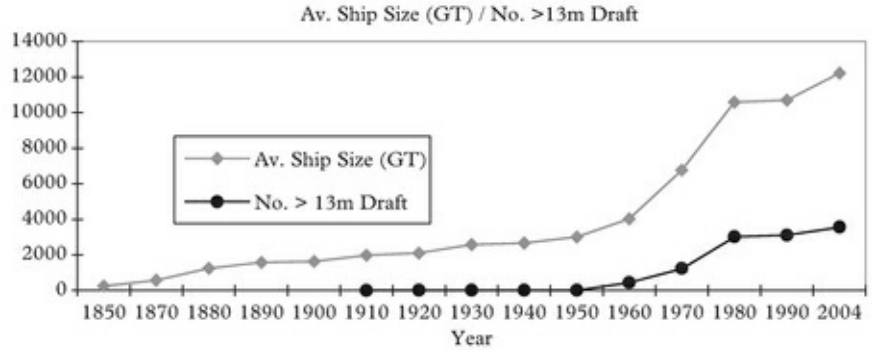

Figure 8: Average ship size

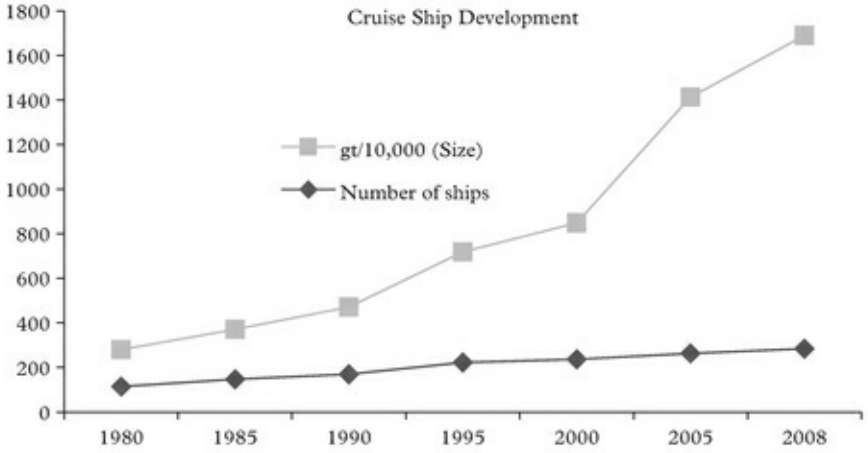

Figure 9: Cruise vessels

Table 5: Dry cargo fleets, 1965–2007

	1965	GT	1980	GT	2000				2007	
Ship type	**No.**	**mn**	**No.**	**mn**	**No.**	**GT mn**	**Age**	**dwt mn**	**No.**	**GT mn**
General cargo	22,000	50	22,676	81.3	16,755	54.9	22	78	16,479	53
Container			662	11.3	2,590	60.2	10	69.1	3,904	111
Refrigerated					1,414	7	18	7.4	1,231	6

Originally cruise ships tended to be relatively small catering for say less than 500 passengers as they needed to be able to manoeuvre in and out of the smaller historical and romantic ports on the “traditional” cruise itinerary.

3.8 General cargo and container ships

Lloyd’s List, January 2001 uses the term ULCS (Ultra Large Container Ships) of ships of 9,000–10,000 TEU capacity. Also proposed terms–Suezmax container ship 12,000 TEU, Malaccamax 18,000 TEU.

In 2006 the *Estelle Maersk* had 170,794 gt, 158,000 dwt and could carry 12,500 TEU.

However in 2007 a spokes person for the Port of LA said that LA would prefer two 6,000 box ships a week rather than an 8,000+ vessel, due to the strain the latter put on the inland distribution services.

In 1998 there were only some 36 container ships with drafts greater than14 metres. From the 3,000-box ship of 1972, container ship size did not increase any further until 1982 when the 4,000 box ship

was introduced.

Table 6: The increasing size of the container ship

Date	Generation	No. of TEUs	Speed	Length (m) Draft (m)
1960–1970	1st	< 1,000	16	200 9
1970–1980	2nd	1,000–2,999	23	275 10
1987	3rd	3,000–4,500	23	300 11.5
Start of post Panamax v/ls – Max size for the Panama Canal				
1996	4th	4,500–6,600	23	320 14.3
1999	5th	6,600–8,300	23	347 42.8b 14.5
2006	6th	8,300–12,500	25	398 56b 16m draft
Designs for	Malacca-max	18,150		411 61 21 draft

Table 7: Ro–Ro

	1965	GT	1980	GT	2000				2007	
Ship type	**No.**	**mn**	**No.**	**mn**	**No.**	**GT mn**	**Age**	**dwt mn**	**No.**	**GT mn**
Ro-Ro cargo					1,882	27.1	17	13.7	2,400	38
pass./Ro-Ro					2,574	13.1	21	3.8	2,805	16

From there another size plateau was sustained until the early 1990s when the 6,500-box ship appeared. As ships' beams increase, cranes must also increase in size. This involves an increase in weight and there comes a point when the terminal cannot take the extra load without considerable civil engineering expense. As ships' drafts increase, depth of water in ports becomes a problem. Virtually all major ports have 10 metres, but few can offer over 15 metres.

For large ships to maintain the same schedules as their smaller brethren cargo-handling speeds will have to be increased. From this it follows that the terminal area will need to be increased and the inland distribution facilities improved. Increasing the size of ships may well also increase the peaking factor which can be a serious cost problem for a centre hub port.

The term "Ro-Ro" can cover a variety of ships such as car ferries, specialist vehicle carriers, of which over 50% are owned by the Japanese, and general cargo ships which are described as having Ro-Ro capability. These Ro-Ro ships are expensive: a 15,000 dwt size would be about twice the price of a conventional ship of this size and the "wasted space" can be considerable but their productivity is very high and their extreme flexibility – virtually anything can be rolled on, containers, heavy loads, large objects, etc. – makes them attractive to operate. These ships have also been referred to as STO/ROs in cases where the cargo is rolled on board by forklift trucks which stow and handle the cargo as in a warehouse. Ro-Ros have also proved very useful in areas where congestion has occurred.

It was originally considered that Ro-Ro was only suitable for short distances many such ships have been operating for years between Europe and Australia and across the Pacific – there are also ships which are part cellular containership and part Ro-Ro. See Tables 5, 6 and 7.

3.9 The dry bulk carrier

A bulk carrier is a large single deck ship, say > 10,000 dwt which carries unpackaged cargo. Statistics concerning bulk carriers may not be always consistent as different authors and different times will arbitrarily determine at what a single decked vessel will classed as a bulk carrier. The term bulk cargo is however simply unpackaged cargo that can be poured, tipped or pumped into the holds or tanks of the ship.

Although there have been colliers for centuries carrying bulk coal and grain and various ores have also a long history of bulk carriage, the modern concept of a variety of bulk cargoes being loaded and discharged quickly into single deck “open hatch” dry cargo ships from modern terminals equipped for handling *bulk* cargoes, dates only from the mid-1950s.

Shipping textbooks written in the 1940s and early 1950s refer to bulkers but these seemed to have been on the Great Lakes or part of a vertically integrated operation. Like container ships they were born of economic necessity. Tramp freight rates were very depressed though demand was increasing after the Korean war, so a cheaper means of carrying bulk cargoes had to be found. Also technically it was not possible to build open hatch ships much before this date. In 1962 there were only 21 bulk carriers over 40,000 dwt and the world total of bulk carriers was only 611.

The particular design features of a bulk carrier are the single deck, a large hatchway and wing tanks. The upper wing tanks are shaped to give a conical transverse section to the hatch, so that when bulk cargo is being poured in the amount of “trimming" is reduced as the cargo is being loaded. When loading bulk cargoes the danger has always been that the upper corners of the hold would be left empty with the consequent danger of the cargo shifting in bad weather.

The large bulk carriers usually trade between special terminals and therefore seldom have any derricks or lifting gear. Smaller bulk carriers have to be pre pared to discharge anywhere so will usually have their own gear. Technology to improve the handling of bulk cargoes had been around since the end of the nineteenth century. For instance in 1888 grabs were mentioned for discharging grain in London as an alternative to grain elevators and by 1935 there was an ore-discharging plant in Rotterdam.

The popular sizes are:

- 10,000-25,000 dwt - these are some times referred to as "handysize" as they can trade to most ports in the world though 20,000 dwt is about the largest size that can use the St Lawrence Seaway. There were some 77.4 million dwt in this class in 2000.
- Handymax are 35,000-50,000 dwt vessels. There were some 45.5 million dwt in this class in 2000.
- Panamax class, the largest size that can use the Panama Canal. This is about 65,000 dwt as the limiting lock width is just over 105 feet (32 metres) and with

Table 8: Bulk carriers

	1965	GT	1980	GT	2000				2007	
Ship type	**No**	**Mn**	**No**	**Mn**	**No**	**GT Mn**	**Age**	**dwt Mn**	**No**	**GT mn**
Bulk dry	1,316	17.6	4,282	83.4	4,886	142.7	14	255	5,807	191
0/0 & OBOs	87	3.4	424	26.2	205	8.6	17	15	109	6.0
Self dis. bulk dry					165	3.2	26	5.4	173	3
Other bulk dry					1,086	6.7	17	8.9	1,115	7

- a maximum LOA of 950 feet (289.5 metres). This class is important as much of the ore trade is through the Panama Canal. There were some 70.5 million dwt in this class in 2000. Note it is anticipated that the Panama Authorities will in the next decade or so increase the size of locks so the Panamax vessel will increase in size.

- Capesize bulkers, which are 100,000-180,000 dwt and are used mainly for ore and coal on specific routes between well-equipped terminals. There were some 86.6 million dwt in this class in 2000.
- VLBC, bulkers greater than 180,000 dwt, of which most are trading between Australia & Japan. See Tables 8 and 9 and Figure 10.

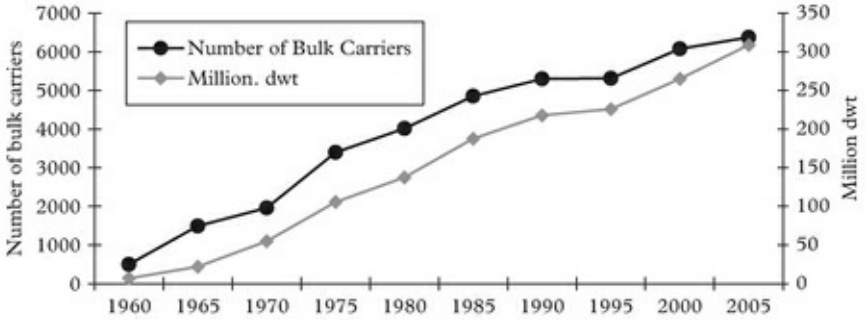

Figure 10: Bulk carrier numbers v million dwt

Table 9: Bulk cargo development

1852	John Bowes – worlds first successful collier – precursor of the bulk carrier 750 dwt. Previous sail colliers c 280 tons.
1873	A Royal Commission on Unseaworthy Ships witness asserted grain the most dangerous of all bulk cargoes. However, the encouragement of the Commission did little to improve the situation. In 1880 there was an effort to reduce the problem of grain shifting. The MSA of 1894 set the standard from then until 1914.
1900	Iron ore carriers.
1900	Associated Portland Cement Manufacturers (Blue Circle) had its first bulk cement vessel.
1904	Carlton claimed to be the first Universal Bulk Carrier.
1956	New design for all purpose bulk carrier.
1965	*Naess Norsemarrr* of 71,183 dwt possibly the first OBO.

Table 10: Types of tankers

	1965	GT	1980	GT	2000				2007	
Ship type	**No.**	**Mn**	**No.**	**Mn**	**No.**	**GT Mn**	**Age**	**dwt Mn**	**No.**	**GT mn**
Liquefied gas	5	0.059	631	7.4	1126	19.7	14	18.5	1,283	30
Chemical			649	2.2	2,534	17.5	14	28.7	3,381	32
Oil	5,307	55	7,112	175	7009	155.5	16	283.7	7,166	183
Other liquids			120	0.2	345	0.5	23	0.7	383	0.8

3.10 The oil tanker market

As can be seen from Figure 5 there has been a considerable correlation between tanker supply and demand, though after the oil price rise in 1973 there was, in the short term, a reduction in demand which left, for that period, an excess of supply.

Until around 1950 much of the oil produced was refined at source and the refined products transported to the consumer. However, the shift in the political control of many oil sources, such as in 1951 when the oil refineries of the Anglo-Iranian Oil Co were nationalised, led to many countries, for strategic reasons, refining the oil at destination instead. (Some argue that the main reason for the change in the position for refining was the rapid development of the chemical industry at this time.) Whatever the reason, the early 1950s saw significant changes. For instance between 1938–1956 oil

consumption increased almost four times in western Europe whereas refinery capacity increased almost nine times. One obvious effect was a large increase in tanker cargoes in the 1950s and 1960s, as the oil was now carried twice, first as crude oil from source to refinery and then to distribute the refined oil. This development saw an increase in tanker size in general, which led to the specific dedication of a class of tankers as Crude Oil Carriers. At the end of World War II, 16,000 dwt was considered a large tanker, whereas by the end of the 1950s there were 100,000 dwt tankers (the largest that could traverse the Suez Canal loaded). By the end of the 1960s when the Suez Canal was closed, the VLCC of 250,000 dwt became a standard size and in 1972 the first of 500,000 dwt was launched.

At the same time there was an increase in the number of tanker owners independent from the major oil companies. Before World War II the oil companies owned 70% of the tanker fleet and the independents 30%.

In the late 1970s Saudi Arabia built two 25 million-ton oil refineries which started to reverse the trend of the 1950s. By the mid-1970s, the situation had reversed with the oil companies owning only 30% of the tonnage, and since then this percentage has been steadily decreasing. By 1998 the independents owned 72%, oil companies 10% and governments 15%, with the final small percentage being owned by traders. This growth of independents has naturally meant a growth in tanker chartering.

The above graph shows considerable correlation between tanker supply and demand, though after the oil price rise in 1973 there was in the short term a reduction in demand, which left an excess of supply for that period. The steep rise in oil prices in 1973 meant an increase in the power of OPEC (Organisation of Petroleum Exporting Countries), with a consequent reduction in the power of the large oil companies' tanker fleets in oil-trading and the growth of oil traders speculating in the market. These oil traders then formed a large proportion of tanker charterers and so affected tanker chartering in several ways. The traders would buy a shipload of crude oil and try to sell the oil at a profit during the voyage. Thus much tanker chartering is "open-ended" i.e. the precise destination is not stated when the fixture is made. This is one of the advantages of using scale rates. In tanker chartering, instead of quoting the freight in actual cash terms it is quoted in scale values, which reflect the profitability in freight per tonne-miles of the charter. The Tanker Freight Scale was introduced by the British and American authorities in World War II. As the scales became popular the system was privatised and in 1962 the International Tanker Nominal Freight Scale Association Ltd published INTASCALE. In 1969 the Association revised the scale and called it Worldscale, again updated in 1989 as New World Scale. See Table 10.

3.11 Type variations and the developments of tankers

Experiments had been made in the 1920s to build combos – that is dry & wet bulkers but it was not until the 1950s that the combination types were built in any numbers and Universal Bulk Carriers (UBCs) were developed. However this type had largely disappeared by the 1980s and were superseded by O/Os (early 1950s) and OBOs (1965).

3.12 Beyond the market view?

So far, the freight market has been outlined in terms of supply and demand. The traditional view of the shipping market has focused upon these economic tenets. Shipping was a slightly mystical business that took place in great waters! Maritime historian, Simon Daniels has summed up the pre-occupation

with the competitive freight market as a result of its development from the Victorian era onwards when:

"… Modest-sized cargo ships plied the seas on shoestring budgets, scraping profits on any cargoes they could secure, they developed principles of shipping upon which so much the economics of shipping are based."[11]

In one sense, the shipping industry has been successful in meeting the market demands of world trade. In 2008, the International Chamber of Shipping released statistics on the quadrupling in the growth of global seaborne trade in the four decades up to 2006.[12] Figure 11 illustrates the triumph of the industry in meeting the demands of booming seaborne trade. Moreover, the environmental performance measured by oil spillages from ships has shown a marked improvement. Innovations in tank cleaning, ballast water filtering and segregation, fuel consumption and exhaust emissions have all been achieved. The amount of oil spilled from tankers has also shown a marked decline. Figure 12 illustrates how the tanker industry has cleaned up its act with estimated spills falling from 172,000 tonnes in 1992 to 16,000 tonnes in 2007. The problem is, however, that the environmental debate is moving its targets at a faster rate than the shipping industry can deliver; the reality is that the green integrity of shipping is only guaranteed up to the next oil spill! From this position the need to achieve environmentally friendly shipping is synonymous with the case for safe shipping. In addition to oil tankers, accidents occurring to virtually any type of shipping are likely to lead to pollution from either/and cargo and fuel oil bunkers. Making the headlines in 2007 the collision of the container ship, *Cosco Busan* with the San Francisco Bay Bridge led to a spillage of 225,000 litres of fuel and the resulting loss of an estimated 2,000 seabirds.[13] The Philippines worst ever oil spill disaster was brought about by the grounding of the small coastal tanker, *Solar 1* (998 gt) in 2006.[14] Environmentally sensitive mangrove swamps and extensive fishing grounds over a 62km spread were seriously damaged by spill of the vessel's bunker fuel.[15] It is now proposed to consider how the green safety issues are shaping an extra dimension to the market. The emphasis will be upon the

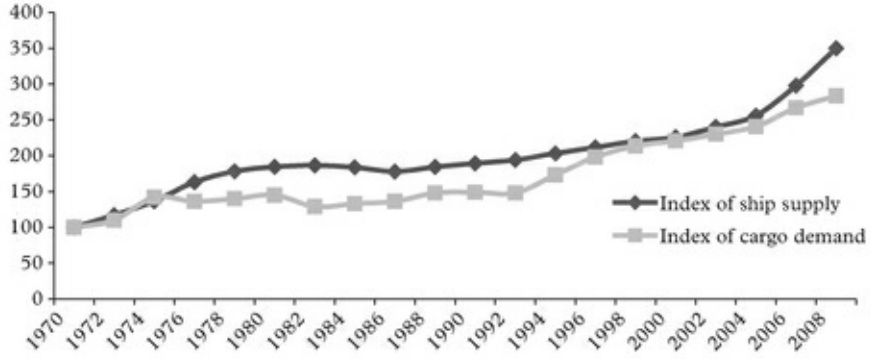

Figure 11: World shipping supply index v trade demand index

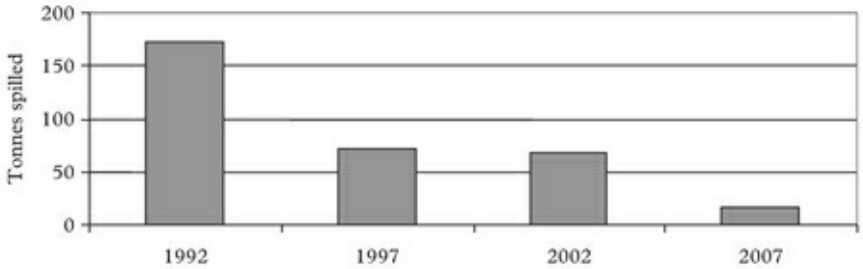

Figure 12: Estimated tanker oil spills 1992–2007

Source: ITOF

empirical analysis of the industry's safety-green performance within the context of an intensifying environmental scrutiny.

3.13 The greening of the market?

It is now impossible to extricate the normal economic transactions of the freight market from environmental standards. The lessons of the Brent Spar oil rig disposal in the mid-1990s demonstrated not only the sensitivity of marine environmental issues, but also negative consumer reaction towards perceived abusers of the environment.[16] In addition, the media view of shipping is increasingly focusing on its environmental performance.

Whilst it is evident that improvements in green safety performance, have been achieved, it is timely at this juncture to at least raise questions over the continued commitment to attention to the environmental imperative, given the global economic crisis post-2008 and its predictable impact on increased cost conscious competition. In 2008 shipping markets fell from their all-time peak to a full-blown recession point by November. The eleven-fold collapse of the Baltic Exchange Dry Index (BDI) from its 11,973 points high to 891 points in this six month period was bound to raise questions over the impact on shipping operations *vis-à-vis* the environmental imperative.[17]

3.14 From full speed ahead to lay-up!

The boom years in the decade up to 2008 brought about an interesting paradox for many ship operators. The shortage of tonnage saw not only unprecedented increases in freight rates but also the postponement of the scrapping of older tonnage. In October 2007, *Lloyd's List* was reporting: "No takers despite record scrap offers."[18] The reluctance of owners to scrap vessels when freight rates and sale and purchase rates were at an all-time high had the effect of retaining ageing tonnage in the world fleet. Figure 12 illustrates the sudden surge in scrapping activity in 2008 as the market veered from boom to bust!

Up until 2008 the industry was under pressure to deliver. Speed and haste can be seen as symptoms of a booming market when ships are hard pressed to meet tight

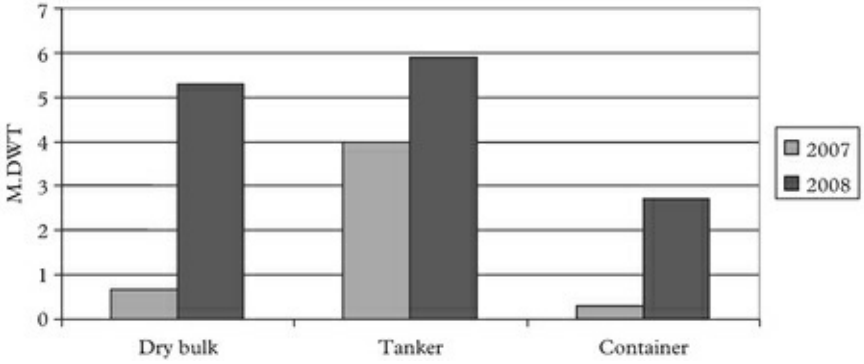

Figure 13: Demolition statistics 2007–2008
Source: Derived from Allied Shipbroking Reports in *Lloyd's List*

schedules. The non-fatal but potentially serious collision between two containers ships in the Taiwan Straits in 2005 illustrated the pressures of deadlines. Neither the 34,617gt *Washington Senator* or the 23,540gt *Lykes Senator* reduced speed in the congested straits which at the time were experiencing restricted visibility. Both vessels maintained their passage speed of 17 and 18.5 knots, respectively, which was required in order to meet their container terminal ETA's in Hong Kong and Vancouver.[19]

The epic salvage exercise following the foundering of the *MSC Napoli* brings into question a number of operational and political/environmental factors. On the one hand an ageing container vessel

being driven fairly hard[20] in stormy weather conditions points to an industry in a hurry (the vessel was reported to have departed Antwerp six days late). This was during a period when freight rates were at a premium and tonnage shortages pronounced. Opinion in the insurance underwriting industry was to conclude:

"that commercial pressures led it to sail in the way it did in these conditions, rather than slowing down and taking appropriate action."[21]

On the other hand, the incident was met by a firm state response in terms of salvage tug operations, beaching the vessel, securing fuel oil bunkers, and ultimately securing the cargo and disposing of the vessel. Maritime opinion has averred that the mechanisms put in place in the UK following the Donaldson Report were enacted most effectively in dealing with the incident.[22] Demonstrating political will and commitment to affirmative action by responding both proactively and reactively in maritime safety. The resulting Anglo-French Coastguard shared provision of Emergency Towing Vessels (ETVs) and the appointment of the Secretary of State's Representative for Maritime Salvage and Intervention (SOSREP) were successfully engaged in averting a possible maritime catastrophe, which would have been caused by the loss of the 2,500 containers and over 1,000 tonnes of fuel oil, as well as jeopardising the lives of the 26 crew, who were all rescued safely by Royal Navy helicopters.[23]

The whole incident demonstrates the not only the commercial pressures on shipping operations but also the renewed state resolve to minimalise environmental disaster. Given the extent of the market turbulence brought about by the credit crunch, from mid-2008 onwards, it is evident that this resolve will be tested in the future by operators seeking to survive at the expense of the environment. The following section discusses the balance between the economics of market survival and the environmental interest.

4. Costs, Competition and the Marine Environment

The juxtaposed pressures of cost and quality, of economy and environment are all to be found at work shaping the modern freight market. In a competitive market costs will always be a key concern of operators. The cost-quality dichotomy is obviously called into question given the state of the shipping industry post-2008 market crash. The threat of declining quality as a result of tough market conditions was highlighted by Lord Donaldson, in his *Safer Ships Cleaner Seas* report. Writing in the early 1990s, Donaldson's perspective was one of over capacity and its impact on standards of safety and environmental probity in the market. The extent of sub-standard ships and their operators can be seen as a function of over capacity, particularly in the low value dry cargo trades. The question now asked is whether these conditions could re-emerge in the latest market crisis?

Three critical areas of shipping safety are considered here: bulk carriers, the ageing tanker problem as highlighted by the *Erika* and *Prestige* disasters and short sea drybulk shipping. The dichotomy between cost competition and the quality of operational standards is a feature of modern freight markets. This is evident in low value bulk markets such as scrap, aggregates and animal feeds. In such highly competitive freight markets, costs are trimmed to the narrowest of margins. The enduring concerns over bulk carrier safety have been a feature of the last three decades. The 1980 *Derbyshire* disaster prompted concerns over bulk carrier safety. Foy's study of bulker losses in the 18-month period up until June 1987 revealed 11 founderings in the steel/scrap/iron ore sectors.[24] The loss of the capesize bulk carrier, *Alexandros T* in 2006, indicates the continuing concern. The vessel itself

demonstrates the extensiveness of the global market. The Romanian built, Greek managed, St. Vincent & Grenadines flagged vessel, was engaged on a charter for the carriage of 155,000 tonnes of iron ore between Brazil and China. Multinationalism was also reflected by the composition of the 33 men crew (only five survived) – four Greek, 24 Filipino, four Romanian, one Ukrainian.[25] Given that the vessel suffered a catastrophic hull structure failure, following wave damage, it is pertinent to note that Port State Control (PSC) inspectors had detained the vessel in 2003 with fracture deficiencies noted in six of the vessel's nine holds.[26] Although no major pollution was reported following the break-up of the bulker 285 nm off Port Elizabeth, the potential for bunker oil spillage is latent in any incident. Capesize bulkers, for example, can carry in excess of 3,500 tones of heavy fuel oil and 400 tonnes of marine diesel.

By coincidence, the Nautical Institute campaign on bulk carrier safety was released on the day that news of the loss of the *Alexandros T* was announced.[27] The Nautical Institute highlighted the dilemmas facing masters who find themselves facing unacceptable commercial pressures when vessel hulls are subject to un-safe loading rates at certain terminals. The loading rate of 16,000 tonnes per hour places considerable stress on the vessel hulls, but the faster the loading, the lower the cost of hire; so it was apparent that some "heavy handed" charterers were influencing their market power to obtain a rapid port turn-round time. Similarly, masters faced charterers questioning over professional decision making on the ship's passage. Charterers were more interested in expediting a fast passage rather than allowing the master to exercise discretion in safe passage planning and management. Bulk carrier expert, Captain Cooper of the Nautical Institute, has expressed his concern: "… that these attitudes and this behaviour should still prevail in this supposedly enlightened and heavily regulated world we operate in."[28]

By the new millennium attention has increasingly focused upon tankers. The shock of the 1999 *Erika* break up and sinking had implications for the industry stretching into the new decade. Ostensibly, the tanker on passage between Dunkerque and Livorno with 25,000 tonnes of heavy fuel oil was a tangible example of the coastal highway at work, a green alternative to road haulage – the 25,000 tonnes of fuel oil represents the equivalent more than 800 road tanker journeys across the Alps. However, the combination of gale force weather conditions and an ageing, metal corroded, vessel was to prove an environmental disaster for the French coastline and its ecology. It has been estimated that compensation payments will be in the region of €300m.[29] For the chartering oil major, Total-Elf, the result was not only heavy financial penalties but also the loss of corporate reputation. However, the immediate aftermath of the *Erika* and similar tanker disasters has led to more stringent state intervention in the market. It was deemed by French court that Total had not carried out sufficient vetting of the ageing vessel in order to ensure its suitability. In June 2008, Total was ordered to pay $298.62m in compensation.[30]

Closely following the *Erika* oil pollution disaster (1999), the (2002) break-up of the *Prestige* off the coast of Galicia raised many questions over the cost-quality dichotomy in tanker chartering.[31] The age and single-hull status of both tankers became a factor in the post-disaster analysis. Evidence from the market shows that the *Prestige* was a very clear exposition of globalisation at the lower end of the market.[32] A mixture of Greek owners, Liberian (nameplate) managers, Bahamas flag, London-Greek shipbrokers and Russian-Swiss oil traders all were traced to the vessel. Underpinning the economics

of this global network of connections is the reality that the vessels was chartered at some $5,000 per day below the normal rate attainable for that particular moment in time. It was to become evident that the charterers were intent on seeking out ageing, single-hull tonnage in order to undercut the market rate. The *Prestige* was fixed at $13,000 per day when it was estimated by Clarkson's that $18,000 would have been asked for a more modern tanker.[33]

The political outcome of the disaster was marked by the EU in March 2009 with the Third Safety Package ("*Erika* 3 Package"),[34] the key elements of which are a strengthening of regulation in:

- Flag state responsibilities;
- Auditing classification societies;
- Port state control;
- Vessel traffic monitoring;
- Accident investigation;
- Liability and compensation of passengers; and
- Insurance of shipowners for maritime claims.

The North European short sea dry-bulk trades are another example of where operational standards are questionable. Many vessels in these trades are operated under flags of convenience, having minimal crews and are driven hard in order to remain profitable. Short sea freight rates are forced down by three powerful factors:

1. the extent of the competition from many small operators of chartered tonnage;
2. the alternatives of road and rail haulage to coastal/short sea shipping;
3. the buying (oligopsony) power of the large cargo generators in grain, steel, aggregates and also (in the feeder trades) containers.

The problem was recently highlighted by the grounding of the 2,446 gt vessel, *Antari* (Larne, 2008).[35] This was one of a series of fatigue-related incidents that have beset the short sea dry-cargo sector in British waters. These include constructive total losses of the container feeder ship, *Cita* (Scilly Isles, 1997),[36] the *RMS Mulheim* (Lands End, 2003)[37] and the groundings of the *Coastal Bay* (Isle of Anglesey, 2000),[38] and the *Jackie Moon* (Firth of Clyde, 2004).[39] In these instances the fatigue factor can be seen as tangible, causal, factors in vessel grounding incidents.

The Marine Accident Investigation Branch (MAIB) report[40] into the grounding of the *Antari* revealed the gruelling schedule that such coastal vessels are required to adhere to. The report found that the vessel had called at 21 ports in the eight weeks prior to the grounding. Furthermore it was found that the mixture of fatigue, absence of a lookout (in darkness) and a solitary watchkeeper was prominent in some 23 similar incidents, observed between, 1994 and 2003. A sample of *Antari's* port calls is included in Table 11.

The MAIB has established that the intensive watchkeeping demands on board the seven man crewed *Antari* necessitated by the availability of just two certified officers was a major causal factor in the grounding:

"This intensive pattern, typical of the short sea shipping trade, is likely to contribute to the cumulative fatigue levels of individuals working 6 hours on/6 hours off, the

Table 11: Sample voyage record of *Antari*, June 2008

Port	Arrive	Depart
Immingham	31.5.08	2.6.08
Tees	3.6.08	4.6.08
Amsterdam	5.6.08	6.6.08
Melsomvik	8.6.08	9.6.08
Vaksdal	11.6.08	12.6.08
Follafoss	14.6.08	14.6.08
Terneuzen	18.6.08	20.6.08
Antwerp	20.6.08	22.6.08
Belfast	25.6.08	26.8.08
Corpach	27.6.08	28.6.08

Source: MAIB (2009) Report on the investigation of the grounding of Antari, near Larne, Northern Ireland, 29 June 2008. Southampton: MAIB.

longer they spend on board, and in this case probably prevented the Chief Officer from obtaining adequate rest."[41]

One way of reducing operational costs, introduced in the early 1990s, was the One Man Bridge Operation (OMBO). International Regulations stipulate that in the hours of darkness and also poor daytime visibility, two watchkeepers will carry out bridge duties. Primarily, this is to limit the risk of watchkeepers falling asleep and to provide extra lookout capabilities – a particularly welcome support in confined and congested waters. The OMBO system was devised as a labour saving device in that it facilitated one watchkeeper operation. Integral to the system is the anti-sleep alarm which ensures that the watchkeeper does not fall asleep. The need to respond to the alarm at frequent intervals, however, may be seen as an irksome task by the irritated officer. Unfortunately this has led to irresponsible behaviour with officers switching off the system. Invariably this results in sleeping watchkeepers and ensuing near misses, collisions and groundings. The fate of the *Cita* was sealed when the Chief Officer switched off the system on a voyage between Southampton and Belfast. The inevitable happened, the Chief Officer fell asleep, and the vessel grounded on St Mary's Isle (Scilly Isles) at full speed.[24] An identical case to the *Cita* was that of the *Coastal Bay*. It was established that the vessel was operated by just two watchkeeping officers, with the Master and the Chief Officer working a fatiguing rotating watch-on, watch-off, system. *Lloyd's List's* editorial comment, "No mystery of the sea," argued that here was an accident waiting to happen![42]

These cases not only demonstrate the economic pressures placed upon operators and their crews but also the growing determination of the authorities to rectify the imbalance between cost and quality operations.

4.1 Maritime safety and public concern

Major environmental advances have occurred in the international maritime regime in recent decades. These include, the prevention of waste dumping waste dumping into the sea, the outlawing of oil tank slops dumping, double hull regulations for oil tankers, segregated ballast water systems and toxic anti-fouling hull protection chemicals. Such factors have become an essential part of the freight market as charterers, owners and operators struggle to come to terms with the new environmental imperative. The imposition of global standards via the IMO undoubtedly leads to an increase in the private costs of shipping. This is at odds with the traditional and enduring concept of "The Freedom of the Seas", which has been held as an essential component of the free market in shipping.[43]

The resilience of this concept is clearly demonstrated by the battles to regulate the safe passage of shipping in one of the world's busiest seaways, the Dover Straits. From the 1880s onwards calls for increased regulation have been resisted by shipowners and their principals on the grounds that there was a need to retain a free market.[44] The market failure – loss of life, pollution, vessel damage, trade disruption – resulting from shipping's failure to manage its own safety in such critical conditions was to prove untenable. In addition, public concern over the threat to coastlines has increasingly been in evidence.

The upsurge in vessel traffic, in conjunction with increases in vessel size, began to manifest as causes of rising trends in serious English Channel collisions and groundings in the 1960s and 1970s. Things came very much to a head in 1971 with a series of collisions and the explosion of the tanker, *Texaco Caribbean.* In total 51 lives were lost and chronic oil pollution was experienced on the Channel's shoreline.[45] The resulting Vessel Traffic Management Scheme (VTS) demonstrated state traffic management in a hitherto free-for-all Channel passage.

Increasingly, coastal management has intensified around the world and some surprising outcomes have been experienced. The circumstances leading to the loss of the *Prestige* in 2002 reveal a defensive mood by the Spanish authorities to a stricken vessel. Despite the efforts of the salvors to tow the stricken tanker to a safe-haven, the Spanish authorities ordered the tug and tow to head away from the coast. Much to the chagrin of the salvors, the prospects of gaining a sheltered safe-haven, where emergency repairs could be undertaken, were effectively denied.[46]

As a sequel to the resulting loss of the vessel and its 77,000 tonnes of heavy fuel oil, the master of the tanker found himself detained in a Spanish prison. As with a number of oil pollution cases around the world since, including the *Tasman Spirit* (2003), and the *Hebei Spirit* (2007) shipcrews have found themselves to be subject to criminal proceedings following accidents.[47]

4.2 The media and the market

Partly the increased attention to environment is a result of the media exposure that shipping now finds itself exposed to, particularly when marine disaster is located in the high profile waters of developed countries. Oil spills from such unfortunate tankers as *Exxon Valdez, Aegean Empress, Braer, Sea Empress, Erika, and Prestige* have made dramatic headlines in the media creating an impression of a reckless "rust bucket" shipping industry. The environmental disaster following the sinking of the *Erika* along the French coastline was reported by the headline: "300,000 Seabirds dead. Only now can Europe count the cost of Sea of Filth."[48] The break up of the *Prestige* off the Spanish coast focused attention on the state of the world's ageing tanker fleet and its off-shore management. *The Independent* article, "A saga of single hulls, double standards and too many flags of convenience"[49] directed criticism at a globally fragmented, substandard industry that was more interested in cost cutting than maintaining safe and environmentally acceptable standards of operation.

The loss of the automobile carrier, *Tricolor,* in 2002 illustrates attention to maritime safety in terms of financial value. Abandoning the rapidly sinking vessel placed great demands on the seamanship of the crew who managing to evacuate the doomed vessel in 45 minutes. Considering that this occurred at 02:45hrs on a cold December morning on the approaches to the Dover Straits, it was to become apparent that a feat of great skill and courage was achieved – all 23 crew members were accounted for safely. The media, however, demonstrated a differing view of the events, with the BBC headline

reporting that, “£30m cargo lost as ship sinks”[50] illustrating the portrayal of maritime disaster in monetary rather than humanistic terms.

4.3 The management of safety

The question over shipping’s environmental performance is inextricably linked with quality. Traditionally, the prevailing “blame culture” in shipping deflected criticism towards captains and their crews. Three leading accident cases, the *Lady Gwendolen*, the *Herald of Free Enterprise* and the *Exxon Valdez* have identified corporate shortcomings. The evolving principle has become that the manner in which the vessel is maintained and operated is a prime function of management.

This principle was established in a leading Admiralty case involving the management of coastal shipping operations. Case law was provided by the *Lady Gwendolen* in 1965.[51] The vessel was directly owned by the Dublin brewer, Arthur Guinness, and was engaged on the important Dublin-Manchester stout beer trade. In order to keep to the schedule the master, Captain Meredith, adopted the practice of navigating at full speed, relying on radar observation, even in the frequently foggy conditions of the Irish Sea and River Mersey. Despite Guinness’ petition to limit their liability, as (they claimed) the collision was the fault of Captain Meredith[52] the brewers were deemed negligent in not adequately monitoring the way the *Lady Gwendolen* was operated. Lord Justice Sellers summarised:

“A primary concern of a shipowner must be the safety of life at sea. That involves a seaworthy ship, properly manned but also requires safe navigation. Excessive speed in fog is a grave breach of duty, and shipowners should use all their influence to prevent it.”[53]

Although there was no evidence to suggest that the master was under pressure from the owners to maintain schedules in poor weather conditions, the case does illustrate the balance between shipping efficiency and operational safety.

A more serious accident which did bring condemnation of the shoreside management was that of the *Herald of Free Enterprise* disaster in 1987, which resulted in the loss of the ro-pax ferry in Zeebrugge Harbour with 189 passengers and crew. Following the lengthy investigation into the disaster, management systems failures were identified as a principal cause. The vessel attempted to leave Zeebrugge without securing her bow doors. The resulting water ingress (from the bow wave) as the vessel picked up speed quickly led to the vessel entering into an irretrievable list situation.[54] Such cases emphasise the duties of the shipowner, the ship manager and the charterer. The UK Department of Transport investigation into the tragedy was to charge that “from top to bottom the body corporate was infected with the disease of sloppiness”.[55] Increasingly this responsibility is becoming a feature of the freight market. The aftermath of the *Exxon Valdez* oil pollution disaster in 1989 and the resulting US Oil Pollution Act (OPA 90) intensified the trend towards corporate liability.[56] The massive public outcry over the disaster has been identified by the Ethical Corporation as marking the birth pangs of corporate responsibility.

Increasingly the vicarious liability for maritime accidents is encompassing the charterer as well as the operator. Following the *Erika* disaster, it has now become evident that chartering companies, particularly the oil majors, will be targeted as a deterrent to sub-standard operations. In Europe the environmental sensitivity of large stretches of coastline has focused attention on qualitative factors including the charterers vetting of ships. Safety standards such as ISO 9000 and the International Safety Management (ISM) Code have placed emphasis on the management systems of not only the

operators but also the charterers.

The reality of shipping supply and demand is that in many markets, many shipowners compete for the business of much fewer buyers of shipping services, the shippers. The role of the charterer is crucial to improving standards of ships in this oligopsonistic market which bestows market power on the buyer of shipping services. Leading UK short sea operator, Michael Everard, has argued that "Charterers should take responsibility for the ships they charter".[57]

Tanker design and operation has been held up to a great deal of scrutiny following well publicised disasters In addition to the potential for devastating large volume spills of crude and black oils, there is also the problem the release of volatile organic compounds into the atmosphere during loading operations. Partly this can be seen as a result of the relocation of the oil extraction regions from the Persian Gulf to the environmentally (thus politically) sensitive US (Alaska) and Europe (North Sea) fields. This sensitivity places a high premium on safety standards in the oil market, as shuttle tankers replace long-haul VLCC and ULCC operations.

The evidence on double hull shuttle tankers in the Russian/North Sea oil trades points to a big risk reduction compared to single hull tankers. A 1998 study[58] by US oil offshore oil specialist, Amerada Hess, in conjunction with Lloyd's Register, has concluded shuttle tanker were more at risk than deepsea trading tankers because of their frequent port calls and passages through confined waters, including the loading location zones.

At the turn of the millennium much concern was expressed by Baltic and North Sea states over the potential for an oil spill disaster given the emergence of Russian oil flows. Clearly an "*Erika***"** or a "*Prestige***"** in the Baltic Danish Belt area would have horrendous environmental implications. The paradox of Russia gaining a competitive foothold in global oil trades was that of securing low-cost sea transport whilst guaranteeing high standards of environmental probity. The question was which end of the cost–quality pendulum would the trade target?

By the mid millennium, perhaps as a positive response to *Erika* and *Prestige***,** there was tangible evidence that quality would prevail. Tanker safety in the Russian oil trades was boosted in 2006 when the Swedish operator, Stena Bulk, commissioned the 117,000dwt, *Stena Arctica* under the high cost Swedish flag. Attention to high standards, including ice-strengthened vessels, is seen as an imperative by Stena.[59] With at least an extra 10% of steel being required for ice strengthening and a main engine system that develops 85% more power than the average AFRAMAX tanker,[60] these vessels do not belong in the lower quadrants of the cost curve!

The commitment of the vessel to the Baltic-UK/Continent oil supply chain marks as the first in a series of 10–15 ice strengthened tankers, resulting from a Russian-Swedish alliance. The partnership with provides a synergy between Stena Bulk's tanker expertise with two Russian businesses, tanker operators, Sovcomflot and oil logistics specialist, Progetra.[61] Such evidence points to adherence to quality in a demanding, high risk market.

4.4 The green performance of shipping?

However, the world's growing concern over environmental factors has emphasised the quality of shipping performance in such terms as sea and air pollution. The issues of engine exhaust emission and waste treatment are two key tests of the commitment of shipping operators to the green imperative. This concern can be noted in the regulatory regime. For example, regulations initiating

from MARPOL on ballast water contamination can be seen as a result of concern over the potentially damaging impact of contaminated water in environmentally sensitive areas. The increased forces towards quality shipping have become manifest in the new millennium; however these forces will increasingly challenged by the need to survive economically.

An increasing area of contemporary media focus has been on the extent of shipping‘s contribution to greenhouse gas emissions. Whilst is evident that in terms of tonne-miles shipping is by far the lowest contributor, given the reality that shipping is the prime mover of world trade tonnages it is tautological that its total emissions will outstrip other modes. It is evident that shipping is increasingly coming under environmental scrutiny and is becoming seen along with road haulage and air freight as a major contributor to global warming gas emissions. In 2007, this was made evident in *The Guardian* headline, “And you thought air travel was bad for the climate.”[62] The tone of newspaper’*s* article (plus similar criticisms) has led to a defensive stance by the shipping industry. The response of the UK Chamber of Shipping (was to remind the public that shipping not only carries 90% of world trade and, moreover, generated, “… less greenhouse gases per tonne mile than any other form of transportation …”[63] It is becoming obvious that emissions scrutiny will continue to intensify into the first decade of the millennium. The polemical discussions surrounding exhaust emissions can be welcomed in that it can only serve to sharpen the resolve of the shipping industry to consistently improve its green performance. The article maintains that global shipping is responsible for some 4.5% of total CO_2 emissions, as opposed to aviation’s 2%. UK Green Party MEP, Caroline Lucas, has added to the criticism that shipping has failed to improve its environmental performance and, “… has got away with doing nothing and maintained a clean image which it does not deserve”.[64] The reverberations of the article were felt across Europe. In Italy, national truck owner’s representative, Maurizio Longo, called for a re-assessment of the environmental status of haulage *vis-à-vis* shipping on the basis of an almost emissions parity between the road and water mode:

“Heavy goods vehicles in Italy, for instance, produce 162,000 tonnes of nitrogen oxide a year, while maritime traffic produces 113,000 tonnes …”.[65]

European Commission (EC) concerns have focused on the impact of air pollution from ship exhausts, in particular where heavy concentrations of shipping occurs. Local communities in port areas and coastal residential spread are at the highest levels of threat. The Norwegian Marine Technology Research Institute A/S has found evidence of high concentrates of air pollution on major traffic flows – the Baltic, North Sea, English Channel, and Black Sea.[66] The global convention on marine pollution, Marpol Annex VI, places a sulphur cap of 1.5% for ships passing through selected Sulphur Emission Control Areas (SECA), such as the English Channel, North Sea and Baltic territorial waters and, moreover, a cap of 0.2% (reducing to 0.1% in 2010) in EU port areas. From May 2006 it was incumbent on vessels >400gt to carry an International Air Pollution Prevention Certificate (IAPP) accompanied by an Engine International Air Pollution Prevention Certificate (EIAPP).[67]

The English Channel-North Sea SECA actually stretches from the Western Approaches to Mongstad in Norway and came into force in Autumn 2007. The Baltic Sea SECA came into force in May 2006. It is seen as protective measure given the heavy volumes of maritime traffic in the region; particularly as the Scandinavian nations have been particularly vulnerable to acid rain pollution. The cross-industry Shipping Emission Abatement & Trading (SEAT) committee has identified the extent of the

problem in Europe. At the May 2006 International Bunker Conference in Gothenburg, SEAT Secretary General Cor Nobel outlined the challenge facing shipping given that 14% of global NO_x and 6.5% of SO_x came from marine-related activities.[68] The Conference heard that emissions pollution from ships travelled between 400 and 1,200km inland. The implications for Europe were made clear when it was added that some 70% of shipping activity took place within 400km of land! European Commission (EC) concerns have focused on the impact of air pollution from ships' exhausts, in particular where heavy concentrations of shipping affected local communities in port city and areas of coastal residential spread.

The impact of emissions regulation on the market is one of rising costs. The International Bunker Industry Association (IBIA) has expressed concern over the impact on voyage costs. In 2002, the IBIA outlined the example of a voyage from Gothenburg to Belfast which under proposed EC rules would require a continuous use of 0.2 sulphur fuel as it consisted of a 100% EC voyage. The IBIA estimated that vessels bunkering in European waters could face an additional $20 per tonne premium.[69] The question facing shipowners and operators is whether such increased cost can be passed onto the shipper, ultimately the consumer. With IMO targets reducing sulphur content globally down to 0.5% by 2020 it follows that the era of low cost fuel is drawing to a close. Such lower sulphur content fuel has the purity and, ergo, cost profile of diesel, leading up to a doubling of costs.[70] Given the correlation between purer fuel oil and higher fuel prices it follows that freight rates will need to be higher in these areas. Again it can be seen how environmental factors are increasingly impacting on freight markets.

The emphasis upon green performance places stringent responsibilities on ship operators. The list of waste disposal prohibited from the ship includes oil and sludge from both bilges and cargo, garbage and extends to exhaust emissions and ballast water.[71]

Cultural change in the disposal of waste has occurred in recent decades. The clean seas strategy of the International Maritime Organisation (IMO) has led to an enhanced ethical attitude towards waste. The Nautical Institute Secretary in 2000, Julian Parker, succinctly summarised the previous "over the wall" culture: "… all the main trade routes could be identified by from beer cans on the bottom of the ocean".[72] In European waters the problem of tank washing and its over-side disposal was evident from coastline pollution. Main tanker routes generated oil trails with a disastrous impact on the coastline environment. Partly the change in behaviour has been as a result of the encouragement of such proactive strategies such as the "Green Award". Tanker terminals such as Sullom Voe and Rotterdam make the award to vessels which attain high environmental standards and entitles the owners to rebates on port dues.

Up until the impact of environmental concern and sensitivity of the late twentieth century much of the vessel's waste went "over the wall" (into the sea). This would include oily rags, empty oil drums, beer and food cans and food waste. Concerns over the amount of carbon soaked and plastic based wastes finding their way into the ocean from ships led to a 1995 amendment of the International Convention for the Prevention of Pollution from Ships (Marpol 73/78). This stipulates that all vessels over 400gt are required to have a garbage management plan and record book. A 2000 study into the efficiency of waste disposal at sea by Captain Patraiko of the Nautical Institute has found that a contrasting pattern of how the plans were initiated.[73] Clearly, the evidence of the study found that

advances were being made in the education of crews and the development of a waste management culture. Examples of waste segregation was found in 70% vessels surveyed. Also, the practice of incinerating wastes such as plastic and oil was well advanced.

A problem area identified was that poor waste reception facilities in some ports. Examples of positive crew attitudes to waste recycling being undermined by inadequate port reception systems. These include simply amassing the carefully segregated waste into one single container. Likewise, the efforts of the crew to achieve efficient waste disposal standards were undermined by poor information on port facilities and in some cases bureaucratic non-user friendly procedures.[74]

Overall, the evidence is of a positive change in waste disposal behaviour with ship's crews and port management increasingly adopting an environmentally friendly response. Having made this point, it remains to add that whilst the problem of waste dumping may be diminishing, cases of infringements are by no means rare. The case of the reefer, *Magellan Phoenix* in 2006 points to the desperate measures that operators will take in order to avoid the expense of implementing the correct methods of waste disposal. Following a USCG inspection in the Port of Gloucester City, New Jersey, it was established that the vessel's oil log was regularly falsified in order to conceal the illegal dumping of engine-room waste oil.[75] The illegal dumping of waste can be seen as a by-product of a cost conscious market. Additionally ships in a hurry, anxious to achieve a fast port turnaround time may attempt to minimise delays by dumping oily waste at sea. Canadian Coast Guards noticed one vessel 20 nm off-shore heading for the St Lawrence Seaway at the head of an oil slick. This resulted in the owners of the panamax bulk carrier, *Nobel Fortuna,* being fined Can $45,000.[76] Arriving in a port with full waste slop tanks could lead to examining PSC Inspectors asking probing question as to the means of disposal! A mysterious culture of "magic pipes" (pipes which provide illicit egress from waste tanks) and falsified waste disposal records still persists. However, ship managers cannot distance themselves from the actions of their crews – the principle of vicarious liability now prevails. This culture was habitually practiced as a cost saving measure by some crews employed by major US tanker operator, Overseas Shipholding Group (OSG). Violations were discovered in 12 of the compnies tankers, leading to a $37m fine in US Federal Court.[77] To their credit, 12 OSG crew members became "whistleblowers" in reporting the malpractice. OSG mananagement, in its defence, expressed surprise that the culture of illegal waste disposal was still in existence in the company's ships. This was seen as a result of the endemic culture of cost cutting being in the industry:

"This was because the industry, historically speaking, has seldom been profitable. Now we are seeing modernisation, professionalism and even some profits, but there are some people in the industry who still believe in cutting corners and saving money."[78]

4.5 Marketing the green image

An increasing area of environmental attention lies in the need for shipping operators and their charterers to exude a green image to the public. Attention to such environmental agenda factors as low fuel consumption, to reduced exhaust emissions of greenhouse gases and minimised oil spills are examples where shipping lines have claimed green credibility. This is then utilised as a marketing ploy. The impact of environmental pressures and political scrutiny engender a new look at how the market is structured. Like most other industries that find themselves under public scrutiny, shipping has moved towards a more pro-active marketing stance. From this perspective, movements towards

the green "higher ground" are a marketing opportunity. Examples of shipping lines championing such green goals as reduced fuel consumption at sea, minimised exhaust emissions, clean ballast water systems are now commonplace when new vessels are commissioned. Illustrating this point, the delivery of the 11,400 TEU boxship, *CMA CGM Andromena* in April 2009 was noteworthy not only as an addition to the global leadership in vessel size, but also as significant move towards the environmentally friendly ship. In addition to engine and hull design improvements which provided for a 6% reduction in fuel consumption, waste compactor systems, fast oil recovery systems (which allow for improved removal access to bunker fuel, following a grounding or sinking and "cold ironing" connections, which allow for a total power shut down in port (shoreside power supplies are used as a substitute for the ship's diesel generator).[79] Joining the shipping lines in promoting the green imperative, ports are increasingly to heralding the green case. A leading exponent of cold ironing has been the Port of Los Angeles, which in September 2007 demonstrated with the 8,500 TEU box ship, *Xin Ya Zhou*, the savings on greenhouse gases. By shutting down the vessel's auxiliary engines and switching to shoreside electricity, more than a tonne of nitrogen oxides (NO_x) and particulate matter (PM) were eliminated per 24 hours port visit.[80]

Grimaldi Line can claim a considerable contribution to the sustainable transport concept with their Euro-Med Motorway of the Sea service. With its 19 port itinerary spanning Southern and Northern Europe, Grimaldi Line have been able to champion their status as a green alternative to road haulage:
"The whole Euro-Med Network is a powerful tool for modal re-balance. Last year the Euro-Med lines have transported over 45 million freight tons, equivalent to an annual total of over 90 billion tons/kilometres, 7.5 times as much as the target set by the European Commission for the first phase of the Marco Polo, most of which would congest and pollute the European motorways otherwise."[81]
An interesting development in the question of hands-on quality operations was noted with the shift in BP's strategy in the post-2000 period. Bucking the generic trend to outsource shipping operations, BP – one of the world's largest fleet controllers – actually set about restoring in-house operations. BP had traditionally been a major player in the tanker fleet but following the dislocations in the post-1975 oil markets had chosen to rationalise its directly owned fleet. Between 1975 and 1990 the BP fleet shrank from over 5m dwt to 0.2 m dwt.[82]

The spotlight on oil tanker practice following the *Exxon Valdez*, *Erika* and *Prestige* coastal pollution disasters can be recognised as a factor in the changing business behaviour of global oil major, BP. The return of BP to large scale shipping operations has considerable implications for the emphasis on quality. Expansion programmes have projected BP into pole position as the UK's most dynamic ship operator, an amazing "sea change" in strategic behaviour from the tanker fleet rationalisations of the 1980–1990s.

Table 12 contains details of BP's order book in 2004, forming part of a $3 billion new build programme, 2001–2006. In 2004 the oil major's fleet totalled more than 40 vessels, including double-hulled crude carriers, product carriers and liquefied natural gas carriers (LNG), as well as some single-hulled coastal tankers. By 2007, this total had doubled to 80 vessels. The scale of BP's commitment to the newbuilding market in the early years of the New Millennium has restored BP as a major world shipping operator. The extensive building programme saw the group take delivery of 15 ships in 2003, with a further 43 vessels delivered in the 2000–2007 period, including four high cost US

builds for the Alaskan Trades. It was reported in 2004 that at any one time BP has 500 cargoes "on the water", 300 of which are deep sea traffic. This includes vessels in its own fleet, chartered tonnage and cargoes purchased on a cost insurance

Table 12: BP's £3b Tanker order resurrection, 2004

Order	Builder	DWT/Volume
10 Product Carriers	Hyundai, S. Korea	46,000
8 Aframax Tankers	Samsung, S.Korea	105,000
4 Suezmax Tankers	NASSCO, USA	185,000
3 Product Carriers	Damen, Netherlands	2,200–3,800
10 Product Carriers	Miura, Japan	1,550–5,000
4 LPG Carriers	Mitsubishi, Japan	83,000m³
4 Platform Support Vessels	Yantai, China	N/A

Source: "Why a Super Major ordered a sea change," *Fairplay International Shipping Weekly*, 19 August 2004.

freight basis. By bringing back in-house tanker operations, BP now finds itself in prime position to measure their efforts to improve safety by playing a more active role in ship operations. In April 2004, BP Shipping were able to claim that its directly operated fleet had "achieved a new level of industry leading performance", with no reportable personal injuries or environmental pollution incidents in a 20-months period. During this time, the officers and crew accumulated 10m hours on board, with more than 1,400 voyages safely completed, 2.7m.nm travelled and about 38mt of cargo carried.[83]

4.6 Towards a sustainable fleet?

The selected evidence discussed here places focus upon the impact of the green imperative on the market. It has been argued that green issues are bringing an extra dimension to the definition of the shipping market. The context of a dramatic-boom-to-bust scenario has been noted; the question over shipping's ability to follow an uncompromising course in improving environmental performance during an economic down turn has been raised. Evidence from cost-driven sectors has proved to be a salutary warning of the dangers of market conditions inducing substandard operations. The impact of public concern and the media focus on pollution incidents has been identified as an intensifying, at times irrational, scrutiny of shipping's performance. Increasingly, the responsibilities of management have been made more onerous and extended to charterers as well as operators. Two areas where shipping faces a strengthening in rigorous scrutiny – exhaust emissions, waste treatment/disposal – were identified. Finally, the prize of shipping marketing its improved green performance was appraised as a positive incentive.

5. Conclusion

Throughout this chapter we have tried to trace the changes in technology, changes in economic pressures, changes in commercial practice, changes in global pressures regarding the environment, changes in cultural expectations and changes in political attempts to regulate and control the maritime industry and hope the basic conclusions are implied in the text. One general observation however is clear – that although the changes since the early 1970s has been greater than the previous century the speed of change has not been uniform in all sectors, with the most pressing problems facing the industries' decision makers having fluctuated wildly. Even in 1970 few maritime economists wrote about the environment. The qualitative evidence on the way the shipping industry delivers has highlighted the indivisibility of green issues from the workings of the market.

Maritime economics is a relatively new area of academic study. If one looks at most areas of academic theory it seems that theory often lacks behind practice. Let us hope that the new generation of maritime economists can keep pace with this fast-changing industry.

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Endnotes

1. Chrzanowski, I. (1985): *An Introduction to Shipping Economics* (London, Fairplay) p. 17.
2. Svendsen, A.S. (1958): *Sea Transport and Shipping Economics* (Bremen, ISL).
3. Thorburn, T. (1960): *The Supply and Demand of Water Transport* (Stockholm, Stockholm School of Economics).
4. Goss, R.O. (1968): *Studies in Maritime Economics* (Cambridge, CUP).
5. *Ibid*. p. 48.
6. Goss, R.O. (1993): The decline of British shipping: A case for action? A comment on the decline of the UK merchant fleet: an assessment of Government policy in recent years", *Maritime Policy and Management*, Vol. 20, No. 2, 93–100.
7. Gilman, S. (1983): *The Competitive Dynamics of Container Shipping* (Aldershot, Gower).
8. Jansson, J.O. and Shneerson, D. (1987): *Liner Shipping Economics* (New York, Chapman and Hall).
9. *Ibid.* p. 288.
10. "Every year 380,000 sailors in the Port of Antwerp," www.mo.be/index, accessed 3 June 2009.
11. Daniels, S. (1992): *The Wake of the Cachalots: Master Mariners of an Island Race* (Eastleigh, Daniels) p. 72.
12. www.marisec.org/shippingfacts, accessed 14 May 2009.
13. Wallis, K. (2008): "Fleet management, pilot charged with *Cosco Busan* offences", *Lloyd's List*, 24 July.
14. "Single-hull crackdown promised as hull of laden *Solar 1* lies on seabed", *Lloyd's List*, 1 November 2006.
15. *Loc. cit.*
16. Kirby, A. "Brent Spar's long saga", BBC, 25 November 1998. http://news.bbc.co.uk/1/hi/sci/tech/218527.stm accessed 27 April 2009.
17. UNCTAD (2008): *Review of Maritime Transport*. Press release: UNCTAD/PRESS/ PR/2008/044 04/11/08
18. Nadkarni, S. (2007): "No takers despite record scrap offers: No deals done as secondhand market raises the stakes", *Lloyd's List*, 1 October.
19. BSU/MAIB (2006): Report on the investigation of the 8.4.05 collision between, *Lykes Voyager* and *Washington Senator* Taiwan Straits (Hamburg/Southampton, BSU/MAIB).
20. MAIB (2008): *Report on the Investigation of the structural failure of MSC Napoli, English Channel on 18 January 2007* (Southampton, MAIB) p. 40.
21. Frank, J. (2008): "Commercial pressures 'contributed to the casualty", *Lloyd's List*, 25 September.

22. Grey, M. (2008): “Napoli beaching averted catastrophe”, *Lloyd’s List*, 6 November.
23. MAIB (2008): *Op. cit*.
24. Foy, D. (1990): “Bulk carrier losses – Unanswered questions”, *Seaways*, May 1990, 21–22.
25. “Capesize sinks off South Africa – 27 crew missing”, *Lloyd’s List*, 4 May 2006.
26. Speares, S. (2006): “Smit tug continues to search for *Alexandros T* crew”, *Lloyd’s List*, 11 May.
27. “Pressure on Masters”, *Lloyd’s List*, 9 May 2006.
28. *Loc. cit*.
29. Commission of the European Communities, *Communication from the Commission to the European Parliament and the Council on a Second Set of Measures on Maritime Safety following the Sinking of the Oil Tanker, Erika.* COM (2000) 802 final. Brussels, 6 December 2002. p. 6.
30. Guest, A. (2008): “Total Liable”, *Tradewinds*, 24 June 2008
31. Fields, C. (2003): “Two losses that brought the charterer into focus”, *Lloyd’s List*, 28 October.
32. Nelson, R. and Fields, C. (2002): “Crown cashes in with older tankers”, *Lloyd’s List*, 27 November.
33. *Loc. cit.*
34. http://ec.europa.eu/transport/maritime/safety/third_maritime_safety_package_en.htm, accessed 15 April 2009.
35. Marine Accident Investigation Branch (MAIB) (2009), *Report on the investigation of the grounding of Antari, near Larne, Northern Ireland, 29.6.08.* (Southampton, MAIB).
36. Marine Accident Investigation Branch (MAIB) (1998), *Report of the Inspectors’ Inquiry into the Grounding of the Feeder Container Vessel, Cita, off Newfoundland, Isle of Scilly, 26.3.97*. (Southampton: MAIB).
37. Speares, S. (2005): “Rhein Maas fined for *RMS Mulheim* grounding”, *Lloyd’s List*, 6 June.
38. “No mystery of the seas”, *Lloyd’s List*, 13 March 2001 p. 6.
39. Marine Accident Investigation Branch MAIB (2005)**,** *Report on the investigation of the grounding of the Jackie Moon, Dunoon Breakwater, Firth of Clyde, Scotland, 1.9.04*. (Southampton, MAIB).
40. MAIB (2009): *Op. cit.*
41. *Loc. cit.*
42. “Mate slept as ship heads for Island”, *Shipping Today and Yesterday*, December 1988.
43. Farthing, B. (1987): *International Shipping: An Introduction to the Policies, Politics and Institutions of the Maritime World* (London, LLP).
44. *Loc. cit.*
45. Source: Dover Coast Guard.
46. Nash, E. (2002): “Wrecked Prestigeis still leaking oil, says Portugal,” *The Independent*, 25 November.
47. Grey, M. (2009): “It is time to read the signs”, *Lloyd’s List*, 6 April.
48. Lichfield, J. (2000): “300,000 Seabirds dead. Only now can Europe count the cost of sea of Filth.” *The Independent*, 8 January 2000.
49. Osler, D. (2002): “A saga of single hulls, double standards and too many flags of convenience”,

The Independent, 20 November.
50. http://news.bbc.co.uk/1/hi/world/ewope/2576179.stm, accessed 31 March 2010.
51. Grimes, R. (1989): *Shipping Law* (London, Sweet and Maxwell) p. 183.
52. Allen, C.H. (2004): *Farwell's Rules of the Nautical Road* (Annapolis, MD, Naval Institute Press) p. 44.
53. Cockcroft, A. (1990): *Collision Avoidance Rules* (London, Newnes) p. 142.
54. Department of Transport (1987): *The Merchant Shipping Act 1984: MV Herald of Free Enterprise Report of Court No 8094, Formal Investigation* (London, Department of Trade).
55. Department of Transport (1987). *The Merchant Shipping Act 1894. MV Herald of Free Enterprise. Report of Court No 8074 Formal Investigation* (London, HMSO) p. 14.
56. "Shell Shocked", *Fairplay International Shipping Weekly*, 21 July 1990, pp. 2–3.
57. Everard, M. (1995): "Rogue ships: a shipowner's view", *Maritime Policy and Management* Vol. 22, No. 3, pp. 179–99.
58. Reported in "Double hulls are safer, says study." *Lloyd's Tanker Focus* October 1998, p. 21.
59. "Stena Bulk banks on quality card", *Tradewinds*, 28 October 2005.
60. Hine, L. "Stena backs ice-class fever," *Tradewinds*, 2 October 2003.
61. O'Mahony, H. (2006): "Largest Swedish flag ship enters Baltic crude trades", *Lloyd's List*, 31 January.
62. Vidal, J. "And you thought air travel was bad for the climate", *The Guardian*, 3 March 2007.
63. McKay, M. (2007): Letter to Editor, "Overall impact of shipping reduces global warming", *Lloyd's List*, 8 March.
64. *Loc. cit.*
65. McLaughlin, J. (2007): "Italy demands reassessment of road vs rail green issues," *Lloyd's List*, 8 March.
66. International Chamber of Shipping (1999), *A Code of Practice* (London, ICS) p. 8.
67. Lloyd's Register: www.lr.org/Standards/Schemes/NOx+Emission+Certification+of+marine+diesel+engines.htm
68. Nobel, C. "Low sulphur the only option for shipowners," www.bi.no/ShippingakademietFiles/_nedlastingsfiler/27,%201230-1300,%20Nobel,%20Cor,%20SECA.pdf, accessed 28 June 2006.
69. Fields, C. (2002): "IBIA backs BP trading system on emissions", *Lloyd's List*, 25 April, p. 4.
70. Corbett, A. (2008): "Doubts fly over sulphur-emissions objectives agreed at IMO", *Tradewinds*, 10 April.
71. Gale, H. (2007): "Pollution prevention: the role of the shipmaster", *Seaways*, October, p. 10.
72. Parker, J. (2000): "Environmentally friendly ship operations: risk and reward", *Seaways: The International Journal of the Nautical Institute*, June, 11–13.
73. Patraiko, D. (2000): "Managing shipboard waste: A Nautical Institute study", *Seaways: The International Journal of the Nautical Institute*, August, pp. 7–10.
74. *Op. cit*. p. 8.
75. "MK shipmanagement pleads guilty", *Fairplay International Shipping Weekly*, 4 May 2006.
76. "$45,000 Fine for marine polluter" Transport Canada News Release 7 June 2007. www.tc.gc.ca/mediaroom/releases/atl/2007/07-a006e.htm, accessed 28 April 2009.

77. "Tanker Company Sentenced for Concealing Deliberate Vessel Pollution." US Department of Justice, 21 March 2007. www.usdoj.gov/opa/pr/2007/March/07_enrd_171.html, accessed 28 April 2009.
78. "OSG comes clean over dumping", *Lloyd's List*, 1 March 2007.
79. Wallis, K. (2009): "CMA CGM Andromeda sets new benchmark", *Lloyd's List*, 6 April.
80. Cold ironing record set in Los Angeles 21 September 2007. www.portworld.com/news/i69183/, accessed 16 May 2009.
81. Grimaldi, E. "Motorways of the Sea", the Mediterranean Experience *Motorways of the Sea – Conference of Commission and Ministers of Transport*. Ljubljana, 24 January 2006.
82. Derived from *Lloyd's Register of Shipping List of Shipowners*.
83. *Loc. cit.*

Chapter 8
Economics of the Markets for Ships

*Siri Pettersen Strandenes**

1. Introduction

Vessels are sold and purchased in several markets. New vessels are contracted and sold in the new building market, whereas the scrapping market balances scrapping volumes and prices. In the second-hand markets vessels are sold and purchased for further trading. Activities in the newbuilding and scrapping markets set the total transport capacities available to sea borne trade and passenger transport worldwide. In this they resemble other markets for capital equipment for use in production of goods or services. Transactions in the second-hand market on the other hand, do not change the available transport capacity world-wide, but only shift ownership of the existing transport capacity between the different shipowners or shipping companies. Therefore, the second-hand markets are kinds of auxiliary markets. (See Eriksen and Norman[1] and Wijnolst and Wergeland[2].)

In this chapter we will discuss the elements and the functioning of the markets for ships. In the next section we describe characteristics and differences of the markets in more detail. Thereafter we comment on the structure of the markets for ships before we discuss pricing and ship values in the last section. The points put forward are illustrated several places by graphs from the *Platou Report*[3] published by R. S. Platou Shipbrokers a.s. on the web. We are thankful to Platou for making their report available on the Internet.

2. Main Characteristics of the Markets for Ships

The markets for ships fulfill, several of the requirements needed for well functioning markets. Generally there are few limits to entry into these markets. It also is fairly easy for ship owners to stay informed on the activities and developments in the markets compared to the situation in most other worldwide markets. The cost of exiting from these markets varies somewhat, but they tend to be fairly low, as we shall point out

Table 1: Real and auxiliary markets for vessels

	Real markets	**Auxiliary markets**
Freight markets	Spot freight market	Time charter freight market Forward freight agreements
Markets for ships	Newbuilding market Demolition market	Second-hand market
	Determination of transport capacity	Trading risk

Source: Eriksen and Norman[1]

below. Shipbrokers operate in markets for ships and they collect relevant information and allocate it to the decision makers in the shipping industry. All these characteristics indicate that well functioning markets for ships exist.

Demand for ships is derived from demand for transport services. This has implications for the markets for ships as it links the development in these markets directly to the conditions in the world economy and in international trade. Since trade flows fluctuate, so do the activities in the markets for

ships. Deliveries and deletions of bulk carriers in the last 10 years may illustrate the degree of fluctuations. Figure 1 shows a wide variation in deliveries and strong shifts in deletions over the last 10 years. Such variations make timing crucially important for profits, but also more challenging to the decision makers in shipping.

In addition to these general characteristics of entry and exit and the availability of information, the markets for ships feature some specific characteristics. They function as the market place both for ship owners seeking ships to fulfil transport assignments and for asset players who focus on the potential rise in ship values, when they decide whether to enter the market. Hence, variations in prices and activities in the markets for ships attract investors that enter mainly to exploit such price variations. These players' activities are positive in that they increase the liquidity of the markets for ships and thus ensure better allocation of vessels among ship owners servicing international trade. As long as the asset players make rational decisions, their activity also contribute by dampening price fluctuations and thus reduce the risk for ship owners who enter mainly to secure transport capacity for seaborne trade.

Similar to deep-sea shipping freight markets, the ships are traded in worldwide markets where agents from all over the world meet to trade. Ships thus, are traded among owners in geographically separate parts of the world. Shipowners do contract and scrap vessels abroad and far away from their home country. The bulk of scrapping activity, for example, takes place in Asia. Asian countries also dominate shipbuilding for large groups of vessels.

Irrespective of the worldwide character of these markets, the activities are not evenly spread around the world. The industry has experienced a geographic shift as more and more of the newbuilding capacity moved eastward, first to Japan and later to South Korea. Now there is also strong competition within Asia, as China has become a major supplier in the market for new vessels together with South Korea and Japan. This move eastwards left Europe and USA with excess shipbuilding capacity. Now Asian shipyards also face excess capacity following the high expansion in yard capacity during

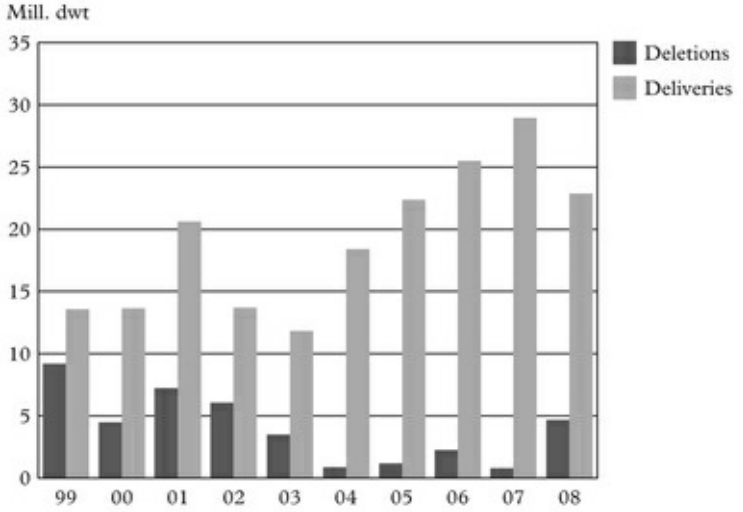

Figure 1: Deletions and deliveries of bulk carriers, 1999–2008
Source: The Platou Report 2009, p. 17

the recent shipping boom. Building capacity in the west partly was closed down and partly converted to other uses, for example to producing offshore equipment. Some yards switched toward building specialised ships. By specialised ships we mean research ships, naval ships and vessels tailor made for a specific trade or route. In this process, subsidies was used to try to halt the downsizing of

newbuilding capacities in traditional shipbuilding nations in the west.

There is a long tradition for securing quality in the newbuilding markets stemming back to the introduction of ship classification in the nineteenth century. Classification societies have inspectors on the site to oversee the construction of the new vessels they are going to class. Quality assessment and quality requirements are challenges also to the functioning of and the activity in the other markets for ships, the second-hand and the scrapping market. The uncertainty about the quality of vessels being traded poses a problem affecting the decision makers' information and therefore influences both pricing and the number of vessels traded. Quality is currently assessed mainly by numerous inspections of vessels. In addition to inspections performed by class societies, cargo owners, ports and creditors require inspections to assess the vessel. This is both costly and time consuming as commented for example in Fairplay.[4] Bijwaard and Knapp[5] find that there is a possible over-inspection of vessels. Introducing incentive contracts and signalling to induce operators to focus on quality may reduce the number of inspections. A preliminary discussion of the possibility for such schemes in the freight markets is found in Strandenes.[6] Problems of assessing quality of vessels represent important imperfections in the second-hand market and influence the functioning of that market.

Quality assessments have other effects for the conditions in the scrapping market. When quality requirements increase, there will typically be a rise in the activity level in the scrapping market. Similarly, whenever policy decisions to phase out low quality vessels materialize, this will increase the volume of tonnage sold for scrapping.

2.1 Characteristics specific to the newbuilding market

Here we concentrate on how the other markets influence activities in the new building market. By the other markets we mean both the two other markets for ships and the freight or passenger markets. For more thorough discussions of the supply side in the newbuilding market and the shipbuilding industry, see Wijnolst and Wergeland.[7]

Ideally demand for new vessels reflects the need for transport capacity in the different vessel categories or types. It takes time, usually one to one-and-a-half years, but sometimes up to four years, from ordering a vessel until the vessel is delivered and starts operating in the market. Since freight markets are volatile this implies that vessels often are delivered into markets with freight rate levels that differ much from the market conditions prevailing when the vessels were ordered. A decision to order a vessel should, reflect the expected future freight rates or correspondingly the future income level over the economic life of the new vessel. Hence, a short-term dip in the freight rates upon delivery is of limited significance to the return from the investment. During the time it takes to build the vessels the long-term prospects for the freight markets may also change and especially so if the time for delivery is long. This means that ship owners sometimes may prefer to cancel an order or to convert the vessel into another size or kind of ship to adjust to the change in expected future demand for transport services.

The large variation in the volume of new vessels ordered is one effect of such uncertainty about the future income for the vessels and the fluctuations in the freight markets. See, for example, Figure 2 on orders for new vessels as a percentage of the fleet

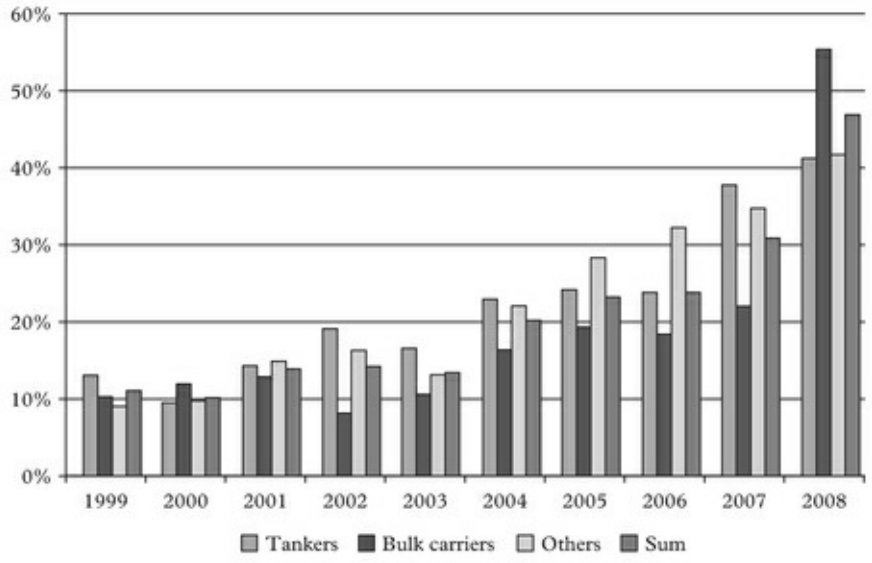

Figure 2: Order book in percentage of existing tonnage of the main vessel types
Source: Based on Table 1 and 4 in *The Platou Report 2009*, p. 40.

over the last ten-year period. Figure 2 also illustrates the variations that exist among the different vessel types when it comes to fluctuation in deliveries. In the years 1990–2001 the order book on the other hand varied from 2 to 13% of the existing fleet, compared to the 15–55% in later years.

2.2 Characteristics specific to the scrapping market

One might expect a synchronisation of the activity levels in the new building and scrapping market. This would be the case if the economic and technical lives of vessels were constant and similar across vessel types and contracting was made to replacement of old tonnage. We know that this is not the case and Figure 1 above nicely illustrates that the variations in the volume of new transport capacity delivered are not linked directly to the volume scrapped.

The activity level in the scrapping markets fluctuates, as do the freight level and conditions in the freight markets. Even though reactions are lagged this indicate that the economic life of a vessel is linked to the freight level and the income expected over the rest of the vessel's technical life.

Scrapping volumes furthermore reflect political decisions on phasing out of vessels that do not fulfil the stricter requirements on environmental and safety standards being introduced. This means that the phasing out plan for single hull tankers set by International Maritime Organisation (IMO) is reflected in the scrapping volumes. Some single hull tankers are converted to floating oil producing vessels instead of being scrapped. This also reduces the oil carrying capacity of the tanker fleet.

Fluctuations indicate that the capacity level in the scrapping industry should be flexible. As stated above entry into the market has hitherto been fairly easy. To set up a new scrapping site one needs a beach and labour. This has been available mainly in the Asian countries with China, Bangladesh, Pakistan and India as the important locations. Environmental concerns have set focus on scrapping activity both following from the potential spills into the waters surrounding the scrapping site and the health problems faced by workers in the scrapping industry. A change in requirements will influence the costs of entry and exit in the scrapping industry and thus the flexibility in capacity. In the future we may therefore experience higher fluctuations in scrapping prices than those we see currently. The effects on pricing will be discussed in more detail below.

2.3 Characteristics specific to the second-hand markets

As pointed out in the introduction to this chapter the second-hand markets differ from new building

and scrapping markets by being auxiliary markets in the sense that they do not change the number of vessels or the transport capacity offered in the markets. This contrasts with the other markets for ships, which have expansion or contraction of transport capacity as their main function. The purpose of a second-hand market is to reallocate vessels among operators and thereby to increase the efficiency in markets for transport services. By doing so, second-hand markets support efficient use of capital equipment in the shipping industry and contribute to reducing transport costs in world trade.

Transactions performed in the second-hand markets also contribute to the efficiency in seaborne transport in another way. When ship owners can sell the bulk of their real capital in a liquid second-hand market, their exit costs are pushed down. Similarly the

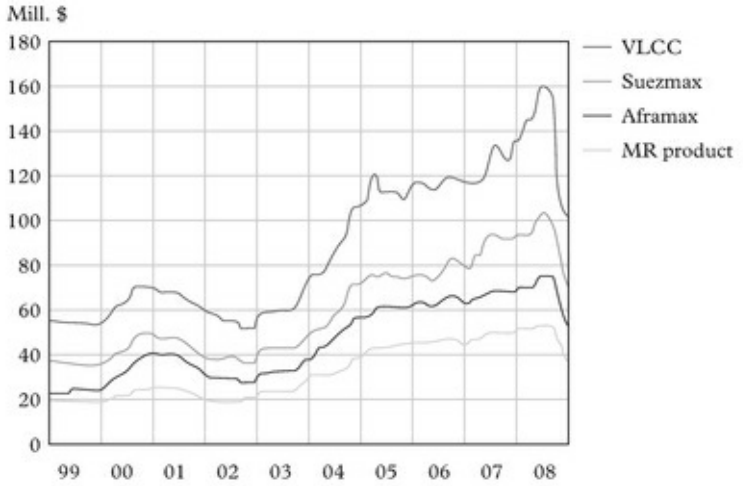

Figure 3: Second-hand values for tankers (5 years old), 1999–2008
Source: The Platou Report 2009, p. 16.

existence of second-hand markets facilitates entry into shipping, since potential suppliers may buy an existing vessel and enter the transport market on short notice. Both aspects affect competition in the freight markets in a positive way. In addition shipowners may also use the flexibility to switch markets or restructure their fleet in line with changes in demand.

Viable second-hand markets do not eliminate the exit costs, however. Ship values fluctuate with freight market conditions as is illustrated by Figure 3. Hence, the value of the vessel may be low when the owner wishes to sell and exit. Therefore second-hand markets reduce, but do not eliminate, costs of exit compared to an alternative setting were ship owners had to scrap their capital equipment to exit.

Not only ship owners who operate vessels, but also investors who purchase and sell vessels for asset play, enter the second-hand market. Their activities increase the liquidity of the second-hand market and contribute to a better functioning market and thus to a more efficient allocation of capital equipment in the freight market. In a study of the dry bulk market Alizadeh and Nomikos[8] thus find that there is a negative relationship between the volume of transactions in the second-hand market and price volatily.

2.4 Characteristics of markets for different vessel types

In the above comments on the different markets for ships we have indicated that the situation differs somewhat among vessel types. In the newbuilding market some suppliers specialise in building a restricted number of vessel types. There are for example, yards that specialise in cruise vessels. Most European shipbuilders concentrate on specialised vessels either cruise vessels, ferries, fast vessels or supply or research vessels. Producing these vessels is more profitable when labour costs are high

labour than producing standardised tanker or dry bulk carriers under similar cost conditions. Thus, a main difference in supply of the different ship types in the new building market is the location of the yards and thereby the cost level for labour employed. There is, however, an eastward move also for specialised vessels, similar to the one experienced earlier by contractors of standard wet and dry bulk vessels.

In the scrapping market there is little differentiation on vessel type. The environmental concern is also similar irrespective of type of vessel, since all vessels contain materials that are potentially harmful to the local environment.

The second-hand markets feature the clearest difference in market conditions for different ships. The differences reflect whether the vessel is suitable for more than one trade or transport service. Standard vessels such as most tankers and bulk carriers are suitable for operating in several trades. Hence, they can operate for a number of shipping firms and fulfil these firms diverse transport obligations. Container vessels may be somewhat less flexible across trades, but the standardised types may still be used in several markets. In addition to the effect of higher flexibility and transferability among trades enjoyed by standardised vessels, the number of vessels that compete in the tanker and dry bulk markets is high. This implies more frequent transactions in the secondhand market involving these vessel types. As a result the second-hand market is more liquid for these vessels than for specialised vessels. At the same time we know that the liquidity in the second-hand market is important for efficient allocation of vessels to their best use.

3. Alternatives to Investing in Vessels: Renting and Leasing

Operators may choose not to invest in vessels and instead concentrate on the commercial operations in the markets for transport services. There are several options open to operators. They may rent vessels for a shorter or longer duration. An operator, either an intermediator in international trade or a cargo owner, may rent vessels for specific trips in the spot charter markets or for longer duration in the time charter markets. Time charters may be available for periods of some months and up to most of the economic lifetime of the vessel.

The possibility to rent instead of investing in vessels increases the flexibility in seaborne transport further and rises the efficiency of the markets. There are, however, interdependencies between the time charter rates and ship values. The similarities in developments in market values and time charter rates are indicated by Figure 4, Panels A and B. The possibility to avoid high prices by postponing the investment and instead hiring a vessel in the time charter markets is therefore limited. Even so hiring poses an advantage since the operator may use this to postpone the investment in a vessel and may thus avoid tying capital into a vessel until he has acquired further information on the conditions in the shipping markets. Decisions on whether to hire now and purchase later or correspondingly to let your vessel now in order to sell it later, are similar to buying a real option to purchase or sell a vessel. Real option analysis and ship pricing is discussed in Chapter 24 by Bendall.

Leasing offers another opportunity for acquiring transport capacity. Leasing has little effect on the capacity offered or the operations in the transport markets, but has

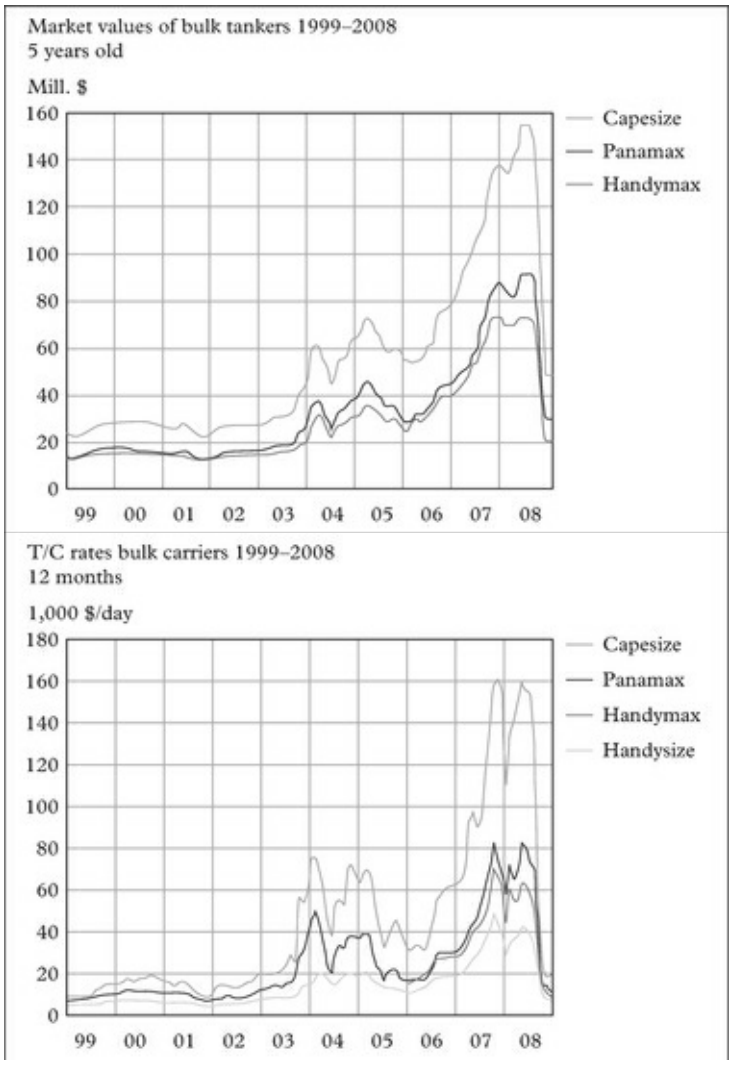

Figure 4: Market values and freight rates for bulk carriers 1999–2008
Source: The Platou Report 2009, pp. 20 and 21

bearing for the way ship owners acquire capital to invest in transport capacity. By leasing vessels the ship owner engages in off-balance operations and may secure more favourable financing than ordinary debt or equity financing. Leasing may also have bearings on the tax position of the shipowning firm and thereby reduce or postpone tax payments.

Leasing may influence demand in markets for ships and the corresponding price level or ship values, if it increases the investment opportunities open to shipowners. It may increase the efficiency of the markets for vessels by lifting a potential restriction on demand stemming from lack of capital at acceptable costs. Leasing of vessels is discussed in more detail in Part 9 of this volume. Here we only want to point out that by facilitating demand, the option to lease also influences the activity level and the liquidity in the market for ships in a positive way.

4. Market Structure and Competition

Above we have made some comments on the effects on market efficiency of the characteristics in the different markets for ships. In this section we will discuss market structure and its implications in more detail.

We found that in general markets for ships fulfil important requirements for efficient markets. These requirements are: low cost of entry and exit; access to relevant information on market conditions and transactions; and high liquidity in the market resulting from a fairly high number of agents demanding or offering ships for sale. Even though markets for ships in general are competitive

and efficient markets posting prices that reflect expected future income to the owner, there are several particulars that differ among the markets. In this section we will point at and discuss such special elements of the market structure for the newbuilding, scrapping and second-hand markets for the main types of vessels.

4.1 Market structure in the newbuilding market

The market structure in the newbuilding market carries several characteristics of a competitive market. There are a number of yards in different parts of the world and several independent ship owners looking for attractive offers to build vessels. New sites are constructed and others are converted from constructing vessels to building other capital equipment, for example for offshore oil production. Thus, entry into and exit out of the newbuilding markets takes place.

The existing order book split by yards and types of ships offers information to the agents in this market. This means that ship owners have information that may induce them to postpone ordering new vessels from yards with high demand or consider switching to types of vessels in lower demand at the time. By doing this ship owners induce a more efficient use of the total shipbuilding capacity with more similar time for delivery and backlog of orders across yards and vessel types. This levelling out of differences is not perfect, however, because the different vessel types are not perfectly interchangeable whether in operation nor in building requirements.

Since transport markets fluctuate and the information on the order book is frequently updated, ship owners may get information that makes them decide to cancel contracts or to convert an order from one type of vessel to another, if for example, they find that there will be delivered too many vessels of a specific type. Cancellation or conversion is prevalent in periods with big changes in expectations. Cancellations represent a cost for the ship owner and the yard, but may result in a lower cost than the expected cost of going on with the investment after conditions have changed. Hence, it opens up for correcting earlier decisions, when conditions in the transport market changes. This also contributes to a higher efficiency in the markets for ships by dampening potential distortion effects of the fluctuations in demand for seaborne trade on the market for new vessels, compared to what would be the situation if cancellations or conversions were not accepted.

Traditionally labour unions have been strong in shipbuilding. This has led to lower flexibility in the labour market. Such imperfections in a factor market affect newbuilding. The result has been a setting where nations compete to keep their shipbuilding industry to avoid layoffs. This competition has been visible and often more influential than competition between individual shipbuilding firms. Changes in relative labour costs induced a movement eastward for shipbuilding capacity, especially for standard vessels. For such vessels costs competition is more important than special designs or qualities that otherwise may make the ship owner willing and capable to pay higher prices. When demand faced by traditional shipbuilders in Western Europe and USA contracted, the authorities in both areas answered by offering economic support to the shipbuilding industry in order to reduce the need for restructuring. Later, when the industry in the upcoming shipbuilding nations in Asia matured, they also faced rising labour costs and competition from other Asian countries that experienced industrial growth later. Thus, Japan met strong competition from South Korea and more recently they both face intense and growing competition from Chinese shipbuilders. Governmental policies support the shipbuilding industry also in the Asian countries. The result is a worldwide subsidy competition that

presses prices. This price effect may increase demand for new vessels. In order to limit the politically induced subsidisation policy OECD at one stage regulated the maximum subsidisation allowed in the industry. For several years subsidisation was limited to yard credits for a maximum of 80% of the new building costs at 8% yearly interest for 8.5 years. There was a movement to curb subsidies by 1996. This failed and the negotiations were paused in 2005 (OECD[9]). The general trend of falling interest rates in financial markets worldwide reduced the subsidisation element in such yard credits, however. For a further discussion on the subsidisation in the new building industry see Chapter 19 in this volume.

What is of interest here is the effect of such policies on ship values and the functioning of the new building market. By offering vessels at subsidised prices demand for new vessels increases other things being equal and so do transport capacities when these vessels eventually are delivered. Subsidisation implies that new vessels are sold at a lower than optimal price, that is at a lower price than the value of the resources going into building the vessel. This favours investments in new relative to buying an operating vessel in the second-hand market and thus results in a higher supply of transport capacity. The result may be a pressure downward on the freight rates. A rising level of subsidisation thus may reduce the return on investment for existing vessels. This introduces a distortion into the markets for ships. Limiting subsidisation in the new building market therefore contributes to a more proper functioning of the markets and the relative values of new versus existing vessels. Dikos[10] analysing the price formation under uncertainty and irreversibility, argue that sub-optimal new building prices may result also without subsidisation given the characteristics of the shipbuilding industry marginal cost curve.

If subsidisation presses ship values strongly, there will also tend to be higher scrapping activity with vessels being scrapped at younger ages than would be the case without such subsidisation. The value of all vessels will fall following the pressure on freight rates and depending on scrapping prices, the reduction in value may push the market value of the oldest or less valuable vessels below their scrapping value. If this link between higher delivery of new vessels and correspondingly higher scrapping is strong, we may still end with a close to optimal capacity of transport services. Subsidisation in this case mainly results in a shortening of the economic life of the vessels. This implies a premature destruction of capital invested in shipping, but do not increase the total volume of transport capacity above the level needed in international seaborne trade. There is little reason to believe, however, that the effects of subsidisation are totally absorbed in this way. If not, subsidisation also induces a cost in the market for transport services. We may conclude that the newbuilding market has been characterised by competition between shipbuilding nations and not only by competition among shipbuilding firms. The resulting subsidisation has influenced markets for ships and ship values.

4.2 Market structure in scrapping market

Above we saw that also the scrapping market carries several characteristics of competitive markets. First and foremost it is fairly easy to enter into the scrapping market. ‘Green field’ scrapping capacity can be installed at a low cost and at short notice. The labour requirement is high, but no special qualifications are asked for. There are also few differences in the work or methods needed for scrapping vessels of different type. This flexibility in expanding scrapping capacity is especially

important since demand for scrapping varies greatly and in correspondence with the wide variations in freight rates for operating vessels (see Figure 4) . Above we also argued that more intense subsidisation of new vessels may induce a shift in the volume scrapped. This increase is not sudden, however, and poses fewer problems for capacity utilisation.

As long as demand for scrap steel is high there will also be economic reasons for the scrapping industry to increase capacities. Demand for scrap steel varies with economic activities, but scrap steel from vessels does not represent the marginal supply in the scrap steel market. Hence, variations in demand are smaller for scrap steel from ships than for scrap from other sources. All the same changes in the conditions in the shipping markets of course induce changes to the scrapping industry. See Figure 5 on variations in scrapping volumes.

Similarly the phasing out of vessels caused by changes in regulations by the IMO agreement on single hull tankers,[11] pose fewer problems to the scrapping markets as long as the capacity adjustment is flexible. Scrapping prices may be depressed for some time since the owners of those vessels do not have further trading as an alternative. If the markets for second-hand vessels are well functioning, this should be anticipated in the values for single hull tankers, at least when the agreement was reached by IMO and thus represent a sunk cost to the owners of these vessels. Converting single hull tankers into floating production units for the oil industry may relax the demand for scrapping capacity. This requires yard capacity for the conversion, however.

Under normal conditions the ship owner can choose between scrapping and selling the vessel for further trading. The decision should reflect the relative costs of the two alternatives. This links the scrapping and second-hand market. The option to alternatively sell the vessel for further trading may vary with the type of vessel, however. For standard tankers and dry bulk carries and standard container vessels sale for further trading may be a viable alternative. Specialised vessels on the other hand, may have low value in other uses. If so, scrapping is the main alternative open to the ship owner. Since there are several firms offering scrapping services, the shipowner still is not captive to that market. No scrapping firm can operate as monopsonist and dictate the scrapping value.

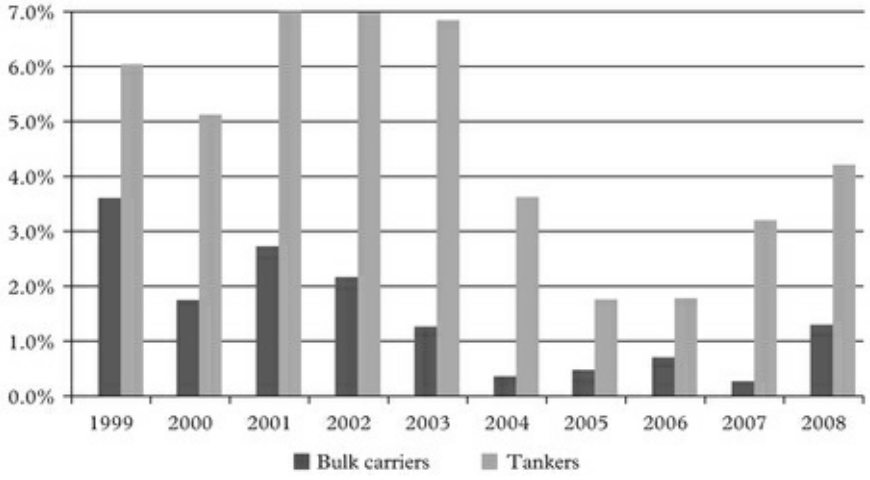

Figure 5: Tankers and bulk carriers sold for scrapping 1999–2008
Source: Based on Tables 11 and 17 in *The Platou Report 2009*, pp. 42 and 44.

Conditions and market structure in the scrapping market may change in the future, however. The relative ease of setting up a new scrapping site is an important element in securing well functioning and fairly competitive scrapping markets. Environmental concerns may limit this by requiring more secure and costly disposal of environmentally dangerous materials from scrapping. This will increase

the cost of scrapping and reduce scrapping values. Even more important, these requirements will reduce the flexibility in scrapping capacity and may increase the market power of approved scrapping firms. It is of less importance whether the ship owner or the scrapping firm are made liable for environmental protection against dangerous materials. There will be effects on the functioning of the scrapping market irrespective of who gets to be ultimately responsible.

We may conclude that the scrapping market is fairly competitive and has remained so for a long time. There may be changes ahead, however, since environmental concerns may increase the requirements for entering into this market.

4.3 Market structure in the second-hand market

Above we argued that the second-hand markets for standard vessels have the characteristics of well functioning markets. The shipbroker's network handles information and financing is catered for by a series of international shipping banks or shipping departments of the larger international banks, in leasing markets and by equity financing.

The main function of the second-hand market is to secure efficient exploitation of the existing capital equipment i.e. the vessels serving seaborne trade. Being what we called an auxiliary market since it does not alter the transport capacity supplied, one important function of the second-hand market is to open up for trade in risk exposure linked to investing in shipping. By opening up for sale of existing vessels for further trade, these markets reduced the risk of lock in to the investor. It does not eliminate all risks, however, since the ship values vary in accordance with the expected future return from investing in the vessel. Hence, a general reduction in the market expectations has to be borne by the current owner even though he has the option to leave the market by selling his vessel as a sale is only possible at a depressed price when expectations indicate a fall. He may curb future losses by selling, but will also forego any upside that might result from being in the market when conditions improve. Thus, the secondhand market reduces, but does not eliminate the risk from investing in standard or tradable vessels.

The ship owner's alternatives to selling a vessel for further trading are to let the vessel on a time charter or to scrap it. Even if he does not see satisfactory income opportunities from operating the vessel in the transport market himself, he may let the vessel to another operator for shorter or longer duration against a fixed time charter rate. By doing this he may postpone or avoid selling the vessel, if he expects to gain by operating the vessel in the future. This link between the second-hand and the time and bareboat charter market implies, however, that a reduction in the second-hand values follow a fall in time charter freight rates. Again the opportunity to let the vessel in the time charter market reduces the risk from investing, but does not eliminate the risk for a reduced return on the investment.

As discussed above investments in specialised vessels are relatively illiquid compared to the situation when investing in standard vessels. The second-hand market may be illiquid or even non-existent for specialised vessels. If the vessel can operate in standard trades, this may represent a sales opportunity at a lower price that do not reflect the costs of the special equipment carried by the vessel. Similarly, the opportunity to let the vessel in the time charter market will be limited by the fact that each vessel is best suited for operations in one or a few trades only.

We may conclude that the market structure and competitive situation in the secondhand markets varies with vessel type from competitive for standard vessels to fairly illiquid and close to monopsony

for specialised ones. These differences have bearings on the efficiency of the second-hand market in reducing the risk from investing in vessels. The allocative function of the second-hand markets that secure that vessels are engaged in their best employment, is less hurt, however, since specialised vessels by definition have fewer alternative uses than standard vessels.

5. Pricing and Ship Values

The expected future return from operating the vessel is the basis for ship values and thus for pricing in the markets for ships. In other words pricing in markets for ships is similar to pricing in other markets for real capital. The existence of viable secondhand markets is fairly common for transport equipment like aircraft, cars or ships. This said, it should be pointed out that the existence of viable second-hand markets implies that ship values are quoted on a regular basis only for the kind of vessel often traded in the market. Hence, for standard vessels the markets valuation is reported daily. The main difference between ships regularly quoted in second-hand markets and more specialised vessels with few alternative uses, is that owners of the first type of ships get regularly updated information on the market assessment of the ships' value. Specialised vessels with no or few alternative uses to the trade they have been built for, will not be quoted in a second-hand market and therefore the information on the current market value will not always be available.

The basis for the market prices in efficient second-hand markets thus is the expected future return from purchasing and operating the vessel. The challenge to ship owners and insurance or finance institutions thus is to assess the *expectations on future income* for the vessels. For older vessels the assessment must also include an evaluation of its *remaining economic life*. This reflects the quality and maintenance of the vessel in addition to whether new technologies are expected that will reduce the value of existing vessels with old technologies.

5.1 Expectations on future income

Extrapolative, rational and semi-rational expectations have been used, when analysing expected return in shipping. Norman[12] and Beenstock and Vergottis[13] are examples of studies using rational expectations, whereas Strandenes[14–15] assumes semi-rational expectations. Under extrapolative expectations assumptions on future prices are based on the historical development of prices and values for the individual vessel type. One example of extrapolative expectations is when future price is assumed to be a linear function of the current prices. Assuming rational expectations on future price formation on the other hand implies that shipowners and other market agents have an economic assessment of the future developments. In this case we assume that a dynamic model of the development in the market finds the expected future price or ship value. In other words agents then are expected to have an opinion both on the long-term equilibrium price level and the time path to be followed by the current prices to reach that equilibrium. When using semi-rational expectations, we assume that shipowners can assess the future equilibrium conditions in the markets, but that they have no theoretical basis for evaluating what time path prices will follow towards long-term equilibrium.

The common assumption of the term structure theory is that agents expect freight rates to fall when current short-term rates are high. Conversely they expect the short-term freight rates or spot rates, to rise in the future in periods when the current spot rates are low. When the spot freight rates are close to the long-term equilibrium level the curve depicting the expected development in freight rates is flat. No large adjustment is needed for the freight rates to reach long-term equilibrium. The term

structure theory is an example of a theory that may handle semi-rational expectations. Originally the term structure theory was applied to the structure of interest rates for assets with different maturities. In the first versions rational expectations were assumed.

Prices or ship values for vessels of different age, that is vessels with different remaining economic life may be 'read' from the curves signifying the paths towards equilibrium. Older vessels resemble short-term investments, whereas newer vessels are investments that are to be recouped over several years. Accordingly when the spot market is expected to rise in the future, newer vessels have a higher market value than older vessels both since they will earn an income for more years and from changing market conditions if these are expected to improve in the future. Currently new vessels will still operate in the future markets, whereas the current older vessels then have been scrapped. If the market expects the values to fall in some year's time and to remain low for a longer period, the value of the older vessels may be relatively high compared to values for newer vessels. They will enjoy a better return on the capital invested for the rest of their economic life, compared to newer vessels that may face several years in a depressed market before their economic life expires. If the current freight rates are very high, and the markets furthermore are expected to fall to a low level even before newly

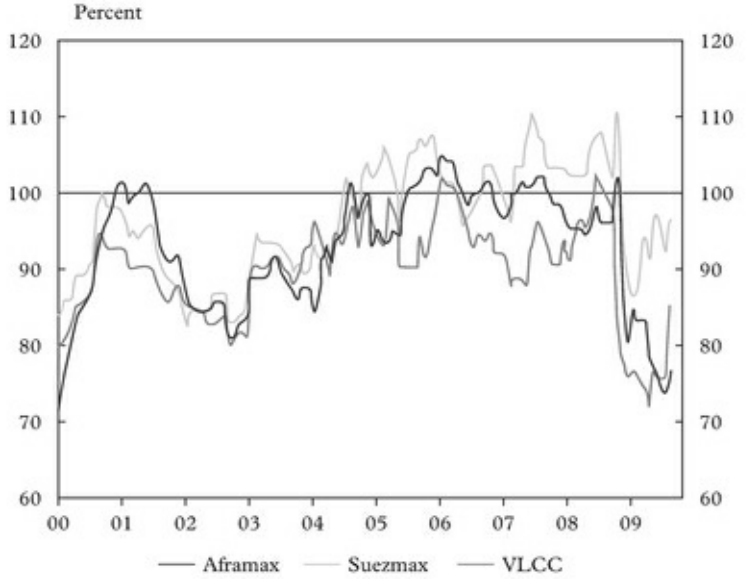

Figure 6: Second-hand prices in percent of new building prices for five-year-old tankers
Source: R.S. Platou Monthly 8 2009.

contracted vessels can be delivered; the values of existing vessels may lie above the price of a new vessels. Figure 6 illustrate this for five-year-old tanker value relative to new building prices for similar vessels. The market then assumes that the freight rates have fallen when the newly contracted vessels are delivered and start operating. Thus, they lose out on the income opportunities in the high markets because they are delivered only after the market conditions have normalised.

Strandenes[14] analysed term structure in ship values for tankers and bulk carriers in the 1970s. The analysis of the components of ship values indicated that for panamax bulk carriers and for medium-sized tankers the long-term equilibrium freight level was more important to the values than the current spot freight rate. For large tankers the results indicated, however, that the current spot freight rates were of great importance for the values of these ships. Newer studies of the term structure in shipping markets indicate that the results must be corrected for ship owners' differences in assessing the risk. Kavussanos' and Alizadeh's[16] results on the term structure for time charter rates indicate that ship owners have time varying risk perceptions. This distorts the term structure of freight rates of

different durations found by the older studies, where risk assessment was assumed to be stable over time. Adland *et al.*[17] introduce and estimate the effect of time-varying delivery lag in the analysis. Using Capsize dry bulk carriers as an empirical example they find that the second-hand values reflect the market fundamentals, i.e. the term-structure of freight rates, new building price and delivery lag. Hence, the expectations on future income and also the evaluation of ship values have several components, risk assessment and expected income in the freight markets for the rest of the economic life of the vessel being the main elements. The prevailing expectations are difficult to model and assess. Real option analysis may increase the understanding of assessment of ship prices. For a discussion of real option analysis see Chapter 24 by Bendall.

5.2 Economic life of a vessel

The relevance of term structure theory to ship values follows from difference in the remaining economic life of the vessel. It is important to assess the length of the remaining active life of the vessel. This includes assessing both the chance of technological obsoleteness, potential political decisions that may render the vessel obsolete, and gaining knowledge on what influences decisions on when to scrap the vessel as it approaches the end of its economic life.

The situation in the newbuilding market will influence the decision to scrap a vessel. In high markets the existence of limited shipbuilding capacity and thus extended time for delivery, may induce ship owners to postpone the demolition of old vessels. In extreme periods such as in the early 1970s when the time for delivery reached four years, existing vessels obtained higher values than new contracts since they were able to take advantage of the very high spot freight levels. We have seen a similar price structure in the booming later years as Figure 6 also shows. The market did not expect these freight levels to remain until the new vessels were delivered and correspondingly these vessels would not be in for the extraordinary profits offered in that period. For that particular period these expectations turned out to be right and several shipowners lost large amounts on their new orders.

6. Concluding Comments

In this chapter we have focused on the markets for ships and discussed characteristics of each type of market and pointed at the differences among them. We explained that there are both real and auxiliary markets for ships. Transactions in the real markets, the newbuilding and scrapping markets, change the number and types of ships available and thus the transport capacity. The auxiliary markets or the second-hand markets, do not change the total transport capacity. Transactions in these markets re-allocate ships among ship owners and contribute thereby to a more efficient use of the available capacity.

There are several agents in the markets for ships and no individual shipping company, yard or scrapping firm can dominate the markets. Entry and exit are possible. Information on the activities in these market is readily available, especially so because shipbrokers function as intermediaries and collectors of market information.

There are differences among the markets, however. In the newbuilding markets governments have engaged to halt restructuring that induced shifts in the geographic localisation of the shipbuilding industry. Subsidisation influences price setting and thus contracting. The scrapping markets have functioned fairly efficiently. In the future they may be controlled more strongly by governments, who are becoming concerned by spill of dangerous materials at the scrapping sites. This may reduce the

flexibility that we have observed for available scrapping capacity and may result in stronger fluctuations in scrapping prices in the future. We argued that the second-hand markets are efficient for standard vessels. For these ships the markets are liquid and prices are quoted regularly. The second-hand markets are not equally liquid for specialised vessels. Thus, owners of such specialised vessels may face larger exit costs.

Ship values ideally reflect the expected future profit gained from operating the vessel for the rest of its economic life. We pointed out that the term structure theory may help in assessing ship values and differences in values for new and existing vessels from differences in the remaining economic life of the individual vessels. Newer studies have revealed, however that shipowner's time dependent risk assessments complicate the analyses of ship values.

Acknowledgements

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Endnotes

1. Eriksen, Ib E. and Victor, D. Norman (1976): *ECOTANK – en modell for analyse av tankmarkedenes virkemåte* (ECOTANK – Econometric Model for Tanker Companies), Report, Institute for Shipping Research, Bergen.
2. Wijnolst, N. and Wergeland, T. (1997): *Shipping* (Delft, The Netherlands, Delft University Press).
3. *The Platou Report 2009* (2009): R. S . Platou Shipbrokers a.s. Oslo, Norway www.platou.com/platoureport.htm.
4. Anonymous, *Vetting again and again*, Fairplay International, 28 February.
5. Bijwaard, G.E. and Knapp, S. (2009): "Analysis of ship life cycles – the impact of economic cycles and ship inspections", *Marine Policy*, Vol. 33, 350–369.
6. Strandenes, Siri Pettersen (2001): Quality incentives payoff? *Proceedings on CD from the Ninth World Conferences on Transport Research*, July, Seoul.
7. Wijnolst, N. and Wergeland, T. (2008): *Shipping Innovation* (Amsterdam, IOS Press).
8. Alizadeh, A. and Nomikos, N.K. (2003): "The price-volume relationship in the sale and purchase market for dry bulk vessels", *Maritime Policy and Management*, Vol. 30, No. 4, 321–327.
9. OECD (2005): OECD, partner countries decide on a pause in shipbuilding subsidy talks, available at www.oecd.org/document/35/0,3343,en_2649_34211_35420579_1_1_1_1,00.html (accessed 8 Sept 2009).
10. Dikos, G. (2004): "New building prices: demand inelastic or perfectly competitive?" *Maritime Economics and Logistics*, Vol. 6, 312–321.
11. IMO (2005): Single-hull oil tanker phase-out www.imo.org/Safety/mainframe. asp? topic_id=1043, accessed 8 Sept 2009.
12. Norman, Victor D. (1981): "Market strategies in bulk shipping", in Studies in Shipping Economics: In Honour of Professor Arnljot Strømme Svendsen, Einar Hope (ed.) (Oslo, Norway, Bedriftsøkonomens forlag). pp. 13–29.

13. Beenstock, Michael and Andreas, Vergottis (1993): *Modeling the World Shipping Markets* (London, UK, Chapman & Hall). Beenstock, Michael (1985): "A Theory of Ship Prices", *Maritime Policy and Management*, 215–225.
14. Strandenes, Siri Pettersen (1984): *Price determination in the time charter and secondhand market*, Working paper, Centre for Applied Research, Bergen.
15. Strandenes, Siri Pettersen (1999): "Is there a potential for a two-tier tanker market?", *Maritime Policy and Management*, Vol. 26, No. 3, 249–264.
16. Kavussanos, M. and Amir, H. Alizadeh-M (2002): The expectations hypothesis of the term structure and risk premium in the dry bulk shipping freight markets", *Journal of Transport Economics and Policy*, Vol. 36, No. 2, 267–304.
17. Adland, R., Jia, H. and Strandenes, S.P. (2006): "Asset bubbles in shipping? An analysis of the recent history in the dry bulk market", *Maritime Economics and Logisitic*, Vol. 8, 223–233.

Chapter 9
Shipping Market Cycles

*Martin Stopford**

1. Introduction

Shipping cycles create endless problems for shipping investors and analysts alike. The shipping industry, like Sisyphus, the mythological character condemned to pushing a stone up a hill, only for it to roll down again, seems to be caught in an endless sequence of cycles over which it has no real control. So why bother to issue warnings?[1] How would Sisyphus have felt if each time he was half way up the hill some smart economist was standing there to warn him that the stone would soon be on its way down again? Shipowners feel the same way about the killjoy analysts intent on spoiling their bit of fun during the all-too-brief freight booms.

It is not just modern shipping executives who feel this sense of frustration. A century ago in his 1894 annual report, a London shipbroker spoke for all of us when he wrote:

"The philanthropy of this great body of traders, the shipowners, is evidently inexhaustible, for after five years of unprofitable work, their energy is as unflagging as ever, and the amount of tonnage under construction and on order guarantees a long continuance of present low freight rates, and an effectual check against increased cost of overseas carriage."[2]

This masterpiece of understatement precisely captures the sense of dedication, purpose and *deja vu* that characterises shipping cycles today, as it obviously did a century ago. It also leaves shipping economists with a legitimate question about what they can really contribute to the commercial shipping industry as it beats its way through these cycles. Warnings aside, what have we to say?

In this chapter we study these cycles, or waves, in the shipping market**.** There are three main aims. First to look at some of the general characteristics of shipping cycles and discuss how they fit into the economics of the shipping market. Secondly we will study the historical pattern of cycles (if we decide they are cycles), so that we get an idea of the many different economic forces which contribute to their progress. We might call this "cyclical recognition". Thirdly we will discuss the causes of cycles and focus more closely on the economic mechanisms which control them.

2. The Role of Cycles in Shipping Economics

Market cycles are the driving force behind shipping investment and chartering. They are the heartbeat of the shipping market, pumping cash in and out of the business. By forcing companies to compete with each other for a share of this wealth, the market lures them in the direction needed to give the most efficient use of resources. In fact the "cycles" are so much a part of the culture of the industry, that it seems hardly necessary to define them. However it is worth spending a little time discussing what the industry generally means by a cycle, and what impact the cycles have. This will help to give some perspective.

2.1 The characteristics of shipping cycles

Strictly speaking a cycle is "an interval of time during which one sequence of a regularly recurring sequence of events is completed".[3] The cycle in Figure 1 is defined by its amplitude (A), which is the distance from peak to trough, and its frequency (F), which is the distance between peaks (or troughs)

in the cycle. Viewed in this way a shape of a regular cycle C can be defined in terms of the values of A and F.

$$C_{t_{1-n}} = f(A,F) \qquad (1)$$

Of course nobody expects shipping cycles to be this regular. There is a widely held "rule of thumb" that they last seven years, but even a cursory examination of the tanker and bulk carrier market cycles in Figure 2 confirms that in the real world the periods of feast and famine bear little relationship to the stylised cycles in Figure 1.

The fact that the cycles are not regular makes it even more important to understand them, at least from the viewpoint of the shipping analyst. The practical importance of cycles cannot be understated. In July 2008 a 280,000 dwt tanker was earning $170,000 a day, but just 12 months later in 2009 it was earning only $11,000 a day. This volatility in earnings has a tremendous impact on the way everyone involved in the commercial operation of shipping views the business. For shipowners it offers an incentive to "play the cycle", earning premium revenue when the market is high and, in an ideal world, fixing the ships on time charter or selling out just before the market moves in to a trough.

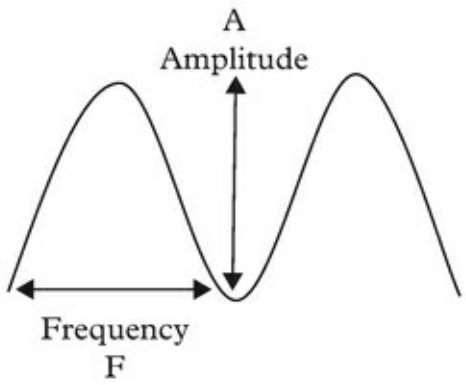

Figure 1: A generic "cycle" showing frequency and amplitude

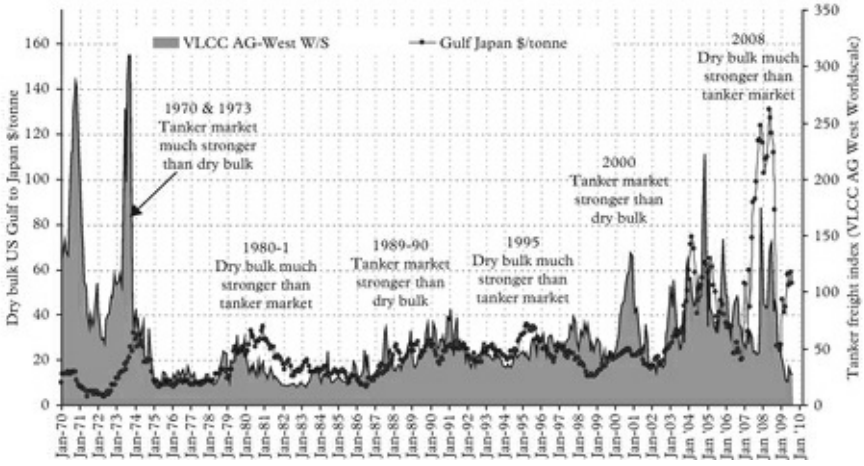

Figure 2: A comparison of tanker and dry bulk cycles 1970–2009
Source: Fearnleys, Clarkson Research Services Ltd

Another feature of the shipping cycle, illustrated by Figure 2, is the correlation between cycles in different segments of the market. The spot market rates in the tanker and bulk carrier markets are compared over the 39-year period 1970–2009. The timing of cycles in the two markets is broadly similar, but the correlation is far from perfect and in some cases the two market segments behave quite differently. In 1971 and 1973 the tanker market surged way ahead of the dry bulk market in a super-boom which the bulkers were not really included in. Note that the market remained firm through

1974 for almost a year after the 1973 oil crisis which happened in October 1973. But in 1980 the bulk carrier peak was longer and stronger than the rather feeble tanker upswing. Then in the late 1980s both markets moved up to a new peak, but this time the tanker market was much stronger than dry bulk. Bulkers peaked in 1995 when tankers had a tough year, but in 1997 the tanker market enjoyed a peak, during a rather bleak year for the bulk carrier market. But then it was the bulk carrier market's turn, with a spectacular boom in 2007–2008 which the tanker market could not match. If nothing else this demonstrates that we cannot generalise about cycles by assuming that even closely related markets have the same peaks and troughs. On the contrary it suggests that different shipping segments are, to some extent at least, isolated from each other.

Even more prominent is the opportunity for "asset play", a term often used to describe speculating on the sale and purchase of ships. Every shipping investor's ambition is to buy in at the bottom of the cycle and sell at the peak. Historically this has always been an important part of shipowners' revenues, especially during periods of inflation. The 1980s provided one of the most spectacular opportunities ever. A VLCC could be purchased in the mid-1980s for about $3 million, but by 1989 its price had gone up to almost $30 million, a tenfold increase in just five years. A Capesize bulk carrier bought for $25 million in 2002 could have been sold for $160 million in 2008. Of course the fact that the cycles are so irregular makes this a tricky game to play, but with so much at stake financially, who would expect it to be simple?

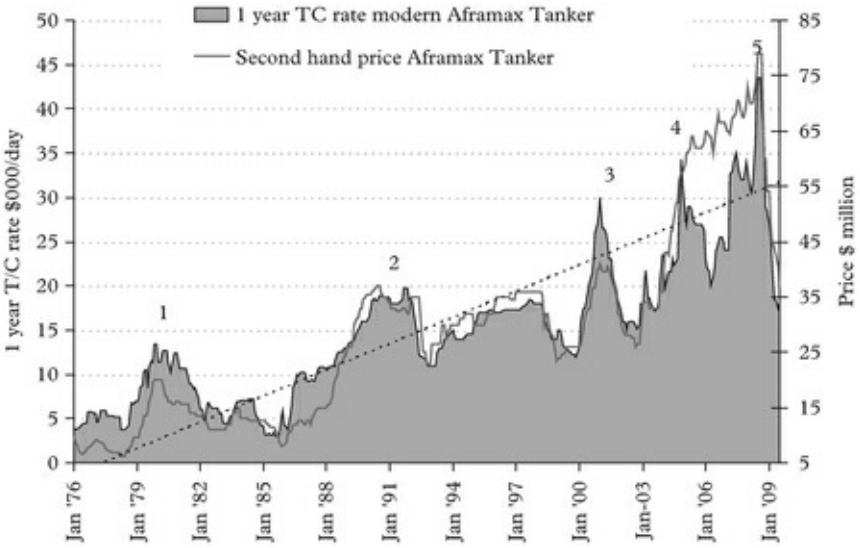

Figure 3: A comparison of second-hand price and one-year TC rate for Aframax Tanker
Source: author

Figure 3 illustrates the link between cycles is earnings and asset values by comparing the one-year Time Charter rate for a five-year-old Aframax Tanker (left axis) with its market value (right axis). The correlation coefficient of 0.87 is very close, with peaks and troughs following the same cyclical pattern, confirming the common sense expectation that the asset's price will be correlated with its earning capacity. With such high volatility it is no wonder that shipowners spend so much time considering how to take advantage of this volatility by buying low and selling high.

In fact the causal mechanism underlying the cycles is simple enough. They are generated by changes in the delicate balance of supply and demand for ships. When demand increases faster than supply, freight rates and second-hand prices move up. Conversely when supply exceeds demand, freight rates are driven down by competition, and in many cases fall to the operating cost of the ship.

But like many “simple” economic mechanisms, in practice it can develop in a host of different ways. In the next section of this chapter we will study the way cycles have behaved over 120 years of modern shipping. This provides some practical insights into the many different permutations of factors which can drive the supply and demand sides of the market. We will then look more closely at the cyclical mechanism and in particular the dynamics of the market cycle, in an effort to understand the economic framework itself.

3. A Brief History of Shipping Cycles, 1869–2002

A dry freight index covering the 140-year period from 1869–2009 is shown in Figure 4. Identifying the start and finish of each cycle is not always easy. Some cycles are clearly defined, but others leave room for doubt. Does a minor improvement in a single year,

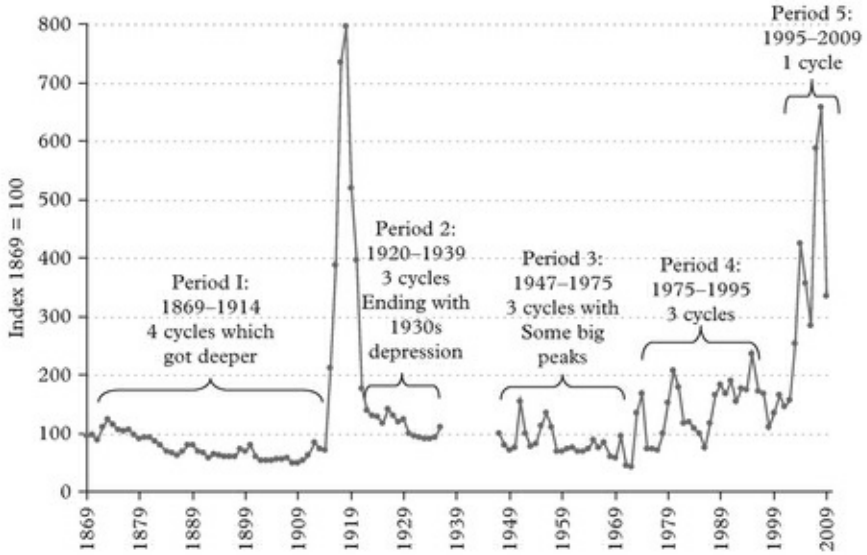

Figure 4: Shipping cycles 1869–2009, divided into five periods
Source: Stopford (2009): *Maritime Economics* (Routledge), Annex C

as happened in 1877, 1894 or 1986, count as a cycle? There are several of these "minicycles" where the freight rates moved slightly above trend. However careful examination of the statistics and other information suggests that taking 1869 as the starting point[4]. I there were 15 dry cargo freight cycles during the 140-year period covered by the graph. For the purposes of discussion in this chapter we will divide this sequence of 15 cycles into five periods, which are marked in Figure 4. The first of these, period 1, covers one of the most exciting periods of modern shipping history, when much of the basic technology used by the industry today was developed. Period 2 covers a much more difficult phase between the World War I and the World War II, and of course it includes the Great Depression of the 1930s. Period 3 encompasses the second era of expansion between the end of the World War II and the first oil crisis in 1973. In a very different way this was another period when the shipping industry was adopting new technology in response to rapid trade growth. Period 4 covers the quarter-century from the first oil crisis through to the end of the twentieth century, including the second great shipping depression in the 1980s. Finally period 5 covers one of the most profitable periods in the shipping industry’s history, incorporating a single lengthy cycle which surged to a peak in 2008.

In the following sections we will review each of these periods, with two main aims. The first is to establish the general economic conditions which existed on the supply and demand sides of the shipping market during each period, to give us an idea of the overall tone of the market. Secondly we will look at the course the cycles took and try to get some sense of how the industry saw them at the

time. In this way we can identify the turning points, marking the beginning and end of each cycle and the length of each trough. Finally we will examine the impact the cycles have had on shipping over the last century. Statistics give no sense of the real events underlying these cycles. For example the brief dips in the index during the 1930s and 1980s give no sense of the desperation and financial hardship which shipowners suffered during these periods. So if we are to obtain a better insight into the nature cycles, and their causes, we must focus more closely at what was going on in each period.

3.1 Period 1: Shipping cycles 1869–1914

The 45 years before 1914 provides an example of the tight interplay between short-term cycles and long-term supply/demand fundamentals. The freight index in Figure 5 shows a long-term downward trend from 100 in 1869 to 45 in 1908. To put this into cash terms, we can take the example of the freight rate for coal from South Wales to Singapore. In 1869 the freight was 27 shillings/ton, but by 1908 it had fallen to a low of 10 shillings[5]. Onto this long term trend was superimposed the series of four shorter cycles of about ten years in length.

This was a period of great activity on both the demand and supply sides of the shipping market. Driven by industrialisation and the expansion of the European empires, trade grew rapidly. Continuous advances in technology on the supply side of the shipping market helped the whole process, not least by reducing transport costs. Ships were becoming bigger and more efficient. In 1871 the largest transatlantic liner was the *Oceanic*, a 3,800 gt vessel with a 3,000 horsepower engine capable of 14.75 knots. It completed the transatlantic voyage in 9½ days. By 1913 the largest vessel was the 47,000 gt *Aquatania*. Its 60,000 horsepower engines drove it at 23 knots. The transatlantic voyage time had fallen to under five days. These vessels were

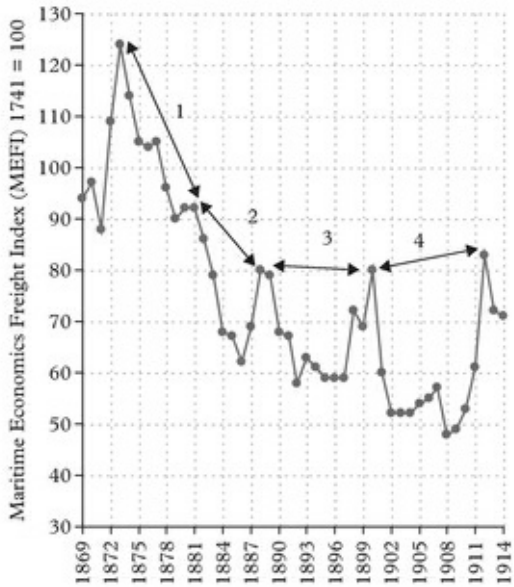

Figure 5: Four cycles 1869–1914

Source: Stopford (2009): *Maritime Economics* (Routledge), Annex C

comparable in length with a 280,000 dwt tanker and vastly more complex in terms of mechanical and outfitting structure.

Perhaps the most important technical improvement was in the efficiency of steam engines. With the introduction of the triple expansion system and higher pressure boilers the cargo payload of steamships increased rapidly. The early steam engines had worked at 6lbs/in pressure and consumed 10lbs of coal/horsepower per hour. They could carry little but bunker coal. By 1914, pressures had increased to 165lbs/in and coal consumption had fallen to 1½lbs/horsepower per hour, giving the

steamer a decisive economic advantage, despite its high capital costs. The economic advantage of steam ships was compounded by economies of scale. As a result, the world fleet doubled from 16.7 million grt in 1870 to 34.6 million grt in 1910 and the continuous running battle between the new and old technologies dominated market economics as each generation of more efficient steamers pushed out the previous generation of obsolete vessels. The first to come under pressure were the sailing ships, which were replaced by steamers. In 1870 steamers accounted for only 15% of the tonnage but by 1910 they accounted for 75% of the world merchant fleet[6]. The growth in demand was matched by equally rapid growth in supply. As shipyards gained confidence in steel shipbuilding, production grew rapidly. Between 1868 and 1912 the shipbuilding output of the shipyards on the Wear, trebled from 100,000 grt to 320,000 grt. Change is never easy and the market used a series of cycles to alternately draw in new ships and drive out old ones. The cycles can be clearly seen in Figure 4 which shows peaks in 1871, 1881, 1889 and 1900.

Cycle 1 started in 1871, and lasted 10 years until 1881. During this period rates fell steadily, as a new generation of steamers competed with the sailing ships which continued to offer low-cost freight carriage. There was a slight recovery of rates in the second half of 1873, the year when Mr Plimsoll published “Our Seamen”, and started his campaign which led to the introduction of the Plimsoll line on ships. From there it was downhill all the way, with rates hitting a trough in 1879, driven by the “excessive and ever increasing supply of tonnage”. However in 1880 the market started to pick up and 1881, the peak of a business cycle in the United Kingdom, saw “in almost every trade a fair amount of business”. This good start lead to a second excellent year in 1882, described by brokers as being “exceedingly satisfactory”. A sure sign that a great deal of money was made.

Cycle 2 started almost immediately and rates fell through 1883 to a new trough in 1884. Brokers reported that rates were unprofitable for steamers, and even in the better months insufficient to provide for depreciation. The next three years from 1885 through to 1887 were still dull and highly competitive, with relatively low rates. By this time the newly founded liner business was working hard to establish conferences that would protect them. However things improved in 1887 and by 1888 brokers were reporting the year as “a remarkable one in the history of shipping. A transformation of the whole trade from abject depression to revival and prosperity”. Again we find that this coincided with a peak in the world trade cycle. The good times continued through 1889.

Cycle 3 commenced in earnest in 1890 when freight rates slumped, driven down by heavy deliveries which greatly exceeded the previous peak in the early 1880s. By 1892 the market was in severe depression and rates remained very depressed through 1894, and 1895. By 1896 the balance seems to have been partly restored and brokers report fluctuating rates which gave way to a much firmer market in 1898. This upward trend continued and the market moved to a peak in 1900 which was reported to be a memorable one for the shipping industry. Brokers reported “vast trade done and large profits safely housed”. This concluded the third cycle, which had lasted the greater part of the decade and was the worst so far.

Cycle 4 turned out to be another long recession. In 1901 the market crashed, leading to a series of very depressed years. This did not let up until 1909 when the market started to believe that the worst was over. For once they were right and 1910 was an excellent year. Once again the explanation of the long recession, at least as reported by the contemporary brokers, was a recession in trade which

followed the great boom of 1900 and over production of ships.

So what was driving these "short" cycles? On the demand side, rapidly growing trade was dominated by the world business cycle, whose cyclical peaks in 1872, 1883, 1892 and 1903 roughly correspond to the peaks in the shipping cycles[7]. On the supply side shipbuilding production amplified the demand instability by overshooting during the booms. This combination laid the foundations for a sequence of cycles which got steadily longer, with the last one stretching out for the best part of a decade.

Looking back over the period, one lesson is that trade growth and technical development do not necessarily lead to easy profits. Many fortunes were made during this period, but across the market competition was cutthroat. Shipbrokers' reports painted a dismal picture of long recessions during which marginal tonnage struggled for survival against a continuous stream of more cost-effective new vessels. There were only a handful of years that did not warrant a complaint about the state of the market. As time progresses the complaints about over-building intensified. A comment on 1884 is typical "This state of things was brought about by the large over-production of tonnage of tonnage during the three previous years, fostered by reckless credit given by the banks and builders and over-speculation by the irresponsible and inexperienced owners".[8] Fleets were growing, but there were no easy profits.

3.2 Period 2: Shipping cycles, 1919–1938

The period between the World War I and World War II was another very difficult period for shipowners, featuring three cycles, numbers 5, 6 and 7 shown in Figure 6.

By 1920 the sailing ships had been driven from the seas, the rate of technical innovation had slowed and the tone was set for a period dominated by a general misalignment of fundamentals. Jones (1957) comments "For most of the period between the wars it appears from the statistics of laid up tonnage that the world was over-stocked with shipping". To begin with in the 1920s trade grew rapidly at about 5% per annum. The problem was on the supply side where there was acute overcapacity in the shipbuilding industry, due to the massive expansion during the war and new entrants to the market. This ensured a weak market. The result was a gradual erosion of freight rates. The freight chart shown in Figure 6 shows freight peaks in 1921 and 1926. From there the trend was downwards towards the recession of the 1930s.

Cycle 5 started with a peak of freight rates in 1921. This was one of the highest levels of earnings experienced for many years, and was the result of an acute shortage of merchant shipping tonnage following the World War I which ended in 1918. During the closing years of this war German U-boat activity had greatly depleted the merchant fleet, and the shipyards had worked flat out to fill the gap. The extent of the shortage ships can be judged from the fact that according to Fairplay the second-hand price of a steamer increased from £71,000 in 1915 to £258,000 in 1920. The rapid expansion of shipyard capacity coincided with a peak in the world business cycle in 1920, producing the peak in freight rates shown in the chart.

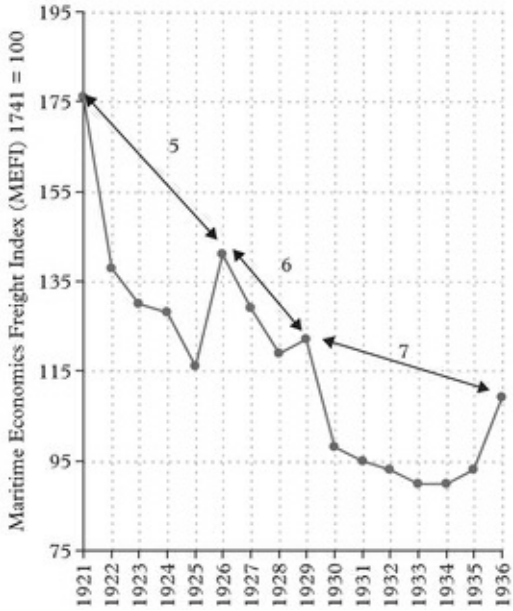

Figure 6: Three inter-war cycles 1921–1936

Source: Stopford (2009): *Maritime Economics* (Routledge), Annex C

Cycle 6 commenced with the downturn in the world economy in 1922 and freight rates fell sharply to a trough in 1925, by which time the second-hand price of a steamer had collapsed to £60,000, one quarter of the price paid five years earlier. There was a brief recovery in freight rates during 1926. *Cycle 7* was short and not severe. Trade grew rapidly between 1928 and 1930, but heavy production of new ships continued to depress the market and rates fell slightly in 1927. By 1929 the shipping industry was anticipating a full recovery next year, but this expectation was not fulfilled.

Cycle 7 started in 1931 as the shipping industry moved into the Great Depression of the 1930s. The Freight Index slumped from 115 in 1929 to a trough of 85 in 1933, the lowest ever recorded. This recession was driven by an unprecedented collapse in the volume of seaborne trade which fell by 25% between 1931 and 1934. The freight index fell by 30% to operating costs and stayed there for five years from 1930–1935. However the best indicator of the severity of the recession is second-hand prices. Between 1933–1935 good quality second-hand ships were sold at distress prices 80–90% below their previous peak, singling this out as a depression rather than a recession. However shipyard production responded very quickly, and by 1936 the market was moving back towards recovery.

3.3 Period 3: Shipping cycles, 1945–1975

The first 25 years after World War II saw an extraordinary growth in sea trade, which increased from 500 million tons in 1950 to 3.2 billion tons in 1973. Once again this was a period of great technical change in the shipping industry. This time the change

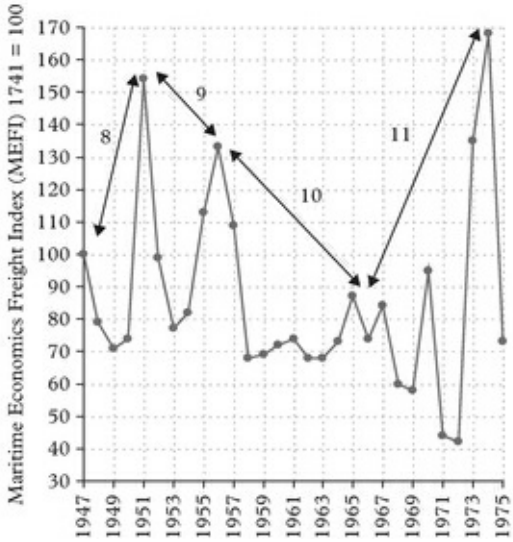

Figure 7: Cycles in the golden era 1947–1975

Source: Stopford (2009): *Maritime Economics* (Routledge), Annex C

was not in the technology of shipbuilding, but in the way the industry was organised. This was the era when the liner and bulk shipping industries applied the principles of mechanisation which were being adopted so effectively in manufacturing production on land. Major shippers in the energy and raw materials took the initiative in developing integrated transport operations designed to reduce their transport costs. The trend towards specialisation and economies of scale was continuous and pervasive.

Against a background of rapidly expanding demand, it was the shipbuilding industry which set the commercial tone for the period. For the first decade from 1945–1956 there was a shortage of shipbuilding capacity, due to the destruction of the Japanese and German yards during the war. The result was a decade of prosperity (see freight chart in Figure 7) . Cycles 8 and 9 which occurred between 1945 and 1956 illustrate the cyclical mechanism at its most favourable. There were two cyclical peaks, the first in 1952 which coincided with the Korean War and the second in 1956 which was amplified by the closure of the Suez Canal, greatly increasing the voyage time to the East from Europe. Unusually both peaks lasted longer than the preceding trough, making this a golden age for shipping, at least compared with the depression of the 1930s and the four deep cycles before 1914. Once the shipyards in Japan and Europe got going in the late 1950s this changed and the cycles became longer and less profitable.

Cycle 10, which lasted from 1957 to 1966**,** probably ranks third in severity behind the 1980s recession and the 1930s recession. It was triggered by an extreme combination of supply and demand developments. On the demand side, the world economy had a severe downturn in 1957 (see Figure 11), and this resulted in a reduction in the volume of seaborne trade, just as the world shipyards were expanding to meet the massive investment demand placed during the 1956 Suez boom. The recession was very severe in the late 1950s, and only started to show sign of recovery in the early 1960s. Freight

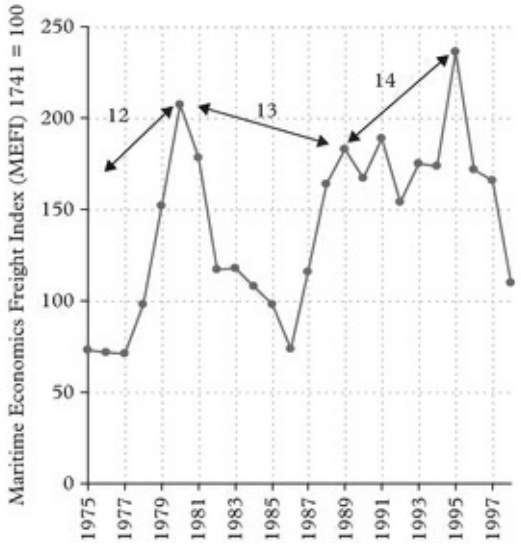

Figure 8: Three dry cargo cycles 1975–1995

Source: Stopford (2009): *Maritime Economics* (Routledge), Annex C

rates slumped to a low level and stayed there for almost a decade. However this low level of earnings is not a reliable guide to the cashflow of the shipping industry. During the 1960s shippers placed many long-term time charters for bulk carriers and tankers. These were generally negotiated at levels which gave an adequate return on capital, so the majority of shipowners had a firm cashflow, and only marginal vessels were traded on the spot market, receiving the low rates reported here. It was really an extended period of weak rates.

Cycle 11 was short and not very deep. The market finally peaked moderately in 1970 (the tanker market had a much stronger peak). Cycle 12 was even shorter. The market slumped in 1971, and with a very large orderbook analysts were predicting that the market would not recover until 1976, proving once again how wrong forecasts can be. In 1973 the market moved into one of the best peaks in its history.

By the end of this period shipbuilding output was geared to high growth, making the market very sensitive to any small downturn. There were profits to be made by those who judged the cycles correctly, but this was a very competitive period.

3.4 Period 4: Shipping cycles, 1975–1995

In the mid-1970s, following the 1973 oil crisis, the shipping environment changed again. The fourth section of our review brings a sequence of three cycles shown in Figure 8, each of which had a very different character. After two decades of continuous growth there was a fall in sea trade in the mid-1970s, followed by a major dip in the early 1980s. The scale of this downturn in trade rivalled the 1930s in its severity. In the tanker market the sprint for size lost momentum and the fleet, which had previously been young and dynamic, grew old and sluggish. Shippers became less confident about their future transport requirements, and the role of tanker owners as subcontractors gave way to an enlarged role as risk takers trading on the “spot” market.

Cycle 12 started in the spring of 1975 when the dry cargo market collapsed after the remarkable boom of 1974. The bigger sizes of vessels had already started to move into recession during the second half of 1974, but in 1975 even the small bulk carriers were affected. This downturn was triggered by a deep recession in the world economy, which followed the 1973 oil crisis. The steel industry was very depressed, with 20 to 30% over capacity, and the chronic over tonnage in the tanker

market forced combined carriers into dry cargo, increasing the oversupply. In 1976 the market remained depressed, though the trade volume was busy, and many owners were beginning to face liquidity problems. About 5 million deadweight of dry cargo ships and 6 million deadweight combos were in lay-up. By 1977 the market had started to edge upwards, with an improvement in the steel industry and the thermal coal trade which was benefitting from a high oil prices. However the real recovery came in 1979, driven by a 7% growth in the major bulks and supply growth of only 2.5%, due to the run-down of the order book. Finally the boom reached a peak in 1980, driven by a strong steel industry and heavy congestion in continental ore discharging ports and the coal ports in the United States. This strong bull market with one year time charter rates lasted until March 1981 when it started to collapse.

Cycle 13 certainly turned out to be unlucky for the dry bulk shipping industry. Rates fell steadily during 1982 and the deep recession in the world economy had a major impact on the movement of dry cargo. By 1983 the one-year Time Charter rate for a Panamax bulk carrier was down to $4,700 a day, less than the operating cost of a 65,000 dwt ship operating under the German flag. However investors remained liquid from the high profits earned during the previous three years and this triggered heavy counter-cyclical investment in the “cheap” new bulk carriers being offered by the shipyards. The surge of deliveries which followed completely swamped the recovery in the world economy which happened in 1985–86. Defaults on time charters, and a long period when freight rates left owners with little cash beyond the level required to pay operating expenses created a serious liquidity crisis in the industry. As one broker’s report put it “the equity was drained out of the industry”.

By the summer of 1986 the financial distress was so great that a Panamax bulk carrier which had recently been delivered for a price in excess of $25 million could be purchased for $8 million. Bankers found that their customers could not even meet interest payments, and the collateral value of the ships had shrunk to a fraction of their market value when the finance had been put in place. Some bankers withdrew from the industry, foreclosing on loans and taking heavy write-offs. However like all shipping recessions, eventually supply and demand adjusted, and by 1989 rates were back to the level of 1980.

Cycle 14 started off with a boom very much like the one experienced in 1979 and 1980. However the following years were quite different. Although there was a recession in the world economy, bulk carrier investors had by now become so conservative in their ordering activity that deliveries fell to a very low level in the early 1990s. This meant that Cycle 14 was unusually shallow, as is clearly apparent in Figure 8. Rates fell briefly to $10,000 a day in 1992, after which they recovered, reaching a new peak in 1995 (some might regard this as a long plateau rather than a cycle). The cycle ended with an exceptionally firm market, with an acute shortage of handy bulk carriers in the Pacific during the summer of that year. In April 1995 Panamax bulk carriers were earning $17,000 per day and Capesize bulk carriers $25,000 per day, the highest ever recorded.

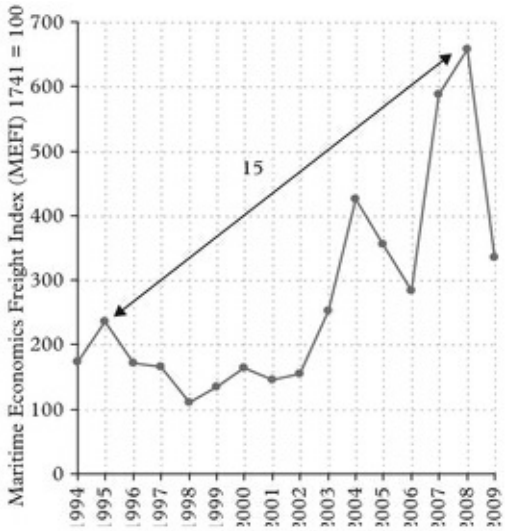

Figure 9: The great shipping cycle 1995–2008

Source: Stopford (2009): *Maritime Economics* (Routledge), Annex C

3.5 Period 5: Shipping Cycle 1995–2008

The next period got off to a bad start. As the market improved in the mid-1990s, the conservative investment policy followed by the dry bulk market in the early 1990s evaporated, and bulk carrier deliveries, which had fallen to 4.7 m dwt pa in 1992, increased to 18.7 million deadweight in 1998, just as the Asia Crisis started to bite, driving the market down to a severe trough.

Cycle 15: The cycle bottomed out in 1998 and then, as Figure 9 shows, the dry cargo market started a long upward journey leading finally to a peak a decade later in the summer of 2008. This proved to be the most extreme cycle in the history of shipping. During the boom markets of 1995 (Cycle 14) Capesize bulk carriers had set a new record of $25,000 a day earnings, but in the summer of 2008 the peak fixture for a Capesize bulk carrier was $304,000 a day, and average earnings for July 2008 were $150,000 a day. At this point a five-year-old second-hand Capesize bulk carrier, which could have been purchased six years earlier for $24 million, was worth $160 million. The market peaked in July, and then in September as the credit crisis deepened, experienced one of the most extreme falls ever seen in the shipping market. By November 2008 Capesize bulk carriers were earning only $2,500 a day. So Cycle 15 was in every way as extreme as the 1980s, but this time in a generally positive way.

The explanation of this cycle seems to have been a fortunate combination of events in the shipping market. On the demand side, following the two short recessions of 1998 and 2001, the world economy embarked on five years of positive growth with GNP for 2003–2008 averaging over 4% per annum growth, the longest boom since the 1960s. This prosperity was enhanced fir shipping Chinese economic growth. Starting in the late 1990s, Chinese industry grew very rapidly, with surging exports of containerised goods and a major infrastructure and real estate development programme which boosted Chinese steel production from 126 Mt in 2000 to 501 Mt in the year to June 2009. This vastly exceeded expectations and shipping investors had not ordered vessels in anticipation of the growing iron ore imports. The shortage of ships which developed was reinforced by congestion as the iron ore and coal terminals could not cope with the rapidly growing demand. Just to complete the positive picture, the ships built during the 1970s shipyard bubble were reaching 30 years of age and the result was heavy scrapping. Taken together this created five years of sustained and exceptionally profitable earnings by dry bulk vessels. The fall in late also 2008 followed a familiar pattern with an economic crisis coinciding with increasing deliveries due to heavy investment during the preceding boom.

Table 1: Dry cargo freight cycles 1873–2009

Cycle No	Start Peak	End Peak	Length (F) Years
1	1873	1881	8
2	1881	1889	8
3	1889	1900	11
4	1900	1910	10
War	1913	1919	
5	1921	1926	5
6	1926	1930	4
7	1930	1937	7
War	1939	1945	
8	1945	1951	6
9	1952	1957	5
10	1957	1966	9
11	1966	1975	9
12	1975	1980	5
13	1980	1989	9
14	1989	1995	6
15	1995	2008	13
Statistical Analysis			
1872–2008	Average St Deviation		7.7 2.6
1872–1937	Average St Deviation		7.6 2.5
1947–2008	Average St Deviation		7.8 2.8

Source: Martin Stopford (2009)

3.6 The length of cycles and volatility

If we look at the statistics of the cycles we discussed in the previous section, we find that between 1872 and 2008, the average shipping cycle had a frequency of 7.7 years from peak to peak (Table 1). The average cycle length of 7.8 years over the period 1947–2008 was similar to the 7.6 years average between 1872 and 1936. This certainly gives credibility to the shipping folk law that shipping cycles last seven years.

However only one of the cycles actually lasted seven years. The longest was 13 years (from 1895–2008), one lasted ten years, three lasted nine years, two five years and one lasted six years. So some cycles were eight or nine years longer than others. A very big difference to a business struggling to survive, so as a predictive device this analysis is not much help!

Another aspect of the cycle which it is useful to analyse is the variation in the frequency of cycles. This can be estimated by using the standard deviation of the cycle length, measured from peak to peak. This statistic is shown at the bottom of Table 1, for three periods. Firstly the average for the whole period 1872–2008; second the average for the first period 1872–1937; and finally the average for the second period 1947–2008. Over the whole period the standard deviation is 2.6 years. However cycles in the earlier period had at standard deviation of 2.5 years, whilst the later period had a standard deviation of 2.8 years.

This is an interesting result. We know that provided the underlying data distribution is normal, the length of a cycle is 95% certain to fall within a range plus or minus two standard deviations of the mean. On the basis of the last 50 years, we would expect cycles to last between 2.1 years and 10.3

years. This confirms the volatility of the shipping market and offers a warning to anyone interested in the future of the shipping market. It is comforting to predict that the market will improve next year (the famous “hockey stick” forecasting model), but this analysis demonstrates that rapid recoveries are not typical, though they do happen. This makes it all the more important to study each cycle as a unique event, examine the fundamentals and determine what factors will drive the next cycle.

4. Cyclical Mechanisms and the Causes of Cycles

4.1 The supply/demand model

So, having established that the shipping market is cyclical, albeit in an irregular way, we now need to explain what causes them. If we can do that it offers the hope that we can use analysis to narrow down the statistical uncertainty about the length of cycles discussed in the previous section.

The usual way to analyse this process is the supply/demand model. Most economists accept that the shipping market is driven by a competitive process in which supply and demand interact to determine freight rates (see Figure 10). A change in the relative demand and supply of ships leads to a shortage or surplus of tonnage, which in turn triggers an increase or a reduction in freight rates. When demand exceeds supply it drives freight rates up and the market responds by investing in more new ships, which have now become very profitable. Conversely when supply outstrips demand, competition drives freight rates down and owners start to scrap uneconomic ships. Shipping cycles can usually be explained by this supply; demand model, and indeed we saw plenty of evidence

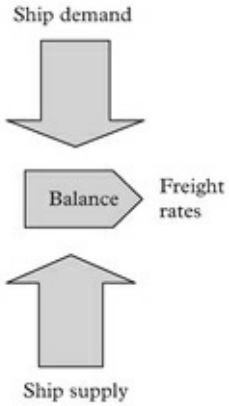

Figure 10

of this mechanism at work in the preceding discussion of the freight cycles. It is useful to distinguish exogenous and endogenous factors. A n *endogenous* factor is an event or mechanism within the shipping market which triggers or accentuates a cycle, whilst an *exogenous* factor is some external event such as a business cycle in the world economy which triggers a cyclical pattern. Both are important.

4.2 Demand factors contributing to the shipping cycle

Starting with the demand side of the model, by far the most important cause of shipping cycles is the business cycle in the world economy. This injects a cyclical pattern into the demand for ships which works through into sea trade. Historically there has been a close relationship between cycles in world industrial production and cycles in seaborne trade. This is illustrated in Figure 11 which compares the percentage change in seaborne trade with the percentage change in industrial production from 1951–2009. Although the correlation is far from perfect, it certainly exists, especially during extreme fluctuations in the world economy. During the major economic crisis of 1957, 1973 (first oil crisis),

1981 (second oil crisis), 1997 (Asia crisis), 2009 (credit Crisis) the correlation was particularly clear. In other years it was less marked, but still visible. Common sense tells us that this is precisely what we should expect. When world industry goes into recession the steel mills use less raw materials, energy consumption drops, power stations import less coal and motorists drive less, so the oil trade reduces. Cumulatively this drags down the demand for sea transport. When the world economy recovers the whole process reverses and the demand for seaborne imports escalates. In fact the majority of freight "booms" shown in Figure 2 coincided with peaks in the economic cycle.

Why does the world economy have cycles? There has been much academic study of these short cycles in the world economy, which were identified by J Kitchin (1923).[9] He suggested that these cycles were due to businesses over-estimating inventory requirements during cyclical upswings, and then cutting back too much during recessions. This injected volatility into their purchasing activity, which tended to accentuate the

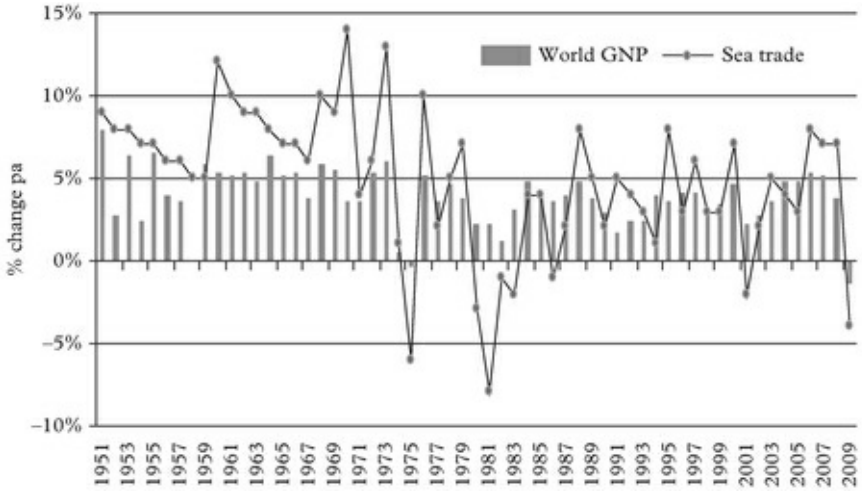

Figure 11: Comparison of cycles in world GDP and seaborne trade
Source: Compiled by Martin Stopford from United Nations, Fearnleys, various

downswing of the cycle and emphasise the upswing. Whilst this explanation does not demonstrate the original cause of the fluctuations, it suggests that once the economy starts to "vibrate" this endogenous mechanism will tend to emphasise the "vibrations" making them more clearly identifiable as cycles.

Another mechanism which contributes to the business cycle is the multiplier and accelerator. This mechanism leads to cycles because when the economy picks up and an increase in investment occurs, it raises income by a larger amount (the investment multiplier), which in turn may produce an increase in demand for the product (the income accelerator) generating demand for more investment goods, so that the economic system expands rapidly. Eventually labour and capital become fully utilised and the expansion is sharply halted, throwing the whole process into reverse. This creates a basic instability in the economic 'machine'.

Investigation of this type of cycle in the nineteenth century was carried out by Juglar[10] who studied cycles in France, the United States and England, and from this concluded that there is a longer cycle of about seven to 12 years driven by investment. The basic mechanism is similar to the Kitchin cycle in that it is built around systematic under correction and over correction, but in this case the variable at work is investment. During the upswing there is a tendency to invest heavily in plant and machinery, but once the peak is reached and capacity is more than sufficient to meet demand, investment activity slows sharply and less works back into the economy through a multiplier effect to generate a sharp

downswing.

Another major factor influencing the demand for ships are economic shocks which suddenly change the demand for sea transport. Shock factors from recent years include the oil crises of 1973 and 1979, the Asia Crisis in 1997 and the Gulf war in 1990–1991. By their nature these events are unpredictable, but that does not reduce their importance.

4.3 Supply factors contributing to shipping cycles

The main cyclical force on the supply side of the shipping market is the investment cycle and in particular the time lag between ordering a new ship and taking delivery. Depending on the state of the shipyard orderbook and the type of ship being ordered, this can be anything from 18 months to three years, and during this period ship demand may have changed. For example, shipowners often place large numbers of orders during the peak of the market cycle when freight rates are high and second-hand ships look expensive compared with new buildings. If the freight market peak is driven by a world business cycle, by the time the ships are delivered it is quite likely that the world economy will have plunged into recession, dragging down freight rates. As a result, the new ships arrive in the market just at the time when they are least needed, driving down freight rates even further. Naturally this discourages shipowners from ordering new ships, and the whole process is thrown into reverse. Few orders are placed, so when the world economy recovers a few years later, few new ships are being ordered and this reinforces the upward trend in freight rates.

The historical review of freight cycles in section 3 provided plenty of evidence that this time lag mechanism has been a great part of the shipping cycle for at least the last 140 years. Surely shipowners should by now have learnt their lesson and developed a strategy of counter-cyclical ordering? In fact there are numerous examples of precisely this happening. For example in the early 1980s shipowners ordered many small bulk carriers at the trough of the recession, and the same thing happened in 1999 after the Asia crisis. They argued that the ships were cheap and they would take delivery in the upswing. Unfortunately it is difficult to beat the market. On both occasions when the world economy recovered, heavy deliveries of new ships kept freight rates down. Counter-cyclical ordering just meant that the shipping market missed out on its “boom”, demonstrating that shipowners need to be quite clever to “beat the cycle”.

One of the most important factors driving at the shipping cycle is market sentiment. The delays between economic decisions and their implementation can make cyclical fluctuations more extreme. Many years ago Professor Pigou put forward the theory of “non-compensated errors”.[11] If people act independently, their errors cancel out, but if they act in an imitative manner a particular trend will build up to a level where they can affect the whole economic system. Thus periods of optimism or pessimism become self-fulfilling through the medium of stock exchanges, financial booms and the behaviour of investors.

4.4 Secular trends and structural factors impacting on cycles

Finally there are long-term structural factors to consider. It was clear from the review of cycles in section 3 that during some periods the shipping industry faced very different characteristics from others. For example 1870–1914, 1950–1973 and 1995–2008 were periods of brisk demand growth. The shipping cycles were clearly influenced by these currents in the economic fundamentals of supply and demand, and contributed significantly to the “market tone” over extended periods. Table 2 shows my

assessment of these factors during the period under review, ranked by the relative prosperity of

Table 2: Shipping market fundamentals analysis

	Demand tendency	Supply tendency	Market tone
1945–1956	Very fast	Shortage	Prosperous
1995–2008	Fast	Lagging	Prosperous
1869–1914	Fast	Expanding	Competitive
1956–1973	Very Fast	Expanding	Competitive
1988–2000	Slow	Expanding	Competitive
1920–1930	Fast	Over-capacity	Weak
1930–1939	Falling	Over-capacity	Depressed
1973–1995	Falling	Over-capacity	Depressed

the shipping industry. We can briefly summarise the impact which the alignment of the fundamentals had on market conditions in the following terms:

1. *Prosperity*: Top of the list was the prosperous 1950s when rapidly growing demand coincided with a shortage of shipbuilding capacity.
2. *Competitive*: There were three periods of intensely competitive activity characterised by growing trade and shipbuilding capacity that expanded fast enough to keep up with demand.
3. *Weak:* There was a weak market in the 1920s when growing demand was damped by over-capacity in the shipbuilding market
4. *Depression*: There were two depressions, in the 1930s and the 1980s when falling trade coincided with shipbuilding over-capacity

Analysis of these long-term cycles in supply and demand is an area where maritime economists do have something to say. The challenge is to help the shipping industry remember the past and anticipate the future. To do this models can be used to improve the clarity of the analysis message with better information, improved analysis, clearer presentation and greater relevance to the decisions made in the commercial shipping market.

5. The Dynamics of Shipping Cycles

So far in this chapter we have concentrated on the dynamics of the shipping supply/demand model. The freight market analysis suggests that there is a cyclical component in the shipping market generated by business cycles in the world economy and reinforced by the time-lag taken to adjust supply to demand and the frequent miscalculation by shipowners of the future level of demand. We now need to ask two questions: first, “How do business cycles feed through into the key variables in which the shipowner is interested – freight rates and prices?” and, secondly, “Are the cycles predictable?”

5.1 Do business cycles affect freight rates?

The simplest way to deal with the first question is statistical analysis comparing the historic pattern of cycles in the world economy, seaborne trade and freight rates. To make such an analysis it is necessary to analyse these variables into a form in which they are directly comparable. The technique used is to take a five-year moving average for the basic statistical series and compute the deviation of the actual observation from the five-year trend. When the variable moves above zero this indicates a cyclical upswing or “boom” and when the variable swings below zero it indicates a depression. The analysis for the dry cargo trade in Figure 11 indicates the remarkable degree to which the world business cycle has influenced dry cargo trade since 1970. There has been a series of alternating peaks

and troughs, with particularly severe troughs which followed the 1973 and 1979 oil crises and the 1999 Asia crisis. It is worth making the point that the use of OECD industrial production to represent world economic activity is a statistical convenience that becomes less valid as the Third World takes a larger share of world economic activity. The problem in carrying out an analysis of this type is the difficulty of obtaining a long, but up-to-date, time series for world industrial output.

Turning to the financial variables, Figure 12 shows the relationship between dry cargo cycles and cycles in the dry cargo freight rate. The correlation is close, with freight market booms coinciding with trade booms in 1974, 1980, 1989, 1995 and 2008. This indicates that in the dry cargo market the growth rate of dry cargo trade has, in the past been an good indicator of freight rate movements, though not a precise one. It is, however, necessary to be cautious in extrapolating this relationship into the future,

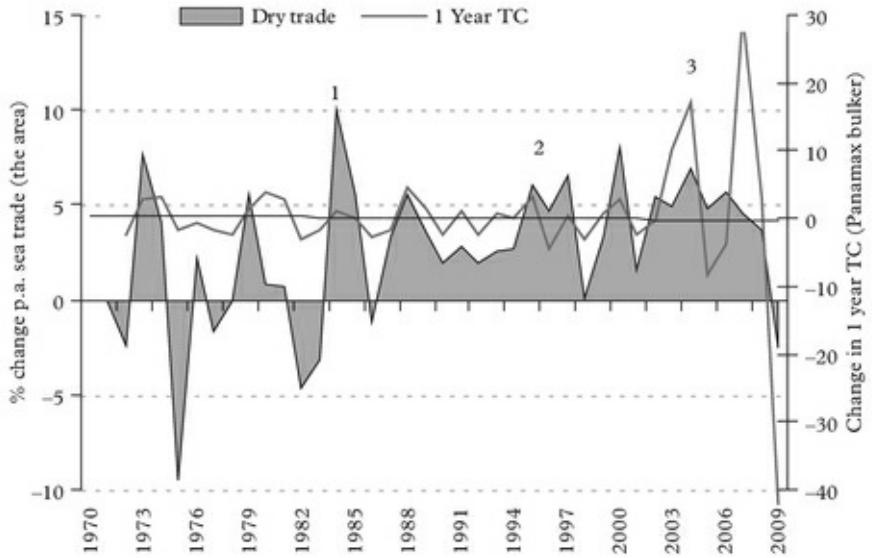

Figure 12: Cycles in dry cargo trade and one year TC
Source: author

since determination of freight rates depends upon supply as well as demand. During the period covered by this analysis the supply of dry cargo vessels was broadly in line with the demand on a trend basis. As a result, peaks in trade caused a shortage of shipping capacity, so that freight rates rose, whilst recession in sea trade caused a surplus of shipping capacity and freight rates fell. This pattern will not occur if there is a permanent mis-alignment between supply and demand, as happened in the tanker market.

6. Are Business Cycles Predictable?

Our analysis of the shipping market has raised several warning flags about the dangers of relying on simple “rules of thumb” about the cyclical nature of the shipping market, but it has also shown the importance of the industrial business cycle in determining the underlying performance of seaborne trade and freight rates. Inevitably this raises the question of whether business cycles are predictable.

The statistical analysis discussed earlier in the chapter offered convincing evidence that the concept of a regular seven-year cycle has little merit as a way of predicting the future of market. In reality the cycles may be three years or 10 years in length. From a practical business perspective that is much too wide a range to be acceptable, so we must look elsewhere.

Our analysis of supply demand models suggested that this might be a fruitful avenue. Although there are far too many variables at work to hope to predict cycles accurately, at least analysis of world

economy and the shipping investment cycle can help to narrow down the possibilities which lie ahead, and give decision makers some idea of the risks which they are of taking. Indeed one of the most useful applications of the supply demand model is to examine the impact of the shipping investment cycle. One lesson which is all too apparent from the historical analysis of shipping cycles is the extent to which the market is driven by supply-side factors, and in particular the ordering activity of shipowners. Analysts often deplore the fact that shipowners order at the top of a cycle, but when they try "counter-cyclical" ordering at the bottom of the cycle, the result can be equally disastrous.

On the demand side of the market, business cycles are clearly a dominant force, though one which can be very difficult to predict. However the historical analysis suggests that it is vital to be aware of the possibility of serious recessions in demand. The two really serious depressions in the shipping industry both coincided with a major depression in the world economy (in 1931 and 1983), so provided we can obtain some forewarning of these factors that can be very helpful. Statisticians have, over the years, developed leading indicators that give an advance indication of turning points in the economy. For example, the OECD publishes a leading indicators index, which is based on orders, stocks, the amount of overtime worked, the number of workers laid off, in addition to financial statistics such as money supply, company profits and stock market prices. It is suggested that the turning point in the lead index will anticipate a similar turning point in the industrial production index by about six months. To the analyst of short-term market trends such information is helpful.

In conclusion, whilst we can usefully employ the concept of a "cycle" to discuss fluctuations in seaborne trade, cyclical peaks and troughs do not follow in an orderly progression. As the graphs show, seaborne trade generally recovers from each trough, but it is difficult to say in which year this will occur or how strong the recovery will be. We must take many other factors into account before drawing such a conclusion.

7. Summary

In this chapter we started by observing that the shipping market can change very quickly and that decisions by shipowners about the sale, purchase and chartering of vessels depend crucially upon timing. In the space of a few months the market value of a vessel may change by millions of dollars. The cycles are certainly not regular, appearing as fluctuations in revenue of variable length. Different market segments, especially tankers and bulk carriers have exhibited similar cyclical patterns during some periods, but in others they have diverged significantly, suggesting that each segment of the shipping market must be treated separately. We also noted that cycles in shipping revenue work through into cycles in the price of second-hand assets.

A cycle is defined as an interval of time during which one sequence of a regularly recurring sequence of events is completed. In section 3 we set about reviewing the sequence of fluctuations in freight rates which have occurred during the period 1869–2008. A total of 15 cycles were identified, with an average length of 7.7 years and a standard deviation of 2.6 years. Although this confirms the "rule-of-thumb" that shipping cycles last seven years, the standard deviation suggests that this specific outcome is not particularly likely. At a 95% confidence level we can expect shipping cycles to last between 2.1 years and 10.3 years.

In the absence of regularity, the best approach to analysing cycles is to understand their causes, and this was discussed in Section 4. Shipping cycles are a manifestation of fluctuations in supply and

demand and freight rates are highly sensitive to quite small movements in either of these variables. On the demand side of the market the main driving force is the world business cycle, and reference was made to the short business cycles identified by Kitchin and the longer investment cycles identified by Juglar. These introduce volatility into the demand side of the market, though random economic shocks occur such as the 1973 oil crisis or the closure of the Suez Canal in 1956.

On the supply side of the market the outstanding influence is the investment cycle, as shipowners struggle to match investment to the essentially unpredictable demand cycles. The genuine uncertainty which triggers these supply-side fluctuations is reinforced by a market sentiment which Professor Pigou first identified as “non-compensatory errors”.

Finally we noted the long-term secular trends which set the tone for the shipping market over periods of the 20 or 30 years. These trends are characterised by differences in the underlying growth rate of seaborne trade, due to economic developments in the world economy, and the level of shipbuilding capacity.

In view of their lack of regularity, the best hope of predicting business cycles is to analyse the underlying causes and project them forward. Many analysts use computer models for this purpose, and although the forecasts may not always be accurate, they help to narrow down uncertainty and give decision-makers a better feel for the way things might develop.

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Endnotes

1. According to Greek mythology, Sisyphus was condemned to roll a stone up a hill, only to have it continuously roll down again.
2. J.C. Gould, Angier & Co, Market Report 31 December 1894.
3. According to Webster’s Dictionary the word is derived from the Greek word kilos a ring, circle or wheel.
4. This was the date when steamships started to become seriously competitive in deep sea trade and an international system of cables allowed the global shipping industry to evolve from the regionally fragmented business which existed during the era of sail.
5. Before decimalisation in 1972, the English pound (£) was divided into 20 shillings. Thus 27 shillings was equivalent to £1.35.
6. These fleet figures understate the true growth of shipping supplies. According to contemporary estimates, the productivity of a steamer was four times as high as a sailing ship, so in real terms the available sea transport capacity increased by 460%. No doubt much of this was absorbed by increasing ton miles as more distant trades were opened up, though unfortunately no tonne mile statistics were collected at this time.
7. Tylecore, Andrew (1991): *The Long Wave in the World Economy* (London, Routledge) Table 9.1.
8. From Angier (1921).
9. Kitchin, J. (1923): “Cycles and trends in economic factors”, *Review of Economic Statistics*, 5, 10–16.
10. Juglar, C. (1862): *Des Crises commerciales et de leur retour périodique en France, en Angleterre et aux États-Unis.*
11. Pigou (1927).

Chapter 10
Recreating the Profit and Loss Account of Voyages of the Distant Past

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1. Introduction

The study of historical freight rate fluctuations over the previous two centuries has attracted the attention of several economists both maritime and non-shipping specialists. The nature of these studies varies and could be sub-divided in descending order of profusion into:

a. long term shipping productivity gains and associated secular fall in across the board ocean freight rates;
b. single route specific studies;
c. the nature and periodicity of cyclical fluctuations;
d. construction of freight rate indices;
e. the contribution of falling freight rates to the reduction in barriers to trade;
f. returns on capital to shipping investors; and
g. port productivity trend developments

The literature is growing at exponential rate yet in certain respects the accumulation of knowledge at times resembles more a "Copernican" lens approach. It sorely lacks a "Newtonian" methodical tidying up system. The appendix contains a non-exhaustive list of such studies. However, in spirit the closest pro-genitor of the present one, is Lewis (1941), which to our knowledge has never been referenced in the subsequent shipping literature.

Empirical investigations have been constrained by the nature of available data with the lowest hanging fruit collected first. In general data on freight rates proliferate. This has encouraged several studies of type (a), (b), (c), (d) and (e) above.

Contrary to this, data on shipping profits is scant hence type (f) studies are rare. In theory one could recreate the profit and loss account of a benchmark ship by using a bottom up approach. Here the economic historian starts with the easily available freight rate data. He then makes certain deductions for costs and divides by the length of the voyage in days to arrive at a measure of unit profit. However, the input requirements of sufficient accuracy through the various steps are very stringent. Thus, to our knowledge, only Davis (1957), Evans (1964) and Vergottis (2005) have attempted such a task for the periods 1670–1730, 1850–1860 and 1950–1974 respectively. An alternative approach is to unearth historic actual voyage accounts. Here Kaukiainen (1990) is the prime example but a rather solitary one. The third alternative, is a detailed analysis of the market performed by an industry expert of the bygone era who had full command of the facts. This is in contrast to the economic historian of today who tries to recreate the puzzle from fragments of surviving information. Such a jewel of expert witness analysis, is equally rare but Allen (1855), provides a thorough and exhaustive evaluation of the Tyne/London collier route and the comparative advantage of steam versus sail in that market.

Furthermore, historical analysis of port productivity trend developments of type (g), are also

extremely rare and sketchy. This is despite certain valiant efforts notably by North (1968). Where they do exist they tend to be of descriptive rather than quantitative nature, as the required time series data is hard to assemble.

Archaeologists can infer the existence of cities, their economic activities, trading links, wars etc from little more than pottery shreds. In our case the existence of freight rate data, which generally is very good, represent the pottery fragments. These can be used to "unearth" the complete picture of the centuries old tramp ship operator economics and their time charter equivalent profits ("TCE"), relating to voyages of the distant past. Accordingly this article presents a hitherto unutilised fourth alternative to shed light on the darkest areas of shipping literature, dealing with profitability of ships and port productivity developments of the distant past. This alternative is a cliometric model which utilizes a multi-route network top down approach. Here the inter-relationship of freights over the cycle is analysed in tandem, across several route arteries of the chosen network. The network cliometric top down approach makes use of the cardinal rule of tramp shipping. According to this rule, arbitrage forces quickly equate the daily time charter equivalent earnings of all routes for ships of the same type, engaged in them simultaneously.

In the case of a stable network of routes where, as first approximation, vessel speed is treated as given over the cycle, the tramp arbitrage law results in a cliometric system of linear equations of disarming simplicity. All that is required is:

a. minimum of two export outlets combined with two import destinations;
b. synchronous freight rate observations across the 2×2 network at two distinct points in the cycle, say "cycle low" and "cycle high".

These eight freight rate data points can mathematically reveal the hidden profit and loss of the tramp arbitrageur in all its essential details route by route including the following hitherto unknowns:

a. port turnaround time;
b. vessel and cargo related port charges as per "custom of the trade";
c. time charter equivalent profit.

This is done with the minimum of knowledge regarding the commercial characteristics of the representative tramper, such as cargo capacity, speed, fuel consumption and bunker prices. Freight rate and bunker price data are generally readily available. The skeleton commercial specification of the typical tramper of various eras is also generally known.

Moreover, the implied system of linear equations is recursive and can be solved first for port turnaround time, then for port charges and then for time charter equivalent profit. This holds the promise that the most obscure subsets of shipping literature may be illuminated by taking a methodical top down cliometric tramp arbitrage approach. It also suggests the potential for new insights across the whole spectrum of maritime economic history. It helps to tidy up and systematize several strands of shipping research.

Armstrong (1993), highlights the risks of using inferred data as substitute for the raw original. Parallel to cliometric approaches such as the one suggested in this article, the more stringent and time consuming process of searching for lost original data should be pursued. Modern IT technology holds the promise that one day such data on port turnaround performance may be "unearthed", collated and analysed. However even then there would be certain risks in linking recorded freight rate time series

to observed vessel port turnaround performance measurements. On the one hand, in tramp shipping, the recorded freight rate time series reflects what was agreed in the loading and discharge clauses of a charter party. It does not necessarily reflect what was actually achieved by ships at the ports. Thus one needs to unearth old charter parties rather than port arrival and departure records. On the other hand, during sail ship days and early steamship era, such clauses often amounted to no more than the phrase “as per custom of the port”. To make matters worse, the sharing of terminal costs between shipowner and charterer varies and can be ad hoc from contract to contract. Once again this necessitates the tracing and analysis of the detailed wording of several clauses of very old and most likely untraceable charter party contracts. The cliometric top down approach presented here overcomes all these issues though the cautionary note of Armstrong is recognised.

In our view, the ideal approach should combine "easy to develop" cliometric calculations with "needle in haystack" efforts to retrieve original data. These can act as a reality check on each other and provide a framework for interpretation and analysis. In this spirit, at the end of this article, we go one step further and explore a bottom up analysis of tramp route profitability using all types of information and methodologies available to the economic historian.

1.1 The cliometric top down framework

Without loss of generality and in order to simplify exposition consider first the sailing ship era where cost of fuel was zero. The time charter equivalent earnings on any route are given by the following formula:

$$E = (F * C - T)/(S + P) \qquad (1)$$

where:

E time charter equivalent earnings ("TCE")
F freight rate per unit of cargo
C cargo size
T terminal charges at all ports involved
S total time in sailing/transit between all ports involved
P total time spent for queuing, loading, discharge at all ports involved
V defined as S + P: complete voyage duration

The cliometric investigation starts by noting that equation (1) can be reformulated as:

$$F = \alpha + \beta * E \qquad (2)$$

where:

$$\alpha = T/C$$
$$\beta = (S + P)/C = V/C$$

Thus the freight rate of each route is made of two components. The first component α, is route specific and varies with the idiosyncratic port charges. The second component β*E, implies that all freight rates move up and down in tandem with the common time charter equivalent market rate. However, the β-sensitivity of each route to the broader market time charter earnings, is also idiosyncratic and reflects the voyage duration. In turn the voyage duration β, can be subdivided into a steaming time component and a port turnaround time element.

Our rudimentary cliometric model treats F, C and S as known inputs and then solves for the

unkowns P, T, E and V. More sophisticated versions can be developed whereby the latter list of unknowns grows "at the expense" of the former list of known inputs.

In passing it is noted that equation (2) suggests that a freight rate index can be constructed by simply taking the arithmetic average of rates across several routes. The index then represents the theoretical freight rate for the network "average route". The α of the index is the mean α of all the routes in the network, and thus captures the average port charges across all routes. Similarly, the index will capture the mean β of all the routes, representing average voyage duration.

1.1.1 Network stability

The notion of "regime change" and its opposite "network structure stability" is introduced here, before proceeding with the rest of the analysis. We define "network structure stability" as a situation where the parameters α and β in equation (2) remain stable over a certain period of time for a certain network of routes for each of its arteries of complete round voyages. In the case of the constant α, this will tend to hold true by the fact that port charges are tariff based and can remain unchanged for decades. In case of the slope co-efficient β, this will tend to trend lower with productivity changes in either or both the sailing speed of ships and/or their port turnaround times. Also the change of trade flows, the inversion between fronthaul and backhaul routes and the triangulation of previous singular routes imply "regime change".

Both α and β have been reducing over the span of decades. However over a typical full cycle of say five years' duration, may be considered as approximately constant. One should not naively make such an assumption. Fortunately "network structure stability" can be tested. This can be done either visually by plotting several freight rates on the same chart or in scatter plots. It can also be tested via econometric means. Regarding the latter, we note that equation (2) implies all freight rates in different arteries of the same stable network will be linearly related to each other. Hence a scatter plot of two freight rate time series should closely resemble a straight line in case of network stability. The cross-correlation matrix of the freight rates of all arterial routes should be populated with one not just on the diagonal but on all off-diagonal entries, in the absence of "regime change". Off course in working with stochastic versions of the above equations one should tolerate certain deviation from the limiting pure ideal of 100% correlation and pure straight line scatter plot patterns.

"Regime change" is not necessarily bad for the econometric investigation. Normally it can be identified (e.g., the point when a fronthaul route reverts to backhaul status can be easily detected) and thus controlled for. It produces a richer set of equations recombining the same parameters. This can be exploited in order to calculate the unknown parameters with better statistical accuracy.

1.1.2 The cliometric mathematical system of equations

Given a minimum of two export outlets ("X" and "Y") and two import destinations ("M" and "N"), the tramp arbitrage rule results in the following system of equations:

$$(F^{L}_{xm} * C - T_{xm})/(S_{xm} + P_{xm}) = (F^{L}_{xn} * C - T_{xn})/(S_{xn} + P_{xn}) \quad (3)$$

$$(F^{L}_{xn} * C - T_{xn})/(S_{xn} + P_{xn}) = (F^{L}_{ym} * C - T_{ym})/(S_{ym} + P_{ym}) \quad (4)$$

$$(F^{L}_{ym} * C - T_{ym})/(S_{ym} + P_{ym}) = (F^{L}_{yn} * C - T_{yn})/(S_{yn} + P_{yn}) \quad (5)$$

$$(F^{H}_{xm} * C - T_{xm})/(S_{xm} + P_{xm}) = (F^{H}_{xn} * C - T_{xn})/(S_{xn} + P_{xn}) \quad (6)$$

$$(F^{H}_{xn} * C - T_{xn})/(S_{xn} + P_{xn}) = (F^{H}_{ym} * C - T_{ym})/(S_{ym} + P_{ym}) \quad (7)$$

$$(F^{H}_{ym} * C - T_{ym})/(S_{ym} + P_{ym}) = (F^{H}_{yn} * C - T_{yn})/(S_{yn} + P_{yn}) \quad (8)$$

where:

F_{xm} reight rate on route linking export port X to import destination M

$T_{xm} = T_x + T_m$; terminal charges at each end from export port X to import destination M

S_{xm} sailing transit time from export port X to import destination M (round voyage basis)

$P_{xm} = P_x + P_m$; port turnaround time at export port X and import destination M

and similarly for other permutations of the subscripts. The superscripts L and H represent "cycle low" and "cycle high" observations.

At this stage we treat cargo size C as fixed across routes and through the cycle for the benchmark tramp ship just to simplify exposition. In the econometric application presented below this restriction is relaxed.

The recursive nature of the system can be exploited by taking the difference between "cycle high" and "cycle low" observations, which allows the unknown terminal charges to drop out of the picture.

$$(\Delta F_{xm} * C)/(S_{xm} + P_{xm}) = (\Delta F_{xn} * C)/(S_{xn} + P_{xn}) \quad (9)$$

$$(\Delta F_{xn} * C)/(S_{xn} + P_{xn}) = (\Delta F_{ym} * C)/(S_{ym} + P_{ym}) \quad (10)$$

$$(\Delta F_{ym} * C)/(S_{ym} + P_{ym}) = (\Delta F_{yn} * C)/(S_{yn} + P_{yn}) \quad (11)$$

This results in three equations and four unknowns, the latter being the port turnaround times for the round voyages. To close the system equation (12) is added:

$$P_{xm} - P_{ym} = P_{xn} - P_{yn} \quad (12)$$

Equations (9)–(12) can be solved for the unknown round voyage port turnaround times.

The next step involves taking either equations (3)–(5) or (6)–(8) and adding the following equation (13) to close the system and solve for terminal charges:

$$T_{xm} - T_{ym} = T_{xn} - T_{yn} \quad (13)$$

Finally time charter equivalent earnings E can be calculated for any stage of the cycle, as all the formerly unknowns that enter a round voyage TCE calculation have been solved for.

In case where there are more export and import points than the simple 2×2 network described above, the resulting system of linear equations is over-determined. A subset of equations suffices to solve for the unknowns. In econometric analysis using stochastic versions of the equations, it offers the advantage of using additional information to derive results and stress test them for accuracy and robustness through statistical means.

Moving on the steamship era, the cost of bunkers has to be factored into equation (1). The engineering technology of representative trampers is well recorded. Harley (1970) provides a succinct summary. Consumption of bunkers for a given speed of the benchmark tramp ship is documented and considered as known input number in our cliometric model. Price of bunkers is also readily available. Hence the bunker cost per tonne of cargo carried can be calculated. For ease of computation, the imputed bunker cost per tonne is deducted from the recorded freight rate per tonne. Thus "net of bunkers freight rates" are derived. The rest of the analysis can then proceed precisely as has been presented above for the sail ship era. Once again more sophisticated cliometric models can be developed which solve for bunker consumption and speed rather than treat these as assumed known inputs.

1.2 Case study: the Northern European coastal coal freight market 1848–1936

The Northern European coastal coal freight market represents a neat compact network of routes to apply the various methodologies described above. The two main export outlets are Tyne (Newcastle, Blyth, Wear) and Wales (Cardiff, Swansea). The main import destinations are London, Hamburg, Havre, Rouen, Caen, St Malo, Dieppe, Honfleur and Brest. It is well known that shipping coal out of the main export UK outlets to nearby UK/North European ports was predominantly a one way market. Tramp coasters departed from Tyne or Wales loaded with coal, discharged their cargo in nearby destinations and ballasted back to the load ports empty.

Some routes are more liquid than others and offer more regular and complete freight rate time series. Weekly freight rate data with certain gaps have been assembled for the period 1848 to 1936. For the purpose of this study and subsequent investigations around 42,000 freight rate data points were collected spanning almost a century of cyclical swings and trend developments. The process of data collection is ongoing.

1.2.1 Historic backdrop 1848–1936

At the beginning of our overall study the 300 tonne collier sail ship reigned supreme. In summer 1852 the first 650 dwt tonne steamer was introduced in the Tyne/London route. After minor teething problems, the concept quickly proved successful. Thus by 1870 steamers had practically displaced the sailing collier in many of the Northern European coastal routes. The size of coastal steamers increased progressively with about 1,000 dwt tonnes being the representative tramper during the period 1880–1900. The average size of coastal collier increased rapidly after the turn of the nineteenth century with 1,450 dwt vessel becoming the benchmark coastal tramper by 1910. By 1936, a combination of economic, industrial and political factors resulted in severe shrinkage of the North European near-sea coal freight market. This delineates the end of our investigation period.

1.2.2 Preliminary tests of network stability

The simple tramp arbitrage model suggests that freight rate observations on a basket of routes that are part of stable network should be 100% correlated with each other. Starting with the sail ship era, Figure 1 shows the freight rate patterns for three of the major routes during the period summer 1848 to winter 1859. If there is a flaw in the conceptual model, a simple chart would normally reveal it easier than "black box" computations.

The figure highlights the close correlation between the various routes during the sail ship era. It also shows that the London short haul route has a low beta as one would expect given that the slope

coefficient, against the unobservable common time charter equivalent, is proportional to voyage duration.

Numeric correlations are provided in Table 1 below. The tramp arbitrage model suggests that not only the diagonal but also the non-diagonal entries should not differ materially from 1.

It is recommended that correlations should be computed over periods that include at least one full cycle. Correlations computed around a period where the market is constantly at a flat low would fail to shed light on the underlying stability, or lack thereof, of the network. Typically during cycle lows, freight rates and the unobservable TCE remain totally flat, with TCE "stuck" at around operating cost level. Thus the whole of the recorded variance taken during a protracted cycle low would be "noise".

Moving to the steamship era, we tend to observe a boom at the turn of each decade. All these booms look very much alike with each other in terms of their main features. We show the detailed figures for the full cycle Jan 1888 to Dec 1893 period, being very representative of the patterns observed in all other steamship full cycle periods around the turn of each decade.

We have grouped the various freight rate plots under different permutation schemes. For practical purposes the first thing to identify before plotting the charts is the most liquid route, in the sense that it has the fewest observation gaps in the series. This we

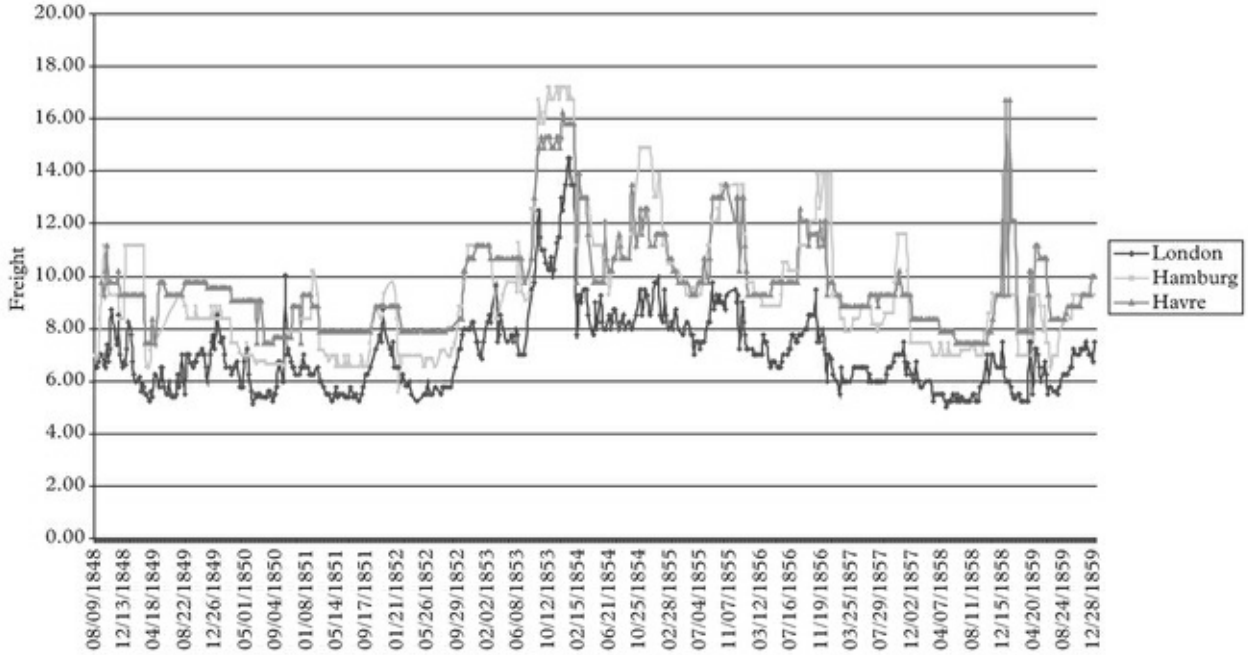

Figure 1: Outbound coal freight rates fromTyne summer 1848 - winter 1859

Table 1. Correlation matrix: Export port Newcastle – cargo coal – various destinations – Home market – summer 1848 to winter 1859

Destination	London	Hamburgh	Honfleur	Rotterdam	Dieppe	Havre	Rouen	Bremen	Amsterdam
London	1.00	0.91	0.88	0.88	0.88	0.88	0.85	0.81	0.83
Hamburgh		1.00	0.90	0.94	0.90	0.91	0.87	0.84	0.93
Honfleur			1.00	0.89	0.89	0.90	0.85	0.87	0.86
Rotterdam				1.00	0.91	0.88	0.89	0.89	0.96
Dieppe					1.00	0.88	0.83	0.92	0.87
Havre						1.00	0.85	0.84	0.84
Rouen							1.00	0.82	0.87
Bremen								1.00	0.86
Amsterdam									1.00

call the benchmark route. For the outbound routes from Tyne the destination to Havre is our chosen benchmark route. For the outbound routes from Wales the same destination Havre is chosen as the

benchmark route.

The charts have been grouped as follows. Figures 2–7 plot each of the outbound routes from Tyne against the benchmark Newcastle/Havre route. Figures 8–13 plot each of the outbound routes from Wales against the benchmark Cardiff/Havre route. Finally Figures 14–20 pair together each destination with the two export outlets Newcastle and Wales. All figures are in shilling per tonne and the freight rates have been computed net of bunkers.

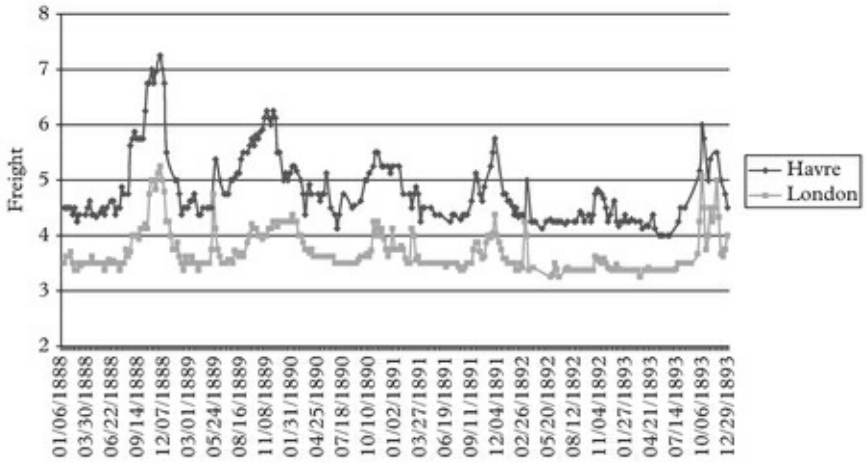

Figure 2: Newcastle/Havre vs Newcastle/London

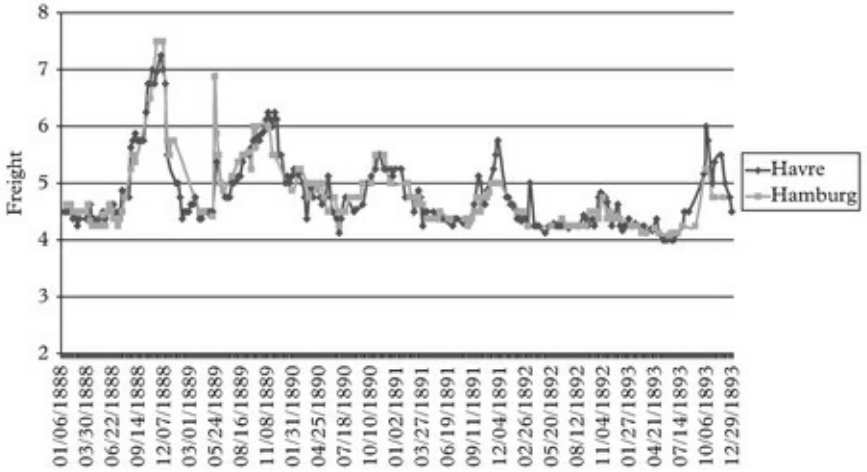

Figure 3: Newcastle/Havre vs Newcastle/Hamburg

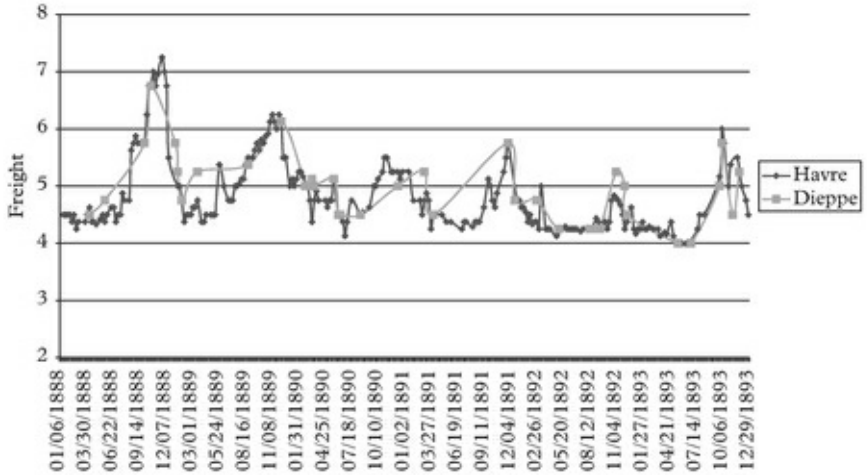

Figure 4: Newcastle/Havre vs Newcastle/Dieppe

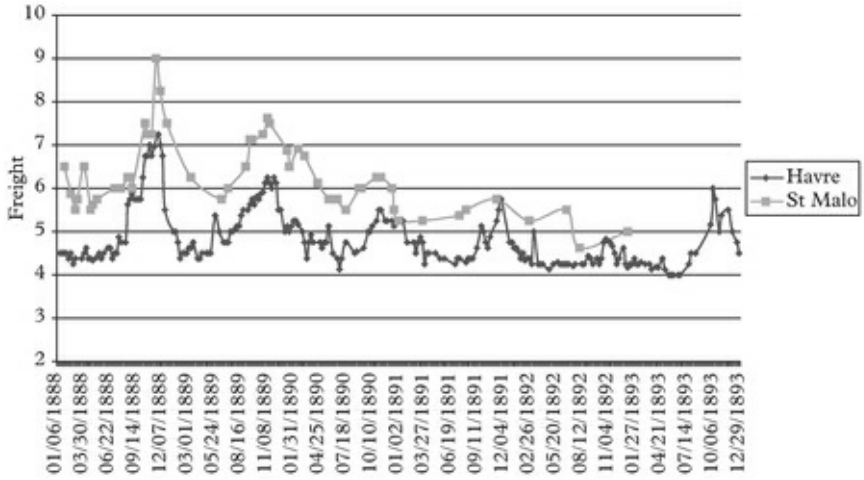

Figure 5: Newcastle/Havre vs Newcastle/St Malo

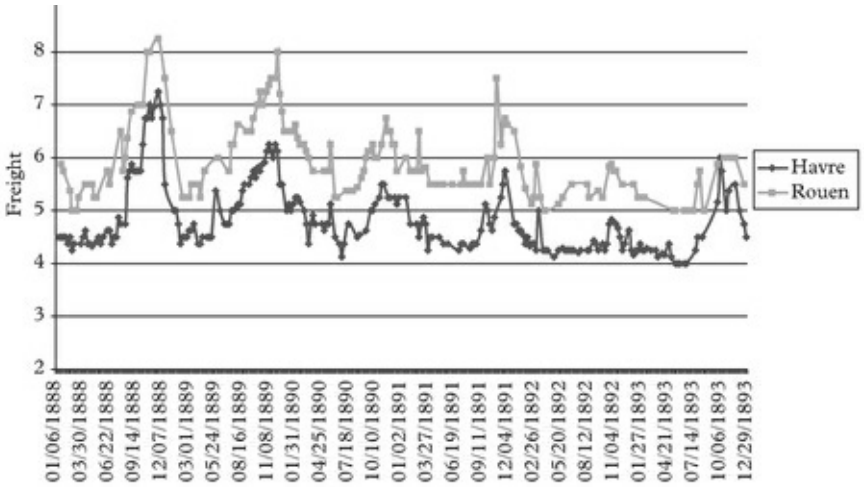

Figure 6: Newcastle/Havre vs Newcastle/Rouen

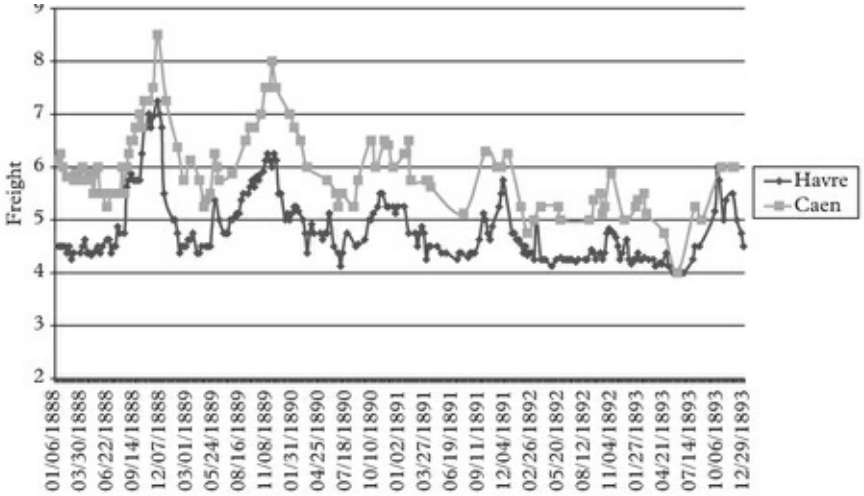

Figure 7: Newcastle/Havre vs Newcastle/Caen

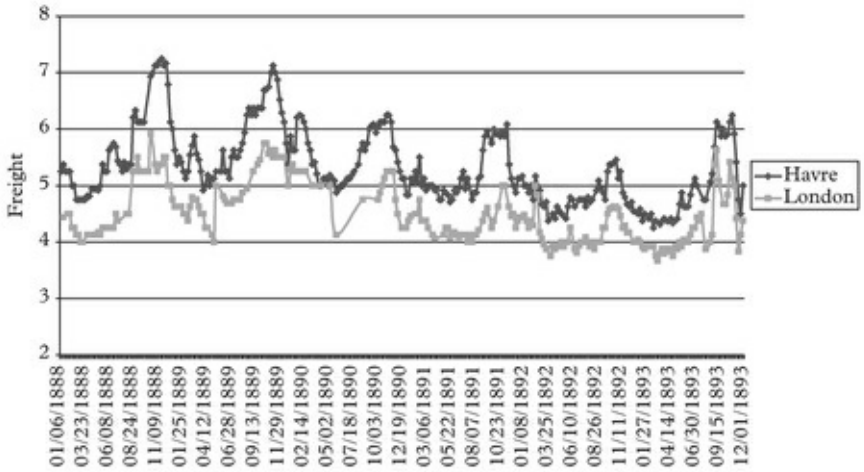

Figure 8: Cardiff/Havre vs Cardiff/London

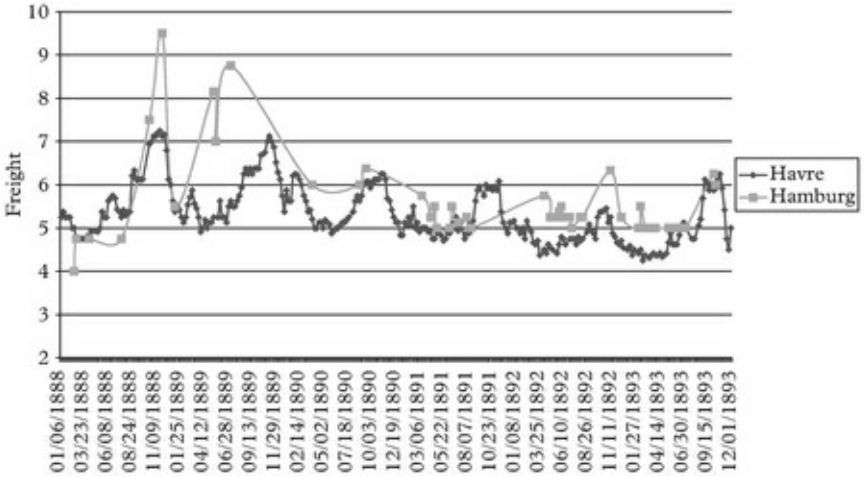

Figure 9: Cardiff/Havre vs Cardiff/Hamburg

Note: The Cardiff/Hamburg route is illiquid. Hamburg is primarily served from Newcastle

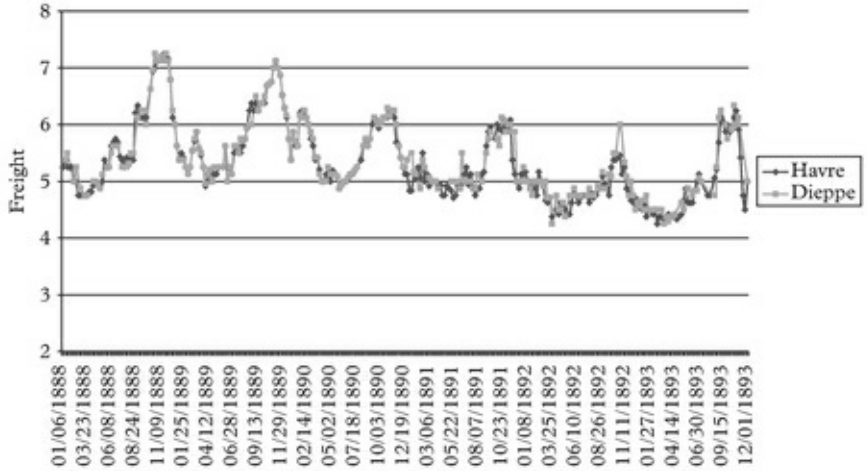

Figure 10: Cardiff/Havre vs Cardiff/Dieppe

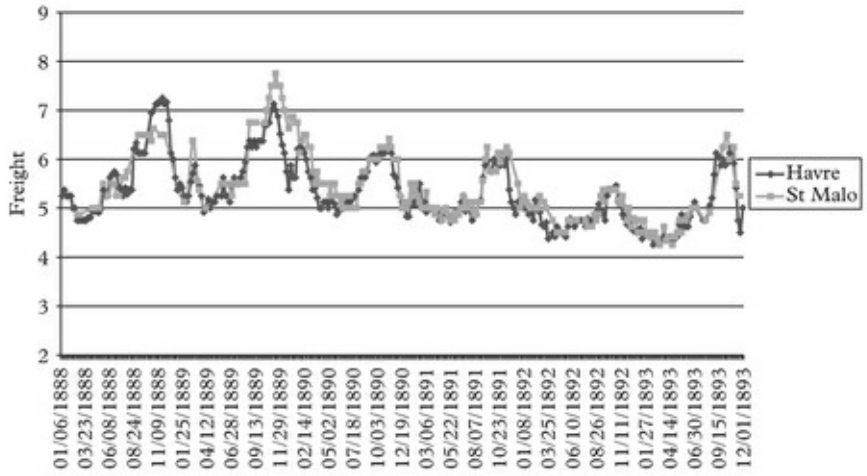

Figure 11: Cardiff/Havre vs Cardiff/St Malo

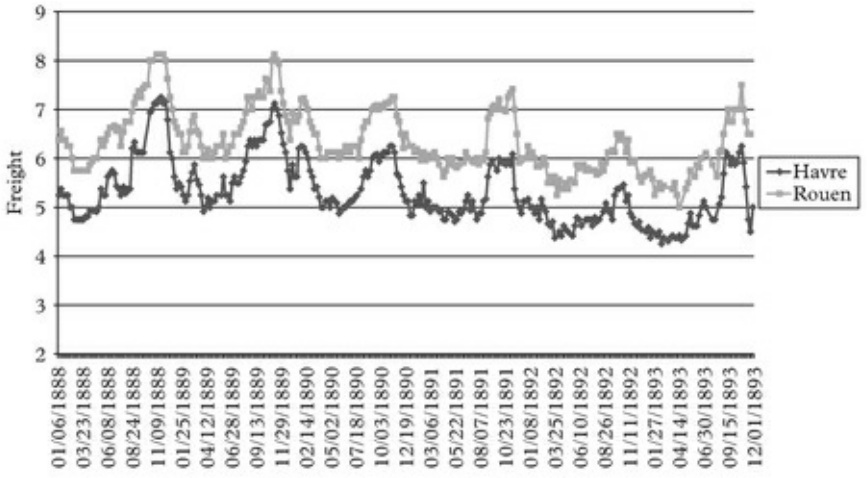

Figure 12: Cardiff/Havre vs Cardiff/Rouen

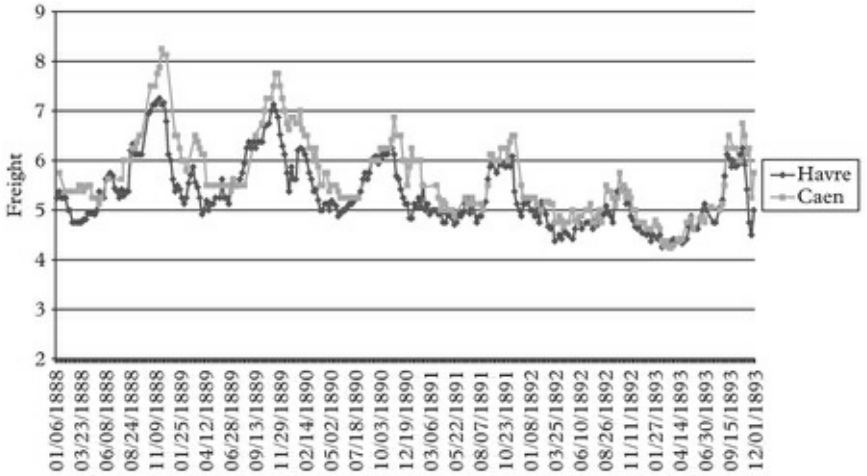

Figure 13: Cardiff/Havre vs Cardiff/Caen

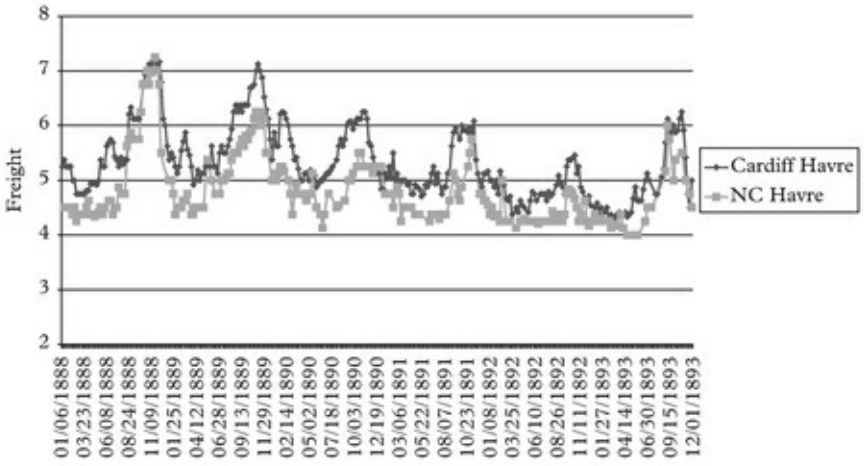

Figure 14: Cardiff/Havre vs Newcastle/Havre

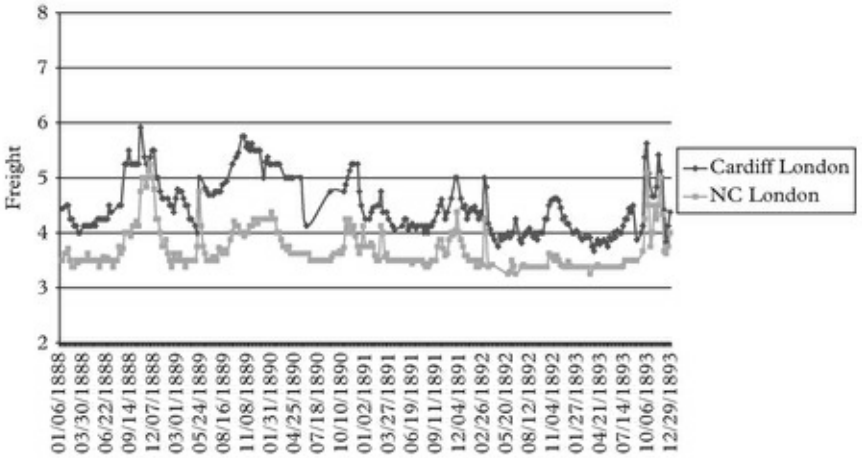

Figure 15: Cardiff/London vs Newcastle/London

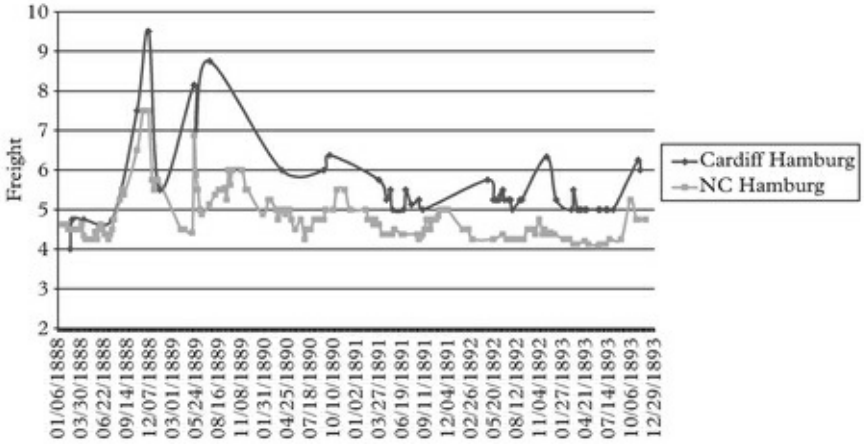

Figure 16: Cardiff/Hamburg vs Newcastle/Hamburg

Note: The Cardiff/Hamburg route is illiquid. Hamburg is primarily served from Newcastle

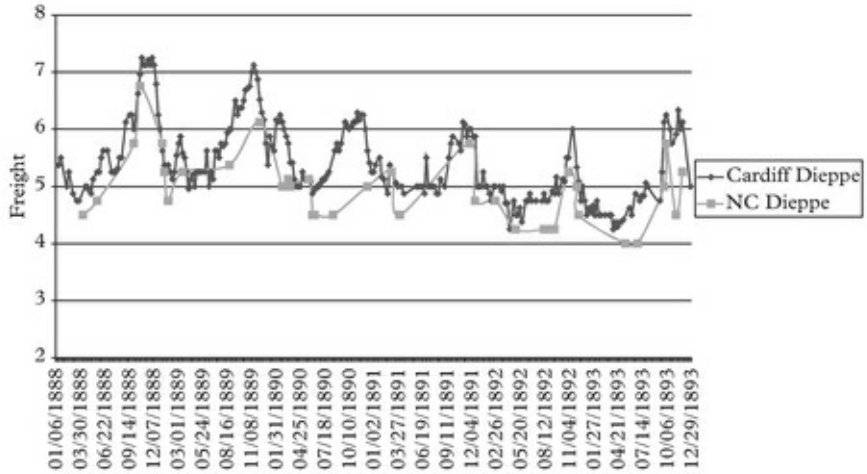

Figure 17: Cardiff/Dieppe vs Newcastle/Dieppe

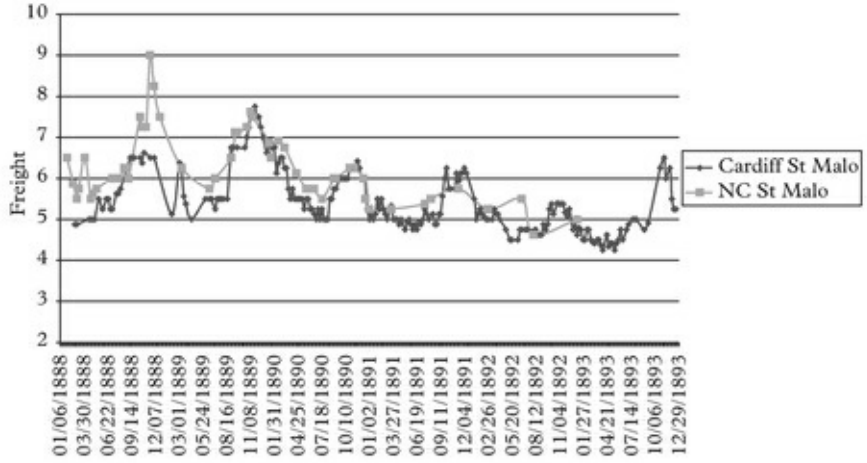

Figure 18: Cardiff/St Malo vs Newcastle/St Malo

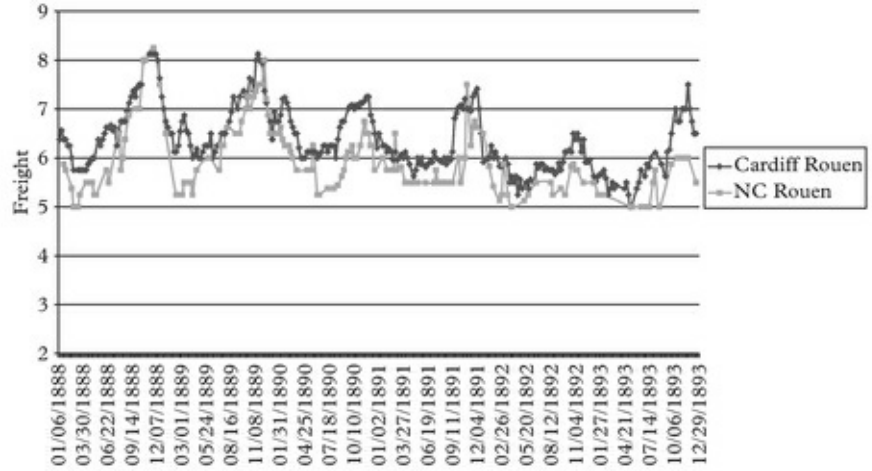

Figure 19: Cardiff/Rouen vs Newcastle/Rouen

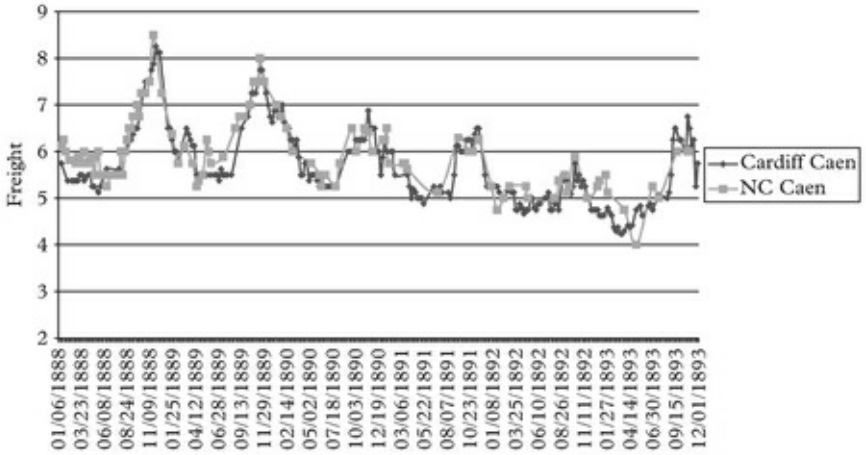

Figure 20: Cardiff/Caen vs Newcastle/Caen

Perusal of the data should be done in the context of the various distances involved. Table 2 contains a distance matrix. Everything else equal, freight rates on longer distance routes should tend to be higher than those on shorter haul routes.

The chart patterns conform to the arbitrage tramp framework. The longer hauls command higher freight rates per tonne. All routes tend to oscillate in synchronous correlated patterns. The correlation matrices presented below provide a numerical measure of this. The correlation data is split into three different tables. Table 3 shows the correlation of all routes out of Tyne. Table 4 shows the correlation of all routes out of Wales. Finally Table 5 shows the correlation of the Tyne routes with the Welsh routes.

The remainder of this article is divided in two parts which jointly span the period 1848 to 1936. The first part of the study is the cliometric top down exercise which due

Table 2: Distances in nautical miles

From	Newcastle	Cardiff
To		
London	311	520
Havre	400	369
Hamburg	417	814
Dieppe	356	404
St Malo	516	310
Rouen	470	439
Caen	414	367

Table 3: Correlation matrix. Export port Newcastle – cargo coal – various destinations – Home market – Jan 1888 to Dec 1893

Destination	London	Hamburg	Havre	Dieppe	St Malo	Rouen	Caen
London	1.00	0.83	0.85	0.71	0.83	0.80	0.77
Hamburg		1.00	0.92	0.85	0.89	0.85	0.84
Havre			1.00	0.91	0.82	0.93	0.87
Dieppe				1.00	0.94	0.91	0.88
St Malo					1.00	0.77	0.89
Rouen						1.00	0.86
Caen							1.00

Table 4: Correlation matrix. Export port Cardiff – cargo coal – various destinations – Home market – Jan 1888 to Dec 1893

Destination	London	Hamburg	Havre	Dieppe	St Malo	Rouen	Caen
London	1.00	0.76	0.89	0.89	0.91	0.86	0.84
Hamburg		1.00	0.73	0.71	0.68	0.70	0.69
Havre			1.00	0.97	0.91	0.97	0.90
Dieppe				1.00	0.89	0.96	0.91
St Malo					1.00	0.89	0.92
Rouen						1.00	0.90
Caen							1.00

Table 5: Correlation matrix. Cargo coal – Cardiff to various destinations vs Newcastle to various destinations – Home market – Jan 1888 to Dec 1893

NC \ Cardiff	London	Hamburg	Havre	Dieppe	St Malo	Rouen	Caen
London	0.79	0.76	0.77	0.80	0.76	0.77	0.78
Hamburg	0.79	0.86	0.81	0.81	0.72	0.77	0.80
Havre	0.86	0.76	0.89	0.90	0.82	0.88	0.84
Dieppe	0.84	0.82	0.84	0.81	0.68	0.83	0.83
St Malo	0.83	0.89	0.86	0.90	0.80	0.86	0.86
Rouen	0.87	0.70	0.87	0.87	0.83	0.85	0.85
Caen	0.81	0.97	0.84	0.88	0.89	0.85	0.91

to data limitations is restricted to the period 1885 to 1936. The second part of the study is a bottom up approach spanning the period 1848 to 1914.

1.3 Coastal colliers: the cliometric top down approach 1885–1936

The rudimentary cliometric model requires overlapping data from two export outlets. Unfortunately, overlapping data from both Tyne and Wales are hard to find, at least so far, prior to 1885. Thus the cliometric sub-part of our broader historic investigation, can only be applied to the period 1885–1936.

From 1885 up to World War I there had been a freight market boom at around the turn of each decade. A couple of more full cycles followed after World War I up to the end of our investigation period. We take each of these boom time "cycle high" freight records and couple them with the adjacent years "cycle low" rate observations to implement the cliometric analysis separately for each full cycle.

1.3.1 Statistical methodology

The coastal market provides freight rates for more routes that our simple 2×2 illustrative model network. Thus statistical methods of best fit are suitable.

We expect a *priori* that port turnaround time has to be a positive number. This can be imposed as a constraint to the econometric routine. The same applies for port charges.

We also expect from experience and the persistent recurrence of layups during downturns, that at cycle low, TCE should be about equal to cash running cost. That can be added as a further constraint to the best fit optimisation method. We do not make such an assumption arbitrarily. Fortunately, our data sources, in several cases, come along with commentary which highlight the incidence of widespread lay ups as and when they occurred. More precisely, the commentary characterises certain freight rate levels as being "lay-up related".

We have run several versions of cliometric calculations as follows:

a. fully unconstrained;
b. partly constrained so that cycle low TCE equals externally and independently calculated cash running costs;
c. partly constrained so that port time and port charges are positive numbers;
d. fully constrained so that port time and port charges are positive numbers, while cycle low TCE is also constrained to equal to the independently and externally estimated cash running costs.

The fully unconstrained computations did not satisfy all the above a *priori* expectations. We have decided to present below the results of the partly constrained method (b) where cycle low TCE is assumed to be equal to cash running costs. Given the discrepancies of the fully unconstrained computations, our results so far have to be seen as tentative and work in progress.

1.3.2 Results

Table 6 shows the rapid improvement in port turnaround time, estimated cliometrically post-1885, with the introduction of steam technology for both vessel and terminals. We have co-mingled in Table 6 the post-1885 top down cliometric findings, with the 1850–1914 bottom up results to be presented in the second part of this study. This is in order to bring out in summary form the full story of the steamship revolution from its very beginning up to and beyond the total elimination of sailers.

The cliometric top down figures shown in the last column are generally larger than the bottom up estimates. This may be because the cliometric study picks up waiting time between two consecutive voyages while the bottom up approach does not. Nevertheless, the magnitude of the decline in port turnaround time from the sail ship era to the steamship days is clearly demonstrated.

We turn our attention now to the cliometrically estimated profitability performance by sub-period groupings in post-1885 era. For this purpose we have calculated the daily TCE across all routes. It is a small step to move from TCE to return on capital employed. As in Vergottis (2005), we prefer to present our results in terms of return on capital employed. This is because over time the size and nature of ships changes as is obvious from Table 6. Thus their TCE's are not easily comparable to the point of

Table 6. Port turnaround time (both end ports)

			Bottom up	Bottom up	Top down cliometric
			Tyne/ London[1]	Tyne & Wales to select ports[2] Hamburg/ London/ Havre/ Rouen	Tyne & Wales to London/Havre/ Rouen/Caen average of 2×4 routes
Year	**Type**	**Tonnes**	**Days turnaround**	**Days turnaround**	**Days turnaround**
1850	Sail	300	17.0	24.8	n.a.
1855	Steam	650	7.0	6.6	n.a.
1865	Steam	650	5.0	5.5	n.a.
1880	Steam	1000	3.8	7.4	n.a.
1890	Steam	1150	3.5	3.2	9.4[3]
1900	Steam	1300	3.3	4.2	5.8[3]
1910	Steam	1450	3.0	2.9	9.3[4]
1920	Steam	1575	n.a.	n.a.	18.9[4]
1930	Steam	1775	n.a.	n.a.	2.2

[1]London was the most organised port of the nineteenth century
[2]See Table 12 "Network average" implied port turnaround figures for route details
[3]The bottom up Tyne/London figures for 1890 and 1900 are the result of simple interpolation between 1880 and 1910
[4]In 1920 Northern European ports and particularly London suffered extreme congestion aggravated by WWI related dislocations. Boom times tend to coincide with congested ports

quickly becoming meaningless as a comparison of the charter revenues between say a 300 tonne sailer and a 1775 tonne steamer would suggest. In contrast, return on capital is comparable over time and across different asset classes no matter how apart in time or nature they are. For cyclical analysis it has the advantage that it tends to mean-revert. This reflects the fact that in competitive markets super-profits or super-losses tend to be eventually eliminated. This is because the long run supply curve tends to become elastic around the fully build-up cost level.

Figures 21–24 show the full cycle returns for the dominant benchmark collier steamer at the turn of each decade where market rose from cycle low to cycle high and reverted back to cycle low.

The intervening years which are not shown in the charts, are cycle low years where TCE just about covered cash operating costs. This implies negative returns on capital, post depreciation charges in the order of –5% annualised. The results for the World War I period have not been computed despite the availability of freight rates. It is well known that returns were extremely high during the war but distorted by abnormal conditions. We have not computed the war time returns because that would require a more in depth analysis of risk and insurance aspects which go beyond the scope of this study.

It can be seen that, once steamship became the dominant technology, the market got saturated and commoditised. This is borne out by the fact that returns on capital were commensurate with cost of capital if not sub-par over a full cycle. Decade-wide returns were even lower as the intervening years not charted were cycle low periods, with the notable exception of World War I. This seems to indicate that by 1885, the entry of steamers into the coastal market had reached mature saturation levels. The mechanisation of short haul coal routes out of UK was in that sense near complete.

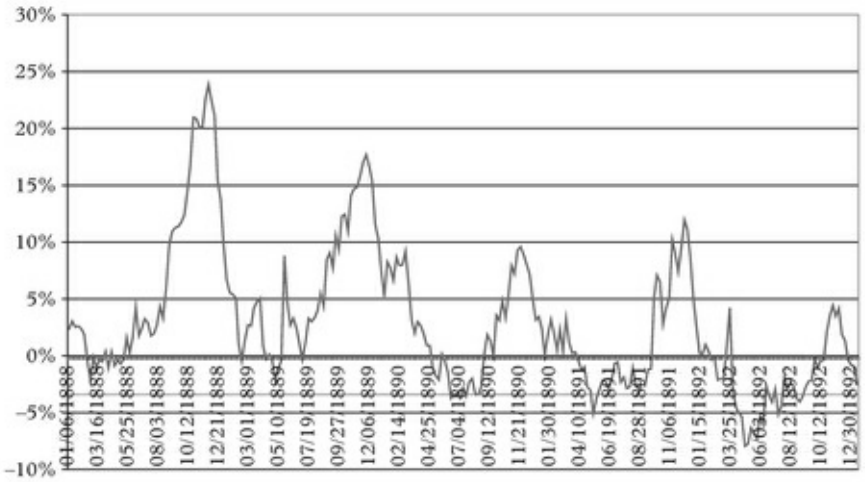

Figure 21: ROCE Jan 1888 to Dec 1892 (average period ROCE = 3%)

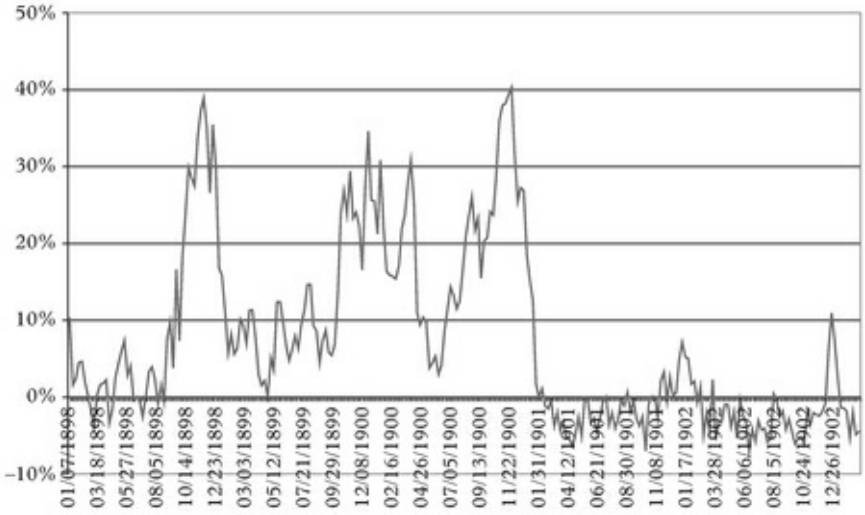

Figure 22: ROCE Jan 1898 to Dec 1902 (average period ROCE = 7.5%)

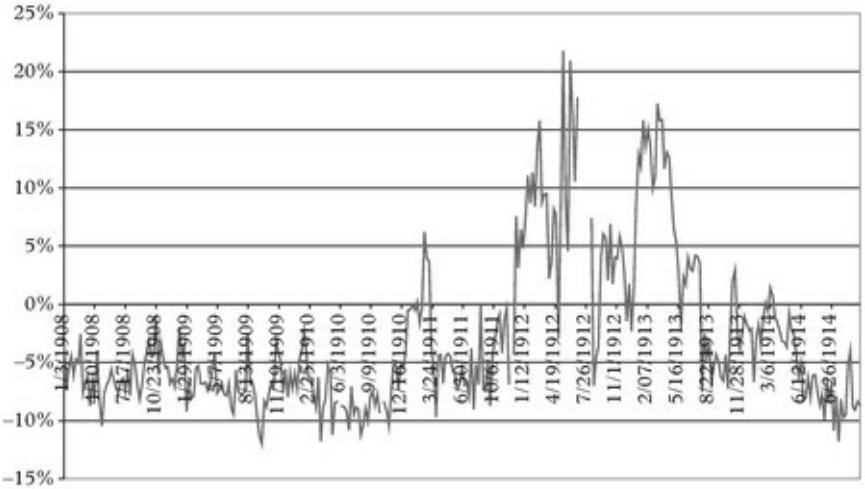

Figure 23: Jan 1908 to Jun 1914 (average period ROCE = –2.8%)

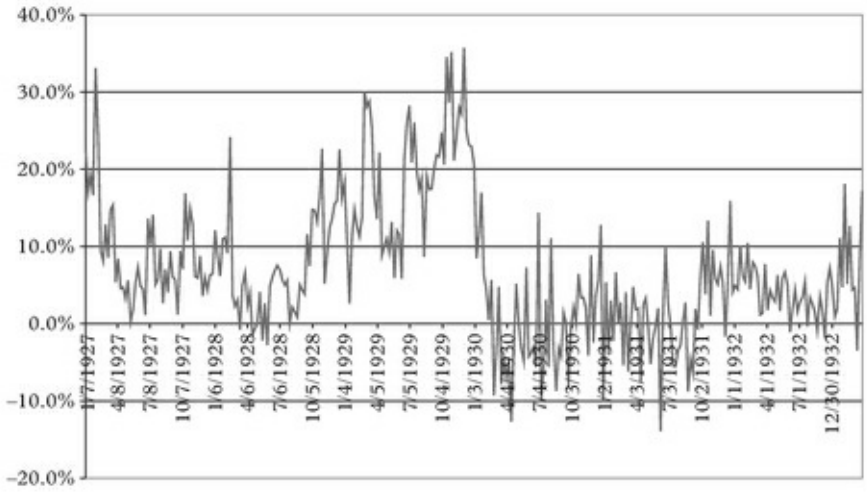

Figure 24: Jan 1927 to Dec 1932 (average period ROCE = 8.2%)

1.4 Bottom up approach 1848–1914

In this section, we utilise a bottom up approach to analyse the steamship revolution in the Northern European coastal coal freight market and its trend development over time. For each era we compute the fully build up freight rate breakeven point. This calculation is based on a fixed target return on capital employed for new replacement capacity. This should provide a measure of "mid-cycle" freight rates given the tendency of freely competitive markets, such as tramp shipping, to mean-revert towards cost of capital related remuneration. We also compute a lay-up rate level equal to cash cost. This should provide a measure of "floor" rates over the low phase of the cycle.

The starting point for our analysis is the tail end of the collier sailing ship era. This is presented in Table 7.

The exclusive source for the computations here is the exhaustive study of Allen (1855). It was presented to a professional audience of shipbuilders and shipowners of both sailers and steamers. It comes complete with a question and answer session between the author and the professional audience. It merits broad recognition as it targets the most critical juncture of steamship revolution. This is the stage where mechanisation of ships proceeded beyond the narrowly specialised liner passenger, and government subsidised mail operations. It heralds the introduction of steamship technology to the voluminous raw material bulk markets.

Table 7 suggests that prior to the introduction of steamships, a rate of 8.14 shillings per tonne was required in order to provide a 10% return on capital on a new sailer. The cash costs of the operation of a sailer were 5.88 shillings per tonne and this provides a floor measure for market lows prior to the introduction of steamships.

Table 7: Breakeven analysis pre-1852, Tyne/London/Tyne coal

Assumptions	
Vessel type: Sailer	
Ship size	120 net registered tonnes
Speed	2 knots[1]
Tyne/London distance	311 miles
Implied round trip transit time	13.0 days
Port turnaround time (total)	17.0 days[1]
Total round trip time	30.0 days[1]
Off-hire per annum	65.0 days[1]
Round trips per annum	10.0 voyages[1]
Cargo handling and port charges	22 dime per tonne
Cargo carried per trip	300 tonnes
Vessel replacement cost	£3,000
Economic life time	30 years
Operating cost	£2.03 per day[2]
Per round trip	
Cargo handling and port charges	£27.5
Operating cost	£60.7
Depreciation	£10.0
Interest on capital	£24.0
Total	£122.1
Freight rate breakeven (per tonne)	8.14 shillings per tonne
Lay-up rate (per tonne)	5.88 shillings per tonne

[1]Allen (1855), p. 319, states "It appears, from careful inquiry, that sailing colliers make, on the average, 10 voyages per annum between Newcastle and London ; "A permutation of speed, port turnaround time and off-hire days has been chosen so as to be consistent with such a performance of 10 trips per annum. There are several other permutations for speed, port turnaround time and off-hire days that could have been chosen that imply identical trip performance per annum. However the bottom line freight rate breakeven and lay-up rate is completely insensitive to the chosen permutation.
[2]Allen (1855), p. 321, provides relevant industry benchmark estimates coupled with, p. 358, actuals for the 12 year old brig "Anda"

The first steamship introduced in the Tyne/London market was the John Bowes which carried its first cargo of coal in July 1852. Its instant success was followed by a wave of new steamship orders targeting this short haul market. Table 8 illustrates the economics for the steamship mode on the main east coast coal route. Once again we rely entirely on Allen (1855) for our computations.

Table 8: Breakeven analysis 1855 Tyne/London/Tyne coal

Assumptions	
Vessel type: Steamer	
Dwt	650 tonnes
Speed	7 knots[1]
Tyne/London distance	311 miles
Implied round trip transit time	3.7 days
Port turnaround time (total)	7.0 days[1]
Total round trip time	10.7 days[1]
Off-hire per annum	44.0 days[1]
Round trips per annum	30 voyages[1]
Cargo handling and port charges	10 dime per tonne
Bunker consumption	13.5 tonnes per day[2]
Bunker cost	6.0 shillings per tonne
Cargo carried per trip	600 tonnes
Vessel replacement cost	£12,500[3]
Economic life time	20 years
Operating cost	£9.26 per day
Per round trip	
Cargo handling and port charges	£25.0
Fuel cost	£15.0
Operating cost	£112.7
Depreciation	£20.8
Interest on capital	£33.3
Total	£206.9
Freight rate breakeven (per tonne)	6.90 shillings per tonne
Lay-up rate (per tonne)	5.09 shillings per tonne

[1]Based on a sample of 471 steamship voyages, Allen (1855), p. 319, states "These particularls justify the conclusion, that 30 voyages per annum may be calculated upon, by an ordinary screw collier, working between Newcastle and London." Allen (1855), p. 370, shows detailed results of the "Northumberland", which are consistent with our chosen permutation for speed, port turnaround time and annual off-hire.
[2]From Harley (1970), p. 265, adjusted to 650 dwt steamship. Also consistent with Allen (1855), p. 322, and our steaming days estimate.
[3]Based on Allen (1855).

The steamship innovation involved a number of tradeoffs in comparison with the competing sailing mode. Steamships suffered from substantially higher construction, voyage related, and running costs. However, they compensated through much higher productivity in both sailing and port turnaround time. The sailing time gains related to the higher average speed of seven knots or above, which was largely independent of the weather. The port turnaround gains partly relate to the application of steam power in loading and unloading devices. Such gains also reflect the ability of steamships to maintain a fixed schedule largely independent of weather. This enabled the shore-side port operations to be co-ordinated, fine tuned, and speeded up around the predictable arrivals of tonnage and cargoes. Indeed it seems that a queuing convention was almost instantly established. Accordingly cheap to rent sailers would be removed from berth to allow expensive steamships to load and discharge cargo with quick dispatch. Mechanisation of ports proceeded in parallel with the mechanisation of ships in a self reinforcing virtuous circle.

The steamship economics compare favorably to that of the sailer in the Tyne/London route, as comparison between Tables 7 and 8 illustrates. The steamer required a rate of 6.90 shillings per tonne in order to generate 10% return on new construction. Thus at the outset, the capital breakeven point for a steamer is 15% lower than that of a sailer. Looking at it from a slightly different angle, the

standard steamship would enjoy a return on capital of over 20% at the previously mentioned rate of 8.14 shillings per tonne required by a sailer in order for the latter to breakeven. At the beginning, investment in cargo steamships did entail certain risks of "venture capital" type. However the productivity gains of steamships in short haul markets were of sufficient magnitude to attract risk capital. This explains the new ordering wave for short haul steamer colliers that ensued. The lay-up rate for steamships was also a reduced 5.09 shillings per tonne, representing a 14% decline in relation to the cash breakeven levels for sailers.

Our next market snapshot is around year 1865, by which time further significant productivity gains had been squeezed out of steamship operations. This expanded the number of annual trips performed by steamships on the Tyne/London route from around 30 per annum in 1855, to 40 and above per annum by 1865. Allen (1855), p. 319, foresees this development clearly. Whereas, at the time of writing, 30 voyages per annum had been calculated as being the fair average productivity "…there can be little doubt, that an average of 36 voyages may be attained, after more experience has been gained in working the vessels, and proper arrangements made for rapidly discharging the cargoes, and speedily repairing any damage to machinery, etc, from collision, or otherwise". It is apparent that the forthcoming productivity gains visible to Allen (1855), do not rely on increased speed and reduced transit time. Instead they lie in faster port turnaround times and reduced technical off-hire per annum.

Accordingly in Table 9, we have sketched such developments accumulated over the first decade or so of steamship operations experience. Our main source here is the accounts of s/s Londonderry which plied the Tyne/London route regularly. These accounts provide a broad enough sample of over 170 representative voyages performed sequentially over the years 1865–1868. The foresight of Allen (1855), allows us to connect the dots with higher degree of confidence. The unit freight rates achieved by SS Londonderry are nearly identical to the benchmark Tyne/London collier rates of our database. This reinforces the view that these 170 voyages are representative of the broader market and the cross comparability of our several strands of analysis.

We have allowed for a marginal increase in speed and corresponding reduction in transit time over the first decade of steamship experience. We estimate that roundtrip

Table 9: Breakeven analysis 1865 Tyne/London/Tyne coal

Assumptions	
Vessel type: Steamer	
Dwt	650 tonnes
Speed	7.5 knots[1]
Tyne/London distance	311 miles
Implied round trip transit time	3.5 days
Port turnaround time (total)	5.0 days[1]
Total round trip time	8.5 days[1]
Off-hire per annum	30.0 days[1]
Round trips per annum	40 voyages[1]
Cargo handling and port charges	18 dime per tonne
Bunker consumption	12.5 tonnes per day[2]
Bunker cost	7.5 shillings per tonne
Cargo carried per trip	602 tonnes
Vessel replacement cost	£14,000[3]
Economic life time	20 years
Operating cost	£9.10 per day[4]
Per round trip	
Cargo handling and port charges	£45.2
Fuel cost	£16.2
Operating cost	£83.8
Depreciation	£17.7
Interest on capital	£28.3
Total	£191.2
Freight rate breakeven (per tonne)	6.35 shillings per tonne
Lay-up rate (per tonne)	4.82 shillings per tonne

[1]The performance of the s/s Londonderry, from the Londonderry Papers at the Durham Country Archives (D/Co/B320(15)) shows 40 voyages in 1865, 45 in 1866, and 44 in each of 1867 and 1868.
[2]From Harley (1970), p. 265, adjusted for 650 dwt steamship.
[3]Based on Maywald (1956)
[4]Based on the s/s Londonderry accounts, adjusted for 650 dwt steamship.

time for steamships on the benchmark east coast coal route, was reduced from 10.7 days in 1855 to 8.5 days in 1865. Out of the total decline of 50 hours in round trip time, 48 hours related to faster port turnaround improvement and only a mere two hours from reduced transit time. Despite a modest increase in unit bunker cost, the fully built up cost breakeven freight rate is reduced from 6.90 shillings per tonne for a steamship plying the route in 1855 to 6.35 shillings per tonne for similar ship in 1865; a percentage decline of 8%. The lay up rate drops by a smaller 5% amount down to 4.82 shillings per tonne over the same period.

In Table 10, we move forward to year 1880 and repeat our breakeven rate calculations after a further accumulation of additional 15 years of steamship experience. One parameter worth highlighting is the significant increase in average steamship cargo sizes in the short sea collier routes. By 1880, the benchmark coal cargo on the east coast short haul route had risen close to 1,000 tonnes compared with the early days of steamers when parcels of 600 tonnes were the standard. This translates to significant additional economies of scale gained across almost all lines of the voyage profit and loss account. Specifically, we identify economies of scale achieved in construction costs, running expenses, and voyage steaming costs. Accordingly, we estimate that by 1880, the fully built up breakeven level had dropped down to 4.23 shillings per tonne. This represents a whopping 34% decline in comparison to the 1865 level. Lay-up rates also dropped to 3.42 shilling per tonne, a

substantial 29% decline over the 15-year period.

Finally in Table 11, we perform breakeven calculations for year 1910, representing an additional 30 years of steamship innovation. Once again we note an increase in average cargo size to about 1,450 tonnes. This also implies further economies of scale in construction costs, running expenses and voyage steaming costs. Accordingly the fully built up breakeven level is slashed by a further 26% down to 3.12 shillings per tonne. The lay up rate reduces by 22% in comparison to 1880, down to 2.66 shillings per tonne.

1.4.1 Tyne/London coal freight market — productivity gains and long-term development in rates

The long-term decline in freight rates on the key Tyne to London coastal market may now be reviewed in pictorial format.

Figure 25 depicts the development in freight rates on the east coast key coal route over the period 1848 to 1911. In addition to the fluctuating market rates, the chart includes two smoother lines. The upper line represents the full cost breakeven point inclusive of capital costs. As already mentioned, this should tend to represent the midcycle point of the market. The lower smooth line represents the development in cash breakeven point. This should represent a floor resistance level during the cycle low phase of the market.

The breakeven lines show a step down change in summer 1852 when the reference replacement ship is switched from a sailer to the more efficient steamer. This step change fully mirrors the modal economics analysed in Tables 7 and 8.

After this step decline, breakeven rates trend smoothly downwards with the occasional upward interruption. The later reflects the cyclical rise in bunker prices that takes place when the economy booms. The long-term trend decline is driven primarily by a combination of two factors. First, the economies of scale implied by a relentless increase in the average size of colliers. Secondly, productivity gains implied by ever faster port turnarounds.

The relative returns on replacement cost achieved by steamer and sailer are shown in Figure 26 over the first two decades of mutual competition. The healthy returns enjoyed by steamers stand in contrast to the poor returns on sailers. This explains the eventual dominance of the former and the rapid extinction of the later.

Table 10: Breakeven analysis 1880 Tyne/London/Tyne coal

Assumptions	
Vessel type: Steamer	
Dwt	1000 tonnes
Speed	8 knots
Tyne/London distance	311 miles
Implied round trip transit time	3.2 days
Port turnaround time (total)	3.8 days[1]
Total round trip time	7.0 days[2]
Off-hire per annum	30.0 days
Round trips per annum	48 voyages
Cargo handling and port charges	20 dime per tonne[3]
Bunker consumption	11.0 tonnes per day[4]
Bunker cost	7.3 shillings per tonne
Cargo carried per trip	961 tonnes
Vessel replacement cost	£14,400[5]
Economic life time	20 years
Operating cost	£9.50 per day[6]
Per round trip	
Cargo handling and port charges	£78.9
Fuel cost	£13.0
Operating cost	£72.3
Depreciation	£15.0
Interest on capital	£24.0
Total	£203.4
Freight rate breakeven (per tonne)	4.23 shillings per tonne
Lay-up rate (per tonne)	3.42 shillings per tonne

[1]Welsh newspaper "Western Mail" , Issue 4022, 31st March 1882, states the guaranteed time for loading 1800 tonnes might be 55 hours.
[2]Harley (1989), p. 322, states "In the early 1880s, other Londonderry vessels were averaging between 6 and 7 days for London voyages."
[3]Dues and charges at British ports; Dues and charges at Foreign ports; various editions
[4]Based on Hartley (1970), p. 265, adjusted for vintage
[5]Based on Maywald (1956)
[6]Economies of scale and macro-economic deflationary forces kept operating costs at low levels, despite increase in ship size.

Table 11: Breakeven analysis 1910 Tyne/London/Tyne coal

Assumptions	
Vessel type: Steamer	
Dwt	1450 tonnes
Speed	8 knots
Tyne/London distance	311 miles
Implied round trip transit time	3.2 days
Port turnaround time (total)	3.0 days[1]
Total round trip time	6.2 days
Off-hire per annum	30.0 days
Round trips per annum	54 voyages
Cargo handling and port charges	16 dime per tonne[2]
Bunker consumption	9.5 tonnes per day[3]
Bunker cost	10.0 shillings per tonne
Cargo carried per trip	1416 tonnes
Vessel replacement cost	£13,500[4]
Economic life time	20 years
Operating cost	£11.50 per day[5]
Per round trip	
Cargo handling and port charges	£94.6
Fuel cost	£15.4
Operating cost	£78.2
Depreciation	£12.6
Interest on capital	£20.1
Total	£220.9
Freight rate breakeven (per tonne)	3.12 shillings per tonne
Lay-up rate (per tonne)	2.66 shillings per tonne

[1]Several voyage charter contracts of 1900 vintage suggest 72 hrs was allowed for loading/discharge on Tyne/London cargoes of about 1600 tonnes size. Source: Colliery Guardian
[2]Dues and charges at British ports; Dues and charges at Foreign ports; various editions
[3]Based on Hartley (1970), p. 265, adjusted for vintage and vessel size
[4]Based on Maywald (1956)
[5]Based on Hobson (1914), adjusted for size

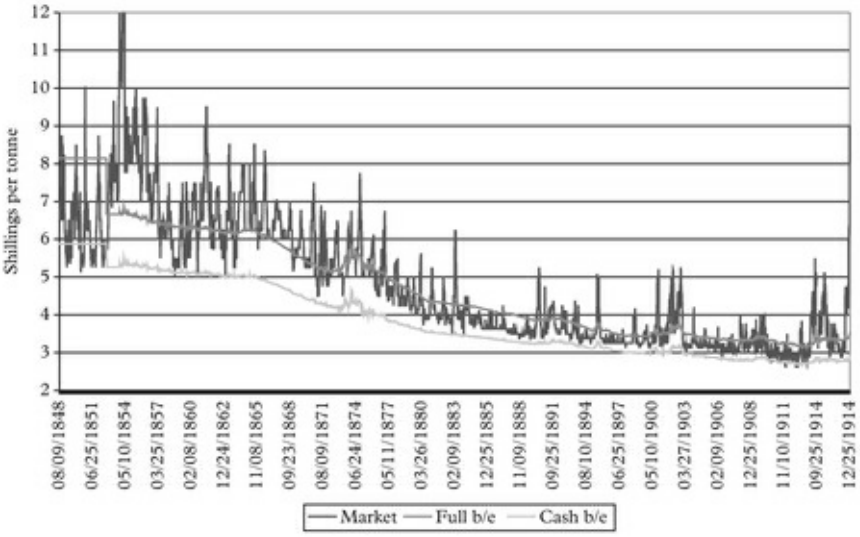

Figure 25: Long term decline in Tyne/London coal freight rates

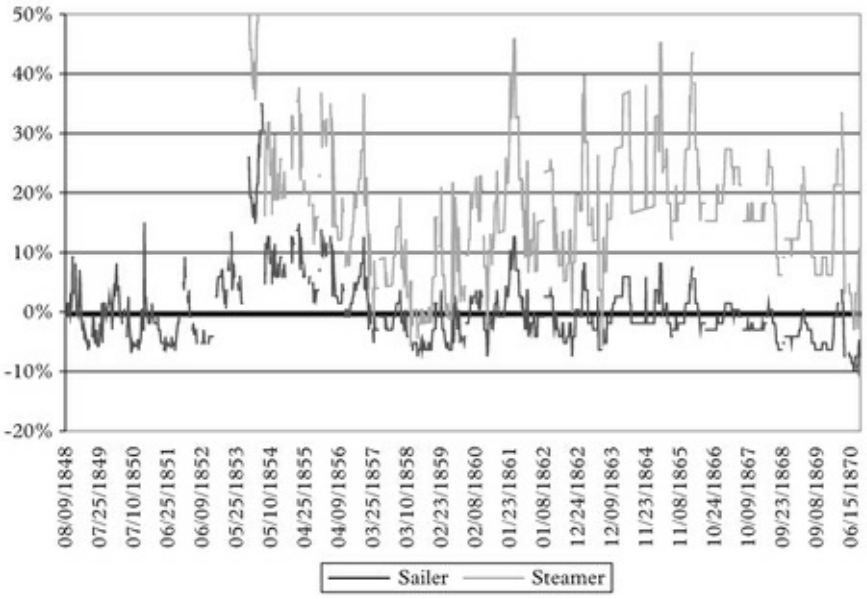

Figure 26: Return on capital employed for steamer and sail ship summer 1848 to summer 1870

Table 12 : Network analysis basis arbitrage off Tyne/London bottom up estimates

Decade	**Source:**	**Number of weekly observations**	**α**	**β**	**Time trend**	**R-squared**	**α t-stat**	**β t-stat**	**Time trend t-stat**	**F-stat**	**Start period assumed vessel dwt**	**Start period implied port charges (α * dwt)**	**Start period implied port turnaround days (β)**	**Start period assumed transit time days**	**Implied round voyage duration–days**	**Implied annual gain through the decade in port turnaround–hrs**
Jan 1850–Dec 1859																
Tyne/London	Allen (1855), Table 7	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	300	£27.5	17.0	13.0	30.0	n/a
Tyne/Hamburg	Regression	490	0.097	25.5	n/a	0.965	9.43	22.84	n/a	5959	300	£29.0	25.5	17.4	42.8	n/a
Tyne/Havre	Regression	499	0.228	13.1	n/a	0.976	26.77	13.95	n/a	10010	300	£68.3	13.1	16.7	29.8	n/a
Tyne/Rouen	Regression	474	0.336	29.7	n/a	0.990	34.24	27.38	n/a	22569	300	£100.9	29.7	19.6	49.3	n/a
Wales/Havre	Regression	74	0.216	30.9	n/a	0.987	9.18	12.77	n/a	2763	300	£64.7	30.9	19.6	50.5	n/a
Network average	**Sailship tramp basis**		0.219	24.8							300	£65.7	24.8	18.3	43.1	
mid-1855	Allen (1855), Table 8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	650	£25.0	7.0	3.7	10.7	n/a
Jan 1860–Dec 1869																
Tyne/London	Table 8, 9, 10 inter-polation	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	650	£45.2	5.0	3.5	8.5	n/a
Tyne/Hamburg	Regression	439	0.103	7.7	n/a	0.980	8.37	15.18	n/a	7054	650	£66.6	7.7	4.6	12.3	n/a
Network average	**Steamship tramp basis**		0.103	7.7							650	£45.6	6.6	3.9	10.5	

Jan 1870–Dec 1879																
Tyne/London	Table 9, 10 interpolation	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	767	£56.2	4.6	3.4	8.0	2.0
Tyne/Hamburg	Regression	396	0.085	7.5	–0.005	0.982	10.82	19.68	–8.69	6984	767	£64.8	7.5	4.5	12.0	6.3
Tyne/Havre	Regression	308	0.121	6.5	–0.004	0.984	13.11	14.28	–6.05	6339	767	£92.5	6.5	4.3	10.8	4.9
Tyne/Rouen	Regression	59	0.235	3.4	–0.008	0.978	8.50	2.84	–3.37	849	767	£180.0	3.4	4.9	8.3	9.7
Network average	**Steamship tramp basis**		0.147	5.8							767	£98.4	5.5	4.3	9.8	5.7
Jan 1880–Dec 1889																
Tyne/London	Table 10	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1000	£79.2	3.8	3.2	7.0	0.6
Tyne/Hamburg	Regression	291	0.047	7.6	n/a	0.990	n/a	22.78	n/a	14156	1000	£47.4	7.6	4.3	12.0	0.0
Tyne/Havre	Regression	295	0.054	8.4	0.000	0.990	10.15	21.91	–0.29	9995	1000	£54.4	8.4	4.2	12.6	0.1
Tyne/Rouen	Regression	121	0.101	9.5	–0.002	0.989	8.86	11.26	–2.75	3673	1000	£101.0	9.5	4.7	14.3	3.0
Wales/London	Regression	264	0.099	2.7	0.002	0.989	16.99	4.98	2.50	8087	1000	£99.4	2.7	4.3	7.0	–1.9
Wales/Havre	Regression	373	0.087	9.2	–0.003	0.981	10.21	13.60	–4.09	6253	1000	£87.3	9.2	3.8	13.0	3.8
Wales/Rouen	Regression	320	0.128	10.6	–0.004	0.991	15.66	16.33	–6.38	11154	1000	£127.8	10.6	3.8	14.4	5.4
Network average	Steamship tramp basis										1000	£85.2	7.4	4.1	11.5	1.6
Jan 1890–Dec 1900																

Table 12: (*Continued*)

Tyne/London	Table 10, 11 interpolation	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1150	£86.0	3.5	3.2	6.7	0.6
Tyne/Hamburg	Regression	272	0.118	1.7	0.000	0.995	42.23	6.55	–1.02	17564	1150	£135.8	1.7	4.3	6.0	0.4
Tyne/Havre	Regression	364	0.112	3.2	–0.001	0.995	40.60	13.21	–4.77	22046	1150	£128.7	3.2	4.2	7.4	1.6
Tyne/Rouen	Regression	184	0.164	2.5	–0.001	0.991	27.07	4.82	–1.30	6990	1150	£188.8	2.5	4.7	7.2	0.9
Wales/London	Regression	345	0.106	2.3	–0.002	0.991	28.87	7.32	–5.38	12128	1150	£121.4	2.3	4.3	6.7	2.4
Wales/Havre	Regression	463	0.109	5.6	–0.002	0.990	26.90	15.71	–4.72	15421	1150	£125.0	5.6	3.8	9.4	2.3
Wales/Rouen	Regression	333	0.173	3.5	–0.001	0.992	33.23	7.87	–2.72	13994	1150	£199.3	3.5	4.6	8.1	1.6
Network average	**Steamship tramp basis**										1150	£140.7	3.2	4.2	7.4	1.4
Jan 1900–Dec 1909																
Tyne/London	Table 10, 11 interpolation	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1300	£91.2	3.3	3.2	6.5	0.6
Tyne/Hamburg	Regression	320	0.064	4.7	–0.004	0.986	16.34	16.46	–9.32	7340	1300	£83.7	4.7	4.3	9.1	4.8
Tyne/Havre	Regression	312	0.095	3.4	–0.001	0.992	26.44	14.04	–1.42	13278	1300	£124.1	3.4	4.2	7.6	0.7
Tyne/Rouen	Regression	230	0.117	4.9	–0.004	0.975	12.97	8.02	–4.42	2944	1300	£152.3	4.9	4.7	9.6	5.5
Wales/London	Regression	175	0.104	1.8	–0.002	0.990	23.28	5.95	–2.82	5586	1300	£135.3	1.8	4.3	6.1	2.4
Wales/Havre	Regression	247	0.085	5.9	–0.002	0.987	14.73	15.20	–2.80	5975	1300	£110.8	5.9	3.8	9.8	2.5
Wales/Rouen	Regression	258	0.122	5.5	–0.003	0.988	19.20	12.43	–3.85	6884	1300	£159.1	5.5	4.6	10.1	3.5

Network average	**Steamship tramp basis**										1300	£122.4	4.2	4.2	8.4	2.8
Jan 1910–Jul 1914																
Tyne/London	Table 11	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1450	£94.8	3.0	3.2	6.2	0.0
Tyne/Hamburg	Regression	140	0.067	2.8	–0.001	0.970	12.56	5.68	–0.48	1475	1450	£97.2	2.8	4.3	7.1	1.1
Tyne/Havre	Regression	139	0.113	2.7	0.000	0.991	25.71	7.14	0.59	4912	1450	£164.1	2.7	4.2	6.9	–0.6
Tyne/Rouen	Regression	77	0.138	2.5	–0.001	0.983	14.10	3.20	–0.64	1436	1450	£200.6	2.5	4.7	7.2	1.0
Wales/London	Regression	44	0.126	1.4	–0.009	0.989	15.05	2.10	–3.10	1214	1450	£182.1	1.4	4.3	5.7	10.6
Wales/Havre	Regression	147	0.086	6.5	–0.005	0.986	14.74	12.45	–2.49	3428	1450	£124.5	6.5	3.8	10.3	6.2
Wales/Rouen	Regression	120	0.150	1.6	0.012	0.939	9.15	1.06	1.78	601	1450	£216.8	1.6	4.6	6.2	–14.5
Network average	**Steamship tramp basis**										1450	£154.3	2.9	4.2	7.1	0.5

1.4.2 Route network portfolio analysis

The London/Tyne route is well documented. This has allowed us to sketch its detailed developments over several decades. For other routes there is only scant information which does not allow for similar approach. However, we can make use of the insights offered by the tramp arbitrage framework. This allows us to evaluate developments across the broader collier coastal network.

Time charter equivalent earnings E have been estimated for the Tyne/London route. Because of arbitrage, similar earnings are imputed to all other routes of the network. Freight rates are readily available for other network routes. Reference is now made to equation (2). A simple regression can provide estimates for parameters α and β of any route against the E common to all routes. Reference is also made to the definitions of α and β. It can be seen that once α and β have been estimated for any route, its port charges and voyage duration structure is fully revealed.

As regards the technicalities of the regression a few comments are in order. We have broken up β in a steaming and port turnaround component. The former is known and thus has been taken to the left hand side of the equation to create a modified independent variable for the regression, namely freight rates net of bunkers and net of steaming time rental. Thus our β estimate in our modified regression can be interpreted straightforwardly as port turnaround days. We have also included a time trend for port turnaround to reflect the relentless productivity improvements through the periods under review. We apply the regressions separately for each decade. Effectively we are assuming that the route network remains largely stable during each decade apart from trend port turnaround development.

Table 12 summarises the results of these regressions. Some interesting comments can be made around these results. First, R-squared is very high in all cases. Second, the time-path development of the β estimates over the decades is significant. It indicates progress in port turnaround time in quantitative terms. Network average port turnaround time, sum-total at both ends, during the late stages of the sail ship era is estimated at 24.8 days. The following decade shows substantial progress with steamship port turnaround time, sum-total at both ends, slashed to 6.6 days. Ten years later, in 1870, this figure drops to 5.5 days. By 1880, there is a set-back in estimated port turnaround times, rising to 7.4 days. One possible explanation for this set-back is the development of larger deep sea trampers. This necessitated the removal from berth of cheaper small steamship coastal vessels in order to accelerate dispatch of the bigger more expensive ships. By 1890, coastal collier network average port turnaround improves once again to 3.2 days. In 1900 we notice another deterioration, with turnaround time rising to 4.2 days before falling again to 2.9 days by 1910. It should be noted that these are inferred numbers from stochastic equations and an element of noise is always inherent in such figures. However, the broad trends over the decades is believed to be correctly reflected in these numbers.

Thirdly, we turn to the regression estimates of the constant term α. Multiplying α with vessel size gives the estimated total port charges, sum-total at both ends, per ship per roundtrip. In the early years, French ports were notoriously expensive, with Rouen being the worst culprit. Towards 1870, France reduced its port charges but Rouen always remained the most expensive port within our sample. That is reflected in the regression estimates consistently throughout the period.

Fourthly, as we move across the decades, it is obvious that for certain routes stochastic noise may shift the α estimate in certain direction, and then the regression compensates

Table 13: Port charges estimates

	From	To	Period		
			1890	1900	1910
Top down cliometric	Tyne	London	£27.1	£13.3	£48.3
Bottom up regression	Tyne	London	£86.0	£91.2	£94.8
Top down cliometric	Tyne	Havre	£31.0	£97.8	£2.6
Bottom up regression	Tyne	Havre	£128.7	£124.1	£164.1
Top down cliometric	Tyne	Rouen	£79.6	£126.6	£56.6
Bottom up regression	Tyne	Rouen	£188.8	£152.3	£200.6
Top down cliometric	Tyne	Caen	£32.8	£85.2	£28.6
Bottom up regression	Tyne	Caen	n/a	n/a	n/a
Top down cliometric	Tyne	Hamburg	£135.8	£83.7	£97.2
Bottom up regression	Tyne	Hamburg	n/a	n/a	n/a
Top down cliometric	Wales	London	£47.0	£17.1	£13.3
Bottom up regression	Wales	London	£121.4	£135.3	£182.1
Top down cliometric	Wales	Havre	£61.6	£91.9	£14.0
Bottom up regression	Wales	Havre	£125.0	£110.8	£124.5
Top down cliometric	Wales	Rouen	£98.4	£131.5	£75.7
Bottom up regression	Wales	Rouen	£199.3	£159.1	£216.8
Top down cliometric	Wales	Caen	£50.9	£88.5	£52.9
Bottom up regression			n/a	n/a	n/a

by shifting the β estimate in the opposite direction. This is required to generate the best fit to the target time charter earnings figure.

1.4.3 Port charges

In Table 6 the port turnaround times estimated through the top down cliometric approach, and the bottom up method were presented and compared. Table 13 does the same for port charges.

It is obvious that the two methods have resulted in offsetting compensating adjustments. The cliometric approach tends to inflate port turnaround time and deflate port charges. In contract, the bottom up approach results in lower port turnaround time but higher port charges. When it comes to estimating bottom line time charter results, both methods result in similar figures. Figure 27 illustrates this with the figures for the 1890 cycle being representative of the relative patterns for all other cycles.

Both methods give near identical results for the cycle low periods. At cycle low the computed time charter results are practically equal to cash operating costs. It is only in the case of the cliometric top down method that this equality between cycle low earnings and cash costs has been imposed by design.

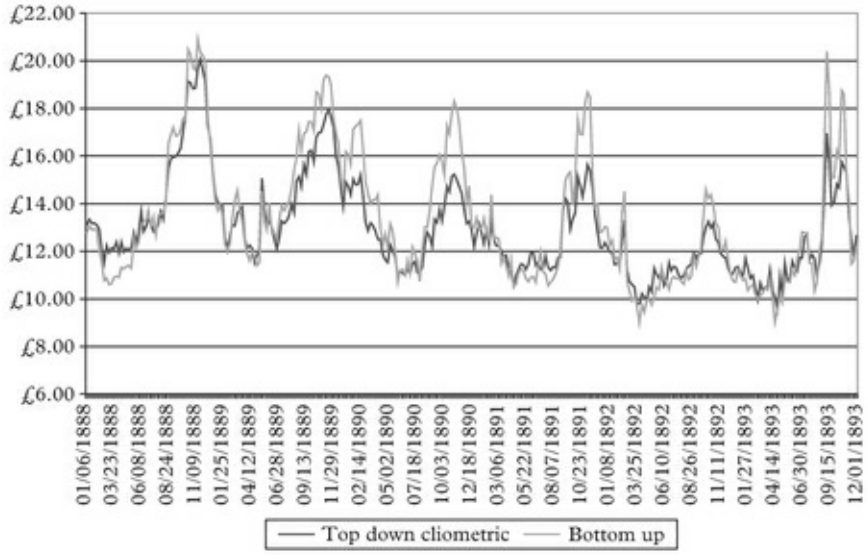

Figure 27: Comparison of computed daily time charter earnings (E)

During boom periods, the bottom up method simulates higher time charter earnings than the top down cliometric approach. This is because of the lower port turnaround times estimated by the former method.

1.4.4 Alternative bottom up approach

We turn now to original sources for port charges. These have been retrieved from various editions of Dock & Port Charges of the United Kingdom, and Dues and Charges on Shipping in Foreign Ports. These directories show port tariff structures worldwide. The directories also provide actual detailed accounts of port charges incurred by specific ships calling at the various ports. For the ports mentioned in this article, many of these detailed accounts represent coastal collier ship calls. We utilise this information to run an alternative bottom up approach. This alternative bottom up approach rests on the following assumptions:

a. port charges as per the above-mentioned directories;
b. at cycle low, time charter earnings equal cash operating costs;

Using the above assumptions, we look at each route separately and solve for the implied port turnaround time. The results are shown in Tables 14, 15 for year 1875. Tables 16, 17 repeat the exercise for year 1910.

The alternative bottom up approach seem to resemble the results arrived through our initial bottom up approach. This suggests that the cliometric top down approach overestimates true port turnaround times and underestimates port charges.

Table 14 : Year 1875–Outbound routes from Tyne

Assumptions							
Route: Tyne London		**Route: Tyne Hamburg**		**Route: Tyne Havre**		**Route: Tyne Rouen**	
dwt	1000	dwt	1000	dwt	1000	dwt	1000
grt	700	grt	700	grt	700	grt	700
nrt	500	nrt	500	nrt	500	nrt	500
Export port tariffs							
Tonnage	2.0d per grt	Tonnage	2.0d per grt	Tonnage	2.0d per grt	Tonnage	2.0d per grt
Pilotage	£1.0 per ship	Pilotage	£1.0 per ship	Pilotage	£1.0 per ship	Pilotage	£1.0 per ship
Stevedoring		Stevedoring		Stevedoring		Stevedoring	
Trimming	2.0d per ton	Trimming	2.0d per ton	Trimming	2.0d per ton	Trimming	2.0d per ton
Wharfage		Wharfage		Wharfage		Wharfage	
Pier and Mooring	1.25d per grt	Pier and Mooring	1.25d per grt	Pier and Mooring	1.25d per grt	Pier and Mooring	1.25d per grt
Towage	1.25d per grt	Towage	1.25d per grt	Towage	1.25d per grt	Towage	1.25d per grt
Other 3		Other 3		Other 3		Other 3	
Export port totals							
Tonnage	£5.8	Tonnage	£5.8	Tonnage	£5.8	Tonnage	£5.8
Pilotage	£1.0	Pilotage	£1.0	Pilotage	£1.0	Pilotage	£1.0
Stevedoring		Stevedoring		Stevedoring		Stevedoring	
Trimming	£8.3	Trimming	£8.3	Trimming	£8.3	Trimming	£8.3
Wharfage		Wharfage		Wharfage		Wharfage	

Table 14 : (Continued)

Pier and Mooring	£3.6	Pier and Mooring	£3.6	Pier and Mooring	£3.6	Pier and Mooring		£3.6
Towage	£3.6	Towage	£3.6	Towage	£3.6	Towage		£3.6
Other 3	£2.0	Other 3	£2.0	Other 3	£2.0	Other 3		£2.0
Total	£24.5	Total	£24.5	Total	£24.5	Total		£24.5
Import port tariffs								
dwt	1000	fx	dwt 1000	fx	dwt 1000	fx	dwt	1000
grt	700	18.0	grt 700	25.3	grt 700	25.3	grt	700
nrt	500		nrt 500		nrt 500		nrt	500
Tonnage	9.0d per reg ton	Tonnage		Tonnage	800	Tonnage		1400
Pilotage	£5.0	Pilotage	406	Pilotage	150	Pilotage		200
Stevedoring	6.0d per cargo tonne	Stevedoring	200	Stevedoring	400	Stevedoring		600
Trimming		Trimming		Trimming		Trimming		
Wharfage		Wharfage		Wharfage		Wharfage		
Other 1 Harbour dues	0.5d per ton	Other 1 Harbour dues	9	Other 1 Harbour dues	95	Other 1 Harbour dues		150
Other 2 Towage		Other 2 Towage	350	Other 2 Towage		Other 2 Towage		
Other 3		Other 3	350	Other 3		Other 3		
Import port totals								
Tonnage	£26.3	Tonnage		Tonnage	£31.7	Tonnage		£55.4
Pilotage	£5.0	Pilotage	£22.5	Pilotage	£5.9	Pilotage		£7.9
Stevedoring	£25.0	Stevedoring	£11.1	Stevedoring	£15.8	Stevedoring		£23.8
Trimming		Trimming		Trimming		Trimming		
Wharfage		Wharfage		Wharfage		Wharfage		

Other 1 Harbour dues	£1.5	Other 1 Harbour dues		£0.5		Other 1 Harbour dues		£3.8		Other 1 Harbour dues		£5.9	
Other 2 Towage		Other 2 Towage		£19.4		Other 2 Towage		£0.0		Other 2 Towage		£0.0	
Other 3		Other 3		£19.4		Other 3		£10.0		Other 3		£10.0	
Total	£57.7	Total		£73.0		Total		£67.2		Total		£103.0	
Voyage assumptions													
Distance loaded	311 miles	Distance loaded		417		Distance loaded		400		Distance loaded		470	
Distance ballast	311 miles	Distance ballast		417		Distance ballast		400		Distance ballast		470	
Steaming speed	7 knots per hour	Steaming speed		7		Steaming speed		7		Steaming speed		7	
Steaming days	3.7 days	Steaming days		5.0		Steaming days		4.8		Steaming days		5.6	
Load days	2.5 days	Load days		2.5		Load days		2.5		Load days		2.5	
Discharge days	2.5 days	Discharge days		3.5		Discharge days		4.0		Discharge days		4.0	
RV days	8.7	RV days		11.0		RV days		11.3		RV days		12.1	
Cycle low freight rates	sh d			sh	d			sh	d			sh	d
Freight rate	4 0	Freight rate		5	3	Freight rate		5	1.5	Freight rate		6	1.5
Freight rate	£0.2	Freight rate		£0.3		Freight rate		£0.3		Freight rate		£0.3	
Fuel consumption	15 tonnes per day	Fuel consumption		15	tonnes per day	Fuel con-sumption		15	tonnes per day	Fuel consumption		15	tonnes per day

(continued)

Table 14 : (Continued)

Fuel price		10	sh per tonne	Fuel price		10	sh per tonne	Fuel price	sh per tonne	10		Fuel price		10	Sh per tonne
Time charter rate equivalent															
Freight revenue		£200.0		Freight revenue		£262.5		Freight revenue		£256.3		Freight revenue		£306.3	
Commission		£10.0		Commission		£13.1		Commission		£12.8		Commission		£15.3	
Fuel costs		£27.8		Fuel costs		£37.2		Fuel costs		£35.7		Fuel costs		£42.0	
Port charges		£82.2		Port charges		£97.5		Port charges		£91.7		Port charges		£127.5	
TCE		£80.1		TCE		£114.6		TCE		£116.1		TCE		£121.5	
tce per day		£9.2		tce per day		£10.5		tce per day		£10.3		tce per day		£10.0	

Table 15 : Year 1875–Outbound routes from Wales

Assumptions															
Route Wales London				**Route: Wales Hamburg**				**Route: Wales Havre**				**Route: Tyne Rouen**			
	dwt	1000			dwt	1000			dwt	1000			dwt	1000	
	grt	700			grt	700			grt	700			grt	700	
	nrt	500			nrt	500			nrt	500			nrt	500	
Export port tariffs															
Tonnage		2.0d	per grt	Tonnage		5.0d	per grt	Tonnage		5.0d	per grt	Tonnage		5.0d	per grt
Pilotage		£1.5		Pilotage		£1.5		Pilotage		£1.5		Pilotage		£1.5	
Stevedoring				Stevedoring				Stevedoring				Stevedoring			
Trimming		2.5d	per tonne	Trimming		2.5d	per tonne	Trimming		2.5d	per tonne	Trimming		2.5d	per tonne
Wharfage		2.0d	per tonne	Wharfage		2.0d	per tonne	Wharfage		2.0d	per tonne	Wharfage		2.0d	per tonne
Other 1				Other 1				Other 1				Other 1			
Other 2 Towage		3.5d	per grt	Other 2 Towage		3.5d	per grt	Other 2 Towage		3.5d	per grt	Other 2 Towage		3.5d	per grt
Other 3				Other 3				Other 3				Other 3			
Export port totals															
Tonnage		£5.8		Tonnage		£14.6		Tonnage		£14.6		Tonnage		£14.6	
Pilotage		£1.5		Pilotage		£1.5		Pilotage		£1.5		Pilotage		£1.5	
Stevedoring		£0.0		Stevedoring		£0.0		Stevedoring		£0.0		Stevedoring		£0.0	
Trimming		£10.4		Trimming		£10.4		Trimming		£10.4		Trimming		£10.4	
Wharfage		£8.3		Wharfage		£8.3		Wharfage		£8.3		Wharfage		£8.3	
Other 1		£2.0		Other 1		£2.0		Other 1		£2.0		Other 1		£2.0	
Other 2 Towage		£10.2		Other 2 Towage		£10.2		Other 2 Towage		£10.2		Other 2 Towage		£10.2	
Other 3		£2.0		Other 3		£2.0		Other 3		£2.0		Other 3		£2.0	
Total		£40.3		Total		£49.0		Total		£49.0		Total		£49.0	
Import port tariffs															
	dwt	1000		fx	dwt	1000		fx	dwt	1000		fx	dwt	1000	

(continued)

Table 15: (Continued)

	grt	700		18.0	grt	700		25.3	grt	700		25.3	grt	700	
	nrt	500			nrt	500			nrt	500			nrt	500	
Tonnage		9.0d	per reg ton	Tonnage				Tonnage		800		Tonnage		1400	
Pilotage		£5.0		Pilotage		406		Pilotage		150		Pilotage		200	
Stevedoring		6.0d	per cargo tonne	Stevedoring		200		Stevedoring		400		Stevedoring		600	
Trimming				Trimming				Trimming				Trimming			
Wharfage				Wharfage				Wharfage				Wharfage			
Other 1 Harbour dues		0.5d	per ton	Other 1 Harbour dues		9		Other 1 Harbour dues		95		Other 1 Harbour dues		150	
Other 2 Towage				Other 2 Towage		350		Other 2 Towage				Other 2 Towage			
Other 3				Other 3		350		Other 3				Other 3			
Import port totals															
Tonnage		£26.3		Tonnage				Tonnage		£31.7		Tonnage		£55.4	
Pilotage		£5.0		Pilotage		£22.5		Pilotage		£5.9		Pilotage		£7.9	
Stevedoring		£25.0		Stevedoring		£11.1		Stevedoring		£15.8		Stevedoring		£23.8	
Trimming				Trimming				Trimming				Trimming			
Wharfage				Wharfage				Wharfage				Wharfage			
Other 1 Harbour dues		£1.5		Other 1 Harbour dues		£0.5		Other 1 Harbour dues		£3.8		Other 1 Harbour dues		£5.9	
Other 2 Towage				Other 2 Towage		£19.4		Other 2 Towage		£0.0		Other 2 Towage		£0.0	
Other 3				Other 3		£19.4		Other 3		£10.0		Other 3		£10.0	
Total		£57.7		Total		£73.0		Total		£67.2		Total		£103.0	

Voyage assumptions															
Distance loaded		520	miles	Distance loaded		814		Distance loaded		369		Distance loaded		439	
Distance ballast		311	miles	Distance ballast		417		Distance ballast		369		Distance ballast		439	
Steaming speed		7	knots per hour	Steaming speed		7		Steaming speed		7		Steaming speed		7	
Steaming days		4.9	days	Steaming days		7.3		Steaming days		4.4		Steaming days		5.2	
Load days		2.5	days	Load days		2.5		Load days		2.5		Load days		2.5	
Discharge days		2.5	days	Discharge days		3.5		Discharge days		4.0		Discharge days		4.0	
RV days		9.9		RV days		13.3		RV days		10.9		RV days		11.7	
Cycle low freight rates		sh	d			sh	d			sh	d			sh	d
Freight rate		4	9	Freight rate		6	9	Freight rate		5	6	Freight rate		6	6
Freight rate		£0.2		Freight rate		£0.3		Freight rate		£0.3		Freight rate		£0.3	
Fuel consumption		15	tonnes per day	Fuel consumption		15	tonnes per day	Fuel consumption		15		Fuel consumption		15	
Fuel price		10	sh per tonne	Fuel price		10	sh per tonne	Fuel price		10		Fuel price		10	
Time charter rate equivalent															
Freight revenue		£237.5		Freight revenue		£337.5		Freight revenue		£275.0		Freight revenue		£325.0	
Commission		£11.9		Commission		£16.9		Commission		£13.8		Commission		£16.3	
Fuel costs		£37.1		Fuel costs		£55.0		Fuel costs		£32.9		Fuel costs		£39.2	
Port charges		£98.0		Port charges		£122.1		Port charges		£116.2		Port charges		£152.1	
TCE		£90.5		TCE		£143.6		TCE		£112.1		TCE		£117.5	
tce per day		£9.1		tce per day		£10.8		tce per day		£10.3		tce per day		£10.0	

Table 16 : Year 1910 – Outbound routes from Tyne

Assumptions															
Route: Tyne London				**Route: Tyne Hamburg**				**Route: Tyne Havre**				**Route: Tyne Rouen**			
	dwt	1450			dwt	1450			dwt	1450			dwt	1450	
	grt	870			grt	870			grt	870			grt	870	
	nrt	580			nrt	580			nrt	580			nrt	580	
Export port tariffs															
Tonnage		2.0d	per grt	Tonnage		3.0d	per grt	Tonnage		3.0d		Tonnage		3.0d	
Pilotage		£5.0		Pilotage		£5.0		Pilotage		£5.0		Pilotage		£5.0	
Stevedoring				Stevedoring				Stevedoring				Stevedoring			
Trimming		1.5d	per ton	Trimming		1.5d	per ton	Trimming		1.5d	per ton	Trimming		1.5d	per ton
Wharfage				Wharfage				Wharfage				Wharfage			
Pier and Mooring		1.25d	per grt	Pier and Mooring		1.25d	per grt	Pier and Mooring		1.25d	per grt	Pier and Mooring		1.25d	per grt
Towage		1.0d	per grt	Towage		1.0d	per grt	Towage		1.0d	per grt	Towage		1.0d	per grt
Other 3				Other 3				Other 3				Other 3			
Export port totals															
Tonnage		£7.3		Tonnage		£10.9		Tonnage		£10.9		Tonnage		£10.9	
Pilotage		£5.0		Pilotage		£5.0		Pilotage		£5.0		Pilotage		£5.0	
Stevedoring				Stevedoring				Stevedoring				Stevedoring			
Trimming		£9.1		Trimming		£9.1		Trimming		£9.1		Trimming		£9.1	
Wharfage				Wharfage				Wharfage				Wharfage			
Pier and Mooring		£4.5		Pier and Mooring		£4.5		Pier and Mooring		£4.5		Pier and Mooring		£4.5	
Towage		£3.6		Towage		£3.6		Towage		£3.6		Towage		£3.6	
Other 3		£2.0		Other 3		£2.0		Other 3		£2.0		Other 3		£2.0	
Total		£31.5		Total		£35.1		Total		£35.1		Total		£35.1	
Import port tariffs															
	dwt	1450		fx	dwt	1450		fx	dwt	1450		fx	dwt	1450	
	grt	870		20.43	grt	870		25.3	grt	870		25.3	grt	870	

	nrt	580			nrt	580			nrt	580			nrt	580	
Tonnage		1.0d	per grt	Tonnage		107		Tonnage		0.3	per grt	Tonnage		0.5	per grt
Pilotage		£5.0		Pilotage		302		Pilotage		0.3	per grt	Pilotage			
Stevedoring		4.0d	per cargo tonne	Stevedoring		1137		Stevedoring		0.1	per tonne	Stevedoring		1	per tonne
Trimming				Trimming				Trimming				Trimming			
Wharfage				Wharfage				Wharfage				Wharfage			
Other 1 Dues and rent on shipping		9.0d	per grt	Other 1 Dues and rent on shipping				Other 1 Dues and rent on shipping		0.5	per grt	Other 1 Dues and rent on shipping		1	per nrt
Other 2 Towage				Other 2 Towage				Other 2 Towage		100	fr per ship	Other 2 Towage		0.77	per grt
Other 3				Other 3		97.5		Other 3		250	fr per ship	Other 3			
Import port totals															
Tonnage		£3.6		Tonnage		£5.2		Tonnage		£10.3		Tonnage		£17.2	
Pilotage		£5.0		Pilotage		£14.8		Pilotage		£11.6		Pilotage			
Stevedoring		£24.2		Stevedoring		£55.7		Stevedoring		£5.7		Stevedoring		£57.4	
Trimming				Trimming				Trimming				Trimming			
Wharfage				Wharfage				Wharfage				Wharfage			
Other 1 Dues and rent on shipping		£32.6		Other 1 Dues and rent on shipping				Other 1 Dues and rent on shipping		£17.2		Other 1 Dues and rent on shipping		£23.0	
Other 2 Towage				Other 2 Towage				Other 2 Towage		£4.0		Other 2 Towage		£26.5	
Other 3				Other 3		£4.8		Other 3		£9.9		Other 3		£10.0	
Total		£65.4		Total		£80.4		Total		£58.8		Total		£134.1	
Voyage assumptions															
Distance loaded		311	miles	Distance loaded		417		Distance loaded		400		Distance loaded		470	
Distance ballast		311	miles	Distance ballast		417		Distance ballast		400		Distance ballast		439	

(continued)

Table 16: (Continued)

Steaming speed		8	knots per hour	Steaming speed		8		Steaming speed		8		Steaming speed		8	
Steaming days		3.2	days	Steaming days		4.3		Steaming days		4.2		Steaming days		4.7	
Load days		1.75	days	Load days		1.75		Load days		1.75		Load days		1.75	
Discharge days		1.75	days	Discharge days		2.25		Discharge days		4.0		Discharge days		4.0	
RV days		6.7		RV days		8.3		RV days		9.9		RV days		10.5	
Cycle low freight rates		sh	d			sh	d			sh	d			sh	d
Freight rate		2	9	Freight rate		3	3	Freight rate		3	3	Freight rate		4	3
Freight rate		£0.14		Freight rate		£0.16		Freight rate		£0.16		Freight rate		£0.21	
Fuel consumption		10	tonnes per day	Fuel consumption		10	tonnes per day	Fuel consumption		10	tonnes per day	Fuel consumption		10	
Fuel price		10	sh per tonne	Fuel price		10	sh per tonne	Fuel price		10	sh per tonne	Fuel price		10	tonnes per day
Time charter rate equivalent															sh per tonne
Freight revenue		£199.4		Freight revenue		£235.6		Freight revenue		£235.6		Freight revenue		£308.1	
Commission		£10.0		Commission		£11.8		Commission		£11.8		Commission		£15.4	
Fuel costs		£16.2		Fuel costs		£21.7		Fuel costs		£20.8		Fuel costs		£23.7	
Port charges		£96.9		Port charges		£115.5		Port charges		£93.9		Port charges		£169.2	
TCE		£76.3		TCE		£86.6		TCE		£109.1		TCE		£99.9	
tce per day		£11.3		tce per day		£10.4		tce per day		£11.0		tce per day		£9.5	

Table 17 : Year 1910 – Outbound routes from Wales

Assumptions															
Route: Tyne London				**Route: Wales Hamburg**				**Route: Wales Havre**				**Route: Wales Rouen**			
	dwt	1450			dwt	1450			dwt	1450			dwt	1450	
	grt	870			grt	870			grt	870			grt	870	
	nrt	580			nrt	580			nrt	580			nrt	580	
Export port tariffs															
Tonnage		2.0d	per grt	Tonnage		4.0d	per grt	Tonnage		4.0d	per grt	Tonnage		4.0d	per grt
Pilotage		£5.0	per ship	Pilotage		£5.0	per ship	Pilotage		£5.0	per ship	Pilotage		£5.0	per ship
Stevedoring				Stevedoring				Stevedoring				Stevedoring			
Trimming		2.5d	per ton	Trimming		2.5d	per ton	Trimming		2.5d	per ton	Trimming		2.5d	per ton
Wharfage		2.0d	per ton	Wharfage		2.0d	per ton	Wharfage		2.0d	per ton	Wharfage		2.0d	per ton
Pier and Mooring		£2.0	per ship	Pier and Mooring		£2.0	per ship	Pier and Mooring		£2.0	per ship	Pier and Mooring		£2.0	per ship
Towage		3.0d	per grt	Towage		3.0d	per grt	Towage		3.0d	per grt	Towage		3.0d	per grt
Other 3		£2.0	per ship	Other 3		£2.0	per ship	Other 3		£2.0	per ship	Other 3		£2.0	per ship
Export port totals															
Tonnage		£7.3		Tonnage		£14.5		Tonnage		£14.5		Tonnage		£14.5	
Pilotage		£5.0		Pilotage		£5.0		Pilotage		£5.0		Pilotage		£5.0	
Stevedoring				Stevedoring				Stevedoring				Stevedoring			
Trimming		£15.1		Trimming		£15.1		Trimming		£15.1		Trimming		£15.1	
Wharfage		£12.1		Wharfage		£12.1		Wharfage		£12.1		Wharfage		£12.1	
Pier and Mooring		£2.0		Pier and Mooring		£2.0		Pier and Mooring		£2.0		Pier and Mooring		£2.0	
Towage		£10.9		Towage		£10.9		Towage		£10.9		Towage		£10.9	
Other 3		£2.0		Other 3		£2.0		Other 3		£2.0		Other 3		£2.0	
Total		£54.3		Total		£61.6		Total		£61.6		Total		£61.6	
Import port tariffs															
	dwt	1450		fx	dwt	1450		fx	dwt	1450		fx	dwt	1450	
	grt	870		20.43	grt	870		25.3	grt	870		25.3	grt	870	
	nrt	580			nrt	580			nrt	580			nrt	580	

(continued)

Table 17: (Continued)

Tonnage		1.0d	per grt	Tonnage		107		Tonnage		0.3	per grt	Tonnage		0.5	per grt
Pilotage		£5.0		Pilotage		302		Pilotage		0.3	per grt	Pilotage			
Stevedoring		4.0d	per cargo tonne	Stevedoring		1137		Stevedoring		0.1	per tonne	Stevedoring		1	per tonne
Trimming				Trimming				Trimming				Trimming			
Wharfage				Wharfage				Wharfage				Wharfage			
Other 1 Dues and rent on shipping		9.0d	per grt	Other 1 Dues and rent on shipping				Other 1 Dues and rent on shipping		0.5	per grt	Other 1 Dues and rent on shipping		1	per nrt
Other 2 Towage				Other 2 Towage				Other 2 Towage		100	fr per ship	Other 2 Towage		0.77	per grt
Other 3				Other 3		97.5		Other 3		250	fr per ship	Other 3			
Import port totals															
Tonnage		£3.6		Tonnage		£5.2		Tonnage		£10.3		Tonnage		£17.2	
Pilotage		£5.0		Pilotage		£14.8		Pilotage		£11.6		Pilotage			
Stevedoring		£24.2		Stevedoring		£55.7		Stevedoring		£5.7		Stevedoring		£57.4	
Trimming				Trimming				Trimming				Trimming			
Wharfage				Wharfage				Wharfage				Wharfage			
Other 1 Dues and rent on shipping		£32.6		Other 1 Dues and rent on shipping				Other 1 Dues and rent on shipping		£17.2		Other 1 Dues and rent on shipping		£23.0	
Other 2 Towage				Other 2 Towage				Other 2 Towage		£4.0		Other 2 Towage		£26.5	
Other 3				Other 3		£4.8		Other 3		£9.9		Other 3		£10.0	
Total		£65.4		Total		£80.4		Total		£58.8		Total		£134.1	
Voyage assumptions															
Distance loaded		520	miles	Distance loaded		814		Distance loaded		369		Distance loaded		439	
Distance ballast		311	miles	Distance ballast		417		Distance ballast		369		Distance ballast		439	

Steaming speed		8	knots per hour	Steaming speed		8		Steaming speed		8		Steaming speed		8	
Steaming days		4.3	days	Steaming days		6.4		Steaming days		3.8		Steaming days		4.6	
Load days		1.75	days	Load days		1.75		Load days		1.75		Load days		1.75	
Discharge days		1.75	days	Discharge days		2.25		Discharge days		4.0		Discharge days		4.0	
RV days		7.8		RV days		10.4		RV days		9.6		RV days		10.3	
Cycle low freight rates		sh	d			sh	d			sh	d			sh	d
Freight rate		3	6	Freight rate		4	2	Freight rate		3	9	Freight rate		4	9
Freight rate		£0.2		Freight rate		£0.2		Freight rate		£0.19		Freight rate		£0.24	
Fuel consumption		10	tonnes per day	Fuel con-sumption		10	tonnes per day	Fuel con-sumption		10	tonnes per day	Fuel consumption		10	tonnes per day
Fuel price		12	sh per tonne	Fuel price		12	sh per tonne	Fuel price		12	sh per tonne	Fuel price		12	sh per tonne
Time charter rate equivalent															
Freight revenue		£253.8		Freight revenue		£302.1		Freight revenue		£271.9		Freight revenue		£344.4	
Commission		£12.7		Commission		£15.1		Commission		£13.6		Commission		£17.2	
Fuel costs		£26.0		Fuel costs		£38.5		Fuel costs		£23.1		Fuel costs		£27.4	
Port charges		£119.7		Port charges		£142.0		Port charges		£120.3		Port charges		£195.7	
TCE		£95.4		TCE		£106.5		TCE		£114.9		TCE		£104.1	
tce per day		£12.2		tce per day		£10.2		tce per day		£12.0		tce per day		£10.1	

2. Conclusions

In this article we have suggested new methods for analysing historic developments in freight rates. We have applied these methods to the coal coastal collier markets. The cliometric top down approach has been presented. Its attraction lies in:

a. the appeal and relevance of the arbitrage principle to the tramp shipping markets;
b. the simplicity of the resulting mathematical structure;
c. the ease of implementation;
d. the ability to tidy up several strands of shipping research; and
e. the nature of the new queries that arise when results do not conform to expectations or other evidence.

However, when applied to the coastal collier market, certain inconsistencies arose. We believe, that the cliometric top down approach requires quality raw data and deep understanding of the structure of the network and its potential instability. Network instability can be an advantage for the econometric investigation but needs to be monitored, and any changes properly detected and modeled. This is not difficult to implement but the scope of this first attempt has not reached that far.

However, we do not think that the inconsistencies of the cliometric approach reflect network instability. Instead we highlight that small changes in the assumptions of the commercial features of the representative tramper, produce rather large shifts in end results. This suggests that future research requires a sharpening of the pencil at this front.

The bottom up approach was also applied to the coast collier market. This gave results which seem to be more consistent with evidence and expectations. The fact that two alternative variations of the bottom up approach gave very similar results, reinforce the appeal of these methods. They also reinforce the faith in the validity of the end results.

Looking ahead, the inter-relationship of freights that Lewis (1941) highlights, seem to be an extremely fruitful approach for tidying up several strands of research and for gaining insights and knowledge into some of the hitherto darkest areas of maritime economic history. The network route

portfolio approach is the way forward for historic freight rate analysis. A combination of top down and bottom up approaches, sheds more light and triggers more interesting questions for further research, when pursued in combination rather than isolation.

Appendix — Data Sources

Newcastle Courant: 1848–1870
Colliery Guardian: 1870–1936
Northern Echo: 1881–1882
Glasgow Herald: 1887–1900
Iron and Coal Trades Review: 1870–1890
Goodliffe & Smart: 1850–1855
Western Mail: 1879–1880, 1882–1900
South Wales Coal Annual: 1902–1936
The Compendium of Commerce: 1916–1934
Coal and Iron: 1896–1915
Cardiff Times: 1858–1868
Cardiff Shipping Mercantile Gazette: 1869–1870
South Wales Coal, Iron and Freight Statistics: 1874
Dock and Port Charges of United Kingdom: various editions
Dues and Charges on Shipping in Foreign Ports: various editions

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References

Allen, E.E. (1855): “On the comparative cost of transit by steam and sailing colliers, and on the different modes of ballasting”, *Proceedings of the Institute of Civil Engineers*. 14, 318–373.

Armstrong, J. (1991): “The shipping depression of 1901 to 1911: the experience of freight rates in the British coastal coal trade”, *Maritime Wales*, No. 14, 99–100.

Armstrong, J. (1993): “The English Coast Trade, 1890–1910: Why calculate figures when you can collect them?”, *Economic History Review, Second Series, XLVI*, No. 3, 607–609.

Armstrong, J. (1994): “Late nineteenth-century freight rates revisited: some evidence from the British Coastal Coal Trade”, *International Journal of Maritime History*, Vol. VI, No. 2, 45–81.

Brautaset, C. and Grafe R. (2006): “The quiet transport revolution: returns to scale, scope and network density in Norway’s 19th century sailing fleet”, *University of Oxford. Discussion Papers in Economic and Social History*.

Brigden, J.B. (1930): “Australian overseas shipping”, *The Economic Record*, Vol 6.

Broeze, F.J.A. (1975): “The cost of distance: shipping and the early Australian economy”, 1788–1850, *The Economic History Review*, 28:4, 582–597.

Burley, K.H. (1929): “The overseas trade in New South Wales coal and the British shipping industry,

1860–1914”, *The Economic Record*, 36, 394–395.
Clark, X. *et al*. (2002): “Maritime Transport Costs and Port Efficiency”, *The World Bank Development Research Group.*
Crafts, N. (2003): Steam as a General Purpose Technology: A Growth Accounting Perspective. Working Paper No. 75/03. London School of Economics.
Davis, H. (1894): "California breadstuffs", *Journal of Political Economy*, 2, 517–535 and 600–612.
Davis, R. (1957): "Earnings of capital in the English shipping industry, 1670–1730", *The Journal of Economic History*, 17:3, 409–425.
Dijk, H.V. and Pinheiro, M.A. (2003): "The changing fact of European ports as a result of their evolving use since the nineteenth century", *Portuguese Journal of Social Science*, 2, 89–103.
Driel, H.V. (2002): "Innovation and integration in mineral bulk handling in the port of Rotterdam, 1886–1923", *Business History*, 44:3, 63–90.
Evans, R. (1964): “Without regard for cost: The returns on clipper ships”, *The Journal of Political Economy*, 72:1, 32–43.
Fischer, L.R. and Nordvik, H.W. (1987): “Myth and reality in Baltic shipping: the wood trade to Britain”, 1863–1908”, *Scandinavian Journal of History*, 12, 99–116.
Graham, G.S. (1956): "The ascendancy of the sailing ship 1850–85", *The Economic History Review*, 9:1, 75–88.
Harley, K.C. (1970): "British shipbuilding and merchant shipping: 1850–1890", *The Journal of Economic History*, 30:1, 262–266.
Harley, K.C. (1971): “The shift from sailing ships to steamships, 1850–1890. A study in the technological change and its diffusion”, in McCloskeym, D.N. (ed.) *Essays on a Mature Economy: Britain after 1840*, (Princeton, Princeton University Press), Chap. 6, pp. 215–231.
Harley, K.C. (1988): “Ocean freight rates and productivity, 1740–1913: the primacy of mechanical invention reaffirmed”, *Journal of Economic History*, 48, 851–876.
Harley, K.C. (1989): “Coal exports and British shipping, 1850–1913”, *Explorations in Economic History*, 26, 311–338.
Harley, K.C. (1990): “North Atlantic shipping in the late nineteenth century: Freight rates and the interrelationship of cargoes”, in Fischer, L.R. and Nordvik, H.W. (eds.), *Shipping and Trade, 1750-1950: Essays in International Maritime History*, (Pontefract), pp. 147–171.
Hausman, W.J. (1987): “The English coastal coal trade 1691–1910: how rapid was productivity growth?”, *Economic History Review, Second Series, XL*, No. 4, 588–596.
Hausman, W.J. (1993): “Freight rates and shipping costs in the English coastal coal trade: A reply”, *Economic History Review, XLVI*, No. 3, 610–611.
Hummels, D. (2001): “Have international transportation costs declined?” *Journal of International of Economics*, 54:1, 75–96.
Hobson, C.K. (1914): *The export of capital* (Constable and Company Ltd).
Hummels, D. (2007): “Transportation cost and international trade over time”, *Journal of Economic Perspective*, 21:3, 131–154.
Isserlis, L. (1938): “Tramp shipping cargoes, and freights”, *Journal of the Royal Statistical Society*, 101:1, 53–146.
Jacks, D.S. and Pendakur K. (2007): *Global Trade and the Maritime Transport Revolution* (Simon

Fraser University).
Jones, P.W. (2005): *Maritime Transport Costs and Port Efficiency*: *A Historical Perspective* (Economic Development Institute).
Kaukiainen, Y. (1990): "The development of gross freight and profitability in international sailing ship trades, 1860–1914: a Finnish sample", *Studies in Social and Economic History*, 10, 64–73.
Kiaer, A.N. (1893): "Historical sketch of the development of Scandinavian shipping", *The Journal of Political Economy*, 1:3, 329–364.
Klovland, J.T. (2002): "Business cycles, commodity prices and shipping freight rates: Some evidence from the pre-WWI period", *SNF Report No. 48/02.*
Klovland, J.T. (2004): A Repeat Sailings Index of Ocean Freight Rates for the 1850s. Norwegian School of Economics and Business Administration.
Knauerhase, R. (1967): "The compound marine steam engine", *A Study in the Relationship Between Technological Change and Economic Development*, 27:4, 615–617.
Knauerhase, R. (1968): "The compound steam engine and productivity changes in the German merchant marine fleet, 1871–1887", *The Journal of Economic History*, 28:3, 390–403.
Kuczynski, R.R. (1902): "Freight-rates on Argentine and North American Wheat", *The Journal of Political Economy*, 10 (June), 333–360.
Lewis, W.A. (1941): "The inter-relations of shipping freights", *Economica*, 8:29, 52–76.
Lower, A.R.M. (1933): "The trade in square timber", *Contributions to Canadian Economics*, 6, 40–61.
Lundgren, N.G. (1996): "Bulk trade and maritime transport costs: The evolution of global markets", *Resources Policy*, 22, 5–32.
Maywald, K. (1956): "The construction costs and the value of the British merchant fleet, 1850–1938", *Scottish Journal of Political Economy*, 3, 44–66.
Merrill, R.T. (1924): "The movement of raw materials and foodstuffs in international commerce and its relation to shipping", *Annals of the American Academy of Political and Social Science*, 234–240.
Mohammed, S.I.S. and Williamson, J.G. (2004): "Freight rates and productivity gains in British tramp shipping 1869–1950", *Explorations in Economic History*, 41, 172–203.
Moneta, C. (1959): "The estimation of transportation cost in international trade", *The Journal of Political Economy*, 67(Feb), 41–58.
North, D.C. (1958): "Ocean freight rates and economic development 1750–1913", *Journal of Economic History*, 18, 537–555.
North, D.C. (1965): "The role of transportation in the economic development of North America", in *Les grandes voies maritimes dans le monde XV–XIX sicles* (Paris).
North, D.C. (1968): "Sources of productivity change in ocean shipping, 1600–1850", *The Journal of Political Economy*, 76, 953–970.
Palmer, S. (1979): "The British coal export trade, 1850–1913", in Alexander, D. and Ommer, R. (eds.) *Volumes not Values: Canadian Sailing Ships and World Trades* (St John's), pp. 333–354.
Paul, R.W. (1958): "The wheat trade between California and the United Kingdom", *Mississippi Valley Historical Review*, 45:3, 391–412.
Persson, K.G. (2004): "Mind the Gap! Transport Costs and Price Convergence in the nineteenth

Century Atlantic Economy", *Europe Review of Economic History*, 8, 125–147.
Rydell, R.A. (1949): "The California Clippers", *The Pacific Historical Review*, 18:1, 70–83.
Sanders, R.Y. (1924): "Foreign Trade and Shipbuilding", *Journal of the Royal Statistical Society*, 87:2, 220–255.
Singleton, J. (2006): "Freight rates for Australian wheat exports, c. 1870–1939 and the globalization hypothesis", *International Economic History Congress, Helsinki*.
Sparks. T.A. (1914): "Relation of the contractor or speculator to the world's ocean transportation problem", *Annals of the American Academy of Political and Social Science*, 55, 232–236.
Stemmer, J.E.O. (1989): "Freight rates in the trade between Europe and South America, 1840–1914", *Journal of Latin American Studies*, 21:1, 23–59.
Swan, D. (1960): "The pace and progress of port investment in England 1660–1830", *Yorkshire Bulletin of Economic and Social Research*, 12, 32–44.
Thomas, D.A. (1903): "The growth and direction of our foreign trade in coal during the last half century", *Journal of the Royal Statistical Society*, Vol 66:3, 439–533.
Walton, G.M. (1968): "A measure of productivity change in American colonial shipping", *The Economic History Review*, 21:2, 268–282.
Whitlam, A.G. (1930): "Australian port charges", *Economic Record*, Vol 6.
Wicksell, K. and Taussig, F.W. (1918): *The Quarterly Journal of Economics*, 32:2, 404–414.
Vergottis, A. and Frangos, K. (2005): "Back to the future", *Marine Money*, Sep 2005.
Ville, S.P. (1987): "Defending productivity growth in the English coal trade during the eighteenth and nineteenth centuries", *Economic History Review. Second Series, XL*, No. 4, 597–602.
Yamada, H. (1964): "A time series analysis of post-war fluctuations in shipping freights", *The Kyoto University Economic Review*, 34:2, 57–80.
Yasuba, Y. (1978): "Freight rates and productivity in ocean transportation for Japan, 1875–1943", *Explorations in Economic History*, 15, 11–39.

Part Four
Economics of Shipping Sectors

Chapter 11

An Overview of the Dry Bulk Shipping Industry

*Amir H. Alizadeh and Nikos K. Nomikos**

1. Introduction

Dry bulk shipping was developed as a result of the need to reduce transportation costs when shipment size of commodities increased enough for the commodity to be carried in shiploads and economies of scale could be utilised. This goes back to the nineteenth century when small wooden ships, fully laden with coal, were employed to meet the increasing demand for coal transportation between North England and London. Nowadays, the number of commodities carried on a "one ship, one cargo" basis has increased, thanks to world economic growth, increased demand for raw materials and energy commodities, liberalisation in international trade, trans-nationalisation of industrial processes as well as technological advances in shipbuilding and design. The growth in international trade led to a corresponding expansion of the bulk shipping fleet to match the requirements of seaborne bulk trade.

The total seaborne trade in commodities reached an estimated 8,128 million metric tonnes (mmt) in 2008. Figure 1 illustrates the evolution of seaborne trade in major dry and liquid bulk commodities between 1965 and 2008. It can be seen that the volume of international seaborne trade has increased from 1,750 million to more than 8,226 million tonnes over the same period, representing an average annual growth rate of 3.5%. The largest proportion of the seaborne trade was in dry bulk commodities with an estimated quantity of 3,065 mmt, followed by liquid bulk commodities, 2,950 mmt and other dry cargo and manufactured goods, 2,114 mmt.[1] More specifically, the dry bulk shipping fleet transported 843 mmt iron ore, 795 mmt coking and steam coal, 322 mmt grains, 107 mmt of bauxite, alumina and phosphate rock and 1,105 mmt of minor dry bulk commodities such as cement, sugar, fertilisers, etc., which makes the dry bulk shipping market by far the largest sector of the world shipping industry in terms of volume and weight. In fact, at the end of 2009, the cargo carrying capacity of the world dry bulk fleet of 418 million tonnes was 34.7% of the total world shipping fleet and the number of dry bulk ships exceeded 7,300 (see endnote 1).Therefore, it is not surprising that a large number of studies have been devoted to analysing the formation and behaviour of

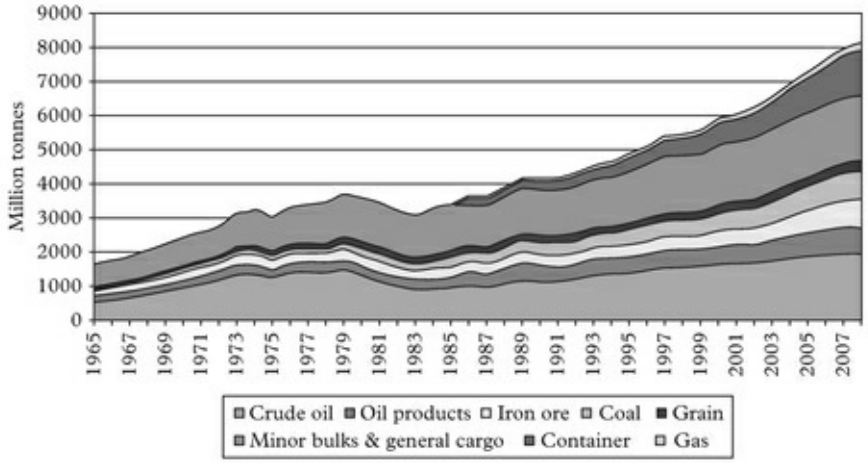

Figure 1: Pattern of international seaborne trade in major commodities

Note: Container and natural gas seaborne trade data are available from 1986.

Source: Clarkson's SIN

dry bulk freight (charter) rates, chartering decisions and policies, transportation strategies and fleet deployments and operations of the dry bulk shipping industry.

Additionally, technological developments led to more sophisticated and larger ship designs, aiming not only to realise the economies of scale, but also to match specific cargo and trading route requirements. The latter depend very much on commodity trade patterns and industrial production processes in the world economy.

The purpose of this chapter is to provide an overview of the dry bulk shipping market and discuss current issues and developments in this area. In particular, we discuss the segmentation of the dry bulk shipping market into different sub-sectors due to different physical and economic factors such as commodity parcel size, the underlying shipping routes, the physical characteristics of the loading and discharge ports as well as the vessel's design features. We also present the structure of the shipping markets as well as the theory for the determination of freight rates. Additionally, we present empirical evidence on issues relating to the properties of the dry bulk shipping freight rates. These issues include the seasonal behaviour of the freight market; testing the dynamic interrelationships between freight rate levels and volatilities for different size vessels in the spot and period markets; testing the expectations hypothesis of the term structure and modelling time-varying risk premia in the formation of long-term rates and finally, investigating the existence of time-varying risk premia in the market for newbuilding and second-hand vessels.

The structure of this chapter is as follows. The next section describes the structure of the dry bulk market and its contribution to the international transport by connecting the sources of supply and demand for raw materials. Section 3 reviews the formation of spot and time-charter freight rates and discusses important issues regarding the behaviour of these rates such as seasonality, volatility and market efficiency. The relationship between freight rates for contracts with different duration as well as interrelationship and spill over effect between freight rate levels and volatilities across segments of the dry bulk market are also discussed in section 3. Section 4, first presents the determination of dry bulk ship prices and then reviews the behaviour of prices in newbuilding, second-hand and scrap prices for dry bulk ships. The issue of efficiency of the market for dry bulk ships is also considered and findings of some recent studies are discussed. Finally, section 5 concludes this chapter.

2. Market Segmentation Within the Dry Bulk Shipping Industry

The significant growth in international seaborne commodity trade along with developments in the shipbuilding industry in the past 50 years or so is a manifestation of the liberalisation in international trade and the inherent economies of scale existent in seaborne commodity transportation. This has encouraged the construction of specialised ships of various sizes, which can be employed in the transportation of certain types of commodities over certain trading routes. Therefore, within the dry bulk sector, different sub-markets with distinctive characteristics in terms of supply and demand features, operational characteristics, risk and profitability, have been developed. Generally speaking, the decision to hire a certain type of vessel for ocean transportation of a certain commodity depends on three main factors; first, the type of the commodity to be transported; secondly, the parcel size and thirdly, the trade route and the physical characteristics and infrastructure at the loading and discharge ports.

For the purposes of shipping operations, market analysis and research, commodities are generally

distinguished into the following categories: liquid bulk, dry bulk, general cargo and unitised (containers). There are also specialised cargoes such as natural gas, refrigerated cargoes, automobiles, forest products and live-stocks, which require special types of ships for transportation. Since it is the type of commodity that determines which type of ship the charterer (cargo owner or shipper) requires for the transportation of his/her cargo, any change in the trade pattern for that commodity is reflected in the demand and freight rates for different types of vessels. For example, in the past two decades industrial developments in the Far East, especially South Korea and China have increased the demand for capesize vessels in that region. As another example, the demand for capesize vessels in the Atlantic has been reduced due to an increase in the European Union's (EU) grain production and a corresponding decline in EU's grain imports from the United States after the 1980s.

The second factor that a charterer should bear in mind before taking any decision to hire a vessel is the conventional shipment size of each commodity, generally known as the "commodity parcel size". This is defined as the amount of cargo, in tonnes, that can be carried by sea considering the economies of scale and associated transportation and storage costs for that commodity. The commodity parcel size also depends on the economics of the industrial process or consumption of such commodities as raw materials for industrial goods and other finished products. For certain commodities such as iron ore, crude oil and coal, the economies of scale in sea transportation have reduced the transportation costs to such an extent that it is most economical to hire large vessels for carriage of these commodities by sea. Therefore, parcel sizes for those commodities are quite large (e.g. for iron ore 80,000 to 300,000 tonnes). However, agricultural commodities are carried in smaller shipments, e.g. from 12,000 to 60,000 tonnes, again depending on the type of cargo transported. This is mainly because of the perishable nature of those commodities and the fact that they need specialised storage facilities (e.g. special storage silos). Therefore, traders prefer smaller shipments as it enables them to store and market these products in time. In addition, the higher storage and inventory costs of agricultural commodities and oil products, compared to lower value goods such as iron ore and coal, suggest that it is more economical to transport these commodities in smaller consignments.

Finally, when the shipper is deciding which size vessel to hire, he must consider factors such as the trading route, the physical characteristics of ports of loading and discharge, such as berth size and draught, as well as the existence of cargo handling facilities at the ports. The draught factor is important because large ships with deep draughts cannot approach ports with shallow harbours and the costs of lightening them at the anchorage should be compared against the capacity loss when using smaller vessels. In ports where cargo-handling facilities are lacking, small and geared vessels are needed. In general, shippers try to minimise the associated transportation costs by hiring an optimal size vessel after considering all the above named factors, which led to segmentation of the dry bulk shipping into five different sectors according to the cargo carrying capacity of the vessels. These are Handysize (25,000–35,000 dwt), Handymax (35,000–45,000 dwt), Supramax (45,000–55,000), Panamax (55,000–75,000 dwt) and Capesize (80,000 dwt and over, mainly 120,000, 150,000 and 175,000 dwt) markets. Historical growth and the composition of the dry bulk fleet in terms of vessel size, is presented in Figure 2. At the end of 2009, the world dry bulk fleet consisted of 2,861 Handysize vessels with total capacity of 76.43 mdwt; 1,856 Handymax vessels with a total capacity of 91.4 mdwt; 1,627 Panamax vessels with a total capacity of 120.76 mdwt; and 939 Capesize vessels with a total capacity of 166.93 mdwt.

Table 1 summarises the associated cargo types and major trading routes that dry bulk vessels serve. For instance, Handysize and Handymax vessels are mainly engaged in the transportation of grain commodities from North and South America and Australia

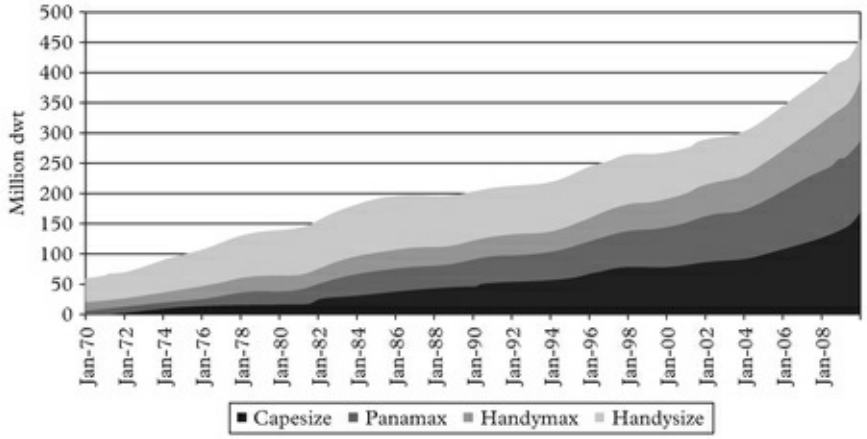

Figure 2: Historical growth of world dry bulk fleet by size category
Source: Clarkson's SIN

Table 1: Different size vessels with their respective cargo and routes

Class of Bulk Carriers	Commodities (percentage of total shipments)				
	Iron Ore	**Coal**	**Grain**	**Bauxite & Alumina**	**Phosphate Rock**
Capesize	70%	45%	7%	–	–
Panamax	22%	40%	43%	45%	20%
Handy class	8%	15%	50%	55%	80%
	Major Routes				
Capesize (80k + dwt)	• Brazil to Western Europe and the Far East; • W. Australia to Western Europe and the Far East	• E.Australia to Far East, Japan and Western Europe • South Africa to Western Europe and the Far East	• Argentina and River Plate to Near East and East Europe		
Panamax (55k–75k dwt)	• Brazil to Western Europe and the Far East • Australia to Western Europe and the Far East	• North America to Japan and Western Europe • E. Australia to Far East, Japan and Western Europe	• North America to Far East, Western Europe and Near East		
Handy class (25k–55k dwt)	• India to the Far East • Canada to USA and Japan • Liberia and Mauritania to Western Europe	• South Africa to Far East and Europe	• Australia to Far East, Japan and Middle East; • North America to Africa and West Europe	• Caribbean to North America and Western Europe • West Africa to Western Europe and Japan • Australia to Japan and Western Europe	• Morocco to Western Europe • Russia to Western Europe • US to Japan and Western Europe

to Europe and Asia and minor dry bulk commodities such as bauxite and alumina, fertilisers, rice, sugar, steel and scrap around the world. Due to their small size, shallow draught and cargo handling gears, these vessels are quite flexible in terms of the trading routes and ports that they can serve. Panamax and Supramax vessels are used primarily in coal, grain and to some extent in iron ore transportation, from North America and Australia to Japan and Western Europe. These vessels are not equipped with cargo handling gears and have deeper draught; therefore, they are engaged in transportation of fewer commodities than Handysize bulk carriers, as they are not as flexible. The majority of the Capesize fleet is engaged in the transportation of iron ore from South America and Australia to Japan, Western Europe and North America and also in coal transportation from Australia and North America to Japan and Western Europe. Due to their deep draught and limited number of commodities that they transport, the operation of these vessels in terms of trading routes and ports they can approach is restricted.

It has also been argued in the literature that the risk/return characteristics of dry bulk carriers vary

across vessel sizes. In particular, Kavussanos,[2,3] and Alizadeh and Nomikos[4] show that freight rate volatilities and second-hand ship price volatilities are higher for larger vessels compared to smaller ones and relate such differences to operational flexibility and trading restrictions of larger vessels. This strong contrast in risk/ return and operational profitability among different size of dry bulk carriers stems from differences in their supply, demand, freight rate and price determination factors which reflect their trading and operational flexibility. This in turn implies a high degree of disaggregation in this shipping sector.

3. The Dry Bulk Freight Market

A freight contract is an agreement under which the shipowner agrees to provide a sea transportation service to the charterer or shipper for a specified amount of money per day for ship hire, or per tonne of cargo transported between two ports, known as the freight rate. This service is provided under certain contractual agreements and documentation, known as the charter party. Depending on the type and duration of the service required by charterers, different types of charter contracts have been developed and used in international shipping. These can be classified into five main types: Voyage Charter Contract; Contract of Affreightment (CoA); Trip Charter Contract; Time-Charter Contract; and Bareboat or Demise Charter Contract. Under each type of contract, duration of the service is specified, type and the amount of cargo to be carried is agreed, methods of payment are standardised and costs and expenses are allocated to the agents involved. Charter contracts are normally negotiated between shipowners and charterers through brokers and, once the terms are agreed, the charter party is drafted and signed by the two parties. Single-voyage, trip-charter and time-characters are the most common types of contracts used in the dry bulk market. Single-voyage and trip-charter contracts, although different in their method of payment and cost allocations, can be classified as short-term or spot charter shipping contracts since they both cover only a single voyage or trip. On the other hand, time-charter contracts are long-term (period) contracts and cover more than one voyage. In the following sections we discuss the formation of freight rates under voyage and time-charter contracts and present results of recent studies on the behaviour and interrelationship of dry bulk shipping freight rates.

3.1 Spot freight rate formation

As in any other market, the shipping freight market is also characterised by supply and demand schedules (functions), each of which depends on several factors that interact constantly for the equilibrium freight rate to be determined. Therefore, to see how shipping freight rates are determined one has to study the supply and demand for freight services, their shapes and the way they behave and interact.

Starting with the demand for shipping services, it has been well documented that this is a derived demand which depends on several factors such as, world economic activity, international seaborne trade, seasonal and cyclical changes for different commodities transported by sea, the distance between sources of production and consumption of commodities (see Stopford[5]) . The supply of shipping services is the amount (tonne miles) of transportation service offered by shipowners based on the optimisation of their fleet revenue. The supply of shipping services at any point in time depends on the stock of fleet available for trading, shipbuilding production, scrapping rate and losses, fleet productivity and the level of freight rates in the market. Therefore, freight rates at any point in time,

reflect the balance between supply and demand for shipping services which, in turn, depend on factors such as world economic activity, the stock of fleet, political events, international commodity trade, etc. (Stopford (see endnote 5)).

It has also been shown in the shipping economics literature that, while demand for ocean shipping is inelastic, the supply of shipping services is convex in shape due to the limitation of supply at any given point in time. This convexity in the shape of the supply curve implies that the supply for shipping services is highly elastic at low freight rate levels (points A to B in Figure 3) and becomes inelastic when freight rates are at very high levels (points B to C in Figure 3). The reason for such bimodality of the elasticity of the shipping supply curve is the availability of excess capacity during periods when the market is in recession; that is, when vessels cannot find employment, are laid up, slow steam or even carry part cargo and freight rates are at very low levels. Under such market conditions, any changes in demand due to external factors such as seasonal changes in trade or random shocks (events) can be absorbed by the extra available capacity and, therefore, the impact on freight rates would be relatively small. For instance, in Figure 3, assuming the demand curve is D_1 and given the supply function, the equilibrium freight rate is at FR_1. An increase in demand would shift the demand curve to, say, D_2 and, assuming that in the short term the supply curve for shipping services does not move, the new equilibrium freight rate will be determined through the new intersection between the demand and supply curves. This means that the freight rate will increase to a new level, FR_2, which represents a relatively small increase compared to the increase in demand.

As market conditions improve, vessels are employed until the point where the stock of fleet is fully utilised and any increase in supply is only possible by increasing productivity through increasing speed and shortening port stays and ballast legs. Under such conditions, the supply curve becomes almost vertical and inelastic. Consequently, any changes in demand due to external factors such as seasonal change in trade, random events, etc. would result in a relatively large change in freight rate levels. For instance, in Figure 3, when freight rate is at FR_3, supply and demand schedules are very tight and the fleet is fully utilised. In this case if, due to some external factors, demand for shipping services increases and the demand curve shifts from D_3 to D_4, then assuming supply in the short term is constant, the new equilibrium freight rate shoots up from

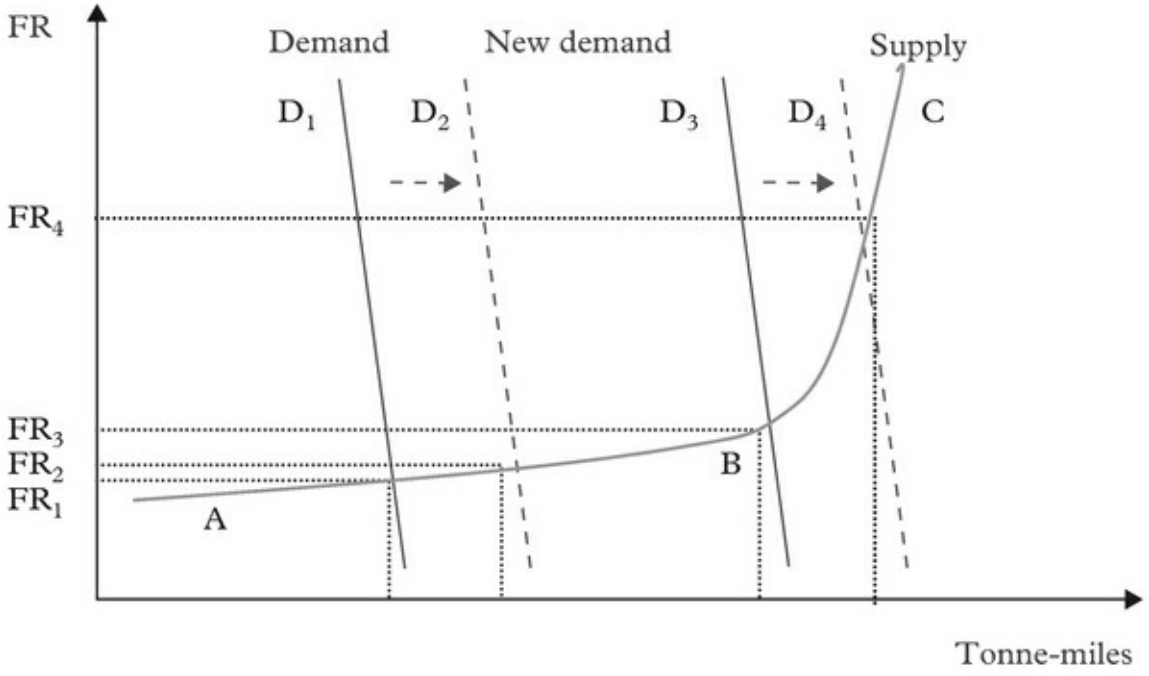

Figure 3: Market clearing supply–demand framework in shipping freight rate determination

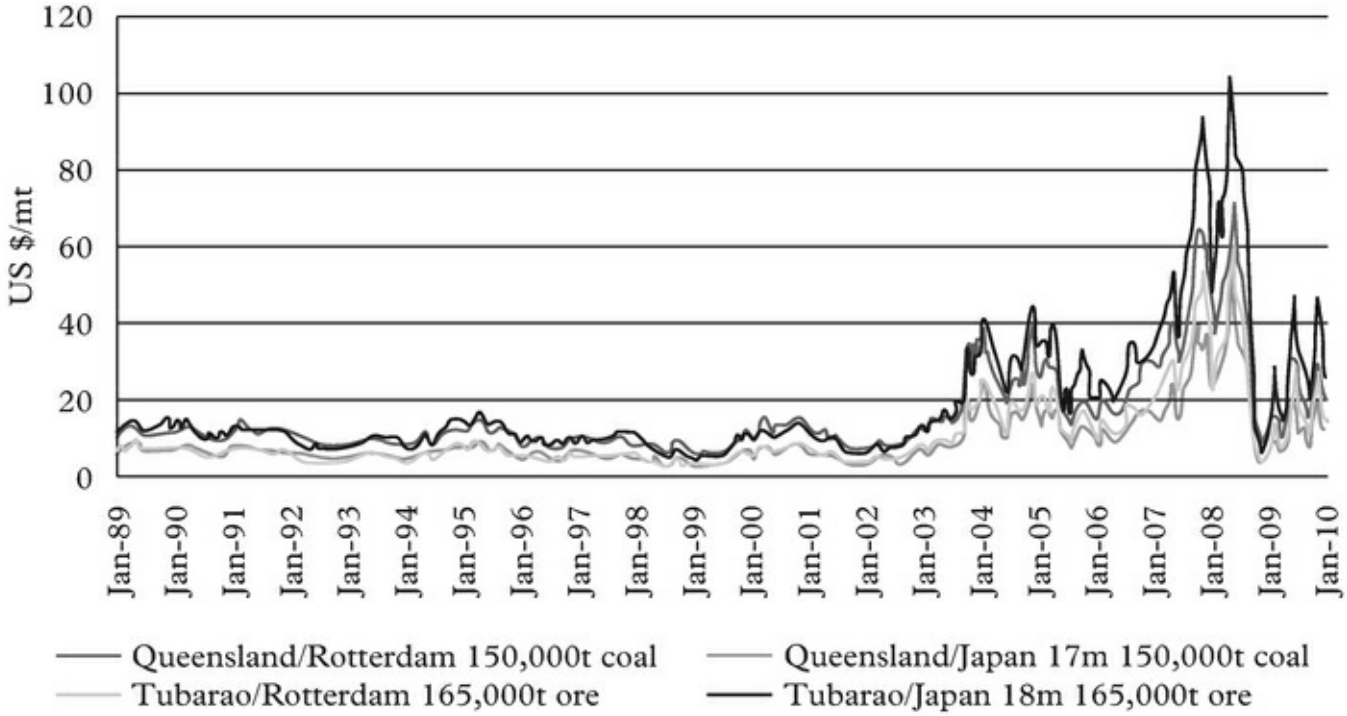

Figure 4: Historical spot freight rates for four major Capesize routes

Source: Clarkson's SIN

FR3 to FR4, which is a relatively large increase. Therefore, it can be argued that market conditions, availability of fleet and level of freight rates are important factors influencing the magnitude of price changes and volatility in the market. Alizadeh and Nomikos (see endnote 20) provide a detailed examination of the relationship between market conditions and volatility of freight rates.

Figure 4 presents historical movements of voyage or spot freight rates, in US $/mt, for Capesize vessels in four major routes: namely, iron ore from Tubarao to Japan and

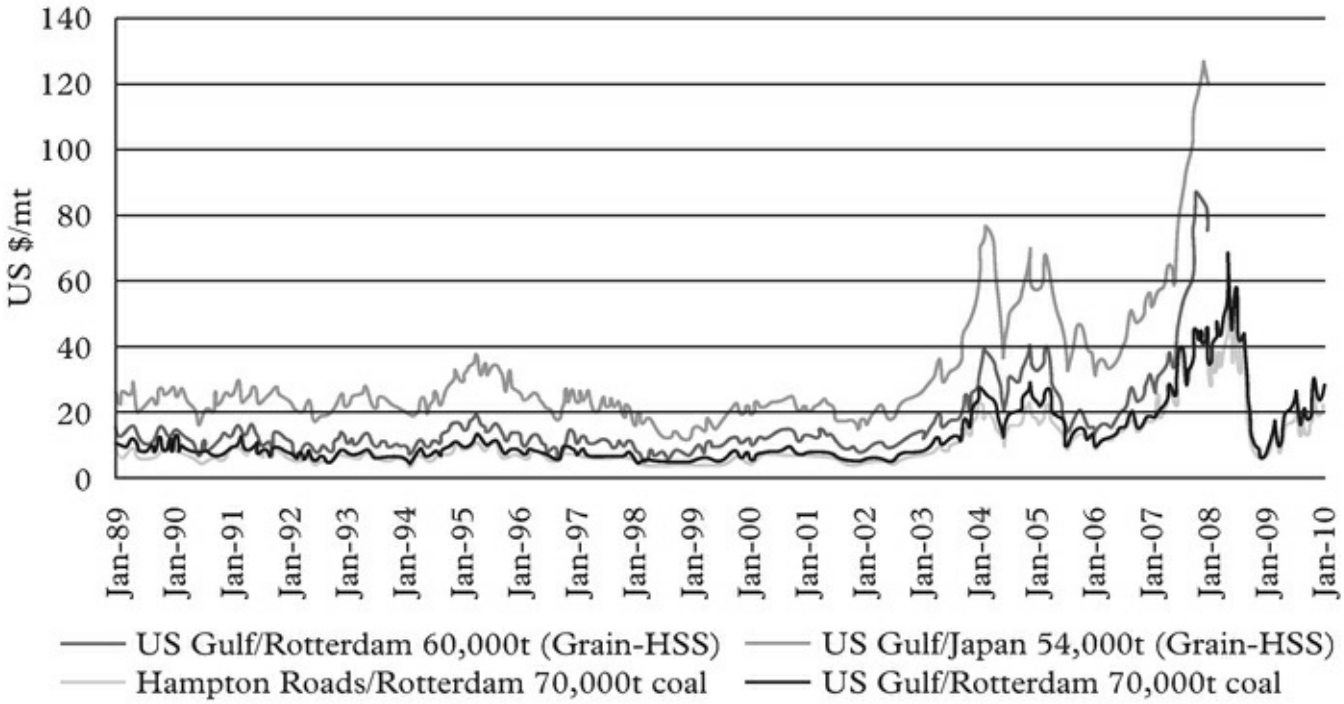

Figure 5: Historical spot freight rates for four major Panamax routes

Source: Clarkson's SIN

Rotterdam and coal from Queensland to Japan and Rotterdam. It can be seen that, while there are co-movements between the series in the long run, short-run movements are quite different across these voyage charter rate series. The existence of co-movements between the series in the long run can be explained by the fact that these rates are driven by the same common factor; that is, the aggregate demand for international commodity transport and general supply conditions for Capesize vessels and their services. Differences between the behaviour of voyage freight rates for Capesize ships in the short term are due to some distinct factors related to trade in a specific route, port conditions and the availability of tonnage over a short period in that specific route. Similarly, Figure 5 presents the historical movement of voyage charter rates for four Panamax routes, namely: grain from US Gulf to Rotterdam and Japan and coal from Hampton Roads to Rotterdam and US Gulf to Rotterdam. The reporting of grain routes has been discontinued since 2008 as the bulk of trade in those routes has shifted towards trip-charter contracts.

3.2 Time-charter rate formation

While voyage or spot freight rates are determined through the interaction between current supply and demand schedules and conditions for shipping services, time-charter or period rates are believed to be determined through the market agents' expectations about future spot rates. The theory which relates the spot rates to time-charter rates is known as the expectations hypothesis and the term structure relationship. This theory is developed in the bond and interest rate markets and first adapted and used to explain the relationship between spot and period charter rate in shipping, by Zannetos[6] and later on by Glen *et al.*,[7] Hale and Vanags[8] and Kavussanos and Alizadeh,[9] among others. *The Term Structure* relationship is based on the no arbitrage argument which states that the agents (shipowner or charterers) should be indifferent in entering into a long-term charter contract or a series of spot/voyage contracts over the life of the long-term contract. In other words, it is assumed that the freight market is efficient and agents should not be able to make excess profit by choosing to operate under either type of contract consistently.

To illustrate the *Term Structure* relationship in the shipping freight market and the formation of time-charter rates, consider the following example. At any point of time, a shipowner has the option to operate under a *n* period TC^n contract or a series of spot contracts each with a duration of *m* period (*m*<*n* and *k*=*n*/*m*) and a rate of *FR*. Obviously, the shipowner may know what is the freight rate for the first voyage, but has to adapt some form of expectations about the future evolution of spot rates over the life of the TC^n contract. Let us assume these are $E_t FR^m_{t+im}$, where E_t is the expectation operator at time *t* and also that the shipowner has to pay VC^n_t as voyage cost for the first voyage and expected $E_t VC^n_{t+im}$ for subsequent voyages. Then the shipowner should be able to compare the *TC* earnings given the expected earnings from the spot market operation. Therefore, assuming that shipping freight markets are efficient, there should not be any difference between the discounted present value of earnings from an *n* period TC^n contract and the discounted present value of a series of spot voyage, each with a duration of *m* periods. This can be written mathematically as:

$$\sum_{i=1}^{k} \frac{TC_t^n}{(1+r)^i} = \sum_{i=1}^{k} \frac{(E_t FR_{t+i}^m - E_t VC_{t+i}^m)}{(1+r)^i} \qquad k = n/m \qquad (1)$$

where, *r* is the discount rate, $E_t FR^m_{t+im}$ is the expected spot charter rate at time *t* of a contract which lasts over *m* periods from *t*+*im* to *t*+(*i*+*1*)*m* and *k*=*n*/*m* is a positive integer indicating the number of spot charter contracts in the life of a time-charter contract. $E_t VC^n_{t+im}$ is the expected voyage costs. The difference between expected spot rates, $E_t FR^m_{t+im}$ and expected voyage costs, $E_t VC^n_{t+im}$, reflects the expected earnings in the spot operation on a daily basis, or the expected time-charter equivalent of spot rates. Equation (1) can be used to derive the n period *TC* rate at time *t*, in terms of expected spot or voyage charter rates, expected voyage costs and discount rate as:

$$TC_t^n = \sum_{i=1}^{k} \frac{(E_t FR_{t+i}^m - E_t VC_{t+i}^m)}{(1+r)^i} \Bigg/ \sum_{i=1}^{k} \frac{1}{(1+r)^i} \qquad k = n/m \qquad (2)$$

However, one important difference between the spot and *TC* operations is the security of the period contract compared to the spot operation, because under a *TC* contract the shipowner is guaranteed to receive *TC* rates whatever happens to the market over the life of the period contract.[10] In contrast, under the spot operations the earnings of the shipowner may vary depending on the future condition of the spot market. Therefore, there is a risk element which should be considered in the spot and *TC* rates relationship. The risk element can be interpreted as the price that the shipowner is willing to pay to pass the uncertainty of the spot market to the charterer. This is also known as the risk premium, ø, which is in fact a discount in the *TC* rate, which the shipowner is prepared to forego in the *TC* market compared to the spot market earnings, to obtain a secure long term *TC* contract. Therefore, we can write:

$$TC_t^n = \left(\sum_{i=1}^{k} \frac{(E_t FR_{t+i}^m - E_t VC_{t+i}^m)}{(1+r)^i} \Bigg/ \sum_{i=1}^{k} \frac{1}{(1+r)^i} \right) - \phi_t \qquad k = n/m \qquad (3)$$

A number of arguments have been put forward in the literature as to why the risk premium term enters into the relationship. First, shipowners operating in the spot market are generally exposed to higher price risk in comparison to those operating in the time-charter market because spot rates show higher fluctuations compared to time-charter rates. Secondly, for a shipowner operating in the spot market,

there is the possibility of unemployment risk, when the owner may not be able to fix a voyage contract for a period of time. Thirdly, there are cases when the owner has to relocate the vessel from one port to the other for a new spot charter contract which involves substantial time and costs. Finally, if voyage spot rates (rather than trip-charter spot rates) are compared to time-charter rates, shipowners are also exposed to voyage (mainly bunker) cost fluctuations. Thus, shipowners operating in the time-charter market are prepared to offer a discount to cover the risk, to which they are exposed, when operating in the spot market. Therefore, the charterer will take the risk of operating in the spot market during the life of the time-charter contract subject to a discount over the spot rates.

Furthermore, the sentiment of the banks and lenders in shipping finance is another important factor in the shipowner's decision to operate in the spot or the time-charter market. Financiers view differently, clients (shipowners) who are committed to long term shipping contracts, when financing a ship purchase or newbuilding, since this ensures a relatively more secure stream of income for the shipowner and reduces the probability of loan default. Thus, shipowners may be prepared to forego a certain amount of earnings when fixing their vessel on a long-term contract, as opposed to short-term ones, in order to fulfil the lender's requirements for the loan. This argument can be quite important during periods of market uncertainty, suggesting that the premium might be time-varying (see Kavussanos and Alizadeh (see endnote 9)).

Figures 6 to 8 plot six-month, one-year and three-year time-charter rates for Capesize, Panamax and Handysize dry bulk carriers over the period 1992 to 2010, respectively. In general, time-charter rates seem to show less short-term fluctuations compared to spot rates. This is expected as long-term charter contracts have been argued to be a weighted average of expected spot rates over the life span of the long term contract (see, e.g. Zannetos (see endnote 6) and Glen *et al.*(see endnote 7)). Therefore, fluctuations in period rates are expected to be smoothened through the aggregation of expected spot rates, which is thought to be the underlying assumption in the formation of period rates. Moreover, period time-charter contracts are normally used by industrial and trading firms for the transportation of industrial commodities, such as iron ore and minerals, which more or less follow regular trading patterns over the year. In contrast to time-charter contracts, voyage charter contracts are generally used for transportation of commodities with irregular and cyclical patterns such as grain (see Stopford (see endnote 5)). It is also well known that industrial charterers use time-charter contracts to meet most of their long-term transportation requirements and use spot contracts for their extra needs, which might be seasonal or cyclical. This type of chartering behaviour is reflected in the patterns observed in contracts of different duration. It seems that the longer the duration of the contract, the smoother the rates.

Furthermore, the plot of time-charter rates of dry bulk carriers indicates a large increase in the levels and volatility of these rates over the past few years. More precisely, while until mid-2003 time-charter rates for Capesize vessels fluctuated roughly between 10,000 $/day to 25,000 $/day and for Panamax vessels between 6,000 $/day and 18,000 $/day, after mid-2003, fluctuations in time-charter rates for these ships have increased and rates have reached levels of 140,000 $/day for Capesize and 75,000 $/day for Panamax

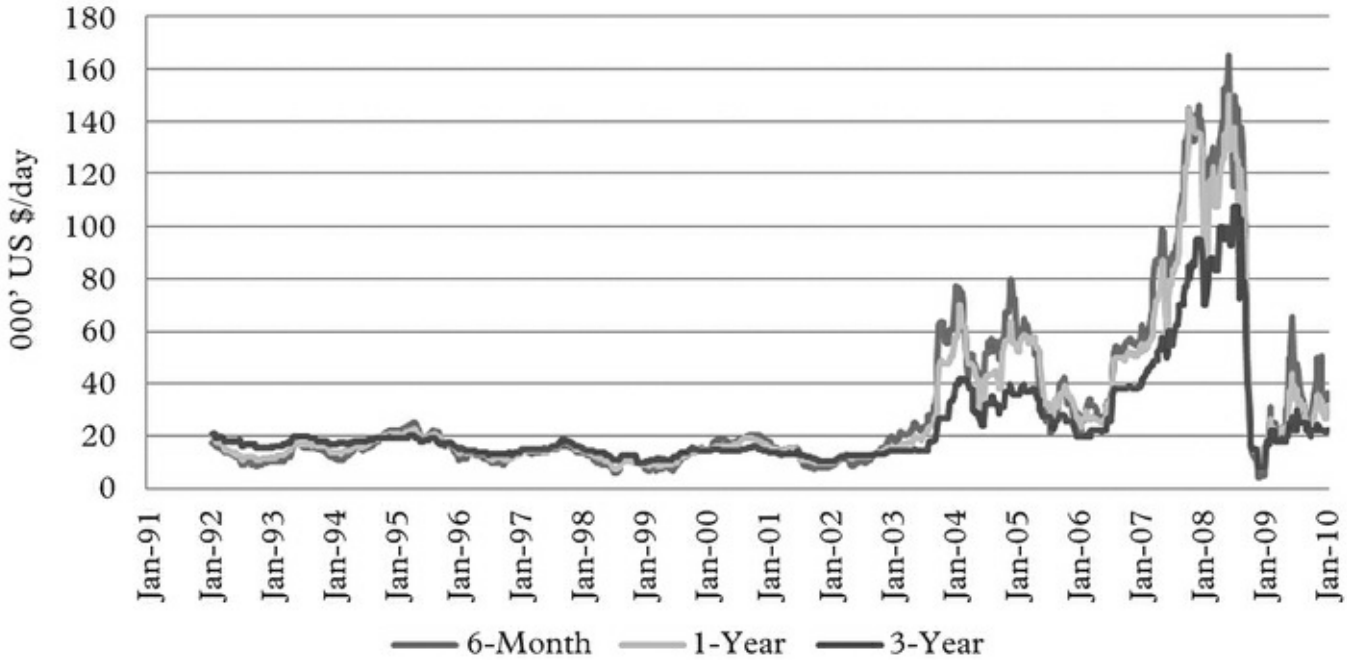

Figure 6: Historical six-month, one-year and three-year time-charter rates for Capesize dry bulk carriers

Source: Clarkson's SIN

Figure 7: Historical values of six-month, one-year and three-year time-charter rates for Panamax dry bulk carriers

Source: Clarkson's SIN

ships. The main reason time-charter rates for dry bulk carriers were pushed to such unprecedented levels was the increase in demand and shortage of supply in recent years.

3.3 Seasonal behaviour of dry bulk freight rates

In the shipping industry fluctuations in ship prices and freight rates are considerable compared to rates and prices in other sectors of the world economy. Unexpected changes

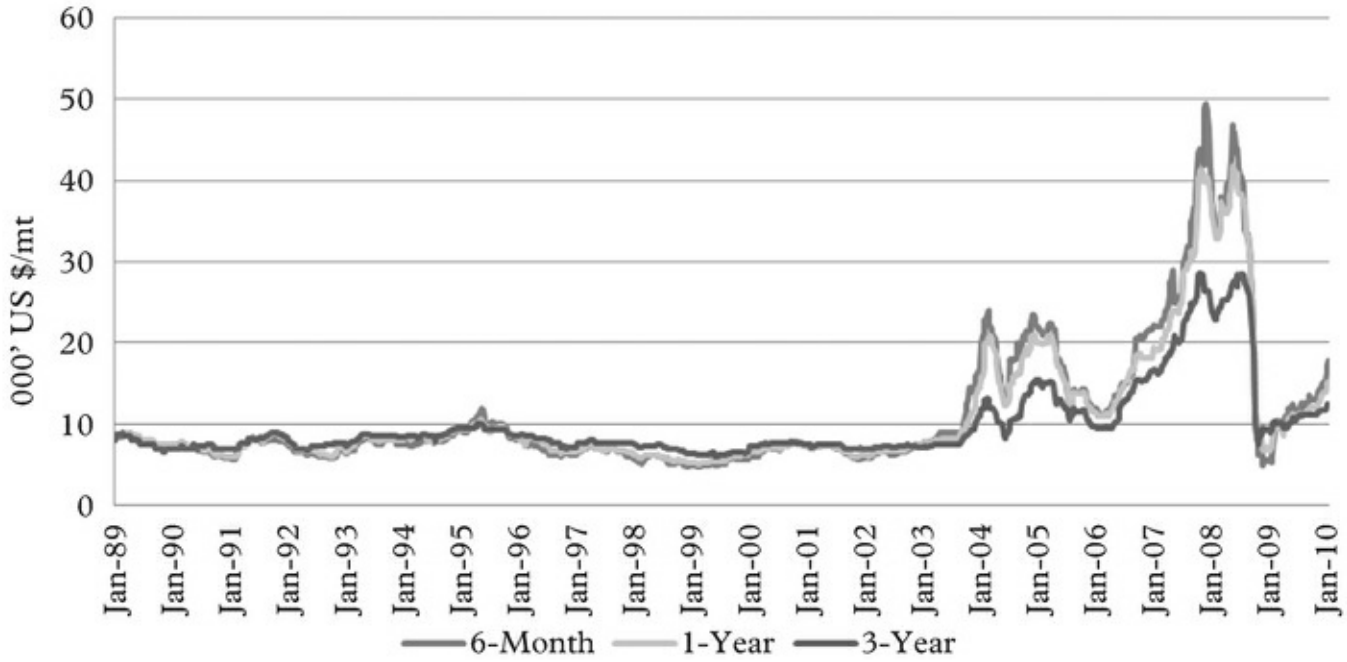

Figure 8: Historical values of six-month, one-year and three-year time-charter rates for Handysize dry bulk carriers

Source: Clarkson's SIN

and sharp movements in freight rates, over short periods of time, hinder the decision-making process whilst, at the same time, provide the opportunity for substantial gains or losses for those involved. Therefore, comprehending and analysing these movements in the market is an essential first step for any decision maker in the shipping industry.

Shipping freight rates reflect the supply-demand balance for freight services. The demand for shipping services is a derived demand, which depends on the following factors. First, the economics of the commodities transported by sea; that is, the level of production and consumption for the commodity to be transported. Secondly, the global economic conditions, world economic activity and finally macroeconomic variables of major economies, which translate to international trade in commodities. These macroeconomic variables are shown elsewhere to have random variations as well as deterministic seasonal components in most cases (Beaulieu and Miron,[11] Dickey[12] and Canova and Hansen[13]). Trade figures in several commodities are also shown to be seasonal; for instance, there are seasonal variations in the grain trade. Therefore, it is possible that those seasonalities are transmitted to shipping freight rates and prices; see for instance, Denning *et al.*[14] on seasonality of the Baltic Freight Index, BFI (see[15]).

Investigating the seasonal behaviour of shipping freight rates is important and has both economic and econometric implications. From the economic point of view, revealing the nature and true behaviour of seasonal fluctuations in freight rates can be of interest to shipowners and charterers in their chartering strategies, tactical operations and budgeting. From the econometric point of view, it is important to investigate the existence of seasonal behaviour in the freight rates for the purposes of modelling and forecasting these series. Kavussanos and Alizadeh[16] examine the seasonal behaviour of dry bulk freight rates and compare them (a) across different size vessels; (b) across freight contracts with different maturities; and (c) under different market condition. The results of their study on seasonality of freight rates for three different size dry bulk carriers are summarised in graphical form in Figures 9 to 11. Each bar indicates the

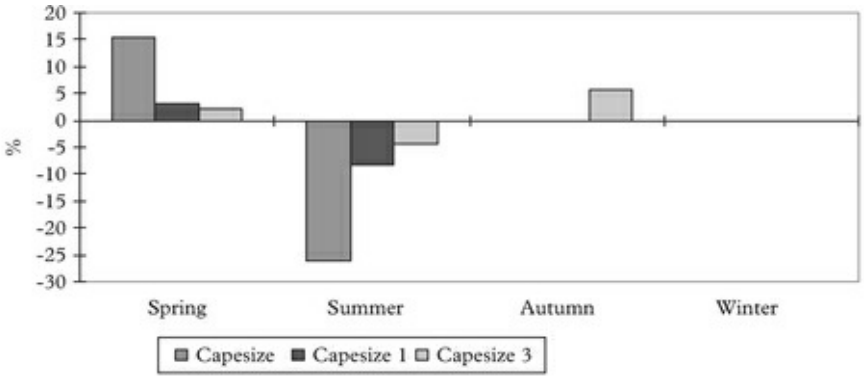

Figure 9: Comparison of seasonal changes in freight rates for Capesize dry bulk carriers

Source: Capesize, Capesize 1 and Capesize 3, represent the spot, one-year and three-year TC rates, respectively

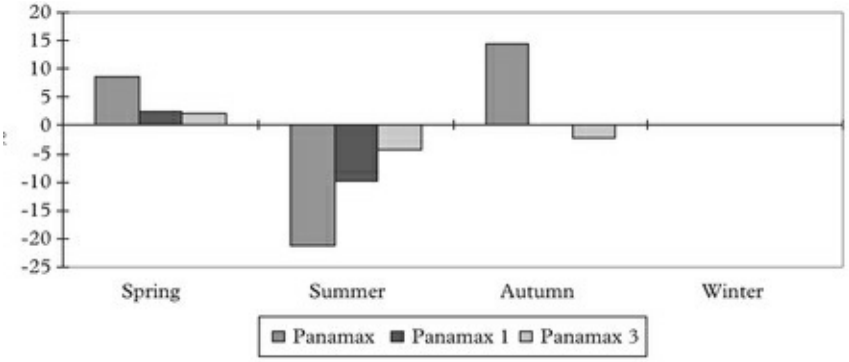

Figure 10: Comparison of seasonal changes in freight rates for Panamax dry bulk carriers

Source: Panamax, Panamax 1 and Panamax 3, represent the spot, 1-year and 3-year TC rates, respectively

average percentage increase or decrease in the freight rate over that particular season. There are several points which can be observed here.

First, freight rates for all dry bulk carriers increase significantly in the first quarter and decrease significantly in summer months. This may be due to two reasons; the reduction in the level of industrial production and trade in midsummer, or switch of spot operators to time-charter operation after the end of the Japanese and harvest-led spring upsurge, which causes an over-supply in the time-charter market. Also, since time-charter rates are linked to the current and expected spot rates, a drop in the

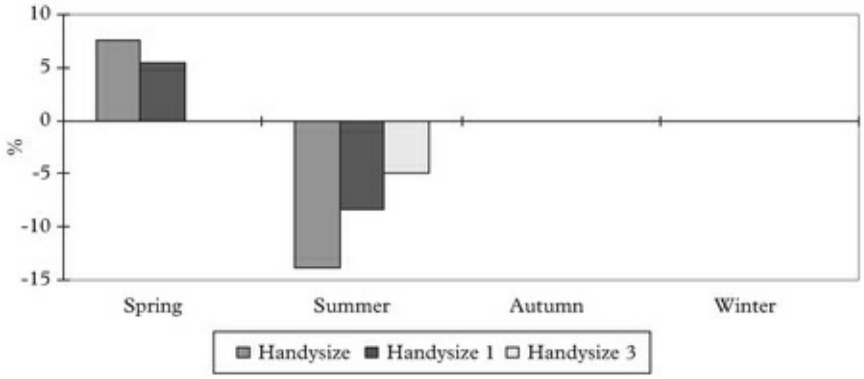

Figure 11: Comparison of seasonal changes in freight rates for Handysize dry bulk carriers

Source: Handysize, Handysize 1 and Handysize 3, represent the spot, one-year and three-year TC rates, respectively

spot market is transmitted to the time-charter market accordingly. There is no seasonal change in the third and the fourth quarter of the year. The only exception is an increase in Panamax spot rates in the

autumn.

Secondly, for all vessel types, the seasonal spring increase and summer drop in freight rates decline as duration of contracts increases. For instance, the impact of seasonal fluctuations is more pronounced for the spot rates and declines as we move to the one-year and three-year time-charters, across all types of vessels. This is because one-year time-charter rates, say, are formed as the expected future spot rates over the year (see Section 3.2). Therefore, one would expect that one-year time-charter rates would have already incorporated expected future seasonal variations and are smoother than spot rates. However, spot rates reflect the current market conditions and any seasonal change in demand for shipping has a direct impact on spot or short-term rates.

Thirdly, the magnitude of seasonal change is related to the size; that is, freight rates for larger vessels show relatively greater seasonal change compared to smaller ones. The weaker seasonal increase or decline in average freight rates for smaller size vessels may be attributed to their flexibility, which enables them to switch between trades and routes more easily compared to the larger ships.

Furthermore, seasonal changes in freight rates for all dry bulk carriers are more pronounced during a freight market expansion and less distinct when the market is in recession. This is in line with the shape of the supply and demand curve for freight services in freight rate determination as shown in Figure 3. More precisely, when the market is in the expansion phase, supply is inelastic and any seasonal change in demand can result in a sharp change in freight rates. Whereas, when the market is in recession, there is spare capacity and tonnage, the supply function for freight services is elastic and any seasonal change in demand for freight services can be absorbed by excess supply, which may result in a moderate change in freight rates.

Finally, another point worth noting is that the degree of seasonal fluctuation of shipping freight rates varies across vessel sizes and duration of contract. For instance, the impact of seasonal fluctuations is more pronounced for the spot rates and declines as we move to the one-year and three-year time-charters, across all types of vessels. This is because one-year time-charter rates, say, are formed as the expected future spot rates over the year (see e.g. Beenstock and Vergottis[17]). Therefore, one would expect that one-year time-charter rates would have already incorporated expected future seasonal variations and are smoother than spot rates. In addition, spot rate seasonalities are expected to be higher than time-charter rate ones to incorporate possible periods of unemployment (see endnote 9). As a consequence differences in freight rate seasonalities between sectors are eliminated since they depend less on the idiosyncratic factors influencing rates in sub-markets and more on the duration (type) of the contract involved. These arguments extend to longer duration, three-year time-charter contracts.

The higher seasonal fluctuations of spot rates compared to time charter rates may be further explained as the result of the chartering strategy of industrial charterers (e.g. power stations and steel mills). This type of charterers use long-term charter contracts not only to fulfil their long term requirements in terms of supply of raw materials, but also to secure and maintain their transportation cost at a relatively fixed level over a long period. They use the spot market then in order to meet their seasonal or cyclical requirements. Therefore, they may enter the spot market at certain seasons, which leads to an increase in demand in the spot market and consequently the freight rates at those periods.

3.4 Volatility of dry bulk shipping freight rates

From the academic point of view, several studies are devoted to assessing, modelling and forecasting the volatility of shipping freight rates. For instance, Kavussanos (see endnote 2), examines time-varying volatilities of the dry bulk freight rates across vessel sizes as well as their aggregate spot and time-charter rates using time-varying volatility models such as Autoregressive Conditional Heteroscedasticity (ARCH) and Generalised Autoregressive Conditional Heteroscedasticity (GARCH) models (see Alizadeh and Nomikos[18] for more details on modelling volatility of shipping freight rates). He reports that the pattern and magnitude of time-varying volatilities in the dry bulk freight markets are different across vessel sizes. In particular, freight rates for larger vessels tend to be more volatile than smaller ones. In another study on time-varying volatilities of ship prices, Kavussanos (see endnote 2) examines the dynamics of volatilities of second-hand prices for different size dry bulk carriers. He concluded that, in general, price volatilities in the dry bulk sector respond together and symmetrically to external shocks; however, there are differences, which are due to market segmentation and the fact that these vessels are employed in different routes and trades. Also, he noted that price volatilities are positively related to the size of vessel; that is, prices for larger vessels show higher volatilities compared to those of smaller ones. This is attributed to the fact that larger vessels are less flexible than smaller ones in terms of trading routes and commodities that they carry. As a result, responses of profitability and prices for larger vessels to any unexpected changes in the market are more drastic compared to smaller vessels.

To illustrate how the volatility of dry bulk shipping freight rates evolves over time, we plot the estimated time-varying volatility of spot, six-month and one-year time-charter rates for capesize and Panamax vessel, using GARCH. The estimated volatilities are presented in Figures 12 and 13 for Capsize and Panamax vessel, respectively. It can be seen that volatility of all types of freight contracts tend to move over time as the market condition changes. In particular, it can be noted that there are periods of relatively low

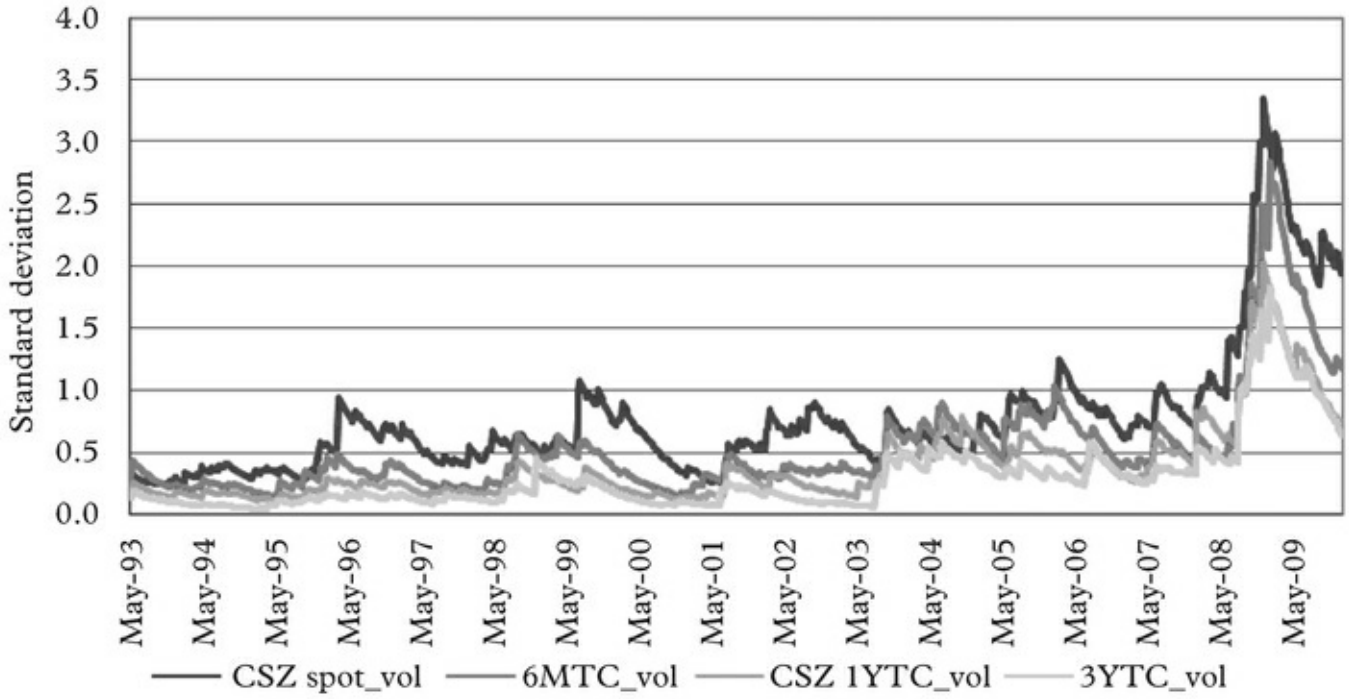

Figure 12: Time-varying volatility of spot, six-month, one-year and three-year time-charter rates for

Capesize dry bulk carriers

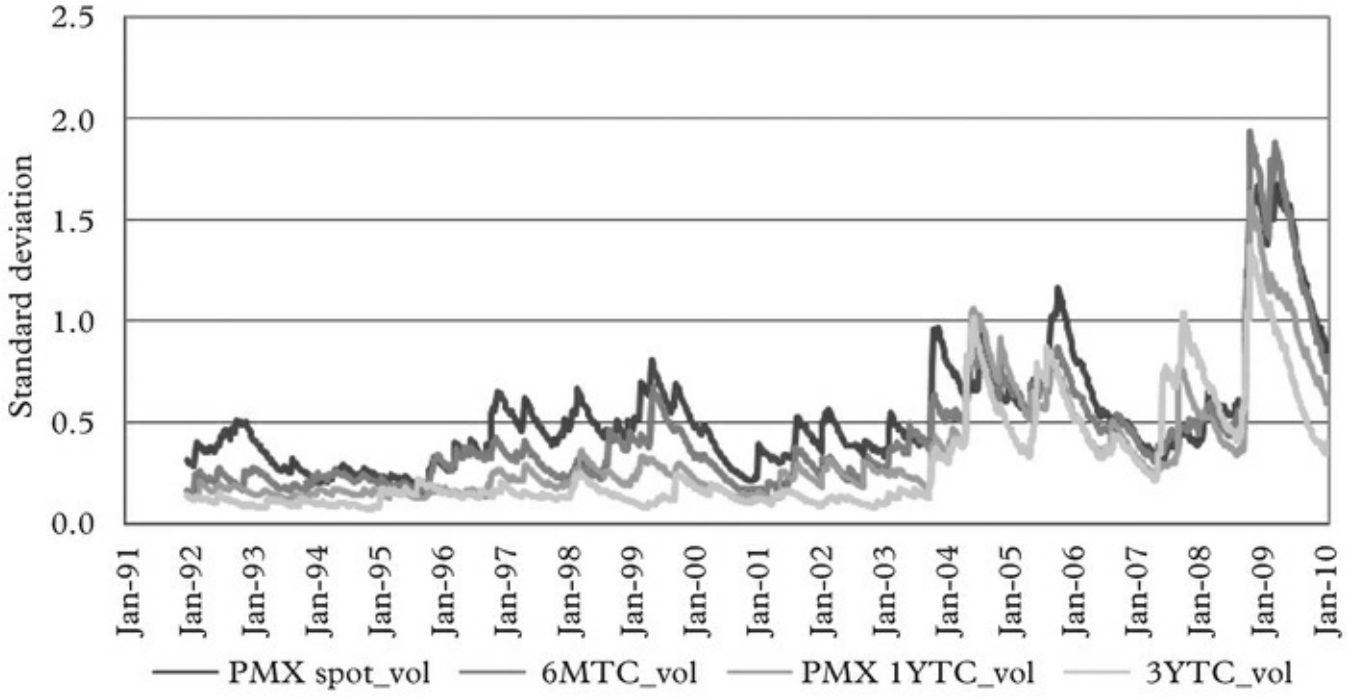

Figure 13: Time-varying volatility of spot, six-month, one-year and three-year time-charter rates for Panamax dry bulk carriers

volatility followed by periods of extremely high volatility across all freight contracts, a phenomenon known as volatility clustering in financial economics. The highest volatility observed in the market was over the second half of 2008, when the shipping market collapsed as a result of the downturn in the world economy. During that period, estimated annualised volatilities of capesize and panamax freight rates were 300% and 180%, respectively. This can be compared to the historical spot freight rate volatilities of 95% and 60% in the Capesize and Panamax shipping sectors, respectively.

Alizadeh[19] utilises multivariate GARCH models to investigate freight rate volatility transmissions between different dry bulk size vessels, both in the spot and time-charter markets. Results of volatility models reveal that there are unidirectional volatility spillover effects from larger to smaller size vessels in the spot and period markets. It is argued that volatility transmissions could be due to substitution effects amongst different size of ships in the dry bulk market as well as the higher sensitivity of freight rate for larger vessels to unexpected news compared to small ones which may force operators of larger vessels to switch to and from the market for smaller vessels and subsequently disturb the supply and demand balance in those markets.

In a recent study, Alizadeh and Nomikos[20] use an augmented exponential GARCH model (EGARCH-X) to examine the relationship between the shape of the term structure and the volatility of dry bulk freight rates. Using a freight dataset covering the period from January 1992 to September 2007, they find evidence which supports the argument that volatility of freight rates is related to the shape of the term structure of freight rates. More precisely, they argue that there is a non-linear relationship between volatility of freight earnings and the slope of forward curve in the form of a cubic function implying that the rate of increase in volatility increases (decreases) as the degree of forward curve market backwardation (contango) increases.

3.5 The efficiency of dry bulk freight markets

The relationship between spot and period (time-charter) rates has always been a pivotal issue in modelling shipping freight markets. Several studies in the literature are devoted to examining this relationship utilising different theories, methodologies and various data sets. The studies on the relationship between long- and short-term rates can be classified into two categories. On the one hand there are attempts to model long-term rates assuming that some form of expectations mechanism relates long-term to short-term freight rates and the efficient market hypothesis holds (e.g. Zannetos (see endnote 6), Beenstock and Vergottis (see endnote 17)[21], Glen *et al.* (see endnote 7) and Strandenes[22]) . On the other hand, a number of studies test the efficient market hypothesis and investigate the validity of the expectations hypothesis in the relationship between short and long term rates (e.g. Hale and Vanags (see endnote 8) and Veenstra[23]).

The notable work of Zannetos (see endnote 6) was the first attempt to study the relationship between long- and short-term tanker rates. He provides comprehensive theoretical arguments and analyses to establish the theoretical relationship between long and short term tanker freight rates during the 1950s. Zannetos points out the similarities between money markets and freight markets and argues that period rates should represent a weighted average of future spot rates. He also proposes the "elastic expectations" theory in the formation of long-term rates, but fails to provide supporting evidence.

Glen *et al.* (see endnote 7) propose a present value model for the relationship between spot and time-charter rates in the tanker market and transform the relationship to estimate an autoregressive distributed lag model which relates period rates to lagged spot rates. They find a different lag structure to that proposed by Zannetos and conclude that the expectations in the formation of period rates may not be elastic. Strandenes (see endnote 22) argues that period rates are formed through agents' "semi-rational expectations". She finds that current spot and long-run equilibrium rates are both important determinants of time-charter rates for Panamax dry bulk carriers, medium and large tankers. However, her estimation results show that current spot and long-run equilibrium rates have different impacts on the formation of long-term rates across different types of vessels; i.e. results are not consistent across sizes.

Beenstock and Vergottis (see endnote 17, 21) assume that Rational Expectations (RE) and the Efficient Market Hypothesis (EMH) in the formation of time-charter rates are valid and base their integrated shipping industry model on these assumptions. They find that current and expected spot rates are significant determinants of time-charter rates. However, they do not attempt to investigate the validity of EMH and rational expectations in the formation of period rates.

Hale and Vanags (see endnote 8) test the EMH and RE in the formation of freight rates using disaggregated dry bulk market series and find no support for the theory. Veenstra (see endnote 23) reports further results on the expectations hypothesis and the term structure relationship of dry bulk voyage and time-charter rates. Although his study suffers from methodological issues (see Kavussanos and Alizadeh (see endnote 9)), he concludes that the results support the expectations hypothesis of the term structure for three size dry bulk carriers. Kavussanos and Alizadeh (see endnote 9), use the present value relationship between long-term and short-term rates and modify a series of tests, proposed initially by Campbell and Shiller[24,25] for the bond market, to investigate the relationship between short and long term freight rates in the dry bulk shipping sector and test for the

validity of the Expectations Hypothesis of the Term Structure (EHTS) in the formation of long-term rates for three different size dry bulk carriers. Tests employed include; the perfect foresight spread test, restrictions on the Vector Autoregressive (VAR) model, variance ratio and cointegration tests. These tests are more robust than those that had been employed previously in studies of shipping freight rates, as they directly take into account the stochastic properties of freight rate series, an important fact which is strongly recommended in the literature in order to avoid several statistical problems.[26]

More specifically, the EHTS is tested (see endnote 9) using the following present value relationship between the spot and period time-chartr rates:

$$\sum_{i=0}^{k-1}\frac{TC_t^n}{(1+r)^i}=\sum_{i=0}^{k-1}\frac{E_t(FR_{t+i}^m)}{(1+r)^i} \qquad k=n/m \qquad (4)$$

where TC_t^n and FR_t^m are n and m period spot and time charter contracts, respectively, k is an integer, r is the discount rate and E_t is the expectations operator. The EMH in the formation of long-term rates (or the relationship between long-term rates and expected spot rates) implies that the above equation should be empirically valid. Kavussanos and Alizadeh9 use different transformations of the above model for one-year and three-year time-charter rates for three different size dry bulk carriers. Based on a series of tests, they find that the EMH is rejected.

They then propose a model which relates spot and long-term time-charter rates and takes into account the risks associated with the spot market. This model uses an Exponential Generalised Autoregressive Heteroskedasticity in the Mean, (EGARCH-M) (Nelson[27]) framework.[28] They find that the coefficient of time-varying risk premium, which relates long term and short term freight contracts, is negative. In other words, shipowners are prepared to offer a discount, which varies over time, to fix charter contracts with longer terms to maturity (time-charters) compared to when they operate in the spot market.

The argument that they put forward for the existence of such negative risk premia is based on the fact that shipowners operating in the spot markets are generally exposed to four types of risk, in comparison to those operating in time-charter markets. First, spot rates show higher fluctuations compared to time-charter rates; risk-averse shipowners may thus respond to this by fixing their vessels in the period market. Secondly, for a shipowner operating in spot markets there is always a chance that the owner may not be able to fix a contract for a period of time (unemployment risk) even when operation and chartering is well planned. Thirdly, there are cases when the owner has to relocate a vessel from one port to another for a new spot charter contract; depending on the occasion this may take some time and involve substantial costs. Finally, if voyage spot rates (rather than trip-charter spot rates) are compared to time-charter rates, shipowners are also exposed to voyage (mainly bunker) cost fluctuations (see endnote 18). Thus, shipowners operating in the time-charter market are prepared to offer a discount to cover the risk, which they are exposed to when operating in the spot market. It seems that the magnitude of this discount is time dependent and reflects the degree of uncertainty in the market.

Furthermore, the sentiment of the banks and lenders in shipping finance might be another important factor influencing shipowners' decision to operate in the spot or the time-charter market. Financiers

view differently clients (shipowners) who are committed to long-term shipping contracts when financing a ship purchase or newbuilding, since this ensures a relatively more secure stream of income for the shipowner and reduces the probability of loan default. Thus, shipowners may be prepared to offer a discount when fixing their vessel on a long-term contract, as opposed to short-term ones, to fulfil the lender's requirements for the loan. This argument can be quite important during periods of market uncertainty, supporting further the existence of time-varying risk premia in shipping freight markets.

The fact that time charter rates can deviate from their theoretical values for considerable time periods has an important implication as risk neutral or risk prone operators can make excess profits by hiring vessels in the time-charter market, when time-charter rates are under priced and operating them in the spot market. Agents involved in freight trading can utilise the difference between actual and theoretical time-charter rates as an indicator of which contract to choose at any point in time. Thus, risk neutral shipowners may choose to operate in the spot market when actual time-charter rates are below their theoretical values and switch to the time-charter market when actual time-charter rates are greater than their theoretical values.

3.6 Interrelationships and spillover effects across dry bulk freight markets

It has been argued earlier, as well as in the literature (e.g. Stopford (see endnote 5), Kavussanos (see endnotes 2, 3)), that the dry bulk market is disaggregated by size and each size vessel is involved in the transportation of certain commodities with a low degree of substitution between vessels of different sizes. This implies a degree of segregation in the behaviour of freight rate levels and volatilities. However, sometimes vessels of adjacent size categories are used as substitutes; for instance, Panamax instead of Handysize, Capesize instead of Panamax and vice versa. Such substitutions become more significant when the demand in one market is relatively higher than in the other market and is enough to attract, say, larger vessels to accept part cargoes and make a profit. There might be occasions when charterers prefer to hire smaller vessels for the transportation of commodities, which are conventionally carried by larger vessels; for example by splitting the large consignment into two or three shipments. This is usually the case when importers prefer or switch to "just in time" inventory management techniques, or try to top up their seasonal requirements, which might be less than a large shipment.

The above argument suggests that although different size dry bulk carriers are not perfect substitutes, they may overlap in their cargo transportation capabilities or even be linked through intermediate size vessels. Therefore, one would expect that shocks to any sub-sector might be transmitted to other sub-sectors. For instance, if there is an increase in demand and subsequently freight rates for Handysize vessels, other size categories such as Panamax vessels may react by participating in the Handysize market by accepting part cargoes, if this is found to be more profitable. This shift from one market to the other will cause an over supply in the Handysize market and a shortage of supply in the Panamax market and, as a result, Handysize rates will drop and Panamax rates will rise. This process will continue until both markets stabilise; that is, until supply equals demand in each market and there is no opportunity to make extra profit by switching between markets.

By investigating the form of interrelationships among these sub-markets in shipping can shed light to important issues such as the degree of substitutability between different dry bulk sub-sectors and

the speed of stabilisation of freight rates in each market. Beenstock and Vergottis[29] investigated the spillover effects between tanker and dry bulk markets. They trace the spillover effects between the markets through the market for combined carriers, shipbuilding and scrapping markets using dynamic econometric models and simulation techniques. Alizadeh (see endnote 19), extends the findings of this study, by investigating the spillover effects between different segments within the dry bulk sector of the shipping industry. He employs cointegration, vector error correction models (VECM) and impulse response analysis instead of dynamic structural models. Charter contracts with different terms to maturity (i.e. spot, one-year and three-year time-charter rates, are analysed and comparisons are made to highlight differences in spillover effects within the spot markets in comparison to those of time-charter markets).

Additionally, the same study also investigates the existence of volatility spillovers from one sub-sector to other sub-sectors within the spot and time-charter markets. This is done by using a multivariate VECM in the mean with a multivariate generalised autoregressive conditional heteroskedasticity (GARCH) specification, in what is termed a VECM-GARCH model. These types of models have been used in the financial economics literature to assess the integration as well as the transmission of information between the capital, interest rates or commodity markets worldwide (see for instance, Koutmos and Booth,[30] Koutmos and Tucker[31] and Kavussanos and Nomikos[32]).

In total, three different systems (for spot, one-year and three-year time-charter rates) of VECM and VECM-GARCH models for freight rates for three size vessels have been estimated over the period January 1980 to August 1997 for the purposes of this analysis. Impulse response analyses on the estimated models reveal that the interaction between freight rates for different size vessels are higher in the spot market than one-year and three-year time-charter markets. This might be due to the difference between the charterers' decision making process on hiring vessels in the spot market and time-charter markets. Decisions on hiring vessels in the spot market are thought to be more instantaneous, based on short terms and sometimes urgent transportation requirements. In contrast to the spot market, decisions made by charterers to hire vessels in the period market are in general based on detailed analysis of costs and transportation needs. Furthermore, there might be situations where owners operating in the spot market find that even a part cargo is better than waiting for a full load. They may even accept a part cargo on a back haul voyage rather than returning to the loading area in ballast. Such decisions by owners in the spot market increase the competition between vessels of different sizes for cargo and consequently increase the interaction between their freight rates. As a result, shocks to freight rates for any size vessel in the spot market are transmitted across to freight rates for other size categories faster than shocks in the period charter markets.

Analysis of spillover effects between volatilities of freight rates for different size vessels in the spot and period markets reveal that volatilities of freight rates for Capesize vessels affect volatilities of freight rates for smaller vessels across the contract maturity spectrum. More specifically, shocks to the Capesize market are transmitted to the market for smaller vessels without any feedback effects. The unidirectional volatility spillovers from Capesize market to the market for smaller vessels can be explained by the fact that the market for larger vessels is more sensitive to news than the market for smaller size vessels. This is because small vessels are more flexible than Capesize vessels in terms of operational flexibility. As a result, shocks to freight rates for smaller vessels, due to changes in the

demand for transportation of certain types of commodities over a particular route, may be absorbed by employment of those vessels in other trading routes. On the other hand, the number of routes and trades at which large vessels operate is limited. As a result, unexpected changes in the market for those vessels may have a greater impact on the whole dry bulk market compared to the effect of unexpected events the market for smaller vessels.

In addition, the carrying capacity of larger vessels compared to smaller ones and the agents' expectations about movements of vessels between markets might be an important factor in causing volatility spillovers. Given that the carrying capacity of a Capesize vessel is two times that of a Panamax vessel (three times that of a Handysize vessel), move of one Capesize vessel to the Panamax market, during the downturn in the Capesize market or a relatively good Panamax market, may satisfy the demand for two Panamax vessels. In an opposite situation, two Panamax vessels are required to satisfy the demand for one Capesize vessel. This suggests that crossovers of larger vessels to markets for smaller vessels may have greater impact on the supply and demand balance in markets for smaller vessels compared to the impact on supply and demand balance in the market for larger vessels caused by the move of smaller vessels to the market for large vessels.

Another interesting finding of this study is that levels of time-varying volatilities of freight rates in each of the spot and period (one-year and three-year) markets are directly related to vessel size; that is, the level of time-varying volatility is higher for larger vessels compared to smaller ones. Results also indicate that the level of time-varying volatilities for each size vessel are also related to the duration of contract; that is, the longer the duration of contract, the lower the level of time-varying volatility. This is because time-charter rates reflect weighted average of expected future spot rates and therefore sharp changes in spot rates are smoothened when time-charter rates are formed. Also, spot rates are more influenced from current market conditions and news, whereas period rates depend on agents' expectations about the future market conditions over a period of time.

3.7 Implied forward time-charter rates

The existence of freight contracts with different maturities (durations) in the shipping industry offers both shipowners and charterers flexibility in their decisions regarding chartering and operational activities. As discussed above, short-term or spot charter rates are determined through the interaction between current supply and demand for shipping services, whereas long-term period rates are believed to be determined through agents' expectations about future short-term rates. Several studies have investigated the relationship between spot and long-term charter contracts (see e.g. Hale and Vanags (see endnote 8), Veenstra (see endnote 23), and Kavussanos and Alizadeh (see endnote 9), among others). The general focus of these studies is how time-charter rates are formed through expected spot rates and whether such a relationship is in line with the notion of the efficient market hypothesis (EMH).

The most important implication of EMH in relation to the shipping freight market is that charter contracts, with different maturities, should be related in such a way that charterers/shipowners be indifferent to operating under a period contract or a series of consecutive short term contracts over the life of the long term contract. Otherwise, there will be instances where the difference between the two chartering strategies can be exploited by agents to make excess profit without taking additional risk. The relationship between short-term and long-term contracts, known as the term structure

relationship, is embedded in theories such as the expectations hypothesis of the term structure (EHTS). According to the EHTS long term time-charter rates, say for one year, should reflect the weighted average of expected monthly (spot) freight contracts over the next 12 months. Furthermore, any deviation from such a relationship is explained through the existence of time-varying risk premia.

Let TC_t^T denote the time-charter rate at a given time t with maturity T. If we observe two time-charter rates with different maturities, say T and T with $T = T_1 + T_2$ and assume that the EMH holds, the implied forward time-charter rate for period T_2 can be calculated. This is due to the fact that if EMH holds, agents should be indifferent in chartering a vessel for the T period or chartering the vessel for T_1 period and renew the contract for another T_2 period at the expiry of the first contract, i.e. T_1. Therefore, using the present value model and assuming a constant discount rate, r, we can wrie:

$$\sum_{i=1}^{T} \delta^i (TC_{t+i}^{T}) = \sum_{i=1}^{T_1} \delta^i (TC_{t+i}^{T_1}) + \sum_{i=T_1+1}^{T} \delta^i (E_t TC_{t+i}^{T_2}) \qquad (5)$$

where δ^i is i period discount factor, $\delta^i = 1/(1+r)^i$ and E_t is the expectations operator. Rearranging the above equation, it is possible to derive the forward time-charter rate, $E_t TC_{T_1}^{T_2}$ as:

$$E_t TC_{T_1}^{T_2} = \left(\sum_{i=1}^{T} \delta^i (TC_{t+i}^{T}) - \sum_{i=1}^{T_1} \delta^i (TC_{t+i}^{T_1}) \right) \Bigg/ \sum_{i=T_1+1}^{T} \delta^i \qquad (6)$$

For example, the present value of a 12-month time-charter contract at time t, TC_t^{12m}, should be equal to the present value of a six-month contract at time t, TC_t^{6m}, plus the present value of another six-month contract which starts in six months later, $E_t TC_{t+6}^{6m}$. This in turn implies that, provided the EMH holds, the implied (expected) forward rate for a six-month time-charter contract would be:

$$IFTC_{t,t+6}^{6m} = E_t TC_{t+6}^{6m} = \left(\sum_{i=1}^{12} \delta^i (TC_{t+i}^{12m}) - \sum_{i=1}^{6} \delta^i (TC_{t+i}^{6m}) \right) \Bigg/ \sum_{i=6+1}^{12} \delta^i \qquad (7)$$

where $IFTC_{t,t+6}^{6m}$ is the implied forward six-month time-charter rate at time t for $t+6$.

In a recent study, Alizadeh *et al.*[33] investigated the predictive power of the implied forward *TC* rates as a forecast of future *TC* rates in comparison with other statistical models in the dry bulk market such as Autoregressive Integrated Moving Average (ARIMA), Vector Autoregressive (VAR) and Vector Error Correction model (VECM). Using historical 12- and six-month time-charter rates for capesize, Panamax and Handymax dry bulk carriers and variety of forecast performance measures, they report that implied *TC* rates significantly outperform all statistical models in all three dry bulk sub-markets. In addition, they find that these implied forward time-charter rates are unbiased predictors of time-charter rates observed in the future; that is, the average forecast error of implied *TC* rates is zero and there is no systematic pattern in their behaviour. This finding is important because it can be regarded as additional evidence on the reliability of the forecasts produced by implied forward *TC* rates in the dry bulk marker.

Finally, Alizadeh *et al.* (see endnote 33) also investigated whether agents can make excess profit by simple chartering strategies based on technical trading rules. This is interesting because if the notion of EMH is valid, then there should not be any possibility for making excess profit through chartering strategies. They examined whether hiring in vessels for long period charters (12 months) and re-letting them over shorter periods (two consecutive six-month periods), is profitable. The trading

strategy is based on application of technical analysis on the differential between short-term and long-term charter rates (the spread). For instance, they use simple moving average (MA) chartering strategy defined as follows: “charter in a vessel on a 12-month *TC* and simultaneously re-let the vessel on a six-month *TC* if the current spread between the two *TC* rates exceeds the average of the spread over the last Y weeks”. The study also reports that the simple MA trading rules generate substantial profit when they are implemented in an out-of-sample evaluation period and that technical trading models perform better on the basis of a rolling or continuously expanding estimation sample.[34]

4. The Market for Ships

The market for ships consists of three different sub-markets, namely: the newbuilding market; the second-hand market; and the scrap market. Within each submarket, the interaction between supply and demand for the asset determines the vessel price. Almost all ship sales and purchases (S&P) are carried out through specialist S&P brokers, with the exception of newbuildings, which may be ordered by investors to shipyards directly. The sale and purchase of ships is a lengthy process, which can take anything between a few weeks and several months to complete. This process involves different stages of placing the ship in the market, the negotiation of price and conditions of contract, preparing the memorandum of agreement, inspections and final closing of the deal, after which the ship is delivered to the buyer.

4.1 Factors determining ship prices

The factors affecting the price of a vessel can be classified into vessel specific and market specific. Vessel-specific factors are those related to the particulars and condition of the vessel. These are size, type, age and the general condition of the vessel, as well as quality of design, build, equipment and engine. In general, we expect larger vessel to be more expensive than smaller ones, older vessels to be less expensive than newer vessels and certain types of specialist vessels (e.g. LNG carriers, Ro-Ro vessels, cruise liners) to be more expensive than conventional box shaped bulk carriers. In addition, the general condition and state of the vessel is important because well maintained vessels tend to be more employable compared to those that are not maintained properly. The age of vessel is another important factor in determination of the second hand price of vessels, since generally older ships are less expensive than modern ones. This is because not only ships are subject to depreciation and, as time passes, lose part of their value,[35] but also because advances in shipbuilding technology over time mean that more modern ships are built with better specifications in terms of fuel consumption and efficiency as well as operating efficiency.[36].

Market conditions are also an important factor in the determination of and changes in, vessel price. It is generally believed and documented in the shipping economics literature that ships are capital assets which generate income and they are priced after their expected profitability (see chapter 13 of Alizadeh and Nomikos (see endnote 18) for details) using an asset pricing model. The most important factor in the determination of ship prices are the current and expected earnings or operational revenue of the vessel over her life. What determines current and expected earnings for a ship is the general state of the freight market. Therefore, current and expected freight rate levels and market conditions are amongst the most important factors in ship price formation.

4.2 The newbuilding market

As the name suggests, the newbuilding market is the market for newly built ships or ships which are

ordered by shipping companies, shipowners and investors to be delivered after the construction period, which takes between several months and a few years. The perfect market condition also holds for this market as not only international shipowners take several quotations from various shipyards before placing orders, but also there are no barriers for shipyards to market their products internationally and to compete with other shipyards. Newbuilding prices are also determined through supply and demand factors for new ships and are generally negotiated and settled between investors and shipyards. In general, Newbuilding prices depend on the market condition and other determinants such as steel prices, the level of freight rates, the backlog of the shipyard (or the shipbuilding industry in general), terms of contract, etc. For example, in a good market, when freight rates are high and shipyards' orderbooks are full, newbuilding prices may rise considerably, whereas when the freight market is depressed and shipbuilding activity is low, newbuilding prices may fall rapidly. This is because shipyards are willing to accept orders at very low prices to survive and avoid down sizing.

Figure 14 plots monthly newbuilding prices for three sizes of dry bulk carriers over the period January 1976 to April 2008, except Capesize prices, which are available from April 1979. It can be seen that newbuilding prices vary by vessel size but show

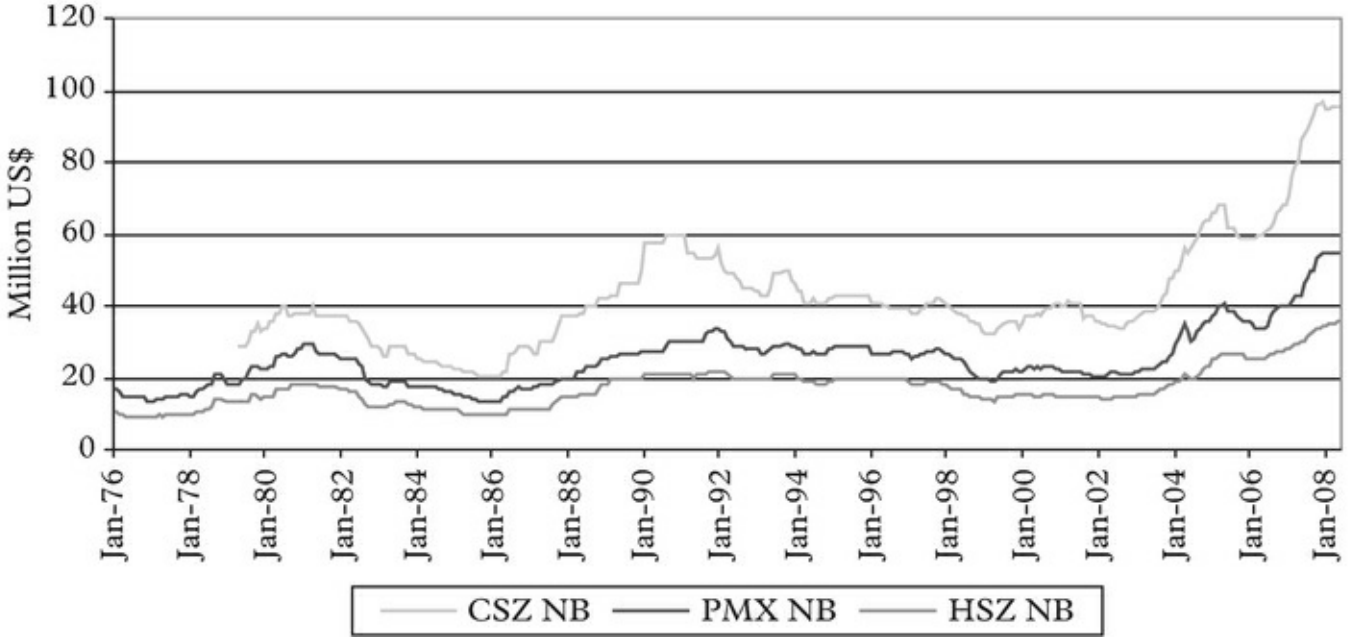

Figure 14: Newbuilding prices for different size dry bulk carriers
Source: Clarkson's SIN

similar behaviour over time. In fact, it can be argued that these series follow similar patterns and move together in the long run, that is, price levels follow a similar cyclical pattern. For example, price levels for all size vessels show peaks between 1980 to 1982 and 1989 to 1992, whilst there are troughs in price levels between 1976 to 1979, 1983 to 1988 and 1992 to 1997. The cyclical behaviour of newbuilding prices is believed to be the combined result of fluctuations in world economic activity (international seaborne trade) and the investment (ordering) behaviour of shipowners (see, e.g. Tinbergen,[37] Vergottis,[38] and Stopford (see endnote 5)). More precisely, when investors expect the freight market to rise, they place new orders to take advantage of the positive market prospects. Therefore, there is excess demand for new vessels, orderbooks grow and prices will rise. By the time, the new vessels are delivered: (1) there might be an excess tonnage in the market due to excessive orders; (2) the freight market may collapse due to excess supply, both from reduction in scrapping of old vessels as well as the arrival of new deliveries; (3) or, even the demand for shipping services may

collapse due to the drop in the world economic activity. This effect is then transmitted back to the shipbuilding market through investment decisions of agents, reducing the demand for newbuildings and prices for new ships. Shipbuilding cycles, which are caused by the mismatch between investors' expectations and the world's economic activity, have been repeatedly observed in the shipping industry.

4.3 The second-hand market

The second-hand market, better known as the sale and purchase market, is the market for vessels, which are ready for trade and aged anything between one year and 20 years or more. In terms of liquidity, about 1,000 vessels are bought and sold in the sale and purchase market every year, out of which about 30% are dry bulk carriers and 30% tanker ships, that is, at least one of each vessel every day. The sale and purchase market is known as one of the most competitive markets in the world as it is an open market and buyers and sellers are under no obligation to follow any sort of price restrictions.

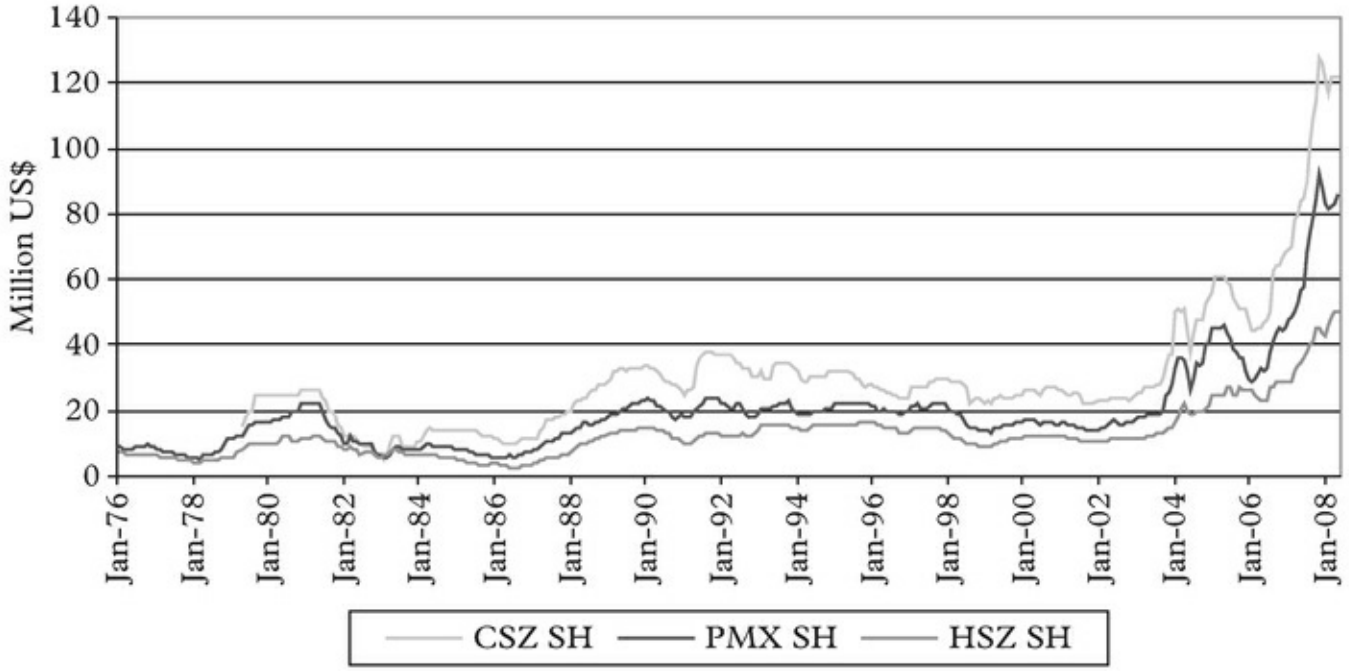

Figure 15: Historical five-year second-hand prices for different size dry bulk carriers
Source: Clarkson's SIN

Therefore, prices are determined through supply and demand conditions in the market which, in turn, depend on the current and expected world economic activity, the current and expected freight market conditions, the current and expected bunker prices and the current and expected ship prices. In other words, second-hand prices directly depend on the profitability of the market (see for example Beenstock,[39] Beenstock and Vergottis (see endnote 17) and Strandenes (see endnote 22)).

Figure 15 presents monthly prices for five-year old second-hand prices for three different sizes of dry bulk carriers over the period January 1976 to April 2008. A visual inspection reveals that second-hand prices for different size bulk carriers move together in the long run. This is the case as the price series are thought to be linked through a common a stochastic trend, i.e. the world economic activity and the volume of international seaborne trade (see Glen (see endnote 43)). However, short run dynamics of second-hand prices do not seem to be identical. These differences are due to variations in the demand for different size vessels and the profitability of the freight market for each size because current and expected freight rate levels are argued to be the major determinants of second-hand prices.

Another interesting point which can be observed from the evolution of the price series is that when the market is in recession (i.e. prices are at lowest levels), the three-price series converge and the difference between prices reduces compared to when the market is good. For example, during the 1982 to 1986 recession, prices for Handysize, Panamax and Capesize vessels seem to converge. The price difference between a second-hand Capesize and second-hand Handysize during this period is less than $8m. When the market is in expansion phase, second-hand prices diverge as larger vessels become relatively more expensive than smaller ones. For example, between 1988 and 1994, the difference between second-hand prices for Capesize and Handysize vessels is between of $15m and $20m. Since it is the operational profitability that determines second-hand prices, the divergence and convergence of prices can be explained by the relative profitability of these vessels under different market conditions. For example,

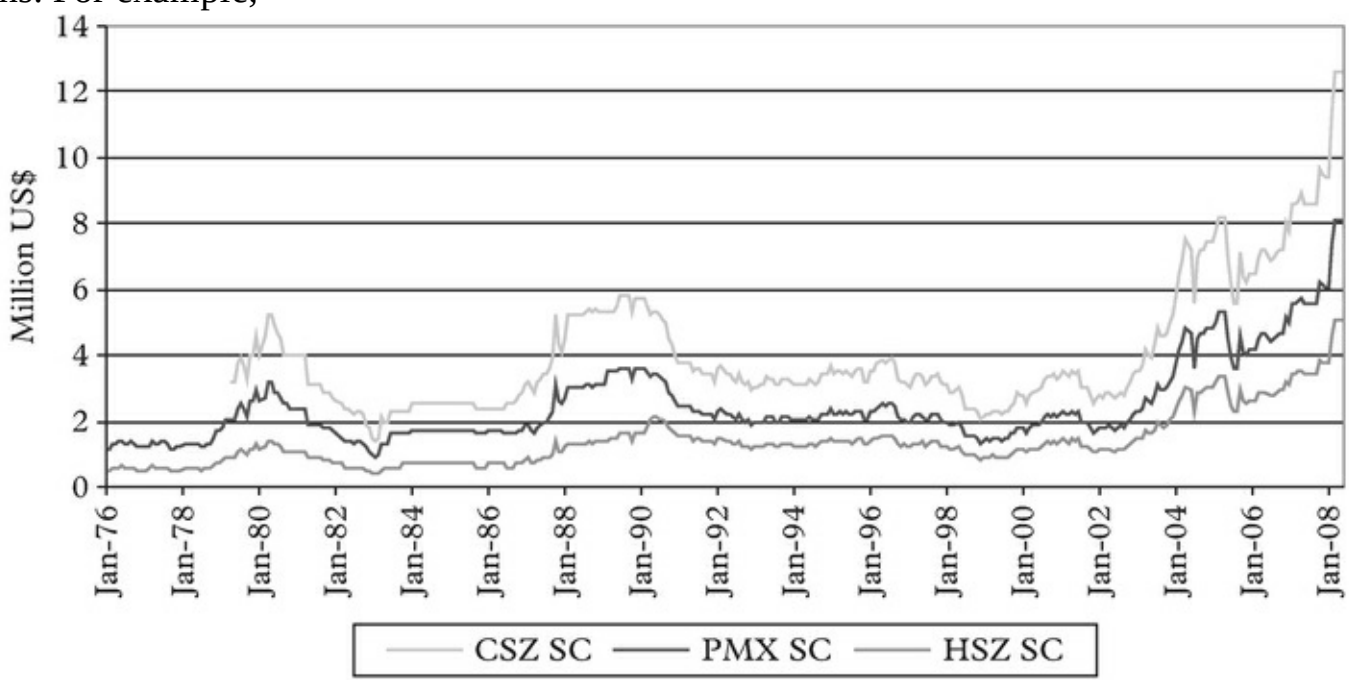

Figure 16: Historical scrap prices for different size dry bulk carriers

Source: Clarkson's SIN

larger vessels generate more revenue and operating profit during expansion periods as they can be used for carrying larger amount of cargo; however, they bear the higher risk of unemployment during recessions due to their operational inflexibility. In contrast to larger vessels, smaller bulk carriers are not as profitable during periods of market expansion, but they are more flexible and can switch between trades during recessions. Therefore, smaller vessels are more likely to be employed in tight markets in comparison to larger vessels and generate reasonable profit even in bad times.

4.4 The scrap or demolition market

The third market for ships is where those ships, which are not economical to operate, are sold for demolition or scrapping. Ship-breakers buy scrap vessels from shipowners for their scrap metal on a $/ldt (light displacement tonnes[40]) basis and dismantle them to reuse the steel and other parts and equipment on board the vessels. The age at which ships are sold for scrap varies over time and largely depends on the condition of the freight market as well as the second-hand, the newbuilding and the scrap markets. For example, when freight rates are low and the expectations for future market improvements are not so positive, owners of relatively inefficient vessels, which may have been laid up due to unemployment, may be forced to sell their vessels for scrap to avoid further losses.

Consequently the increase in supply of scrap vessels causes the scrap price to fall. When freight rates are relatively high and there is a shortage in the supply of shipping services, even older, less efficient vessels could be profitable; therefore, there may not be any pressure to scrap old and inefficient vessels. As a result, there will be a shortage of supply in the scrap market, which causes the scrap price to rise.

Figure 16 plots the monthly scrap prices, in million US$, for different sizes of dry bulk over the period January 1976 to February 2008, respectively. In general, scrap prices tend to follow the trend in shipping freight markets. Scrap values of larger vessels are higher than those of smaller vessels in both sectors because of their greater steel

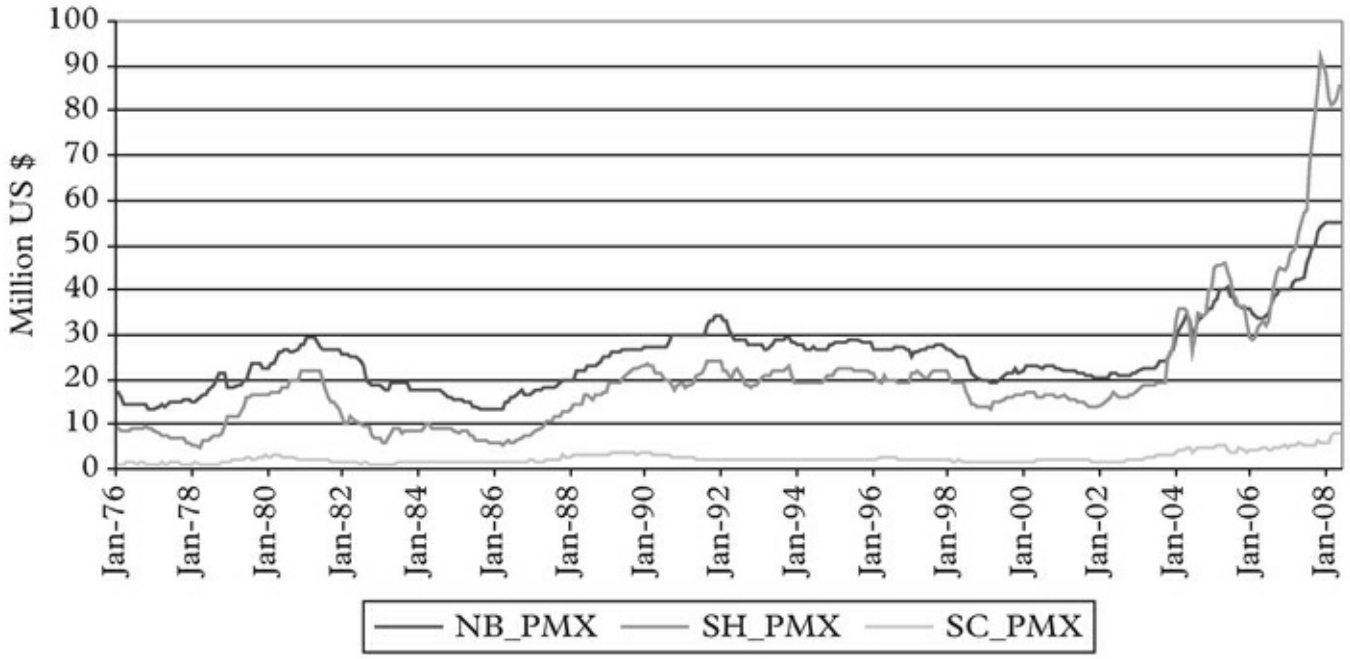

Figure 17: Historical newbuilding, five year old second-hand and scrap prices for Panamax dry bulk carriers

content and light displacement weight. In addition, scrap prices for all types of ships seem to have reached record highs in 2008, due to the bullish freight market conditions, increase in world scrap steel prices and the limited number of vessels available for scrapping. Furthermore, it seems that scrap prices for larger vessels show relatively greater variation compared to those of smaller ships. This is evident from the range within which scrap prices fluctuate. For instance, while historical scrap values of Capesize vessels vary between $1.5m and $12m, historical scrap prices for Handysize dry bulk carrier vary between $0.3m and $5m.

Figure 17 plots the historical newbuilding, second-hand and scrap prices for Panamax dry bulk carriers. It can be seen that newbuilding and scrap prices set an upper and a lower barrier for second-hand Panamax prices, respectively and second-hand prices for five-year-old Panamax fluctuate within this band over time. However, an interesting point is that when the shipping market is in recession (1982 to 1986), second-hand prices are closer to scrap prices and when the market is at its peak (1988 to 1990 and 2003 to 2008) second-hand prices are close to newbuilding prices. Furthermore, when the dry bulk market is exceptionally profitable and the orderbooks for newbuildings are relatively full, the second-hand price can exceed the newbuilding price, as was the case for the period 2006 to 2008. This is mainly because investors are prepared to pay a premium for immediate delivery in the second-hand

market to avoid waiting for a relatively long time for newbuilding delivery. In recent years, given the record levels of orderbook and delivery time of four to five years (up to 2011 and 2012 for orders placed in 2007), having a second-hand ship was preferred to placing a newbuilding order. This is because, given the freight rate levels, investors can benefit from high freight revenue and recoup part of their investment rather than waiting for newbuilding delivery, which may take a few years.

The higher sensitivity of second-hand prices to market conditions implies that secondhand prices are more volatile than newbuilding and scrap price. However, scrap or demolition prices for ships generally depend on world scrap steel prices and ship-breaking activities. This means that the volatility of scrap prices for ships is linked to the volatility and changes in the market for scrap steel, rather than the changes in freight market.

4.5 Efficiency of the market for dry bulk carriers

One of the most important and interesting areas in the shipping economics literature is the determination of ship prices. Many studies have been devoted to modelling, evaluating and forecasting ship prices and their volatilities in the past, among these are: Strandenes (see endnote 22), Beenstock (see endnote 39), Beenstock and Vergottis (see endnotes 17, 21), Charmeza and Gronicki,[41] and Kavussanos (see endnotes 2, 3). Studies on the determination of ship prices, e.g. Strandenes (see endnote 22) and Beenstock and Vergottis (see endnotes 17, 21), consider ships as capital assets and share the same theoretical framework. Present value models, which posit that the price of an asset should reflect the discounted present value of expected income that the asset may generate over its life, are used extensively in modelling ship prices. The major difference among the studies on ship price determination is the way they deal with the expectations about the future income generated by ships. More precisely, they assume that the EMH is valid and utilise different forms of expectations hypothesis in their pricing models. For example, Strandenes (see endnote 22) assumes that expectations are semi-rational, while Beenstock (see endnote 39) and Beenstock and Vergottis (see endnotes 17, 21) assume rational expectations in price formation.

Hale and Vanags[42] dispute the assumption of rational expectations and the EMH in models for ship prices and argue that such assumptions should be investigated and their validity must be verified prior to any modelling and forecasting. This is because rejection of these hypotheses may have serious consequences on the ensuing empirical results. They argue that for the EMH to be valid, prices for different size vessels should incorporate all the available information; that is, given past prices, no other information should improve the predictability of prices. They propose a test based on the cointegration approach and Granger- causality between prices for the three sizes of bulk carriers. They find that not only there are cointegrating relationships between the price series, but also prices Granger-cause each other. They conclude that their results cast doubt on the validity of the EMH and RE in price formation in the dry bulk sector. Glen[43] re-examines the informational efficiency in dry bulk carriers price determination using Johansen's multivariate cointegration test,[44] which is more powerful compared to the test employed in Hale and Vanags (see endnote 42), although his finding are similar. However, he attributes the link between prices for different size vessels to the existence of common stochastic trends rather than the failure of the EMH.

Wright[45] attempts to examine different forms of expectations in the formation of second hand prices for small dry bulk carriers for the period 1980 to 1990 using quarterly data. He tests three

different hypotheses, namely, rational, static and adaptive expectations hypotheses. Apart from statistical issues, such as the direct use of non-stationary variables, his tests also suffer from theoretical shortcomings, so not much reliance can be placed on these results. Nevertheless, for the sake of completeness, we report here that he finds mixed results and concludes that ship prices are formed under a mixture of expectations depending on market conditions.

Alizadeh,[46] employs cointegration and non-linear tests on the VAR model proposed by Campbell and Shiller (see endnote 24) to examine the present value model and the EMH in the determination of newbuilding and second-hand prices in the dry bulk sector. One advantage of the VAR approach is that stochastic properties of variables are explicitly considered. In addition, the bivariate model of Campbell and Shiller is extended to a trivariate model, which incorporates the residual (scrap) values as the third variable in the model. He employs the following present value model, which relates the price of a ship (either newbuilding or second-hand) to the discounted present value of expected profits, generated through chartering operations plus the discounted present value of her expected residual alue:

$$P_t = \sum_{i=1}^{n}\left(\prod_{j=1}^{i}(1+E_tR_{t+j})^{-1}\right)E_t\Pi_{t+i} + \left(\prod_{j=1}^{n}(1+E_tR_{t+j})^{-1}\right)E_tP_{t+n}^{sc} \qquad (8)$$

Where P_t is the price of the vessel, E_t is the expectations operator (expectations formed at time t), $E_t\Pi_{t+i}$ represents expected profit in period $t+i$, E_tR_{t+j} is the expected discount rate and $E_tP^{sc}_{t+n}$ is the expected terminal value of the vessel. Variables in (8) are found to be non-stationary, a fact which would invalidate direct tests for EMH. As a result, the Campbell and Shiller transformation is used to re-parameterise (8) and hence, obtain a model with stationary variables.

Two distinct cases are considered for testing the price efficiency of newbuilding vessels. In the first case, it is assumed that the vessel operates for five years and her value after five years reflects the price of a five-year old second-hand vessel; the second-hand price is then used as her terminal value. In the second case, it is assumed that the new-building will be used for her entire economic life and, as a result, the residual value is her scrap price. A limited economic life of 20 years is assumed for a newbuilding and 15 years for a five year-old second-hand vessel.

Alizadeh (see endnote 19) also investigates another implication of the EMH, which requires unpredictability of excess (or abnormal) one period returns, that is returns on shipping investments over the market return. The EMH implies that one period excess returns should be independent of information available at time t. In other words, in an efficient market abnormal returns should be unpredictable; otherwise, excess profit making opportunities may be identified and exploited by a group of investors.

Empirical results from the tests, based on equation (4), reject the EMH in the market for newbuilding and second-hand dry-bulk vessels. In addition, it is found that excess returns on shipping investments (second-hand vessels) over LIBOR are highly predictable, which is again against the notion of informational efficiency in the market for second-hand dry-bulk ships. These findings can be explained by the fact that investors in the shipping industry are characterised by heterogeneous behaviour and different investment objectives and horizons and hence may use different pricing models, discount factors or weights depending on their investment objectives and horizons. This

seems to be a very important point since the EMH requires homogeneous investment behaviour and pricing formulas across all the investors.

5. Conclusions

The aim of this chapter was to provide a description of the dry-bulk shipping markets and discuss current issues and developments in this area. In particular the segmentation of the dry bulk markets in different sub-sectors, which is due to the different physical and economic factors which determine supply and demand conditions in these sectors, is discussed and the factors which contribute to this segmentation are identified and analysed. These factors include, among others, the commodity parcel size, the nature of the underlying shipping routes, the physical characteristics of the loading and discharge ports as well as the vessel's design features. Furthermore, the conditions under which the dry bulk market can be categorised as a perfect market are highlighted and discussed.

Additionally, this chapter also presents recent empirical evidence on issues relating to the properties of the dry bulk shipping freight rates, such as the seasonal behaviour of freight rates. The magnitude and pattern of seasonal fluctuations is measured and compared across freight rates for different size vessels as well as contract durations. Moreover, the seasonal behaviour of freight rates is examined and compared under different market conditions.

Empirical evidence on the term structure relationship between long and short term rates for different sizes of dry bulk carriers is also presented. Recent studies in the literature have employed a variety of testing methods to test the validity of the expectations hypothesis. Their results indicate rejection of the expectations hypothesis of the term structure which may be due to the time-varying perception of the risk of the agents involved in the market. The interrelationships between freight rate levels and spillover effects between freight rate volatilities for different size dry bulk carriers within the spot, one-year and three-year time-charter markets are also analysed. Finally, results from recent studies on the existence of time-varying risk premia in the market for newbuilding and second-hand vessels, are also presented.

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Endnotes

1. Statistics are from Clarksons Research Services (Shipping Intelligence Network).
2. Kavussanos, M.G. (1996): "Comparisons of volatility in the dry-cargo ship sector: Spot versus time charters and small versus larger vessels", *Journal of Transport Economics and Policy*, January, 67–82.
3. Kavussanos, M.G. (1997): "The dynamics of time-varying volatilities in different size second-hand ship prices of the dry-cargo sector", *Applied Economics*, Vol. 29, 433–444.
4. Alizadeh, A.H. and Nomikos, N.K. (2010): "An investigation into the effect of risk management on profitability of shipping investment and operations", *The International Handbook of Maritime Economics*, Kevin Cullinane (ed.).
5. Stopford, M. (2009): *Maritime Economics* (2nd edn.) (London, Routledge Publications).
6. Zannetos, Z.S. (1966):*The Theory of Oil Tank Shipping Rates* (Massachusetts, MIT Press).
7. Glen, D., Owen, M. and Van der Meer, R. (1981): "Spot and time charter rates for tanker, 1970–1977", *Journal of Transport Economics and Policy*, No. 1, 45–58.

8. Hale, C. and Vanags, A. (1989): “Spot and period rates in the dry bulk market: some test for the period 1980–1986”, *Journal of Transport Economics and Policy*, 281–291.
9. Kavussanos, M.G. and Alizadeh, A.H. (2002a): “The expectations hypothesis of term structure and risk premia in the dry bulk shipping freight markets”, *Journal of Transport Economics and Policy*, Vol. 36, 267–304.
10. One element of risk here is credit risk; in other words the risk that the charterer may not honour the contract if there is a significant drop in freight rates in the market. However, we do not consider this type of risk here.
11. Beaulieu, J.J. and Miron, J.A. (1992): “A cross-country comparison of seasonal cycles and business cycles”, *Economic Journal*, 102, 772–788.
12. Dickey, D.A. (1993): “Discussion: seasonal unit roots in aggregate US data”, *Journal of Econometrics*, 55, 329–331.
13. Canova, F. and Hansen, B.E. (1995): “Are seasonal patterns constant over time? A test for seasonal stability”, *Journal of Business & Economics Statistics*, Vol. 13, 237–252.
14. Denning, K.C., Riley, W.B. and Delooze, J.P. (1994): “Baltic freight futures: random walk or seasonally predictable?”, *International Review of Economics and Finance*, Vol. 3, 399–428.
15. Nomikos, N. and Alizadeh, A. “Use of derivatives in shipping risk management” in *The Handbook of Maritime Economics and Business*, C. Th. Grammenos (London, Lloyd's of London Press).
16. Kavussanos, M.G. and Alizadeh, A.H. (2001): “Seasonality patterns in the dry bulk shipping spot and time-charter rates” in *Transportation Research Part E; Logistics and Transportation Review* (forthcoming).
17. Beenstock, M. and Vergottis, A. (1989): “An econometric model of the world market for dry cargo freight and shipping”, *Applied Economics* 21, 339–356.
18. Alizadeh, A. and Nomikos N. (2009): *Shipping Derivatives and Risk Management* (London, Palgrave-Macmillan).
19. Alizadeh, A. (2001): “Time series analysis of freight markets and their properties”, Unpublished PhD Thesis (London, City University Business School).
20. Alizadeh, A.H. and Nomikos, N.K. (2010): “Dynamics of the term structure and volatility of shipping freight rates”, *Journal of Transport Economics and Policy*, forthcoming.
21. Beenstock, M. and Vergottis, A. (1989): “An econometric model of world tanker market”, *Journal of Transport Economics and Policy*, 23, 263–280.
22. Strandenes, S.P. (1984): “Price determination in the time-charter and second-hand markets”, Working paper No. 6 (Norwegian School of Economics and Business Administration, Centre for Applied Research).
23. Veenstra, W. A. (1999): “The term structure of ocean freight rates”, *Maritime Policy and Management*, Vol. 26, 279–293.
24. Campbell, J.Y. and Shiller, R.J. (1987): “Cointegration and test of present value models”, *Journal of Political Economy*, 95, 1062–1088.
25. Campbell, J.Y. and Shiller, R.J. (1991): “Yield spread and interest rate movements: a bird’s eye view”, *Review of Economic Studies*, Vol. 58, 495–514.

26. See Campbell and Shiller for more details on associated statistical issues in testing the expectations hypothesis of the term structure in the bond market and Kavussanos and Alizadeh (2002) for the freight markets.

27. Nelson, D.B. (1991): "Conditional heteroskedasticity in asset returns: A new approach", *Econometrica*, Vol. 59, 347–370.

28. More details of ARCH, GARCH and EGARCH-M models see Bera, A.K. and Higgins, M.L. (1993): "ARCH models: Properties, estimation and testing", *Journal of Economic Surveys*, Vol. 7, No. 4, 305–366 and Bollerslev, T., Chou, R.Y. and Kroner, K.F. (1992): "ARCH modelling in finance: A review of theory and empirical evidence", *Journal of Econometrics*, 52, 5–59.

29. Beenstock, M. and Vergottis, A. (1993): "The interdependence between the dry cargo and tanker markets", *Logistics and Transportation Review*, Vol. 29/1, 3–38.

30. Koutmos, G. and Booth, G.G. (1995): "Asymmetric volatility transmission in international stock markets", *Journal of International Money and Finance*, Vol. 14, 747–762.

31. Koutmos, G. and Tucker, M. (1996): "Temporal relationships and dynamic interactions between spot and future stock markets", *The Journal of Future Markets*, Vol. 16, No 1, 55–69.

32. Kavussanos, M.G. and Nomikos, N. (2000): "Hedging in the freight futures market", *Journal of Derivatives*, Vol. 8, Fall 2000, 41–58.

33. Alizadeh, A. H, Adland, R. and Koekkebaker, S. (2007): "Predictive power and unbiasedness of implied forward charter rates", *Journal of Forecasting*, Vol. 26, No 6, 385–403.

34. It must be pointed out that, from a practical point of view, it may not be possible for a ship-operator to take the opposite position (i.e. charter a vessel in on two consecutive 6-month charters and re-let the same vessel on a 12-month charter) but one can use six-month time-charter contract with an option to extend for a further six-months. Moreover, this strategy would also be feasible for an owner (i.e. charter in vessels on two consecutive 6-months time-charter contracts and charter out an *owned* vessel on a 12-month charter). However, in their simulations they take the view of a ship operator and impose the restriction that vessels can only be chartered in on a 12-month TC basis and then re-let. This is likely to underestimate the profitability of the technical chartering strategies and is similar to a short-sale restriction in financial markets.

35. Ships are considered to be capital assets with limited life of normally 20 to 40 years depending on the type, size and quality of built. Therefore, they are depreciated at a relatively high rate.

36. Modern efficient ships not only consume less fuel for propulsion in comparison to older ships, they are designed to operate with smaller crew which also reduces operating costs. Generally, modern ships benefit from better design and material quality which requires less maintenance and is also supposed to elongate their economic life.

37. Tinbergen, J. (1934): "'Scheepsruimte en vrachten De Nederlandsche' Conjunctuur", March, pp. 23–35.

38. Vergottis, A. (1988): "Econometric Model of World Shipping", PhD Thesis, City University Business School, London, UK.

39. Beenstock, M. (1985): "A theory of ship prices", *Maritime Policy and Management*, Vol. 12/3,

215–225.

40. ldt stands for light displacement tonnes, which is in fact the actual weight of the ship in tonnes, without any cargo, bunkers and fresh water on board.

41. Charemza, W. and Gronicki, M. (1981): “An econometric model of world shipping and shipbuilding”, *Maritime Policy and Management*, Vol. 8, 21–30

42. Hale, C. and Vanags, A. (1992): “The market for second-hand ships: some results on efficiency using cointegration”, *Maritime Policy and Management*, Vol. 19/1, 31–140.

43. Glen, D. (1997): “The market for second-hand ships: Further results on efficiency using cointegration analysis”, *Maritime Policy and Management*, Vol. 24, 245–260.

44. Johansen, S. (1988): “Statistical analysis of cointegration vectors”, *Journal of Economic Dynamics and Control*, Vol. 12, 231–254.

45. Wright, G. (1993): “Expectations in the shipping sector”, *International Journal of Transport Economics*, Vol. 20, No. 1, 67–76.

46. Kavussanos M.G. and Alizadeh, A. (2002b): “Efficient pricing of ships in the dry bulk sector of the shipping industry”, *Maritime Policy and Management*, Vol. 29, No. 3, 303–330.

Chapter 12
The Tanker Market: Current Structure and Economic Analysis

David Glen and Steve Christy†*

1. Introduction

What is a tanker? A tanker is defined as a vessel that is designed specifically to carry liquid cargoes. Refined oil products and crude oil are the most common types of cargo carried in such vessels, but tankers also transport chemicals, wine, vegetable and other food oils. The market for crude oil tankers is by far the largest. The markets for crude oil and refined products are often referred to as the tanker trades. This chapter reviews the world tanker market as it stands at the start of 2009. It has two objectives:

- to provide the reader with an outline of events that have shaped the present tanker market;
- to review economic theories of tanker market dynamics.

2. The Shaping of the Present Tanker Market

On the 1 January 2009, the world tanker fleet, (measured in terms of carrying capacity, the deadweight tonne) stood at 379.1mn dwt.[1] The world fleet consists of around 3,605 vessels of 25,000 dwt or more, all engaged in activities related to the extraction, storage, and distribution of both crude oil and its refined products.[2] One might assume that this level of activity has been reached by a steady, continuous expansion of the industry, but this is far from the case. In fact, the 1990s was a decade of "recovery" for the industry from shocks that affected it in the early 1970s, and which led to record deadweight tonnage capacity by the early 1980s. The period since 1999 has seen the first tanker market boom that has been driven by commercial factors rather than by war and political events.

Indeed, the story does not start in the tanker market at all. Its behaviour can only be understood by knowing something of the economic development of the oil industry itself. The reason for this is simple. The great bulk of oil is transported from its production areas to the main consumption areas by sea. Some is transported by pipeline, and road and rail transport are used as well for intra-country movements; but approximately 95% of the inter-area oil movements are seaborne. In 2008, approximately 2.7 billion tonnes of crude and products was exported, from a total production level of 3.9 billion tonnes.[3] Thus 67% of the world's total oil production was moved across the world, predominantly by sea, generating the source of demand for oil transportation services, and creating the demand for oil tanker services.[4]

The major oil consumption regions happen to be net importers of oil, so their demand creates a need to move oil safely and efficiently from its various sources. The oil tanker, which emerged as a specialised vessel during the 1940s and 1950s, was developed to meet that need.

Oil transportation can be viewed as a productive input, a part of the process that turns crude oil extracted from the ground or from under the sea, into a variety of refined products, from petrol for cars, heating oil, marine diesel fuel, feedstock for the chemical and plastics industry. The capital investment required to develop the industry was very large, with significant expenditure required to

develop oilfields, construct refineries, and develop distribution systems for the products in the rapidly growing markets of the United States and Western Europe. The industry evolved as a 'vertically integrated' structure, with several very large multi-national companies dominating all aspects of exploration, extraction, storage, distribution and refining of the product. Investment in tankers is on-going, with approximately 5% of the fleet delivered annually by the world's shipyards. In addition, there is an active market in the buying and selling of existing tankers for continued trading. Whilst this does not represent new capacity, it does indicate that there are relatively few barriers for new entrants wishing to join the industry.

This economic arrangement, whilst efficient, meant that the principal owners of oil tankers, and of course, their principal users, were the oil majors. By the late 1960s, the seven oil majors that dominated the global industry became known as the "Seven Sisters". The industry was highly integrated and very concentrated. The dominant players at the time included Esso, BP, Shell, Mobil, Texaco, and Gulf. In addition, many European countries had one state-owned oil company "champion"; Italy had ENI, France had Elf and Total. In other parts of the world, state-owned companies were significant local players; for example, Petrobras in Brazil. The very largest companies had large departments whose function was to manage each of the segments of the oil production process. Oil transportation was one of those segments.

The domination of the "Seven Sisters" of the retail side of the oil industry has declined from its peak of the late 1960s. One reason for this was the emergence of a spot market for lots of refined petrol from Rotterdam, the result of refinery overcapacity. New companies entered the retail market, and put competitive pressure on the incumbents. The world of a regulated market was finally destroyed by the Arab–Israeli war of October 1973, and the resulting embargo of oil exports to certain European countries including the Netherlands, along with a dramatic rise in the oil price, from $1.80 per barrel to nearly $40 during 1973–80.[5]

The dramatic rise in the world crude oil price, coupled with the nationalisation of American and European oil interests in the Middle East and Libya, led to a transformation of world economic growth prospects and a shift in the balance of economic power towards OPEC (Organisation of Petroleum Exporting Countries).[6] A major, and long-lived slowdown in world economic growth occurred, and a new era for the oil industry began. In the period since 2000, oil demand continued to grow, boosted by the emergence of India and China as significant consumers of energy as they grew at sustained high rates.

Much of the present structure of the tanker market has been created by these events. Indeed, the past two decades could be argued to be the first period in which the tanker market was primarily driven by economic and environmental issues, rather than politics. Political events of course, are always of potential consequence – they are woven into the history of both the industry and the tanker market.

3. Oil Consumption

The world's demand for oil is large, and grew at around 1.3% per annum between 2000 and 2008. Figure 1 shows the trend in world oil consumption over the past 35 years. Demand declined after 1973, recovered, peaked in 1979–80, and then fell until 1985. In fact, world oil consumption peaked at around 3,100mn tonnes in 1979, and declined by approximately 10%, to 2,801mn tonnes in 1985. The 1979 peak was not surpassed until 1990; and even in 1995 it had only reached 3,200mn tonnes, rising

to 3,500mn tonnes in 2000. Between 2000 and 2008 consumption continued to grow, reaching an all time record of 3,937mn tonnes in 2007, then declining to 3,928mn tonnes in 2008.[7]

Table 1 shows that the trend growth in oil consumption over the past ten years was 1.3% per annum, consistent with the 2002 International Energy Agency (IEA) forecast (1.4%), which was conditional on assumptions about the behaviour of the price of crude oil. Its 2008 projection predicts growth at around 1% per annum until 2030.

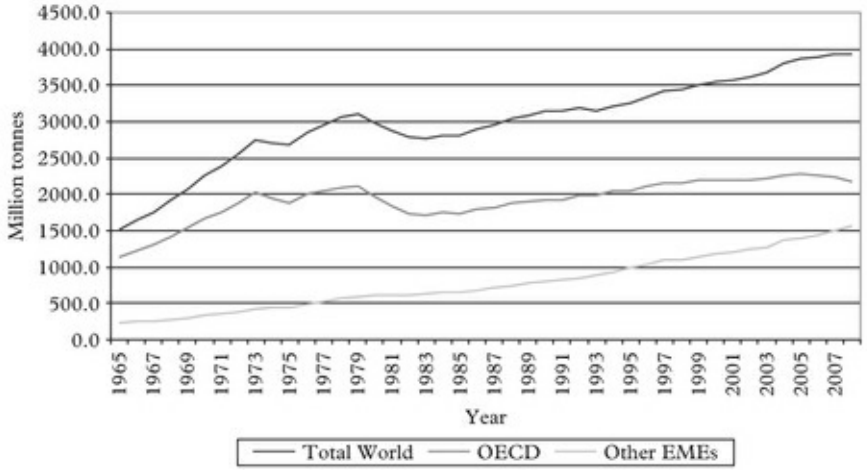


Figure 1: World oil consumption 1965–2008
Source: Derived from data from BP Review of World Energy, 2009

Table 1: Regional consumption patterns, 2008

	Mn Tonnes		Annual Growth		Share %	
	2000	2008	1990–2000	2000–2008	2000	2008
North America	1,071.4	1,076.6	0.01	0.06	30.2	27.4
S & Cent America	218.7	270.3	0.03	2.65	6.2	6.9
Europe & Eurasia	928.1	955.5	0.01	0.36	26.1	24.3
Former Soviet Union	173.2	189.5	-0.09	1.12	4.9	4.8
Middle East	222.3	306.9	0.02	4.03	6.3	7.8
Africa	115.1	135.2	0.02	2.01	3.2	3.4
Asia Pacific	988.4	1,183.4	0.04	2.25	27.8	30.1
Total	3,551.2	3,927.9	0.01	1.26	100.0	100.0
of which: EU	696.7	702.6	0.51	0.11	19.6	17.9
OECD	2,199.7	2,179.8	1.33	-0.11	61.9	55.5
Other EMEs	1,178.4	1,558.6	3.81	3.50	33.2	39.7

Source: Derived from BP Statistical review of Energy, 2009

This is slower than recent experience, but still positive, despite developing environmental concerns over greenhouse gas emissions, and policy initiatives designed to lower the world's consumption of fossil fuels. In June 2009 the IEA revised its medium-term growth projection (to 2014) to 0.6% per annum, from the 1.1% projected in 2008.[8] It is possible that such revisions may be reversed in a year or two, when the word economy has recovered from the 2008–9 downturn.

The composition of oil consumption has also altered over the period, and will continue to alter in the future. Figure 1 shows the oil consumption of the OECD countries for 1965–2008. It is clear from visual inspection that the share of non-OECD members has increased over the past two decades. Despite its declining share (74% in 1965; 62% in 2000; 56% in 2008), the economic performance of the OECD countries is still important for the growth in demand for oil. By far the most significant player in this sector is the USA. In 2008 it alone accounted for nearly 1,100mn tonnes of oil (down

from a 2005 peak of 1,140mn tonnes), or just under 23% of the world's consumption. The whole of Europe and Eurasia accounts for 955mn tonnes, whilst Asia accounts for around 1,180mn tonnes. Japan, Asia's wealthiest economy, (which has not exhibited its former growth pattern and that of the other countries in the South East/Pacific Asian economies), consumed 222mn tonnes, in 2008, approximately the same as it consumed in 1973. The major new contributors to growth since 2000 have been China, whose consumption has risen from 224mn tonnes to 376mn tonnes, and India, 106mn tonnes to 135mn tonnes in 2008. As Figure 1 shows, the emerging market economies now account for 40% of world oil consumption. Figure 1 shows that the OECD's share has fallen sharply in the last decade. The present pattern of regional consumption is shown in Table 1.

A number of points are worthy of note. Firstly, it is clear that the annual growth of world oil consumption rose significantly between 1990–2000 and 2000–2008, from 0.01% per annum to 1.26%. The Middle East's own consumption has risen, reflecting its own economies' diversification and development. South and Central America and the Asia pacific regions have also grown above the world average. Second, the previous decline in consumption in the economies that constitute the former Soviet Union has been reversed. This reflects, at least in part, the well-known problems affecting these economies in the period 1989–1998. Oil consumption in this region remains lower than that in the Middle East, although its growth rate has increased to 1.1% a year. Third, the changing balance of importance, tilting economic impacts more towards the emerging market economies and away from the traditional major oil consumers, continues apace. North America's share of oil consumption has declined to 27.4%, Asia Pacific's rising to 30.1%. This trend is set to continue. The 2008 World Energy outlook projects all of increase in oil demand to 2030 to be derived from non-OECD countries, with 80% plus from China, India and the Middle East region.[9]

4. Economic Drivers of Oil Consumption

Having briefly outlined the present profile of oil consumption and its regional pattern, attention is now turned to addressing the question as the principal factors driving oil consumption. The standard set of economic factors are: Incomes (the price of crude oil and its refined products; the price of substitute products; the price of complementary products) Tastes; Political factors, and Expectations. The exposition is necessarily short. The relationship between Incomes or Gross Domestic Product (GDP) and oil consumption or its constituent components has been extensively studied. Professor Dahl has published a survey of 100 econometric studies of the relationship between gdp and petrol demand.[10] She concluded that the income elasticity of demand was greater than unity, which implies that gasoline consumption will grow faster than the economy under examination. The survey reports estimates of between 0.80 and 1.38 for the long-run response.[11] The short-run response was much lower however, between 0.4 and 0.5.

The second key element in the behaviour of oil consumption is the reaction of consumers to changes in the real price. Dahl reports estimated values of –0.22 to –0.31 for short-run values, and –0.58 to –1.02 for long-run values derived from the 100 studies surveyed. These figures are indeed inelastic (the proportionate fall in demand is significantly less than the proportionate rise in the price), but they relate to just gasoline demand, which constitutes around 30% of world oil consumption.[12]

Figure 2 shows the time path of real (i.e. adjusted to reflect the changing purchasing power of the dollar over time) and nominal price (dollar price in the relevant year) of Arabian Light oil from 1972

– 2008, in annual average form. The data shows tremendous variations, from $1.90 per barrel in 1972, to $10.41 in 1974, peaking at $35.69 in 1980, declining to $12.95 in 1986, before peaking again at $20.50 in 1990, declining to a low of around $8.00 in the late 1990s, before rising in the boom of 2000, following the introduction of production quotas by OPEC members in the second quarter of 1999. The price of Brent Oil, which is highly correlated with Arabian Light, had reached $30 per barrel in 2002. From 2002–2008 the annual average price has risen to historically high levels, reaching $97 per barrel for 2008. This increase masks the

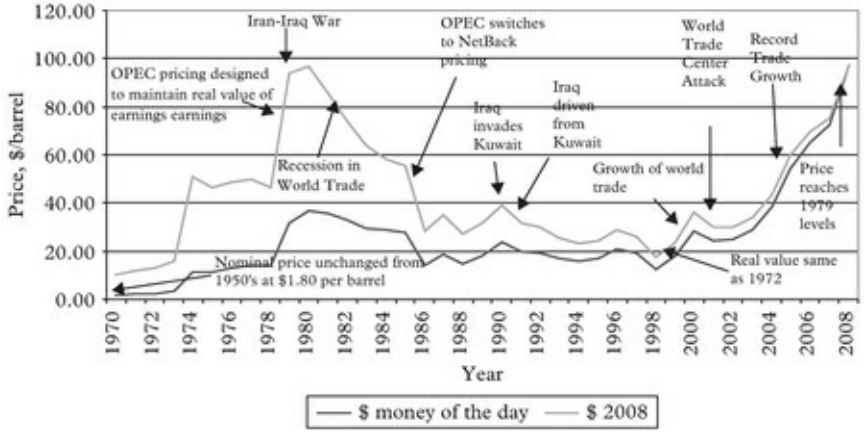


Figure 2: Real and nominal prices of crude oil, 1970–2008
Source: BP Statistical Review of World Energy 2009

considerable volatility that exists within the year itself, but even on an annualised basis, the changes have been dramatic. It should be noted that Arabian Light is not traded as such, but is subject to "netback pricing" – a notional crude price based on the value of constituent products from a barrel of oil on the Rotterdam market, after deducting refining and sea transportation costs.

Figure 2 clearly shows that many of the peaks in the oil price are associated with Middle-East wars or other globally significant economic events. It should be noted that the Iraq war of 2002 made little impact, the main drivers being oil demand and capacity issues. The only item that might need further explanation is the apparent change in direction in the nominal price before and after 1979–1980. The primary causes were the world recession of 1979–1982, and the accelerating substitution of oil by coal for power generation, along with initiatives to reduce energy consumption in the principal consuming areas. It has been argued that the eventual abrupt relinquishment of the high price oil strategy in April 1986 was the result of joint undertakings between the world's largest consuming nation and the OPEC's largest producer.

The second reason relates to the changing pricing policy of OPEC members themselves. By the mid-1980s, after five years of oil prices between $25 and $20, oil production from the North Sea, and Alaska provided competition from non-OPEC suppliers; and OPEC, watching the decline in oil demand, dramatically altered its policy on oil pricing. Prior to the change, OPEC would try to maintain the real value of its earnings in nominal dollar terms. Whenever the dollar fell in value, (as it did in the 1970s), the nominal price of oil was raised to offset the fall. In the mid-1980s, OPEC members changed their policy, switching to "netback pricing". This change, in response to declining market share as Mexican and North Sea production became more important, meant that the real price of crude oil was no longer being maintained. OPEC was under the impression that the marginal cost of non-OPEC crude was $21/barrel, and tacitly applied an $18 "benchmark" price for the basket of OPEC crudes. In fact, the real price of crude oil fell to its lowest value since the early 1970s, following the

1986 watershed. The history of oil pricing since 1990 has been one of high volatility and subject to prolonged stock-building as more non-OPEC oil came on stream. In addition, there has been periodic weakness in demand, before its recovery in the late 1990s.

When the "real price" series is examined in Figure 2, the changes in oil price over the past 30 years are even more exaggerated. It is clear that only in 2007 did oil prices exceed the levels last seen in 1979–1981. Prices have eased off since, but the high real oil price in recent years reflected two elements – a resurgence of demand growth, as noted above, and a tightening of refinery capacity margins, which itself was in part due to the low oil prices observed in the 1990s, which mitigated against significant investment in refineries during the period.

A noteworthy element of the surveys by Dahl[13] is the *absence*, in many of the econometric studies, of cross-price effects. There may be two reasons for this. First, the investigations ignored the effects by failing to include any cross-price elements in their model. For example, it could be argued that the demand for petrol will be negatively influenced by downward changes in the price of public transport, where it is available. Thus cross-price effects may influence oil consumption. Secondly, the investigators may have tried such factors, and discarded them, when they prove to be statistically unimportant. Indeed, given the low own-price elasticities of demand, it would not be surprising if cross-price elasticities were negligible. Economic theory implies that the smaller the degree of substitutability between goods or services, the lower the level of cross-price elasticity. For many uses, oil products have few, if any substitutes.

Oil demand can be affected by changes in the price of complementary products. For gasoline consumption a vehicle is required. For fuel oil, a power station. In many cases the price of the oil product is extremely small as a proportion of the overall costs of deriving the service that it generates. It is true, however, that two of the key drivers of the growth in oil consumption in the past 50 years were the rise of the motor vehicle, and the switch to oil as a source for power generation, away from coal. The former is an example of complementarity; the latter an example of price substitution.

Shifts in tastes can influence demand. The rise of the motor car has been a major event in the western economies, and appears to be happening in the developing economies too. Until the 1970s, little or no regard was being paid to the negative effects of this expansion; namely the rise in carbon dioxide emissions, the growing evidence of the damage that lead additives to petrol caused, and the rising levels of environmental damage caused by the exploitation of the word's resources. Environmental awareness has been raised significantly over the past 25 years, and this has had an impact on the oil industry. Energy conservation has become a key issue, although the more cynical observer is more likely to point to the oil price increase of 1973 as being the event that forced many governments to develop such policies. In addition, a number of significant oil pollution incidents led to successively tighter regulatory frameworks governing the production, distribution and transportation of oil.[14]

Since the end of World War II, oil has been a strategic resource. The fact that significant shares of the world's oil resources are located in the Middle East and the Soviet Union meant that Western Europe was particularly vulnerable to disruption of oil supplies. The USA switched from being self-sufficient in oil to becoming increasingly dependent on oil, in particular from North Africa, the Middle East, Venezuela and West Africa. Major political crises punctuate the history of the oil

industry, and have identifiable effects on the tanker market. The UK and French attempt to occupy the Suez Canal, following its nationalisation by Egypt, and the nationalisation of US oil interests in Libya, created tensions in the Near- and Middle East, which focused on the conflict between Israel and the Palestinians. The Egypt–Israeli war of 1967 caused the closure of the Suez Canal for eight years, and led to another clash in 1973. This was the event that precipitated a major shift in the economic balance of oil, as OPEC exercised its economic power, and raised the price of crude oil by 400% in the space of a few months. Political instability remains a theme at the present time. The 1981–1989 Iran-Iraq war, the 1990 invasion of Kuwait by Iraq, the 2001 Iraqi invasion of Kuwait and the consequent invasion of Iraq by the USA and her allies, the continuing tensions between Israel and the Palestinians, all show that oil is still a strategic product. However, a very significant change has occurred which makes it likely that embargoes will be less likely – there has been a significant shift in OPEC's pricing strategy.

The demand for oil is also affected by players' *expectations* of future events. Oil prices are volatile; nowadays some of the risk volatility can be hedged against by taking out forwards or futures contracts on the International Petroleum Exchange. Whether or not all of the risk can be hedged depends on the efficiency of the markets and the nature of the contracts available. Nevertheless, the presence of these markets allows oil companies to hedge some of the risk of current price volatility by "taking a position" on the paper markets to offset some of the risk.

The existence of such markets can also generate forward prices, which can be viewed as the market's guess as to the future path of present (spot) prices. In some recent economic theories, current prices for a commodity or financial asset are viewed as being entirely determined by the expected price. In other words, today's price is determined by the today's expectation of tomorrow's price. When political uncertainty increases, market expectations are for a shortage of oil in the future, and this leads to a sharp increase in the present price of oil. Thus expectations may play a key role in understanding market dynamics. It might be noted that the very high prices achieved by crude oil in 2007 have been blamed on "speculative" activity, with forward prices driving spot prices. This conjecture is very hard to verify.

It has been shown that the demand is very insensitive to own price, but quite sensitive to economic growth. The sharp change in conditions in 1973 led to lower growth trends for oil demand, and a significant incentive to lower the intensity of oil use. Both of these effects led to decline in oil consumption until 1985–1986, with 1975 levels reappearing only in the late 1990s. The continuing future growth of demand is sensitive to economic growth, switches to alternative energy sources, and increasing improvements in the efficiency in which oil is used, for example, in the fuel efficiencies of motor car engines.[15]

5. World Oil Production Trends

Not surprisingly, world oil production tends to track demand very well. There is an important element that "gets in the way" of this relationship however – oil is produced in regions were there is little demand, and traded. The time taken to move the oil to its region of consumption means that there is inventory, either in the form of oil on ships or in storage tanks at oilfields, oil terminals and refineries. In addition, since 1973 many countries have instituted strategic reserves of oil, in the event of any oil export embargo repeating itself. One estimate of the OECD countries' crude and product inventory

puts it at 2.7bn barrels, or 355mn tonnes, roughly 57 day's supply at 2009 consumption levels.[16]

Production can therefore be divorced from consumption to a certain extent, and there will be periods when demand exceeds current production and vice versa. But over the longer period, it is consumption that drives production. Comparison of the average annual growth rate over the period 2000–2008 for world oil consumption and production yields figures of 1.26% and 1.1% respectively.

5.1 Regional production patterns

Examination of regional patterns yields a different story (Table 2). In the period 1990–2000, North American production declined slightly, and there were significant falls in production in the economies of the former Soviet Union (FSU). Elsewhere Europe and South America experienced the largest growth in production. In the period 2000–2008, the Russian Federation recovered lost ground, growing at 6.1% per annum, whilst output from African countries grew strongly. However, it is the Middle East that still dominates world production, with a 32% share in 2008, unchanged from 2000. Whilst this is lower than at some points in the past, it is also higher than at other times, particularly in the early 1980s.

Putting the two tables of production and consumption together leads to the generation of a crude estimate of the need to move oil between one region and others; this generates a "derived demand" for oil tanker services. BP's estimates of inter-area oil movements are shown in Table 3.

These figures will not correspond to the volumes of oil traded by sea, because the data includes other modes of transport, but they give a general indication of the major directions that oil is traded. In fact, many of the movements shown in the Table will be

Table 2: Regional production patterns, 2008

	Regional Production Patterns, 2008			
		Annual Growth %		Share
	Mn Tonnes	1990–2000	2000–2008	2008
North America	619.2	−0.1	−0.6	15.8%
S & Cent America	335.6	4.2	−0.3	8.5%
Europe*	362.5	4.1	−1.2	9.2%
Russian Federation	488.5	−3.7	6.4	12.4%
Middle East	1253.7	2.7	1.2	31.9%
Africa	488.1	1.5	3.9	12.4%
Asia Pacific	381.2	1.6	0.1	9.7%
Total	3928.8	1.3	1.1	100.0%

Source: Derived from BP Statistical Review of World Energy, 2009
Note:
* "Europe" is defined as Europe & Eurasia excluding the Russian Federation

Table 3: Regional flows of oil, 2008 (mn tonnes)

From	To North America	South & C America	Europe	Africa	Asia Pacifc	Other	Total
North America	217.8	29.9	33.7	1.8	13.4	1.6	298.3
South & C America	121.7	–	25.2	1.1	30.3	0.1	178.3
Europe	57.4	4.8	–	16.9	8.8	9.7	97.6
Former Soviet Union	25.6	3.0	318.5	1.1	44.8	11.8	404.8
Middle East	126.5	5.8	127.6	44.5	693.3	3.1	1,000.7
Africa	138.0	20.1	151.3	5.5	93.1	0.1	408.1
Asia Pacific	9.1	8.2	9.7	2.6	246.3	2.3	278.2
Unidentified	14.8	–	14.9	–	1.9	–	31.7
Total	710.9	71.9	680.9	73.4	1,131.9	28.6	2,697.6

Source: Derived from Inter-Area Trade Flow Matrix, BP Statistical Review of World Energy, 2009

entirely by sea; for example, exports from West Africa to the USA and Europe, exports from the Middle East to Japan. The trade data emphasises the importance of Middle East exports in the oil trade; In 2000, nearly 50% of the world's oil was exported from that region. By 2008, this had fallen to 37% as some countries diversified their oil supplies. Note that the Asia-Pacific region, containing some of the most dynamic economies, obtained 61% of its oil from this region.

6. Tanker Demand

It is clear from inspection of Table 3, that the need to service consumption from the major oil production centres leads to a demand for the transportation of oil, either in its crude (unrefined) form, or in the form of refined products.

6.1 Derived Demand

Maritime economists define this demand for this service as a *derived* demand. That is, the need to move oil is not demanded for its own sake, as there is no intrinsic value or utility in so doing. The movement is made to "add-value" to the commodity, by selling it in a market where the marginal utility to the consumer is much higher than it is at the point of production. The process of moving the cargo is not directly determined by the consumer, as it is a part of the "supply-chain" process, and is best viewed as part of the production process. This means that the act of transporting oil is in effect, a factor input, and the laws that apply to factor demand apply to oil. There are four "Marshallian rules"[17] of factor demand.

These rules are useful in indicating, from first principles, the likely demand responsiveness for oil movements to changes in freight rates. The rules are as follows:–

1. The elasticity of demand for the factor input (oil transportation) will be higher (lower), the higher (lower) the elasticity of demand for the final product (petrol, fuel oil, feedstock, heating oil, etc).
2. The elasticity of demand for the factor input will be higher (lower), the higher (lower) the degree of substitutability between the factor and other factor inputs in the production process.
3. The elasticity of demand for the factor input will be higher (lower) the higher (lower) the share that the input takes of the overall costs the consumer of the final product.
4. The elasticity of demand for the factor input will be higher, the higher the elasticity of supply

of the factor input.

Having already discussed some of the evidence of the income and price elasticities of demand for the final product, it is easy to realise that the above rules imply that the elasticity of demand for oil transportation with respect to changes in the cost of transporting it (the freight rate, in the case of shipping) is very likely to be extremely small, if not zero. The reason for this is to be found in rules 1 to 3. Rule 1 implies that the freight rate elasticity of demand will be proportional to the own price elasticities of demand for the final good, which has been, at the most optimistic, been estimated at –1, with most studies in the short run yielding –0.4. Rule 2 implies that this elasticity will be lower, the lower the degree of substitutability. Whilst oil pipeline transportation can and does, have a significant role in certain parts of the world, the fact remains that the overwhelming majority of oil has to be moved by sea, or not at all. Rule 3 implies that the smaller the share of the input cost as a proportion of the final landed price to the consumer, the lower the freight rate elasticity. In the UK, it is estimated that the freight cost component in the retail price of petrol is around 1p on a current price of around £1.00 a litre; large variations in the freight rate will have almost no noticeable effect on the retail price in the UK.

The conclusion from the combination of empirical evidence and economic theory is that oil transportation demand will be highly price inelastic in most situations, but elastic with respect to changes in economic activity. Where substitute transportation forms exist however, such as major oil pipelines, or alternative fuels for vehicles, such as in Brazil, cross price elasticities may be considerable.

6.2 Demand measurement

It has been demonstrated that large volumes of oil are annually transported from region to region. This provides *one* indicator of the derived demand for oil movements. Transportation is a non-storable *service*; it requires the movement of the oil cargo between two geographical points for that service to be performed. Oil demand has to be measured in two ways. First, in terms of the tonnes of oil being moved per time period; and second, in terms of the *tonne miles* being demanded per time period. Transportation service demand is a flow demand, and it is the product of cargo volume and distance travelled per time period that generates overall demand.[18] Average voyage length is thus a proxy for route structure, since changes in that structure, say a

Table 4: Trends in oil transportation demand 1990–2008

	1990	1995	2000	2008
World production (Mn tonnes)	3,164	3,269	3,589	3,929
Seaborne trade				
Mn tonnes	1,526	1,808	2,119	2,681
Bn tonne miles	7,821	9,320	10,420	12,440
Average haul (miles)	5,125	5,155	4,917	4,640
Seaborne trade share of production	48%	56%	59%	68%

Source: BP Statistical Review of World Energy; OECD Maritime Transport Review, various issues

significant shift to short haul trades, will reduce tonne mile demand even if oil volume demand is unchanged. A shift towards long haul routes does the opposite.

6.3 Tanker demand trends

Table 4 gives some information on the trends in tanker demand, in terms of tonnes of cargo carried

and tonne miles performed per year, for the period 1990–2008. It is worth noting that the average haul of crude and products movements is around 5,000 miles over this period. Whilst this appears to be relatively constant, it has not always been thus. In 1967 the average haul was 4,775 miles; in 1977, 6,651 miles. The closure of the Suez Canal between 1967 and 1975 clearly divorced tonne miles demand from tonnes demand. Over the period 1968–1973 tonne mile demand grew at an annual average of 21.4% per annum, whereas tonnage demand grew at 13.6% per annum; for the period 1978–1983 tonnage demand fell by 5.6% per annum, whilst tonne mile demand declined by 9.0% per annum.[19] For the tanker markets, the main reasons for discrepancies between tonne mile demand and tonne demand are the closure of strategic routes, such as the Suez Canal, and the changing structure of oil demand patterns, towards or away from long haul trades. The early 1970s also saw the rise of the 200,000 tonne-plus tanker, or Very Large Crude Carrier (VLCC), which became dominant on long haul crude oil movements, essentially from the Middle East, to Europe and the Far East, since modified by a growing trade from West Africa to the Far East. The size and draft of these vessels made laden transit of the Suez Canal impossible, but the new technology provided sufficient scale economies to make the "distance" considerations irrelevant.

Table 4 shows clearly that the volume of oil transported has grown over the past ten years. The oil trade movement map published by BP,[20] shows that there is a wide variation in the volume of cargoes being moved on the principal oil trade routes, whose structure has remained relatively stable, but which can change in response to new oil-field; developments, interruptions of existing supplies, and changing patterns of oil consumption. There are new major oil flows from West Africa to the Far East, and Singapore has become a major focal point for oil movements, reflecting the dynamism of the region in the past decade.

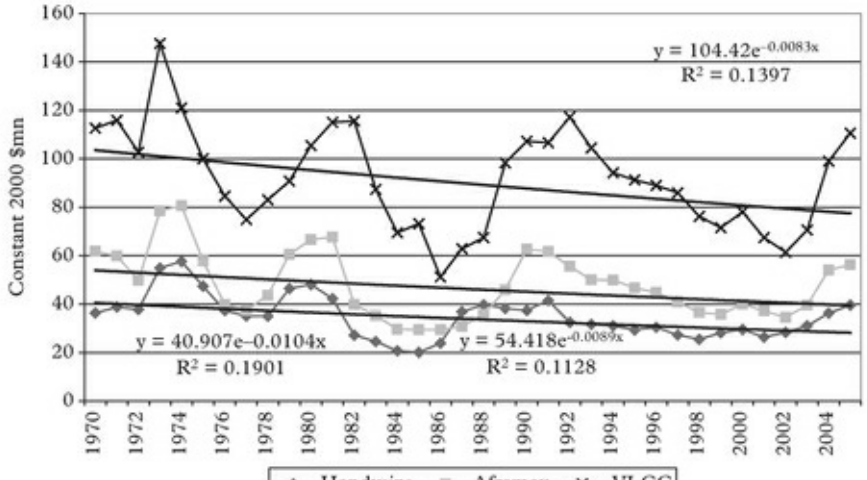


Figure 3: Real tanker prices 1970–2005
Source: Authors

6.4 Cyclical features

The data so far presented might suggest to the reader that demand trends are rather long term and gentle. In fact, there are very marked cycles of economic activity in the shipping markets, and the tanker industry is no different. It was argued that the most recent tanker boom, which peaked in 2001, is the first for many years that has not been triggered by an external shock, such as a Middle-East war. The marked cyclical nature of the industry can be seen in Figure 3, which shows the behaviour of real tanker prices for three size classes over the period 1970–2005. The positive deviation from the trend

shows the boom periods, the negative deviation, “recession”. Asset values are a good measure of the expectations held by agents of future earnings and profitability. The most recent cycle upturn occurred in 2003 and came to an end in 2009. In the early part of the present cycle, some commentators claimed that the cycle had disappeared. Obviously they were ill-informed.

An alternative view of the market is to examine tanker charter rates, the “hire price” (in dollars per day) set for running a tanker for one’s own use, but not owning it. Figure 4 shows the historical development of one year rates from 1990 to May 2009.

The peaks in hire rates, in 1997–1998 and in 2001, are marked, especially in 2008. The recent “boom” from 2004–2008 is also apparent. These periods do not correspond to external events, and are a sign that the tanker market escaped the legacy of the 1970s and 1980s.[21]

Whilst every player in the tanker industry is aware that their business is cyclical, no-one has been able to develop a successful method of consistently forecasting the points at which the cycle switches from one phase to another. The cyclical behaviour of rates reflect the cyclical growth in demand, and supply, neither of which change at a constant rate.

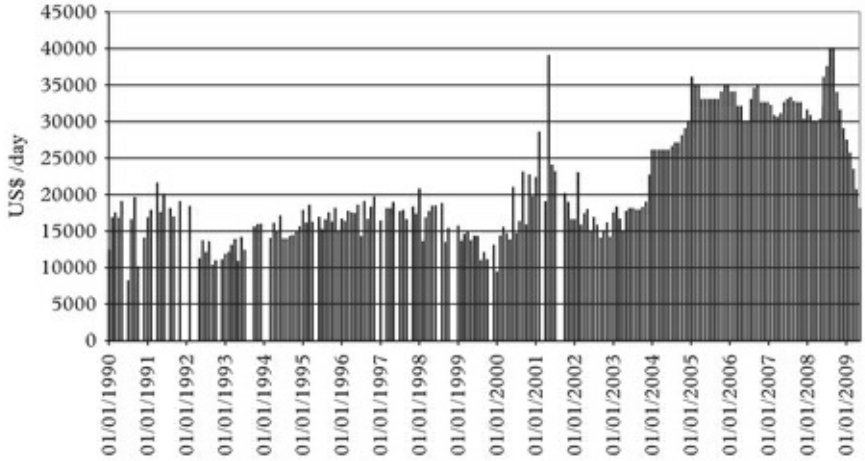


Figure 4: Alframax one-year TC rates 1990–2009
Source: Authors *Note*: Blanks mean no fixtures reported in that month

7. Tanker Supply

7.1 The structure and composition of tanker supply

The tanker supply situation has become increasingly fragmented over the past 30 years. Analysts and industry observers now segment the supply side into a number of different categories. Whilst overall macroeconomic conditions will drive all segments, each component of the market has its own characteristics. After reviewing fleet developments in broad terms, these segments will be examined in more detail.

7.2 Tanker fleet development

The world tanker fleet is defined as all those vessels that are classified as being dedicated to the movement of crude oil or refined products. It constitutes approximately 33% of the world’s cargo fleet. Conventional analysis defines the smallest as 25,000 dwt, a convention adopted here. In addition, a number of vessels were designed and built to operate in both the oil and dry bulk cargo trades. These are called combination carriers, and can be used to carry either iron ore, or bulk, or crude oil. In 1999 there were 159 such vessels, or 16.0mn dwt. This contrasts with the 3,307 tankers, or 287.4mn dwt. The potential oil carrying fleet includes both of these types. Table 5 provides some summary statistics for the tanker fleet itself.

The falling average age of the fleet reflects the industry's phasing out of single hull tankers with double hull vessels, as required under the IMO "phase out", and the improved profitability of tanker ownership from 2000 on.

Table 5: World tanker fleet 1995–2008

	1995	2000	2005	2008
World tanker fleet (Mn dwt)	234.3	245.4	320.9	379.1
(% of world cargo fleet)	39.7	30.7	36.4	32.8
Tanker productivity				
(Tonnes cargo moved per dwt per year)	6.7	7.3	6.7	7.0
Fleet average age (years)	14.9	13.9	10.0	10.1

Source: Lloyd's Register-Fairplay 2008, UNCTAD Review of Maritime Transport 2009, Gibsons
Note: Fleet data for 25,000 dwt and above

7.3 Structure of tanker supply

The world's tanker fleet is segmented into various submarkets. The segmentation is by size and by product type. Analysts distinguish between the markets for products tankers and crude oil tankers, and between a number of important size ranges of both of these segments.

The distinction between crude and products is an important one. The small products tankers have segmented (parcel tanks). The current fleet of products carriers includes vessels over 120,000 dwt, all of which have tank coatings and more complex cargo pipe work and pumping arrangements to protect the vessel against its highly corrosive and volatile cargo, whilst also maintaining and protecting the cargoes specification. Generally, product carriers are significantly smaller in size than crude tankers. Both construction and operating costs are higher for product vessels. The increasing concerns over product contamination have led to these ship types limiting their trading to clean or white petroleum products. Whilst it is possible to carry "dirty cargoes" in these vessels, the consequent contamination risk to future cargoes means that switching back would be difficult, and owners incur cleaning costs for the removal of residues, before their vessel becomes acceptable to potential charterers for the carriage of clean products again. No crude vessel is used to carry products, so there is a significant degree of segmentation between these market components. The "clean" sector is also very different in terms of industrial concentration. This is a market that academic maritime economists have largely ignored.[22]

More problematic is the segmentation of the crude oil market by ship size. The main workhorses of the tanker industry are now the Very Large and Ultra Large Crude Carriers, (VLCC/ULCC), defined broadly as vessels of 200,000 dwt or above; vessels of 120<200,000 dwt, which can transit the Suez Canal (Suezmax[23]), the Aframax Tanker, of around 80,000–120,000 dwt, and the Panamax tanker, 55–80,000 dwt. Products tankers tend to be smaller (25–50,000 dwt), although there are some quite large vessels (100,000 dwt) in this category. Essentially, the wide variation in draft/beam specification in vessels means that there is considerable potential overlap between these segments, but it is the case that the different ship sizes are generally found on different routes, reflecting the underlying economic drivers.

The VLCC/ULCC market is the one that has suffered the most in the past. Vessels of 200,000 dwt or more did not become significant in numbers until the mid-1970s, at the time of economic slowdown. For some years in the early 1980s, no-one placed any orders at all for this size of vessel. Thus from a

rapidly increasing, young fleet, the VLCC sector became a story of weak trading conditions and an ageing fleet.

The Oil Pollution Act, OPA90, which followed from the *Exxon V aldez* oil pollution incident in 1989, and the accelerated phase out of single hull vessels agreed after the *Prestige* (2002) and *Erika* (1999) disasters under IMO MarPol Regulation 13G, have had a great impact on the structure of the fleet. Good trading conditions, particularly after 2003, have also had an influence. Seventy-five per cent of the 147mn dwt that constitute the 200,000 dwt + sector are aged 15 years or less, and 60% are aged 10 years or less.[24] The phase out of single hull tankers, and recent record high rates, have created a modern, young VLCC sector. ULCC's have largely disappeared.

The primary routes for these vessels are long haul, mainly from the Middle East, to Japan and the Far East, but increasingly, West Africa to the Far East. Trading into the North American east coast is restricted by port and draft limitations, although vessels can call at LOOP.[25] Significant increases in VLCC activity can thus raise tonne mile output significantly, because of the combination of ship size and voyage distance. Trading to Europe is the other primary route. At 1 January 2009, there were 506 vessels of 147mn dwt, and an orderbook for a further 67 more to be delivered 2010–2011.[26]

The Suezmax tanker trades on more specific routes. In the mid-2000s, half of the Suezmax fleet was deployed on the trade from Nigeria and other West African loading terminals to the USA and Europe[27], with trading being generally restricted to the Atlantic basin. The fleet has an age profile which is even younger than the VLCC's, with 66% being less than 15 years old, and a staggering 81% being younger than 10 years, of a fleet of 364 vessels of 55.3mn dwt. There were 260 vessels, or 38mn dwt, in this sector in 2002, indicating a buoyant segment in the past few years.

The age profile of the Aframax fleet is now not noticeably different from the larger tankers.. There were 467 vessels of 45mn dwt as at February 2002, growing to 792 vessels and 82mn dwt at end 2008. The Panamax sector is a smaller segment of the market, with 390 vessels totalling 27mn dwt. The Panamax fleet expanded as crude oil exports from the west coast of South America increased and found their way to the US Gulf refineries. At the same time, the increasing number of products carrier movements from the US Gulf and Venezuela to the US west coast will necessitate more coated tankers to transit the Panama Canal, and therefore be subject to the canal's present 32.3 metre beam restriction.

Products tankers' load factors are much higher than for crude vessels and long balancing ballast voyages usually only apply to the large products carriers, and they tend to operate on shorter haul routes. However, the cubic capacity tends to be the main limiting factor for products carriers. The clean products tend to be lighter, having lower specific gravities, than those for dirty products and crude oil. In fact, vessels carrying full cargoes of clean products do not attain their maximum deadweight draft. An important trade is moving refined products from the Caribbean refineries to the US east coast.

7.4 Tanker ownership structures

The tanker market has undergone a significant change in the composition of ownership over the past 35 years. Three key elements can be identified in this process. Firstly, the emergence of significant refinery overcapacity in Europe. In the period 1965–1971, capacity increased by 50%.[28] This process created a "spot market" for oil and oil products in Rotterdam, and helped to alter the structure of the

UK's market for petrol. Second, the collapse in tanker demand in the 1970s led to many oil companies changing their tanker strategy. Analysis of data provided by Gibsons shows significant changes in the proportions of the tanker fleet that were employed by the oil majors in terms of owned vessels, the proportion hired on long term (5–10 years) time charters, or employed on a "spot" basis. The transformation from a highly controlled structure, where oil companies relied on spot market transactions for only 10% of their needs, to a situation where they take approximately 90% of tanker capacity from the spot market, was greatly accelerated by the drop in demand in the 1970s, which was accompanied by a severe oversupply of tonnage, especially in the VLCC segment.

The third element that helped to transform the structure of ownership has been the significant shift in attitudes to environmental pollution, mentioned earlier. In 1989, the *Exxon Valdez* struck a submerged reef whilst sailing in the Prince William Sound, Alaska, laden with crude oil. The vessel struck rocks, and lost 37,000 tons of crude oil through her single hull into the sea. Whilst not a large spill by historic standards,[29] the political reaction in the USA had ramifications that are still felt today. The ratification of the Oil Pollution Act of 1990 led to many major oil corporations deliberately reducing their direct ownership of oil tonnage, in an attempt to reduce their exposure to liability in the event of future incidents.[30] The decline in the apparent role of the major oil companies, and the rise of the so-called "independent" tanker owners, means that in economic terms, the market has become more competitive than it was. In 2009, only a few of the original "Seven Sisters" have a significant direct ownership of tankers, for example, BP.

The standard method of examining the degree of dominance of specific companies in an industry is to measure its degree of industrial concentration. The simplest way is to measure the share of the industry total accounted for by the five largest or 10 largest companies. Whilst this method has weaknesses, it is simple and easy to understand. In 2002, the largest oil company fleet was Vela, of Saudi Arabia, which owned 5.9 mn dwt. They were followed by Petrobras (Brazil) and NITC (Iran) with 3.7 mn dwt each. ExxonMobil was fifth largest with 2.3mn dwt, and the total for the five largest oil companies was 27mn dwt. The five largest independents owned 70.8 mn dwt, and the smallest of these, Astro tankers, would rank fourth, irrespective of organisation type. Table 6 provides data on the tanker fleets *owned* by the top 20 tanker owners in 2009. The industry has been transformed by the emergence of publicly quoted tanker companies. Traditionally independent companies were essentially private companies, not subject to the rules required for a publicly quoted entity. But many of the larger independents have "floated" on stock markets as a means of raising finance. Table 6 shows the largest companies in each sector.

The five largest companies accounted for 15% of the world's tanker fleet in 2002, whilst the 10 largest companies would account for 25%. In 2009, irrespective of sector, the corresponding figures are 15% and 24% in terms of deadweight. Looking at tanker numbers, the 2009 figures are 9% and 16% respectively. These figures are very low

Table 6: Largest tanker fleets by ownership, 2009

Independents			Stock Market quoted			State Oil or Shipping Cos.		
	Mn Dwt	No.		Mn Dwt	No.		Mn Dwt	No.
Maran Tankers	8.17	34	Mitsui O.S.K.	13.70	90	NITC	10.34	44
Ofer Group	6.68	53	Ship Finance International*	12.26	50	Sovcomflot	8.13	95
Dynacom Tankers	5.40	35	NYK	11.26	56	Vela	7.06	27
NSCSA	5.19	28	Teekay	10.57	89	BP†	3.13	32
Ocean Tankers	4.71	67	Euronav	6.57	29	KOTC	3.10	18
Cido Shipping	3.66	42	Overseas Shipholding Group	5.70	50	K Line	2.97	15
American Eagle Tankers	3.43	23	BW Group	5.57	27	Cosco Dalian	2.87	24
Minerva Marine	3.37	33	Tsakos	5.56	51	SK Shipping	2.44	10
Thenamaris	3.36	29	Moller A. P.	5.48	46	Ming Wah	2.17	12
Nanjing Tanker	3.00	38	GENMAR	3.87	31			
Top 10	46.98	382	Top 10	80.52	519	Top 9	42.20	277

Source: Gibsons
Notes:
* Ship Finance International and Frontline are both controlled by Fredriksen
† BP is included here because it is a traditional oil major, but it is a stock market quoted private company

compared to many industrial market structures. They imply that acting singly the very largest tanker owners have no potential to influence market behaviour. Even if the five largest companies got together to try to influence rates, they would not have sufficient market power to do so.

The tanker market has become more fragmented than it was in the past. In the 1960s, the oil companies owned significantly more tonnage, and contracted a very large share of independent owner's vessels as well. With 90% of oil company needs being met from the spot market, it is clear that they do not have the potential to influence rates. Whether this composition remains the same for the next decade is difficult to surmise. One major oil company has reversed strategy and become a significant tanker owner, but others, such as ExxonMobil and Chevron-Texaco, no longer figure in the top 30 tanker owners.

7.5 Impact of external regulation on tanker supply: The environmental dimension

The present structure and future transformation of the tanker industry has been directly affected by regulatory changes brought in by the US Government and the IMO. Both of these changes were triggered by oil pollution caused by the grounding or loss of oil tankers at sea. The first incident, the *Exxon Valdez* incident in 1989, has already been referred to. The passing of the Oil Pollution Act in 1990 by the US Congress had two effects on the world's tanker markets. First, it led to the decision, by the IMO, to introduce double-hull tanker technology embodied in regulation 13F, which came into effect in 1992. This required all new tankers over 20,000 dwt to be double hulled. Tankers of specific size and vintage had to comply with OPA requirements which phased in the double hull specification over time. Vessels not complying with the rules would not be permitted to trade in US waters. The IMO was also spurred into the adoption of a phase-out programme for existing single-hulled tankers, regulation 13G, which was based on the OPA90 legislation. OPA90 also required that all owners

trading into the US should have a certificate of financial responsibility, in effect a providing a guarantee that they would be able to pay for the costs of any accident shown to be their responsibility. Furthermore, if the owners were shown to be grossly negligent, their liability to damages is unlimited.

The choice of double-hull technology to improve the safety of crude oil transportation has not been unchallenged. Indeed, its worthiness on the basis of economic costs and benefits has also been questioned.[31] At the time of its introduction, other forms of increasing safety were being discussed, including the use of hydrostatic balancing. Under this alternative, single hull vessels would not have their cargo tanks fully loaded. Instead, they would be loaded until the point sea pressure from the outside of the tank wall would be greater than the pressure of the oil. This meant that any rupture would mean that sea water would ingress rather than oil escape. There would be a loss of cargo carrying potential of around 15%. Whilst this is a feasible solution in principle,[32] the market rejected it. The major oil charterers refused to accept single-hulled vessels certificated for this process, and, in consequence, double-hull has become the standard.

An important effect of the OPA law should be noted. The legal liability under the OPA regulation was laid squarely at the feet of the owner of the vessel, not the *charterer.* Oil companies noted this, and Exxon, who owned the *Exxon Valdez*, and who thus were liable for the claims resulting, began to reduce its fleet of owned tankers. It was a deliberate strategy, because any future oil pollution incident would appear to be focussed upon the owner, rather than the charterer. The fewer the ships that they directly owned, the smaller the risk exposure. This trend has continued, as the earlier discussion on ownership in 2009 pointed to the absence of the traditional oil majors.

Other events which have affected the market were the losses of the *Erika* and *Prestige*. The *Erika* was a 24-year-old single-hulled 37,000 dwt tanker which literally split in two and sank in the Bay of Biscay, carrying 30,000 tonnes of heavy fuel oil Dunkerque to Livorno in Italy.[33] Both sections sank on 13 December 1999. During her life the vessel had changed names seven times and been classed by four different classification societies. She was owned by a Maltese registered company, The vessel had apparently passed its recent classification survey, and had been chartered from an Italian shipowner. The oil washed up on the Brittany coast at a crucial time for tourism, causing significant loss of business to French fishing and tourism industries, as well as significant clean-up costs. The French authorities reacted by arresting the Total-Fina managers responsible for chartering the vessel, as well as those directly responsible for the ship's operation. The implication of this action is that not only is the shipowner liable in the event of an oil pollution incident, the charterer themselves may also be liable when the judicial process is completed.

Charterers for oil tankers re-appraised their policies as a consequence of this action. Tanker brokers reported the first signs of significant price premiums for new tonnage, as owners of old tonnage suddenly found that the charterers had begun to discriminate by age.[34] As a direct consequence of this incident, the EU proposed that the phase-out of single-hulled tankers, agreed at the IMO after the US unilateral action in OPA90, should be accelerated.[35] The accelerated phase-out was adopted by the IMO in 2001.

In November 2002, the *Prestige* developed cracks in her hull off the North-Wet coats of Spain. Her request to move into more sheltered waters was refused by the Spanish authorities and she split and sank, spilling crude oil that polluted French and Spanish beaches. As a consequence, the planned phase

out of single hull tankers was accelerated yet again.

It is unsurprising, but perhaps disappointing, to note that the two major legislative changes affecting the operation of the tanker industry per se in the past decade have both been a result of a *reaction* by governments and international organisations to the political pressures created as a result of a well-publicised environmental accident.[36] The South Korean government introduced a 2010 phase out on single hull tankers after the *Hebei Spirit* incident in November 2007. Indeed, Gibsons has formed the view that it is unlikely that many single hull tanker owners will opt to continue trading after 2010. It was thought that some would continue to trade, primarily in the Far East, up until 2015, providing that the vessel was less than 25 years old and flag registry permission from both loading and disembarking countries had been obtained. The *Hebei Spirit* and other incidents in the Far East have changed that perception.[37]

There is a widespread perception in the industry that the tanker market has significantly improved its performance in terms of oil spills and tanker accidents, post-*Prestige*. There is now some evidence to support this view. Homer and Steiner[38] used probit or binomial models to determine the key drivers of the time series of US Coastguard data on oil spills. They found that both the introduction of tighter monitoring under OPA'90 and the shift to double hull tankers were statistically significant explanatory factors in oil spill incidents. Glen,[39] using a similar approach, showed that the introduction of double hull technology had reduced the expected number of oil spills over the period from an expected 72 per year in the absence of double hulls, to 21 per year, given seaborne trade levels. However, attempts to detect impacts from OPA'90 and the introduction of the ISM code in 1998 were unsuccessful. The key change appears to be double hull technology.

The IMO has also moved to reduce the amount of airborne pollution generated by shipping, namely reducing NO_xx and S_xO outputs from marine engines, especially in sulphur oxide emission control areas (SECAs). These changes, and those related to the drive to reduce C_2O emissions from shipping, are not specific to tankers so are not developed here.

8. The Economics of Tanker Markets

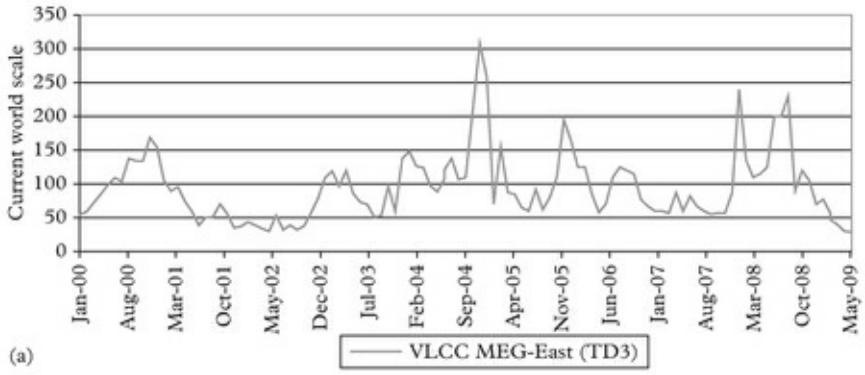
8.1 Freight rate and ship price behaviour

Tanker freight rates and asset prices display marked features. Freight rates are expressed in either $/tonne, a dollar lump sum amount, or in WorldScale. The WorldScale system is well established, replacing its predecessor, IntaScale. It in turn originated in World War II, when the UK's ministry of transport set up a set of common scales to be used to reimburse tanker owners for the use of their requisitioned assets. Expressing rates in dollars per tonne of cargo delivered was felt to be uninformative when trying to make comparisons of the relative revenues being charged for across different routes. This is because the voyage fixture cost will be affected by fuel prices in the region, the voyage distance, the port dues being charged, and of course the vessel size. The WorldScale system in effect tries to provide a "standard", a reference marker, to allow some comparison to be made across routes. It is based on setting up a Reference rate, "WorldScale Flat", which is to be charged for the carriage of one tonne of cargo between any two ports. The absolute value of the Flat rate depends on an assumed bunker price, and is based on a 75,000 dwt tanker with specific fuel consumption and speed. Port and cargo discharge dues are surveyed annually at every port, and the fuel costs for the voyage are estimated. In addition, a fixed notional daily hire charge is included.

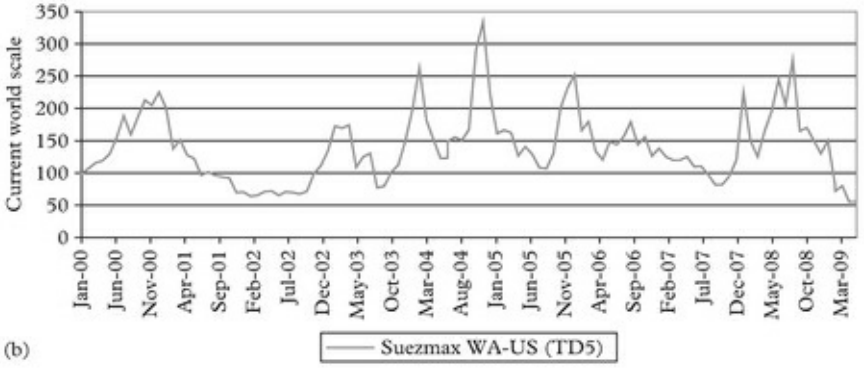
WorldScale Flat is then arrived at. The WorldScale Association calculates these flat rates for thousands of voyage possibilities. The rate is based on a round voyage and allows a standard 48 hours for both loading and discharging. WorldScale flat rates are updated annually; from the mid-1970s they were updated twice a year, because of high inflation rates. In 1989, WorldScale reverted to an annual review and update of the Flat Rate, as inflation rates stabilised.

Any spot voyage fixture that takes place on the market is then translated from the $/tonne cargo into a WorldScale equivalent. Given the cost structure of ships, even if a 250,000 dwt vessel were to earn the same net revenue as the reference 75,000 dwt vessel, its rate would be well below WS100, the reference value. Norman[40] states that the advantages of a scale system are; the simplification of communication, the simplification of charter parties for option fixtures by the replacement of alternative freight rates by one scale reference, the simplification of charter parties for consecutive voyage agreements, and the simplification of the comparability of earning opportunity, because differences due to voyage length and port cost s have been embodied in the flat rate itself. Norman demonstrated that the ability to make comparisons across routes was more to do with the high correlation and limited variation of bunker fuel prices around the world than the reference system itself. The existence of WorldScale does cause a second problem. Whilst freight rates are often quoted in WorldScale (strictly, nominal WorldScale), time charter rates are quoted in $ per day, and the prices of ships, both new and second-hand, are also quoted in $. To match spot earnings to time charter hire rates therefore requires a transformation – and time charter rates are sometimes quoted as WorldScale Equivalent. Similarly, owners convert their prospective revenues, less commission, and the particular voyage related costs, to produce a time charter equivalent daily rate. This is the first stage in the voyage budgeting and accounting process.

The pattern of tanker freight rates has not changed in any significant way in the past 20 years. Spot rates are quoted for the various size segments discussed briefly above. The behaviour of tanker spot rates over the past is illustrated in Figures 5(a)–5(d).



(a)



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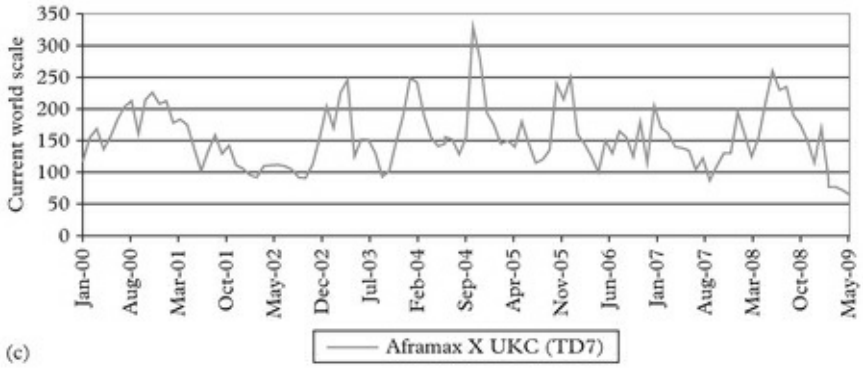

Figure 5: (continued)

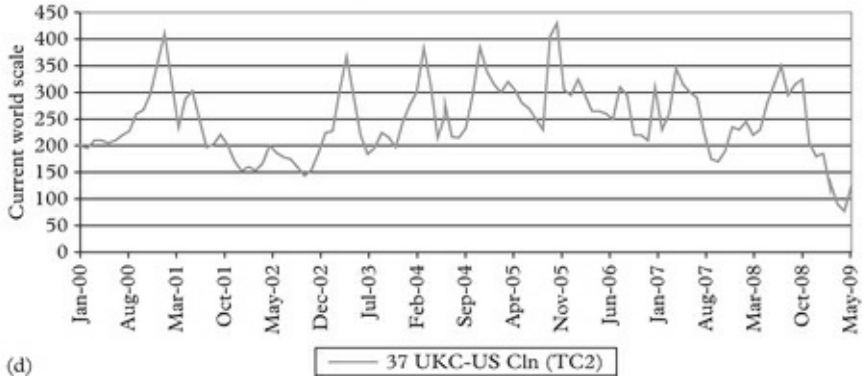

Figure 5: (a) Spot rates current VLCC 2000–2009; (b) Spot rates Suexmax 2000–2009; (c) Spot rates Aframax 2000–2009; (d) Spot rates Handy Size Clean 2000–2009

Source: Gibsons

The charts illustrate two basic points. One is the great volatility of rates; on the Middle East to Japan route, spot rates reached WS168 at the end of 2000; but six months later, they had fallen to WS39. In December 2007 the monthly average was WS207, July 2008, WS30. By May 2009, the rate was WS29! More formally, the coefficient of variation (the ratio of the standard deviation to the mean), which allows comparison of volatility across series with different mean values, is found to be 0.54 for the VLCC, 0.39 for Suezmax, 0.31 for Aframax, and 0.28 for the Handy Clean series. This means that the volatility of the series increases with ship size, with the clean trades being notably less volatile. The peaks can be observed across all the routes and oil cargoes shown, which illustrates the second feature, the very high correlation of rates across all routes. Similar patterns exist for all sizes.

The behaviour of both the new and second-hand price of ships is also of interest. It is well known that both of these prices fluctuate over time, reflecting changing conditions in the freight market. The behaviour of the real price of new buildings was noted earlier. The relationship between the relative prices of different tanker sizes is not constant over time; nor is the relationship between the second hand price of a vessel and the newbuild and scrap prices of a similar type.

The relationship between the asset price and freight earnings has been the central focus of recent econometric studies of the tanker market, as will be discerned in the following sections.

8.2 The demand and supply approach

The standard approach to analysing the tanker market has been to use the static competitive model. This approach can be split into two interrelated segments – the modelling of demand and supply for oil tanker services, i.e. transport demand and supply; and the modelling of the change in the stock of tankers that provide the services, i.e. the newbuilding, second-hand tankers, and scrapping markets.

It has already been established that the industry structure is very fragmented. It has also been shown

that the derived demand for tanker services is extremely inelastic with respect to the freight rate. How does tanker supply respond?

The conventional answer to this question is to employ the argument that the tanker supply side is determined by competitive conditions. The standard economic model of perfect competition requires four principal assumptions to be made before it can be applied. They are:

a. *The presence of a large number of buyers*. In the tanker market, the buyer is the charterer of the tanker service. There are indeed, hundreds, if not thousands, of individual companies who hire tankers.
b. *The presence of a large number of sellers*. It has already been established that the largest owners of oil tankers control only a very small percentage of the tanker fleet, and this percentage has, if anything, declined in the last 30 years. There are hundreds of tanker owners.
c. *Free entry and exit*. An important feature of a competitive market is the ability for new entrants to win business without being impeded by existing companies, or suffering from a significant cost disadvantage when they enter. If this condition.
d. *Homogeneous product*. In order to ensure that buyers view each supplier's service as identical, the product offered must be very similar. The 'product' in this case is the safe and reliable transportation of the cargo, as specified by the contract. Providing that tanker owners ensure that their vessels' can comply with this condition, the only criteria for choosing between competing suppliers is the freight rate.[41]
e. *Full information*. The market is extremely well served by the specialised shipbroking companies who keep in constant contact with both owners and charterers on a 24-hour basis all round the world. These companies have offices in strategic points all round the world to offer this service. The role of London is crucial, because it is located in a timezone that allows trade with the Far East and New York in the same trading day. This unique position makes London the ideal base for such companies. In addition, there are many specialist companies offering consultancy services to companies. All this activity means that charterers and owners are continuously informed of recent events and prices. Many shipping fixtures are publicly reported, with all salient details available. This makes the provision of market information relatively cheap and very efficient.

Overall then it would appear that all of the fundamental assumptions of perfect competition are fulfilled when one examines the tanker market, particularly the crude sector. This means that modelling its behaviour using demand and supply analysis can thus be justified.

8.2.1 Explaining the freight rate

The nature of supply differs between the short-run period, defined as the period in which the tanker fleet is unchanged in size, and the long run, in which the tanker fleet is allowed to contract or expand. Contraction occurs if the rate of scrapping of tankers exceeds the rate of newbuilding deliveries; expansion when newbuilding deliveries exceed scrapping.[42]

The short run supply schedule for the market as a whole is assumed to have a "reverse L" shape, which is very elastic (flat) when there is a low demand for tanker services relative to the existing fleet size, but which becomes very inelastic (vertical) as demand approaches full capacity of the existing

fleet (Figure 6). The "flat" range of the supply curve is created by the ability to "mothball" tanker tonnage by placing the vessel in layup when trading conditions are poor, and freight earnings are low. As demand approaches the potential maximum productive capacity of the present fleet, all lay ups are brought into use, and the ability to further expand supply becomes very limited. This explains the vertical section of the short run supply curve.[43] The position of the short run cost curve is also indicative of the overall level of marginal cost. One very important determinant of this is the assumed value of factor input prices. In the case of ships, the most significant of these in the short run is the price of bunker fuel, since most of the short run variable costs are related to voyage activity. The position of the short run costs curve will shift upwards if bunker price rise significantly, and shift downwards if they fall.

The 80:20 split is based on the analysis by Platou[44] of tanker rate volatility– they argue that practically all of the variations that are observed in the tanker market are observed when the utilisation of the fleet was in the last 20%– this is consistent with the shape of the supply curve above – elastic over the 80% range, but becoming less and less elastic until full capacity utilisation was achieved.

It is important to remember that this is a model for the short run supply of shipping. The assumption is being made that the stock of tankers is unchanged; variations in tonne miles produced are generated by variations in lay-ups, storage, and speed.

In a perfectly competitive market, the short run "floor" for prices is given by the short run marginal cost of producing output above the minimum short run average variable cost floor. Adland and Strandenes[45] have shown how close this is to empirical reality for the VLCC market, in a groundbreaking study. They show that for most periods between 1988 and 2005, the spot rate for VLCC's rarely, if ever, fell below the

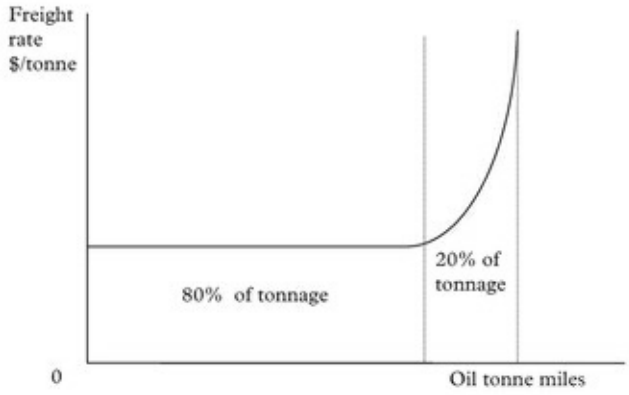

Figure 6: Short run supply curve for tanker services

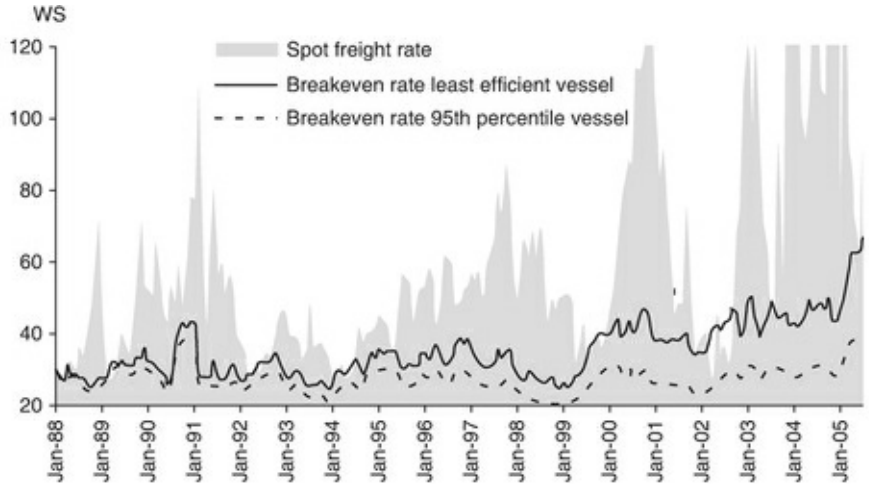

Figure 7: VLCC spot freight rates vs short-run marginal cost

Source: Adland, R. and Strandenes, S. (2007) Figure 2, p. 198. Reproduced by permission of the *Journal of Transport Economics and Policy*.

estimated short-run marginal cost, and in many periods was well above that "floor". Figure 7 is reproduced from their article.

How "realistic" is the "reverse L" model? Adland and Strandenes[45] have generated such a supply curve for the actual VLCC tanker fleet. Their supply curve looks remarkably like the theoretical one shown in Figure 6. As they point out, the modernisation of the tanker fleet has led to less variation in fuel consumption between the vessels as the age distribution is reduced, leading to a near horizontal supply curve over a large range of tonnage.

Putting the very inelastic demand schedule together with the varying elasticity supply schedule generates a model of the equilibrium spot freight rate for tanker services. as shown below, in Figure 8. The important feature to note about this figure is the asymmetric response of the freight rate to shifts in the position of the demand curve. When demand increases from D0 to D1, a large *shift* in demand, there is little effect on the market freight rate, because of the presence of unemployed or underemployed vessels. The equilibrium freight rate moves from P1 to P2, whilst tonne miles increase from Q1 to Q2. When demand shifts again, from D1 to D2, which is a smaller *shift* in demand, spare capacity is less readily available, so the result is larger increase in rate. The freight rate rises from P2 to P3, and tonne miles increase from Q2 to Q3. Finally, when demand shifts from D2 to D3, tanker supply is perfectly inelastic, and small shifts in demand generate large increases in rates. In this case, the freight rate rises rapidly from P3 to P4 but tonne miles performed rise only slightly from Q3 to Q4.

The long run supply of tanker services is found by allowing the short run supply schedule to shift its position over time. As the total fleet expands, the curve will shift down (slightly) and to the right, reflecting two elements. Firstly, new tankers tend to be more efficient than old ones. The long economic life means that technical change

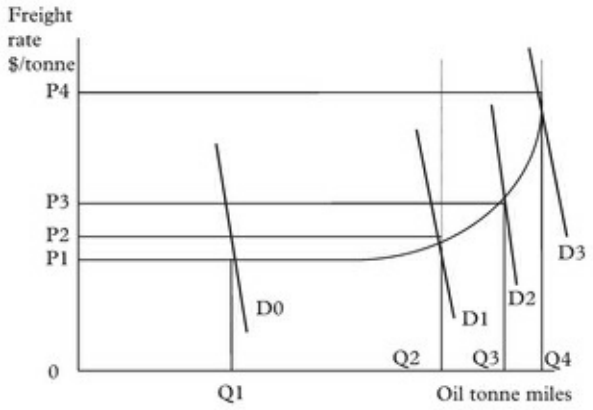

Figure 8: Modelling tanker demand and supply in the short run

will be embodied in the new vessels, particularly in terms of the fuel consumption of new engines, levels of automation, and days off-hire for servicing and repair will be lower. So a similar size vessel, when replaced with its modern equivalent, will have a lower short run marginal cost per tonne mile. This change is gradual, but its cumulative effect is important. Second, owners do not necessarily replace same sized vessels with their modern equivalent. As trade volumes change, the optimal vessel size for a specific trade route will alter. When demand grows in volume, average tanker sizes will increase. Because of the scale economies inherent in ship size, irrespective of type, larger vessels will tend to mean lower short-run marginal costs. It is important to note however if the fleet is doubled in size, the same basic short run supply relationship will still exist. There will always be a finite productive capacity whatever the size of the fleet, and hence, with sufficient demand volume, a limit on short-run output. But this is not true of long-run supply. In principle, the long run supply will expand in line with demand. Indeed, the efficient allocation of resources requires that the capital embodied in the tanker companies should be sufficient to meet long term demand needs, but no more. It is expected then, that over time, the growth in the tanker fleet should be in proportion to the growth in the level of tonne mile demand.

The application of this model helps to explain the short-run fluctuations in freight rates observed in the market, which are viewed as the result of the interaction of the short run supply schedule with the shifting demand schedule. The long-term trend will appear as demand trends assert themselves, and supply adjusts through the expansion or contraction of the fleet. It is thus possible to explain both short-run volatility of freight rates and profits, and at the same time, explain the long-term trend decline in the real costs of transporting oil, brought about by the use of larger and more technically efficient ships. Given that demand responds primarily to the balance between economic activity and the prevailing level of tanker supply (the fleet), whilst costs are directly affected by the behaviour of bunker prices, it is not surprising to find that these three variables are regularly employed as explanatory factors in the econometric modelling of the tanker freight rate.

8.2.2 Freight rates and profitability by tanker size

The above analysis has taken for granted that the market for all tankers is the same: the market for 50,000 dwt crude is identical to the market for 350,000 dwt crude vessels. But one or two authors have suggested that the changes that occurred in the 1970s have made that assumption incorrect. The different size classifications of tankers have already been outlined. The key question is: do these different segments behave differently, in economic terms, or are they all so highly correlated that it is still valid to analyse the market as if it were a single entity? Earlier research suggested that there are

indeed sufficient differences to warrant separate analysis, which has been confirmed more recently by others. Svendsen showed that different tanker sizes had different own-price and cross-price elasticities of demand with respect to freight rates. This implies some degree of differentiation in the market. Glen,[46] in a study of tanker profitability in the 1970s, showed that the gross profit margins varied widely between sizes, and that large tankers had significantly greater variability in those margins. If the tankers were all in the same market, the variability should have been the same. More recently, Kavussanos showed that there are significant differences in the volatility of tanker freight rates by size, and therefore, significant differences in the level of risk associated with owning different sizes of tankers. This implies that, viewed as a financial asset, they are distinct. This result has been confirmed by Glen and Martin.[47]

The question arises, does this mean that the segments of the tanker market can be viewed as independent of each other? The answer to this is a resounding no, because although the segments within the tanker market may have become more distinct, allowing them to behave differently in the short run, it does not follow that they are unrelated in the long run. This is because shipowners have the choice of investing in all of these segments – none is closed to them. Thus free entry and exit exists in all parts, so that market imbalances may exist for a few years, but will be self-corrected by different rates of entry and exit in the sectors. Thus, if the market for VLCC's is badly hit, this sector will have very high lay-ups, higher than average scrapping rates, and few new orders – owners will be concentrating on the sectors that are relatively more profitable – until the excess supply problem is resolved. In the long run then, one would expect to see the same common factors driving each of these sectors, and common trends appearing.

8.2.3 Term structure relations

The simple demand supply explains the determination of the spot rate, but does not directly help analyse the behaviour of time charter rates. One way of exploring the relationship between these two is to note the similarity between the term structure of interest rates, whereby long-term rates on interest are explained in terms of short-term rates, and the tanker market, in which the period rate which is return to the owner, is expected to be equivalent to the sum of the expected discounted returns earned by the owner if they operated their tanker on the spot market over the same time horizon as the relevant period charter, In an efficient market, the only difference between these two should be a liquidity premium, normally assumed to be negative, because by hiring the vessel for a longer period, the owner has transferred some of the risk of ownership to the charterer. The hypothesised relationship can be written as:

$$TC_t^{(n)} = \varpi^{(n)}\delta^{(i)}E_t V_{t+1} + \lambda \qquad (1)$$

which states that a time charter equivalent of n period duration will be equal to the present value of the expected returns obtained from trading in the spot market (V). The last term in the expression can be positive or negative as it reflects the liquidity cost or benefit from being in the spot market, which depends on present market conditions. In rising markets the owner would prefer to be trading in the voyage market, but if the market is declining, fixing a period charter is preferable, and the "liquidity premium" is reversed.[48] This relationship can be transformed, in terms of the 'spread' or the difference between the time charter rate of a given period and the appropriate spot rate. It can be

shown that the spread is a function of the expected future changes in the corresponding spot rate. Veenstra, using modern econometric methods, has tested this model, and argues that it is a valid representation of the relationship between spot and time charter rates, with the exception of that for the VLCC market.[49]

This so-called "present value" relationship is very important, as it also appears when the determinants of the price of ships are examined.

8.2.4 The price of ships

The price of second-hand ships correlates very well with movements of spot and timecharter rates. When market conditions are very good, second-hand prices are high, and in some extreme cases have risen close to, and even above, the newbuilding price of an equivalent sized tanker. When market conditions are poor, the second hand price may be closer to the value implied if the vessel were to scrapped; its value determined by the prevailing price of scrap. Both of these situations have been observed in the past. In the poor market conditions of the early 1980s, second-hand prices were at the scrap price "floor". In 2001 and 2007, some second-hand tankers were being sold at newbuild prices.

The key to understanding this lies in the present value relation introduced in the previous section. This time, the relationship is between the ship price, (the asset), and the stream of earnings it is expected to generated to the owner whilst they trade it. This is best defined in present value terms.

$$P_t = \sum \beta \prod_{t+i} + \beta^{t+n} D_{t+n} \qquad (2)$$

where the second-hand price, P_t is determined by the expected future profits earned by trading the vessel, plus any income, discounted back to the present, obtained when it is disposed of D_{t+n}. This last term represents either the price received from another shipowner if the vessel is sold on for further trading, or the scrap value. The former is determined by the expected future second hand price of the vessel, the latter, the expected price of scrap. Since the expected future price of a second-hand ship depends on earnings, the relationship implies very high levels of correlation between freight rates, bunker costs, scrap prices and the second-hand price.

Putting these elements together provides a model of tanker market behaviour. Freight rates are determined by the joint interaction of the supply of, and demand for tanker services. The latter is very insensitive to the freight rate itself; it has been shown to be highly price inelastic. But demand is sensitive to changes in expectations about the future, and to political and other external events that can impact on it. The reaction of the freight rate to shifts in demand will depend in part, on the level of utilisation of the existing fleet. At high levels of employment, shifts in demand will create large movements in the freight rate; but when there are significant numbers of vessels laid up, supply is more elastic and freight rates will tend to be less volatile.

Because of the fact that second-hand tanker prices are driven by expected future earnings, high levels of freight rates will lead to greater expected profits and an immediate rise in second-hand prices. The variation in the price of tankers is thus highly correlated with events in the spot market. High profits mean increasing orders, and an increased level of tanker deliveries in the near future. If demand growth declines, or fails to grow as anticipated, the increased level of deliveries will lead to a lowering of spot rates in the future as the newbuildings are delivered. In addition, at high levels of demand, older vessels, which might have been scrapped, are traded for longer. This reduces the supply of tankers for scrap and raises the scrap price. At the same time, the pressure of owners on yards

increases, and newbuilding prices will tend to rise. Thus freight rates, second hand prices, scrap prices and newbuild prices will tend to move together in a cyclical fashion. This process is driven by the interaction of many owners, charterers, shipbuilders and shipbrokers, none of whom have any significant control over their environment.

Although this model of dynamic behaviour appears to be very plausible, some of the econometric studies carried out in the past few years have cast a shadow over its veracity. In particular, work stemming from Kavussanos and Alizadeh[50] has been very important in highlighting the empirical failure of the joint term structure – rational expectations hypotheses that underpin this approach. Although their studies focused on the dry bulk sector, their findings are important enough to be mentioned here, as there is no reason to expect that dry bulk and tanker markets will be different in terms of expectations formation. Their findings suggest that the link between spot and time charter rates, and between ship prices and time charter rates, is not of the form required to satisfy the hypothesis of constant market expectations on the part of market players. Either expectations must be heterogeneous, or they vary over time or both of the above must be true.

8.2.5 Tanker long-run cost structures

One area of the tanker market that has been neglected by maritime economists of late is the structure of long run costs. Tanker average size has stabilised, with the largest vessels being smaller than they were 15 years ago. Most of the ULCC fleet has disappeared, with only a handful of 400,000 dwt plus vessels still existing. The question arises: Have economies of scale changed in this industry?

In a recent study Glen and Reid[51] revisited the traditional modelling of ship costs, using data provided by Gibsons. A simple method of estimating scale economies is to construct cost elasticity estimates for the various elements of ship costs, namely, capital, operating, and voyage. The authors found, somewhat to their surprise, that the estimated elasticity coefficients for these components were more or less identical to those reported in the literature, often 30 years ago. Using the resulting elasticity estimates, the cost structure by route length and ship size were calculated. These showed that optimal tanker size increased with round voyage length, as one would expect. What was more interesting is the fact that the unit costs for a fully laden vessel continued to decline on most voyage lengths, up to and beyond the 400,000 dwt size. This suggests that the “optimal tanker size” for a given route is not determined solely by costs, but is driven by the present lot size requirements of oil refineries, and the ideal lot sizes used by charterers and oil traders. In other words, demand characteristics appear to drive ship size rather than pure cost considerations.

9. Alternative Views

The above discussion has concentrated on the “traditional view” of the dynamics of the tanker market. But not all maritime economists are “convinced” by this story. In the past decade, a number of significant contributions have tried to develop alternative ways of explaining the observed dynamics of freight rate behaviour over time.

One approach is has been to argue that rates follow a time path determined by stohastic differential equations. These equations have two elements. The first component models or predicts the behaviour of the “mean” or average rate value. But to that is added a second component, which adds a forecast of the likely expected variance that will occur, the most likely “deviation” from the mean. Putting these two elements together gives a dynamic path for rates to follow. Such an approach avoids worrying

about the niceties of order and scrapping levels, and despite its mathematical sophistication, is "mechanical" in the sense that it require no insight into the market being studied. These models have been put to use in valuing ships, given this requires forecasting the future time path of ships. For example, Tvedt[52] models the dynamic path of freight rates over time and obtains valuations for a VLCC for a number of different conditions, such as the 'options' to scrap or to lay up. He shows that the scrap option adds little to the value of a VLCC at the start of its life, but is more valuable if the vessel has only 10 years to "live". This is a reassuring result, in the sense that it fits with one's own intuition!

Adland and Strandenes (2007)[53] have tried to combine elements of this approach with elements of understanding the market dynamics. They argue that the conventional model, discussed above, is flawed because it has no explanation for the upper bound of spot rates if tanker movement demand is truly freight rate inelastic. This is not hard to see, because the floor is the short run marginal price, and the ceiling would be the maximum price that the shipper is prepared to pay to move the cargo. If demand is price inelastic, this is infinite in theory, but in practice, the company would be bankrupt before infinity was reached! Their model is an attempt to address this problem by estimating an implied demand relation and modelling scrapping and deliveries to determine supply over time. The result is a dynamic model that has elements of stochastic processes, yet also models the demand limitation side.

This brings the third possibility, one not explored to any real extent at present. That is, instead of viewing the market as a perfectly competitive entity with lots of identical elements, suppose each element was regarded as unique. After all, every tanker is slightly different in some way from every other tanker. In this situation, the rate obtained for each vessel is unique, and to be determined almost by "auction". Modelling the bidding and contracting process between shipowners and charterers (or their agents) may be a fruitful way of analysing the dynamics of the tanker market in the future.

10. Summary and Conclusions

The tanker market is a fascinating sector of the shipping industry. It has played a pivotal role in the transportation of oil from the major production centres to the major consuming ones. The industry is dynamic, and very sensitive to political and environmental issues.

The tanker market has proved to be a fruitful sector for applied economic research, ranging from modelling of rate and price behaviour, to measuring the economic impact of oil pollution on the environment. Whilst the composition of the individual players has changed considerably over the past 30 years, it is still a very good example of a competitive industry. It exhibits many of the behavioural traits that are associated with fierce competition, and will no doubt continue to do so in the future. This chapter has:

1. *Outlined developments in the oil industry*. The market for tanker services is derived from the movement of oil, and an understanding of the tanker market is not possible without an understanding of the structure of the oil industry. It was shown that some 60% of the world's oil is traded across regional boundaries. The oil tanker market directly serves this trade.
2. *Examined the demand for tankers*. It was shown that demand is derived, and this characteristic means that the demand for tankers is essentially perfectly inelastic with respect to the cost of transporting it.

3. *Explored the supply of tanker services*. The low degree of industrial concentration was discussed, and the structure of tanker supply was explained. The impact of oil pollution on future tanker supply was discussed.
4. *Reviewed the economics of the tanker market*. Section 8 discussed the determination of freight rates, and the interaction between the freight market and the market for new and second-hand tankers. These relationships have formed the focus of research efforts in this area in the past decade.

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Endnotes

1. Source: Gibsons Ltd.
2. The data provided in this chapter concentrates on crude and dirty products. The combination carrier, a vessel that can carry bulk cargoes and crude oil simultaneously, has been ignored. Whilst important in the past, their numbers have declined (Lloyds Register Fairplay, *World Fleet Statistics 2009* reports 98 ships at December 2008, compared with 2,100 crude oil tankers of more than 100 gross tonnes), and their trading patterns tend to be based either in dry cargo or in the crude oil trades. Empirical evidence suggests that their potential to link the dry and wet sectors of shipping, through shifting their capacity, and hence supply, is very slight in practice.
3. All data quoted are from the BP Statistical Review of World Energy (2001, 2009). The 2009 edition is available at www.bp.com.
4. See Table 3 for details.
5. The annual average price of Brent Light was $36.83 for 1980. Source: BP Statistical Review of World Energy, 2009, available at www.bp.com.
6. The Organisation of Petroleum Exporting Countries. Formed in 1960, its first real exercise of economic power came in October 1973 with the oil price rise and an embargo on oil exports to the USA and the Netherlands.
7. See n 3 for reference.
8. IEA (2008): *World Energy Outlook 2008*, Executive Summary, p. 5, and *Lloyd's List*, (2009) "IEA slashes oil forecast" *Lloyd's List*, 30 June, p. 4.
9. IEA (2009): *Short Term Energy Outlook*. Available at www.eia.doe.doc.gov/steo, accessed 23 June 2009.
10. Dahl, C. and Sterner, T. (1991): "Analyzing gasoline demand elasticities: a survey", *Energy Economics*, 13, 203–210.
11. See Dahl, C. and Sterner, T. *op. cit*., Table 2, 210.
12. According to 2000 data, world oil consumption split 21% gasoline, 40% middle distillates, 23% fuel oil, and 16% others. North American oil consumption is 41% gasoline, 31% middle distillates, 8% fuel oil, 20% other. Source: BP Statistical Review of World Energy, 2001.
13. Dahl, C. (1993): *A survey of oil demand elasticities for developing countries* OPEC Review, XVII, 399–419, and Dahl, C. (1994): *A survey of oil product demand elasticities for developing*

countries, OPEC Review, XVIII, 47–86.

14. Some significant tanker disasters are the *Torrey Canyon*, 1967, the *Amoco Cadiz*, the *Exxon Valdez*, 1989, the *Erika*, 1997, and the *Prestige*, all of which led to change in the oil industry.

15. It should be noted that the prevailing oil demand forecasts of the early 1970s were totally unsustainable in terms of the rationale underlying the demand projection; the notion that supply, or oil discoveries and production, could continue to expand exponentially, and of course without political and environmental resistance. Could output actually have reached the projected 200 million barrels a day by year 2000? (Actual consumption was almost 75m b/d.)

16. See n 9 for the reference.

17. Named after the economist, Alfred Marshall, who first developed them.

18. The distinction may not make a lot of difference in a market with a constant route structure, because average voyage length may remain constant over time. If there is a dramatic change in voyage length, the demand for shipping services can be significantly affected even if tonnage movements are constant. For example, the average voyage length for oil rose dramatically in 1967 with the closure of the Suez Canal, from 4,775 to 6,540 miles in 1974. Demand for tanker services, measured in tonne miles, rose in proportion to this, assuming that oil volume demand remained constant.

19. Figures calculated by the authors from *OECD Review of Maritime Transport*, various issues, OECD Paris.

20. See BP Statistical Review of World Energy, 2009, p. 23, available from www.bp.com, accessed 29 July 2009.

21. The time charter rate is the daily rate, in thousands of dollars, that is paid to hire a vessel by a charterer from its owner or present operator. The rate is a charge for the use of the vessel, complete with crew, insurance and other costs, except for those related to voyages, i.e. fuel, food, port and cargo dues. The most extreme form of charter, and bare-boat charter, for 25 years, would give the charterer the use of the vessel for that lifetime. The charterer would then pay the entire costs of operating the vessel, including manning and insurance. A bare-boat charter is in effect, a rent to the owner for the use of the capital tied up in the vessel.

22. The products and chemical tanker segments are much more concentrated than the crude sector. The European Commission has closed (May 2008) an ongoing enquiry into rate making in the chemical parcel tanker sector, with no action being taken. See www.jotankers.com/AboutJoTankers/Media/tabid/102/newsid525/2/The-EuropeanCommission-closes-the-chemical-tanker-case/Default.aspx

23. These vessels are sometimes called “one million barrel” tankers. There are approximately seven barrels to one tonne of crude oil, so this translates into 130,000 tonnes. The measure is a convenient parcel size for transporting, storing, and trading.

24. Source: Gibsons.

25. Louisiana Offshore Oil Port. The alternative is transhipment at sea, but increased environmental pressure mean that these activities are not desirable. The US Coastguard has designated areas suitable for transhipment and lightering operations.

26. Source: Gibsons.

27. *Ibid.*

28. See BP Statistical Review of World Energy, 2001.

29. The *Atlantic Empress* lost 287,000 tonnes of crude oil off Tobago in 1979; the *Amoco Cadiz* lost 223,000 tonnes off Brittany in 1978. See Tusiani, (1996): *The Petroleum Shipping Industry*, Vol. 1 (Pennwell Publishing) pp. 1–225.

30. For a discussion of the *Exxon Valdez* incident, see Tusiani (1996): *The Petroleum Shipping Industry*, Vol. 1 (Pennwell Publishing) pp. 227–251.

31. It has been argued that the void space between the two hulls will become corroded by sulphuric acid created by cargo fumes and moisture interacting. Inspection of the void space may be difficult. See Brown R. and Savage, I. (1996): "The economics of double-hulled tankers", *Maritime Policy and Management*, 23, 167–175, for an assessment of the economic arguments for double-hull technology.

32. Indeed, a tanker that operates under HBL is exempted from the revised phase out dates. See, for example, ABS, 2001, *Oil Tanker Outlook:Assessing the Impact of the Revised IMO MARPOL 13G Phase Out*, ABS at www.eagle.org/index.html

33. Details of the *Erika* incident can be found in Annex 1A of Commission of the European Communities, 2000, Proposal for a Directive of the European Parliament and of the Council amending 95/21/EC, 94/57/EC and accelerating phasing of double-hull or equivalent design requirements for single hull tankers. COM(2000) 142 final 121pp, and in OECD, (2001): The Cost to Users of Substandard Shipping 45pp. Paper prepared by SSY Consultancy and Research Ltd. Both available from www.oecd.org. For the *Prestige*, information is available at www.imo.org e.g. www.imo.org/includes/...asp/.../Prestige%20(4%20March%202003).doc

34. Tamvakis, in a study of rate differentials on fixtures for vessels trading to the USA post OPA'90, could not find strong evidence to support the idea that there would be a premium for better quality vessels. See Tamvakis, M. (1995): "An investigation into the existence of a two-tier spot freight market for crude oil carriers", *Maritime Policy and Management*, 22, 81–90. For an analysis based on simulation, see Strandenes, S. (1999): "Is there a potential for a two-tier tanker market?", *Maritime Policy and Management*, 26, 249–264.

35. Regulation 13G, adopted in August 2001.

36. It would be nice to be able to comment on a proactive industry decision to raise standards without such pressures – but we can't think of one.

37. Bockman, M. (2009): "Single-hull tankers likely to exit in 2010; International tanker trade to be almost exclusively double-hull", *Lloyd's List*, May 18, p. 13. (Quoting one of the authors!)

38. See Homan, A. and Steiner, T. (2008): "OPA 90's impact at reducing oil spills", *Marine Policy* doi:101016/j.marpol.2007.12.004.

39. Glen, D. (2008): "Modelling the impact of OPA 90 and double hull technology on oil spill numbers", Paper presented to IMSF Conference, Gdansk 2008 p. 13.

40. Norman, V. (1977) *An Assessment of the WorldScale System.* Paper presented to INTERTANKO annual meeting, Italy.

41. It is possible, under certain local conditions, for owners to be able to charge a premium; if for example, only one vessel is open for cargoes at a particular terminal at a particular time. This will not last long however; the mobility of tankers ensures that such premia rapidly disappear.

42. This corresponds to the notion that capital, at least that tied up in the tanker, is the fixed factor of production. In economics, the short run is defined as the time period in which the firm cannot vary the employment of at least one factor of production.

43. For a discussion of a model constructed for tankers on this basis, see Wijnolst, N. and Wergeland, T. (1996): *Shipping* (Delft, Delft University Press). The principle is to estimate the short-run marginal costs of tankers, and then rank in increasing order of cost, until all vessels are included. The result is the short-run supply curve, and it looks similar to the one used in the text.

44. Platou, M. (1996): *Platou Market Report* (Oslo, Platou).

45. Adland, R. and Strandenes, S. (2007): "A stochastic partial equilibrium model of tanker market dynamics", *Journal of Transport Economics and Policy*, 41, 189–218.

46. Glen, D. (1990): "The emergence of differentiation in the oil tanker market, 1970–78", *Maritime Policy and Management*, 17, 289–312.

47. See Kavussanos, M. (1996): "Price risk modelling of different size vessels in the tanker industry", *Logistics and Transportation Review*, 32, 161–76, Glen, D. and Martin, B. (1998): "Conditional modelling of tanker market risk using route specific freight rates", *Maritime Policy and Management*, 25, 117–128.

48. This relationship was first formulated by Zannetos Z. (1966): *The Theory of Oil Tankship Rates* (Boston, MIT Press). See also Glen, D., Owen, M. and Meer, Van der (1981) "Spot and time charter rates for tankers, 1970–1977", *Journal of Transport Economics and Policy*, XV, 45–58, and Veenstra, A. (1999) *Quantitative Analysis of Shipping Markets* (Delft, Delft University Press). For a modern analysis of the tanker market, see Beenstock, M. and Vergottis, A. (1993): *An Econometric Model of World Shipping* (London, Chapman & Hall).

49. See Veenstra (1999): 201–206.

50. Kavussanos, M. and Alizadeh, A. (2001): "Efficient pricing of ships in the dry bulk sector", Paper presented at the *IAME Annual Conference*, Hong Kong p. 6 and Kavussanos, M. and Alizadeh, A. (2002), "The expectations hypothesis of the term structure and risk premiums in dry bulk shipping freight markets", *Journal of Transport Economics and Policy*, 36, 267–304.

51. Glen, D. and Reid, S. (2008): *Tanker cost elasticities revisited*. Unpublished paper, 19 pp. copy available from first author on request.

52. Tvedt, J. (1997): "Valuation of VLCCs under income uncertainty", *Maritime Policy and Management*, 24, 159–174.

53. See n 45 for reference.

Selected References

BP (2009): Statistical Review of World Energy, BP, London, UK.

Beenstock, M. and A . Vergottis (1993): *An Econometric Model of World Shipping* (London, Chapman & Hall)

Gibsons (2008): *Tanker Register 2008* (London, Gibson Shipbrokers Ltd)

Kavussanos, M. and Visivikis, I. (2006): *Derivatives and Risk Management in Shipping* (London, Witherby).

McConville, J. (1999): *Maritime Economics:Theory and Practice* (London, Witherby)

Newton, J. (2002): *A Century of Tankers* (Oslo, Norway, Intertanko).
Tusiani, M. (1996): *The Petroleum Shipping Industry* (Tulsa, OA, Pennwell Publishing).
Wijnolst, N. and Wergelend, T. (1996): *Shipping* (Delft, Delft University Press).
Veenstra, A. (1999): *Quantitative Analysis of Shipping Markets* (Delft, Delft University Press).
Zannetos, Z. (1966): *The Theory of Oil Tankship Rates* (Boston, MIT Press).

Chapter 13
Economics of Short Sea Shipping

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1. Introduction

1.1 Purpose

The idea of promoting short sea shipping (SSS) aims at achieving a more sustainable transport network, where least damaging transport modes have a role to play. SSS statistics concerning safety are relatively good when compared with other means of transport.[1] It is claimed that the development of SSS is crucial to enhance land-sea intermodality, thus pursuing (i) environmental benefits since it reduces pollution levels and road transport accidents and (ii) economic benefits; within this context SSS reduces transport networks congestion levels, reduces investments in transport infrastructure and increases port hinterlands' competitiveness the international markets.[2]

SSS has been growing significantly over the past 40 years mainly due to the growth of intra-regional trade and the boost of hub-and-spoke maritime transport. Its importance is high in the South-East Asia and Europe but other regions of the world are also considering it. The American continent, particularly North America, and Australia are looking carefully at the European experience as a learning process so that they can also implement SSS or coastal shipping as it is called in some regions of the globe. Yet, there seems to be a gap between present growth rate and the goals of policy makers, namely in the European Union (EU). So far, growth seems limited to captive markets, i.e. connections of mainland with islands and deep-sea shipping (DSS) feeder services. SSS does not appear to be a real alternative to land transport, namely road haulage, when intra European trade is being considered. The logistics needs of shippers and just-in-time production philosophies have fostered the road transport usage due to its inherent advantages in detriment of waterborne transport services.

In the light of the above paragraphs, this chapter aims at looking at the European SSS arena not only for the experience gained over the years (i.e. other regions of the world can look at the benefits it offers and what needs to be done towards its implementation), but also because the lack of adequate statistical data from a regional perspective prevents a deeper insight into other SSS geographical areas. To achieve this objective, the present work is structured in five sections. Section 1 presents the purpose of the work, addresses the concept of SSS and shows the lack of consistency in what definitions are concerned. Section 2 concerns SSS market information; it considers modal split, the demand and the supply sides of SSS markets and in doing this it looks at the average size of short sea vessels. Section 3 considers SSS in a multimodal context; it investigates the geographic and economic conditions for integrating SSS in a multimodal transport chain so that a shift of cargo from road to sea takes place, looks at the factors influencing SSS competitiveness, investigates SSS obstacles and challenges and presents a list of possible policies for SSS in a multimodal context. Section 4 investigates the European SSS policies and general policies that support its development and Section 5 concerns conclusions and further comments.

1.2 A definition of short sea shipping

Despite many efforts, the literature still lacks an unambiguous definition of SSS as pointed out by Van de Voorde and Viegas (1995) and Marlow *et al*. (1997).[3,4] Some authors consider it to be the same as cabotage, i.e. all seaborne traffic between ports of the same country, sometimes including frontier ports of adjacent countries[5] while others envisage it as an alternative mode to land transport.[6] Marlow *et al*. (1997) presented a tailored definition suitable for specific situations. The authors defined SSS as seaborne flows of all kinds of freight performed by vessels of any flag, from EU Member States to whichever destination within the territory embracing Europe, the Mediterranean and Black Sea non-European countries (see endnote 4). In this regard, Peeters *et al*. (1995) acknowledged the existence of many regional-based (often European-based) definitions.[7]

Against this framework, the literature also proposes very pragmatic definitions. Stopford (1997) states that SSS is normally a maritime transport within a region, essentially serving port-to-port feeder traffic which can be in competition with land transport,[8] while Bjornland (1993) considers SSS as waterborne movement of goods that does not cross the ocean.[9] Sometimes this pragmatism turns to tautology since some authors consider that SSS includes any services which are not considered to be DSS, or which are related to relatively short distances.[10,11] Within this perspective, Papadimitriou (2001) considered SSS a maritime transport service that excludes deep sea crossing; instead, the author acknowledged that SSS embraced pure national cabotage services, maritime connections between mainland and the islands, international cabotage services as well as sea-river transport performed by coastal vessels leaving aside the pure inland waterway navigation.[12]

From a technological viewpoint, some authors focus on ships' characteristics. Against this perspective Van de Voorde and Viegas (1995) suggested that it would be better to define SSS in terms of trading patterns rather than ships characteristics, since it is not practical from an operational viewpoint the 100% exclusive use of ships in SSS or DSS (see endnote 3). The authors followed Linde's viewpoint that from a broad perspective considers SSS as a global phenomenon, but from a narrow viewpoint relates the concept to the European SSS which is operated within a large European area and managed by European shipping companies.[13–17]

The concept of coastal shipping is also addressed by Bagchups and Kuipers (1993) who defined coastal shipping as all forms of maritime transport within Europe and between Europe and adjacent regions, irrespective of whether it involves small oceangoing vessels, large ocean-going vessels or coasters.[18] Paixão and Marlow (2002), in an attempt to present a holistic definition, defined SSS as a complex maritime transport service, performed by five classes of ships capable of carrying unitised and non-unitised cargo, offered by different channel intermediaries within well-defined European geographical boundaries (see endnote 16).

At a European policy level, the concept of SSS was addressed in the 1992 communication on the European common transport policy. The European Commission (hereinafter the Commission) envisaged SSS as a means to shift goods from road to sea making use of underused capacity and the document in question does not present a definition of the concept.[19] Despite this, in 1992, the Commission defined maritime cabotage as a maritime service that embraced (i) the carriage of passengers and goods by sea between ports situated on the mainland of one Member State without call at islands (mainland cabotage); (ii) offshore supply services; and (iii) services between ports of one *Member State* where one or more ports are situated on islands (island cabotage).[20] The above

definition shows that SSS clearly has a broader meaning than maritime cabotage, which seems to have a merely juridical meaning (based on state borders), instead of an economic one (potential competition between sea and land transport). The European SSS definition was first presented in its 1995 communication on SSS.[21] In an attempt to harmonise the concept, the European Conference of Ministers of Transport, the United Nations Economic Commission for Europe, and the Commission got together in 2001 and defined SSS as the movement of freight between intra-European ports and between European ports and other ports as long as the latter were located along a coastline bordering Europe as is the case of North Africa.[22] An insight into the definition provided by the Commission in 1995 (see endnote 21) clearly shows that both definitions are similar but the recently motorways of the sea (MoS) concept presented by the Commission as the "*crème de la crème*" of European SSS services[23] contributed to increase further the lack of consensus regarding a SSS definition and how these services can be decoupled from MoS services. Following the Commission's view of the MoS concept as a floating infrastructure, Baird (2007) presented the seaway concept as the ships' decks where cargo is moved, which can be measured in lane meters and compared with road and rail infrastructure, and raises the issue about public investment in surface transport, given that with a few exceptions the shipbuilding industry cannot be subsidised.[24]

Consequently, it can be said that so far there is no generally accepted SSS definition, since different criteria are used for defining it, namely (i) geographical criteria (based on the length of maritime leg); (ii) supply criteria (based on type/size of vessels, or on being part of a longer journey); (iii) demand or commercial criteria (competition with land transport; distinction between feeder or intra-regional traffic; nature of cargo); (iv) juridical criteria (ports belonging to the same state). Moreover, some definitions are tailored for a certain geographical space, or for a certain time and correspondent level of technical progress.[25] Unfortunately, the numerous and ambiguous definitions imply the non-homogeneity of the (few) available data and statistics, leading to some confusion in the scientific and technical debate. As Wijnolst *et al*. (1993) point out, statistics are often neither reliable nor consistent, since flows vary considerably according to the definition considered; definitions of import and export may also vary and differences exist also in goods classification criteria.[26]

The solution to overcome this vagueness can be linked with the possibility to choose an existing definition or proposing an additional one. The best approach should, nevertheless, outline two important keypoints underlying all the definition efforts presented in the literature. One is certainly whether land transport is possible or sea transport has no alternatives (one or both ports being located in an island without tunnels or bridges connecting them). In this case there is a captive market with no or very little competition from other modes (air transport for passengers or some high value-added goods; pipelines for liquid bulks). If a land alternative does exist, this sets a structural difference compared to DSS as for market organisation and competition between substitute issues. The framework proposed in Section 3 addresses this situation. The case for SSS competing with land transport is thus the most interesting from a theoretical viewpoint and for policies and future development.

The second key question is whether SSS is the main leg of a regional intermodal traffic, or a feeder service belonging to a hub-and-spoke cycle based on DSS. While at an intra-regional transport level SSS introduces an intermodal option competing with land transport, at a feeder traffic level it is

normally the opposite: the maritime hub-and-spoke cycle is a unimodal solution where SSS competes with land transport feeders (rail or road) which would set an intermodal transport. Most remarks proposed in this chapter apply to both cases. Yet the current debate and policy issues mainly refer to the opportunities of enhancing intermodality based on a SSS leg, while less interest is shown for SSS as feeder traffic to DSS, unless this traffic can be alternatively supplied by SSS or by land transport.

2. Short Sea Shipping Market Information

Over the last four decades, the importance of SSS has been increasing all over the world especially due to the growth of feeder traffic (as a result of growing DSS transport) and the reduction of port calls in the DSS market because of increasing vessel size. With a coastline of about 89,000 kilometres (km), having 60/70% of the industries located within a 150–200 km range from a port, the EU has definitely one of the most suited geographical areas for the development of SSS (see endnote 21). In addition, a transport network made up of 97,600 km of conventional and high speed railway lines, 70,200 km of road infrastructure, 25,000 km of inland waterways (IWW) of which 12,000 km are included in the combined transport network, 439 ports of which 319 are seaports (remaining ones are IWW ports) has made EU one of the most relevant SSS markets in the world, along with Asia. Feeder trade will obviously follow the developments in transhipment hubs, which are rapidly occurring in the Caribbean, Middle East and South America. The next paragraphs provide information about the European SSS market modal split, demand and supply.

2.1 The European Union modal split

Since 1970, freight transport in Europe has grown significantly (see Table 1) as a result of the European economic growth and commercial exchanges taking place at a European and international levels. This trend has been witnessed at a worldwide

Table 1: EU-25 performance by mode: Freight transport (1,000 million tonne-kilometres)

Year	Transport modes						Total
	Road	Rail	Inland waterways	Pipelines	Sea (intra-EU)	Air	
1970*	487.0	282.0	102.0	64.0	472.0	–	1407.0
1980*	717.0	290.0	106.0	85.0	780.0	–	1978.0
1990*	974.0	256.0	107.0	70.0	922.0	–	2329.0
1991*	1006.0	235.0	106.0	79.0	956.0	–	2382.0
1995	1289.0	386.0	122.0	115.0	1150.0	2.0	3064.0
1996	1303.0	392.0	120.0	119.0	1162.0	2.1	3098.0
1997	1352.0	410.0	128.0	118.0	1205.0	2.3	3215.0
1998	1414.0	393.0	131.0	125.0	1243.0	2.4	3309.0
1999	1470.0	384.0	129.0	124.0	1288.0	2.5	3397.0
2000	1519.0	404.0	134.0	127.0	1348.0	2.7	3534.0
2001	1556.0	386.0	133.0	132.0	1400.0	2.7	3610.0
2002	1606.0	384.0	132.0	128.0	1415.0	2.6	3668.0
2003	1625.0	392.0	124.0	130.0	1444.0	2.6	3718.0
2004	1747.0	416.0	137.0	132.0	1485.0	2.8	3920.0
2005	1800.0	414.0	139.0	136.0	1520.0	2.9	4012.0
2006	1855.0	440.0	139.0	135.0	1548.0	3.0	4120.0
2007	1927.0	452.0	141.0	129.0	1575.0	3.1	4228.0

Source: EUROSTAT (various)
* Data from 1970 up to 1991 (inclusive) concerns the EU-15 rather than the EU-27.

level as shown in the UNCTAD Review of Maritime Transport and Fearnleys market reports. In conformity with Table 1, the movement of freight transport tripled from 1970 until 2006. Over this period the movement of freight by air is very small and has stabilised relatively to the total cargo being moved and according to the data provided in Table 1, it is expected that its share will remain more or less the same.

Freight movement by pipeline has increased in terms of billion tonne-km (tb-km), but from a market perspective it has lost 1.5% between 1970 and 2007. This can be attributed to the use of alternative energies which are more environmentally friendly, in detriment of the fossil oils as well as, to the fact that liquefied natural gas (LNG) is also being transported by waterborne transport, which implies that the pre- and on-carriage legs of the LNG supply chain will make use of pipelines to reach the final consumer. Although the demand for IWW transport has increased over the years, in terms of market share, it has been unable to follow the trends of sea and road transport markets. Data from Table 1 shows that its market share was reduced almost by half. Freight moved by rail has also been subject to a negative trend, even though freight being moved by rail increased from 282.0 tb-km (1970) up to 452.0 tb-km (2007).

As a result, two modes have been responsible for moving freight and for accommodating the growth that has taken place. In 1970, road transport was responsible for moving 487 tb-km, about the same as sea transport. Between 1970 and 1990 freight being moved by road doubled relatively to 1970 (the base year), and the same trend occurred between 1990 and 2007, but within a shorter period of time (16 years). The reason for such a shorter cycle is explained by the 2004 and 2007 enlargements of the EU and because data from 1995 onwards concerns the EU-27 rather than the EU-15. From a market share perspective this growth results from the ability of road transport in absorbing the market share decreases that occurred in rail and IWW, from the SSS inability to meet customers' needs and from cargo derived from growing market economies. According to 2007 data provided by the EUROSTAT, road transport is responsible for 45.6% of the freight being moved in Europe.

In what concerns sea transport, this mode has not been able to increase its market share despite the effort made by the Commission at a policy level since 1992 in the quest of sustainable alternatives to road transport. Freight being moved by sea also suffered an increase from 472.0 tb-km up to 2007, reaching 1575.0 tb-km. However, the growth cycle appears to be longer. Cargo being moved by sea doubled between 1970 and 1991 (one year more when compared to road), and because of its weaknesses it has increased only 64.7% between 1991 and 2007. The annual average growth since 1995 until 2007 is 2.8% against 3.8% in road transport which explains its market share decrease. After reaching a market share of 40.1% in 1991, SSS share of goods being moved has been decreasing relatively to road transport and in 2007 accounted for a 37.3% of the market. The data also provides no evidence that a reverse of the present trend will materialise in the near future, unless the road is subject to further strict rules and regulations as it does happen in the maritime sector and the small medium sized short sea operators adopt more collaborative strategies among them (see endnote 16). The present economic and financial crisis also does not contribute to change the above mentioned behaviour, and the question raised is how SSS is able to grasp the 14% of freight being moved by long-distance haulage.

From another perspective SSS accounts for 69% of all international traffic taken place within the

EU against 18% performed by road. SSS average journeys are longer (1,385 km) than road (100 km) (see endnote 13). The opposite situation takes place when domestic traffic is considered; here SSS is responsible for carrying 6% of the total tonnes being moved against road transport which carries over 80% of freight. Data provided in Table 1 and Figure 1 also suggest that sea and road market shares should always be under constant monitoring and an analysis between the two of them makes sense in the European arena where more and more focus is given to environmental issues.

SSS competition with land transport, particularly with road, is high due to geographical reasons and due to comparatively highly developed land transport infrastructure. To these factors, others can be added which have very much resulted from economic growth and crisis or policy changes. Examples are the opening of the European internal market in 1992, the restructure of companies' production and distribution systems, the enlargement of the EU and inventory management strategies like just-in-time, have given to road transport a real boost in its development thanks to its superior flexibility and relatively low prices.[27–29] Indeed, sea transport needs to be accommodated

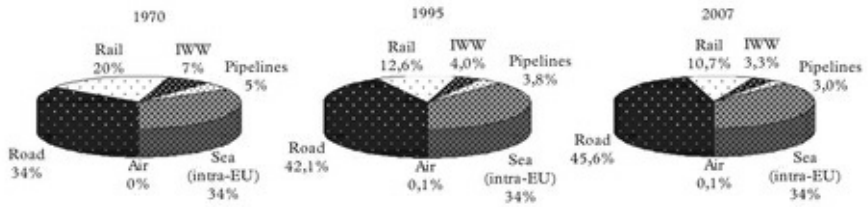

Figure 1: Modal split in %*
Source: EUROSTAT (various)
* Data from 1970 concerns the EU-15 rather than the EU-27

at specialised infrastructures (i.e. ports/terminals), breaking the overall logistics chain more often than road transportation and preventing, sometimes the information to flow smoothly among the different actors. Nevertheless, one must bear in mind than road infrastructure has been financed by public funds, to a great extent. The considerable difference between the averaged distances performed by SSS and road leads to say they are partially separated up to the distance of 300 km, since it is difficult to find an alternative to road transport inherent flexibility. The railway sector lacks investment, which explains why the potential for SSS for such short distances is not so high, unless the threshold for competitiveness with road transport is considerably shortened. This point is one of the critical issues of the recent EU transport policy as pointed out in the 2001 White Paper.[30]

The present modal split, where road and sea are responsible for about 82.9% of all freight being moved in 2007 (SSS has been able to keep up with road transport growth) can also be explained by the lack of investment in transport infrastructure since 1975, resulting in numerous bottlenecks and a daily congestion of 7,500 km, even though the Commission has embarked on the development of a comprehensive trans-European transport network to promote the modal shift to underused capacity (rail, SSS and IWW) and of a policy that resulted in the liberalisation of freight rail freight services in January 2007. As for competition with land transport the choice of lift-on-lift-off (Lo-Lo) or roll-on-roll-off (Ro-Ro) operations will depend upon the distances to be covered and port costs incurred (see endnote 16).

2.2 The demand side of the European short sea shipping market

For the purpose of the present study, only data related to cargo/freight will be considered, which implies that the movement of passengers is left out of the analysis. In the European Union 70% of its

external trade and 30% of its internal trade goes by sea. Of this 30%, according to Drewry (1993), two-thirds concerns intra-North European traffic, 30% relates to trade between North and South Europe, leaving just a 3.3% of the total short sea trade as pure intra-South European movements.[31] This division of the SSS market can be explained by the higher concentration of cargo in the ports located in the Le Havre-Hamburg range, about 70% of the European industry is located mainly in the six original founder EU Member States, and because the North and Baltic Seas very much promote the use of SSS. In what concerns the movement of cargo towards the South of Europe competition with land transport is stronger both for feeder and intra-regional traffic. Channel ports are facing overcapacity due to competition from the Channel Tunnel, while the opening of road haulage to Eastern European firms has provided low cost alternatives to both shipping and railways. This has contributed to a fall in the freight rates squeezing the SSS industry profitability which has been fostered by the pressure that DSS operators exert over short sea operators when negotiating standard shipping services to the final destination.

The problem related with the analysis of the SSS demand side concerns the lack of available data at European level; only recently has this issue been addressed subject to Council Directive 95/64/EC of 8.12.1995. Table 2 shows the quantity of cargo being moved by SSS annually between 2000 and 2006. Data concerning EU-15 is available since 2000 and its annual average growth is about 30% and supports the idea that SSS has not been able to grasp cargo from road transport. From an EU-27 perspective little conclusions can be taken since data is only available from 2004 when the former Central and Eastern European countries (CEECs), Malta and Cyprus became EU *Member State*s. The only conclusion possible to be drawn at the present moment is that its annual average growth is about 2.6% which can be explained by these countries geographical location, since the former CEECs rely on road and rail modes rather than on SSS. In 2006, the total goods transported by the EU-27 SSS accounted for more than 1.9 billion tonnes, corresponding to 62% of the maritime trade. Both the North and Mediterranean Seas played a major role in the movement of goods inside the EU, reporting 599 million tonnes (28.1%) and 560 million tonnes (26.3%), respectively.[32]

From a country perspective, Ireland, Spain and Finland have witnessed the biggest annual average growths between 2000 and 2006, 6.6%, 7.5% and 4.3% respectively (see endnote 32). The Spanish annual growth is explained by the trade performed between the mainland and the islands and because some new ports have been added to the statistics. This situation highlights that the data gathered at an EU level must fill in some gaps, even though it provides a good indication of the cargo being moved. The cargo moved falls within five different categories: liquid bulk, dry bulk, containers, RO-RO units and the cargo which refers to all unknown cargo. The analysis that follows has been carried out from an EU-27 perspective.

According to 2006 data, the bulk market represents 69.2% of the cargo being moved by SSS, and seen from an individual perspective, the liquid bulk and the dry bulk short sea markets account for 49.5% and 19.7%, respectively, of the whole cargo being moved by sea (see endnote 32). These figures are in line with the 2007 statistical data provided by Drewry, where the liquid bulk and dry bulk short sea markets accounted for 50% and 20% of the overall cargo being moved on that year.[33] The main active countries in the liquid bulk market are France, Italy, the Netherlands and the United Kingdom (UK). Together they handled 624.3 million tonnes equivalent to 66.2% of

Table 2: Goods carried by short sea shipping, 2000–2006 (in million tonnes)

	2000	2001	2002	2003	2004	2005	2006
EU-15	1505.5	1563.6	1600.1	1650.6	1725.5	1792.9	1802.7
EU-27					1810.4	1892.7	1907.3

Source: Adapted from Amerini (2008) (see endnote 32)

the liquid bulk short sea market. As far as the dry bulk short sea market is concerned, Spain, Italy, the Netherlands and the UK dominate, and most dry bulk cargo is transported in cargo sizes of 1,000 and 2,000 tonnes subject to long term and spot voyage contracts.[34] Likewise, they handled 200.7 million tonnes (53.3% of the dry bulk short sea market).

Ro-Ro units follow the dry bulk short sea market (12.8%). This can be explained by the high concentration of ferry vessels' operations in the North and Baltic Seas. Germany, Italy, Sweden and the UK are responsible for the biggest share of units being handled. Together, they handled 206.0 million tonnes equivalent to 84.2% of the Ro-Ro short sea market. Interesting to see that the data for EU-15 and EU-27 are very close to one another which suggests that the new countries had a very low impact on the cargo being moved in this market segment. Most of the countries cases are self explanatory but in the case of the UK, it should be highlighted that the country is a gateway for cargo originated from/destined to Ireland which makes use of a sea-road transport system to/from mainland Europe.

Container short sea market ranks in the fourth place and has presented a 10.5% market share for both 2006 and 2007 (see endnotes 32, 33). Germany, Italy, the Netherlands and Spain dominate the container short sea market, and this is highly explained by the geographical location. In the case of Italy, the country is strategically located in the Mediterranean to the extent that divides it into two navigational areas the Eastern Med and the Western Med, and this can very much be attributed to the position of Gioia Tauro container terminal that serves about 55 different Mediterranean ports. Germany is a gateway to the Baltic and to the CEECs. The four countries handle 152.2 million tonnes which represents 76.2% of the market. Despite being in fourth place, the market for the EU-15 has witnessed an 8% annual average growth rate (see endnote 32). This explains why the container short sea market is reported to be one of the most dynamic markets of the shipping industry, both in feeder traffic and intra-regional trade.

The number of containers being moved on an annual basis can be seen in Table 3. The annual average growth rate is not provided by Amerini (2008) but the data provided shows that the number of containers did not increased considerably after the enlargement, which suggests that well strategically located ports in the EU-15 geographical area were already responsible for handling cargo particularly destined to the Central Eastern European Countries. Moreover, the number of TEUs reported empty provides empirical evidence to sustain the presence of unbalanced trades as shown in other studies caused by density of population, separation of production and consumption markets, type of goods and alternative infrastructure.[35–36] Germany, Spain, the Netherlands and the UK greatly contribute to this situation due to their hub-and-feeder status, and which contributes to increase the freight rates charged to the final end user.

Table 3: Containers carried by short sea shipping, 2000-2006 (in 1000 TEUs)

	2000	2004	2005	2006
EU-15	14462.9	20312.3	21946.3	22922.3
EU-27		21108.2	22751.7	23700.0

Source: Adapted from Amerini (2008) (see endnote 32)

Finally, Spain, Italy, the Netherlands and the UK are responsible for the biggest share of other cargo, totalising 72.8 million tonnes or 50.9% of the market.

Absolute trade volumes continue to rise in Europe. Growth of trade patterns will create additional demand for SSS movements and additional demand for feeder vessels. The expanding economies of the Commonwealth of Independent States (CIS) countries present further opportunities for the European SSS sector, which can only be fostered through the implementation of strict environmental controls to reduce the amount of emissions into the atmosphere. Ro-Ro and the container market offer potential for modal shift as together they account for 23.3% of the goods being moved by sea, and because the market is far from having reached a mature state. In the case of containerised cargo, the market shows a service gap since shippers have not been offered the desirable service frequency they claim since the volumes being moved are insufficient and that explains why so many containers are being moved by road.

From a port perspective, Rotterdam accounts for the biggest share of cargo handled through ports (7.4%) to be followed by Antwerp, Marseilles, Hamburg and Le Havre, most of them located in the Le Havre–Hamburg geographical range. What is interesting to see in this overall picture is that Rotterdam handled more SSS cargo (184.4 million tonnes) than deep sea cargo (168.4 million tonnes) (see endnote 32), which shows how important Rotterdam is to the overall European SSS market.

2.3 The supply side of the European short sea shipping market

The high number of journeys (of normally less than four days, e.g. the ferries that ply the Baltic Sea and the English Channel) makes management and organisation costs of SSS comparatively high, although the cost structure is very different for feeder and intra-regional markets. In the first case, costs are mainly vessel related: capital (or charter), operating and voyage costs. Overhead and administration costs are relatively small. Consequently, feeder carriers rely mostly upon chartered vessels (with the exception of a few Asian carriers).[37] In the second case, the carrier involved in intra-regional intermodal SSS will bear high costs for handling cargo and providing land transport. Administrative overhead costs will also be higher. Despite these technicalities, the definition of what is a short sea vessel is a subject of much debate since different authors present different definitions.

Hoogerbeets and Melissen (1993), state that the European SSS can be divided into three main ships' categories: the traditional single-deck bulk carriers, the container-feeder vessels and the ferries.[38] Crilley and Dean (1993) report that vessels operating in the SSS market have frequently been defined as sea-going cargo-carrying ships that transported both freight and passengers with a gross tonnage (GT) less than 5,000, and that ships with a GT less than 100, non-propelled vessels, and harbour or IWW vessels were not part of the definition.[39] Peeters *et al*. (1995) created a splitting line between short sea and deep sea vessels. The authors considered that the former comprehend all ships whose deadweight capacity is less than or equal to 10,000 deadweight tonnes (dwt) which is equivalent to an average ship of about of about 8,000 GT (see endnote 7).

Marlow *et al*. (1997) pointed out that the SSS fleet is normally identifiable as a number of carriers with similar characteristics (SSS is usually performed by vessels up to a certain size and conversely vessels up to a certain size are usually deployed in SSS). Even if these parameters are likely to change significantly over time, they estimate that SSS include tankers and bulk carriers up to 13,000 GT and/or 20,000 dwt; general cargo and break bulk carriers up to 10,000 GT and/or 10,000 dwt; and combined passenger/cargo ships and Ro-Ro vessels between 1,000 GT and/or 500 dwt and 30,000 GT and/or 15,000 dwt (see endnote 4). Stopford in 1997 considered SSS vessels to be within the 400 to 6,000 dwt range against some authors that talk about 10000+ dwt (see endnote 8).

Paixão and Marlow (2002) identified five types of SSS vessel categories (i.e. the traditional single-deck bulk carriers, the ferries, container feeder vessels, a fleet of bulk carriers and tankers and sea-river ships often with retractable wheelhouses), provided and individual description of each of the vessels and investigated the differences between Lo-Lo and Ro-Ro operations (see endnote 16). This classification which partly agrees with the one provided by Hoogerbeets and Melissen (1993), is similar to the one provided by Verlaat (2008) (see endnote 38).[40] The difference between Verlaat and Paixão and Marlow is that the former considered the fleet of tankers, dry bulk carriers and traditional single-deck bulk carriers often used in the carriage of neo bulk within the same category of conventional ships.

Besides the traditional ships mentioned in the above paragraphs, the short sea market has been witnessing a trend towards the introduction of faster ships such as wave pierce catamarans, air cushion vehicles, hydrofoil, surface effect ships, and the small waterplane area twin hull (SWATH). Their main problem concerns their consumption levels to perform their designed service speed; any increase in their speed means an increase in the cost of bunkers, a decrease in their cargo carrying capacity meaning a revenue reduction. The question to be raised at this point is to ask shippers about their interest in having their cargoes being moved by this type of vessels. Despite being able to shorten cargo transit times and provide high service levels, how far they are willing to pay higher freight rates when Becker *et al*. (2004) recognised that the high speed vessel market offers potential to compete with certain road transport market segments.[41]

Overall, short sea ships are normally much smaller than deep sea ones although there is a trend towards an increased vessel size. Several reasons explain why such vessels are small: (i) demand is normally weak for SSS routes; and (ii) the high number of short journeys requires smaller ships in order not to spend too much time in port calls. The lack of an unambiguous definition, towards the size and types of ships that work in the SSS market, causes additional problems when authors try to characterise the fleet operating in this market which may be a reason why most studies on fleet analysis set the dividing line between SSS and DSS at 10,000 dwt or 6,000 GT.

According to a Lloyd's Register survey quoted in Peeters *et al*. (1995), by the end of 1992, the world SSS fleet amounted to 68.5% of the existing fleet corresponding to 9.6% in terms of GT, 8.9% in terms of the total dwt carrying capacity with an average size equal to 1,319 GT. From a European perspective, the same survey estimated that the European SSS fleet amounted to 57.3% of the existing European fleet corresponding to 7.9% in terms of GT, 6.7% in terms of the total dwt carrying capacity with an average size equal to 1654 GT. The figures reported on ships which are supposed to be employed in SSS show that on a worldwide basis there seems to be a quite constant share of ships

employed in SSS, as well as in terms of GT and dwt. The same survey showed that general cargo and liquid bulk carriers prevail in the EU SSS fleet. Peeters *et al*. went on saying that the average age of the world SSS fleet was 18 years, two years younger than the European one that amounted to 20 years (see endnote 7).

The Colton Company (1997) estimated that the European SSS fleet was made up of 5,650 units embracing 5,000 sea-river ships often with a retractable wheel house, 400 containerships ranging between 100 and 700 TEUs and 250 Ro-Ro ships. Most popular container ships moved 200 TEUs and the most popular sizes of sea-river ships presented deadweight capacities between 1,500 and 2,200 tonnes.[42] However, the data provided presents two main problems since the short sea dry and liquid bulk carrier fleet was left out of the calculations and there is no reference to the year that the data relates to. The Commission in its report on the implementation of Council Regulation 3577/92, presented data relatively to the 1996 and 1998 SSS fleet (see Table 4), and considered for this purpose ships of less than 10,000 dwt.[43]

The data supplied by the Commission does not discriminate the type of ships being considered which prevents from having a real perception of the composition of the actual fleet. What type of ships predominate in each group of Member States is unknown and even if the ratio of dwt to GT were to be used to identify if the fleet is mainly formed by passenger/cargo ferry and Ro-Ro (ratio of dwt to GT below 1) or by tankers and dry cargo vessels (ratio of dwt to GT above 1), its outcome would be far from being a reliable one. The data supplied by the Commission also shows no evidence that sea-river ships have been included in the calculations and so, the number of ships calculated for 1998 are well below those estimated by the Colton Company in 1997.

The only possible conclusion is that the SSS fleet has increased in numbers and in dimension but very slightly. The average SSS vessel size in terms of GT and dwt for 1996 were 4,267 and 4,909, respectively and that the figures for 1997 amount to 4,288 and 5,149, respectively. Various studies on the SSS have observed a gradual increase in the average size of the SSS vessel. According to Dynamar quoted in Peeters *et al*. the SSS vessel average size increased from 1,400 dwt in 1970 up to 2,000 dwt in 1980, and up to 2,400 dwt in 1990 (see endnote 7).

According to Lloyd's Marine Intelligence Unit (LMIU) quoted in Wijnolst (2005) the 2003 European SSS fleet from Baltic Sea to the Black Sea comprehended 10,000 ships between 500 and 10,000 GT of which 3,825 and 2,110 ships were older than 25 and 30 years, respectively and that a total of 3,460 shipowners operated in the European short sea market.[44] Part of the 2004 world short sea fleet can be seen in Table 5 since vessels operating on the SSS were aggregated in eight different categories, rather than in ten as shown in Table 6. Smits left out the general cargo and ropax fleets which according to the 2007 data represent about 47% of the world short sea fleet and all vessels below 1000 dwt which are about 10,000 vessels,[45] and such a situation

Table 4: EU-15 short sea shipping fleet (GT and dwt 1000)

	1996			1998		
	Number	GT	Dwt	Number	GT	Dwt
Northern Member States	2018	8609	10932	2091	8520	11349
Southern Member States	1252	5343	5120	1428	6570	6772
	3270	13952	16052	3519	15090	18121

Source: European Commission (2000) (see endnote 43)

Table 5: 2004 World short sea shipping fleet

Vessel type	Number of vessels	Total deadweight (dwt)	Average deadweight (dwt)	Total cargo transported (tonnes)
Bulk fleet	2,523	42,270,141	16,754	513,761,250
Reefer fleet	1,027	4,232,991	4,122	80,010,000
Container fleet	1,592	16,868,102	10,596	451,822,000
Oil tanker fleet	357	9,359,581	26,217	153,367,200
Product, chemical fleet	2,206	13,143,522	5,958	312,840,000
Ro-Ro fleet	1,185	7,607,750	6,420	294,336,000
LNG fleet	15	288,205	19,214	4,617,000
LPG fleet	945	4,970,303	5,260	90,420,000
Total	9,850	98,740,595	11,817	1,901,173,450

Source: Adapted from Smits (2007) (see endnote 45)

Table 6: 2007 World short sea shipping fleet at the end of the year

Vessel type	Number of vessels	Total deadweight (dwt)	Average deadweight (dwt)	Total cargo transported (million tonnes)
General cargo fleet	16,601	76,568,255	4,612	1,729
Dry bulk fleet	7,366	384,735,783	52,231	2,603
Reefer fleet	1,217	6,598,420	5,422	129
Container fleet	4,205	100,395,981	23,875	1,902
Oil tanker fleet	2,055	293,989,385	143,061	1,854
Product, chemi-cal fleet	3,626	56,782,773	15,660	943
Ro-Ro fleet	2,360	16,731,136	7,089	507
Ropax fleet	2,728	3,943,400	1,446	
LNG fleet	248	17,075,828	68,854	97
LPG fleet	1,080	12,311,988	11,400	152
Total	41,486	969,132,949	33,365	9,916

Source: Adapted from Lindstad (2008) (see endnote 47)

creates a distortion relatively to the 2003 data. Nevertheless, if the percentage split provided by Peeters *et al*. (1995) is applied, (i.e. the EU-27 short sea fleet amounts to 31.5% of the world short sea fleet) what can be said is that the European short sea fleet embraces about 9166 vessels including those with a deadweight below 1,000 tonnes. Shipowners based in Germany, the Netherlands Greece and Italy dominate the market and control 62% of this short sea fleet.[46]

Table 5 also provides the average deadweight for the eight vessel segments, and what can be said is that short sea vessels' sizes have increased for the past years, which meet the findings reached by Marlow *et al*. in 1997 (see endnote 4). The added value of Table 5 rests on its ability to provide more detailed information for the different types of cargo being moved by sea rather than the statistics

provided by the EUROSTAT, but prevents possible comparisons with the data gathered by other consultancy houses and/ or eventually EUROSTAT.

The Lloyd's Fairplay data of the worldwide short sea fleet quoted in Lindstad (2008), shows that at the end of 2007, the world short sea fleet includes 10 vessel categories and is much more accurate than the 2004 data.[47] With the assumption that the EU-27 short sea fleet represents 31.5% of the world short sea fleet, it can be estimated that the EU-27 short sea fleet has about 13,050 units, which means an average yearly growth of 7.6% relatively to 2003 where data quoted in Wijnolst (2005) was provided by LMIU. The average size of short sea vessels goes on increasing and against the findings of Corres and Psaraftis who estimated the average size of short sea vessels to be around 11,000 dwt by 2007–2008,[48] the average size appears to be within the range of above 30,000+ dwt, much at the expense of the tanker fleet size employed in the SSS market.

The biggest problem of the European short sea fleet is still its age and the main concern of an ageing short sea fleet is its pollutant emissions which in 2000 accounted for 36% of the total nitrogen oxide (NO_x) and 6% of total greenhouse emissions. The problem of an ageing short sea fleet is not new, since it has already been mentioned by Øvrebø in 1969 (see endnote 25) and more recently by Lowry in 2008 who identified that the dry bulk short sea fleet had an average age of 31 years (see endnote 34). This suggests that a renewal scheme is desirable for SSS to be competitive with road transport and to be integrated into multimodal/intermodal transport chains. The absence of legislative measures enforcing the renewal of the fleet has been a negative influence since until recently the dwt of most short sea vessels was under 5,000. Moreover, short sea operators do not possess sufficient funds to embark on a short sea fleet renewal programme, the costs of building a small ship are four-and-a-half times more per dwt, and bank credit is very expensive (see endnote 48).

The resultant reduced profitability is therefore a serious strategic concern in capital intensive companies planning for growth and the renewals that have taken place result more often than not from the existing rivalry between shipowners operating in this market, from port state control inspections and the enforcement of important legislation to protect the environment. Most focus has been giving to the development of efficient vessels ranging from 30,000 up to 300,000 dwt while the SSS fleet has been more or less neglected. Nevertheless, this trend has started to reverse due to the numerous research and development projects being funded by the European Commission in last years in the quest for more efficient ships such as the CREATE3S new generation of short sea vessels,[49] the ENISYS ship concept[50] or generic short sea vessels based on a common platform and built in series as it happened in the past (see endnote 48). In 1994, Wijnolst *et al*. had already acknowledged that SSS technology and operations needed to be changed before any significant modal split materialised.[51]

The point is that new ships are needed to compete with road transport on cost, speed, flexibility, reliability without jeopardising safety and the environment, attractive sailing times, maintained transit times, and guarantee of delivery. Two key aspects that these ships must target are the reduction of the turnaround time in port and the ability to develop intermodal solutions that meet the needs of the entire logistics chains. If significant reductions of 20–25% are achieved in terms of cost and lead time a modal shift is expected to occur (see endnote 50), an improvement relatively to the 35% reduction required to shift cargo from road to sea as suggested by APAS in 1996.[52] Under the present environment and taking into account the modal split presented in Figure 1, an analysis of SSS in a

multimodal supply chain context makes sense in the European arena, as competition with land transport is higher due to geographical reasons and to the comparatively highly developed land transport infrastructure.

3. Short Sea Shipping in a Multimodal Supply Chain Context

3.1 Geographic and economic conditions for developing short sea shipping: a theoretical framework

Maritime transport is normally part of a transport cycle involving other transport modes. The maritime leg can be a complex cycle, when organised from a hub-and-spoke perspective, involving ships of different size to attain economies of scale/density on some routes. Since the goal is to attain the cheapest, fastest and most reliable transport conditions (i.e. to minimise the generalised cost), the demand for sea transport is related to the generalised cost of the whole transport cycle. From a microeconomic approach, the use of generalised costs explain the user's choice (i.e. providing transport solutions for producers), but the use of total costs (including infrastructure and external costs) from a macroeconomic approach explain general utility enabling a shift of volumes from congestioned land infrastructure to sea.

The proposed framework considers jointly geographic and economic conditions involved in the mode choice, and identifies the critical thresholds in land/sea distances and land/sea generalised costs which determine SSS potential competitiveness. It applies either to the case of a SSS intermodal chain competing with land transportation, or to feeder traffic for DSS. The boost of intermodality over the last 30 years is due both to increasing benefits and decreasing transhipment costs, as: (i) the growth of world trade allowed economies of scale not conceivable before, also because production functions are more capital intensive and involve relevant fixed costs; and (ii) new handling techniques reduced costs, times and risks of transhipment. If SSS replaces a part of a journey otherwise performed by a single vehicle, the additional modal change implies higher generalised costs. Total time increases, while reliability, punctuality and safety are jeopardised by bottlenecks, congestion, mistakes, damages, among others. These costs are compensated by savings that the different modes/vehicles allow in the different part of the journey, because of changing cargo volumes and economies of scale/density. SSS is chosen when the optimisation of modes/vehicles on the different legs generates benefits higher than the additional transhipment costs. In both key areas (feeder traffic and intermodal traffic competing with land transport) a simple cycle is replaced by a complex one. Unlike SSS captive markets, where there is no user's choice and the goal is to minimise generalised costs of modal change, SSS is chosen only if it allows generalised benefits higher than the generalised costs of additional transhipments.

Therefore, the problem under study fits within the approach *à la* Hoover[53] as it accounts for different terminal and haulage costs of the different modes, which cause different costs per mile, which explains why different modes have a different competitiveness for different distances, and therefore different markets and why at a European level, the different modes are competitive in different distances.[54] While road transport has low terminal costs but relatively high line haul costs, sea transport has high (generalised) terminal costs but comparatively lower transport costs and rail has intermediate levels for both terminal and transport costs. Since terminal costs do not vary with distance, road transport will be cheaper on shorter journeys and sea transport on the longer ones. Such

a framework points out the conditions for SSS competitiveness. The paragraph that follows considers the case of SSS as a main leg of an intra-regional transport chain, competing with land transport. The approach is similar if a feeder traffic case was being considered.

In Figure 2, a journey *OD* is considered, where in the central leg *AB* both road and sea transport are available, while only road transport is available in *OA* and *BD*. The function a shows total transport cost if only road haulage is chosen. The function *b* shows the cost of transport using SSS in the central leg. While modal change costs are added in *A* and in *B*, a lower cost is paid on the leg AB. SSS is then advantageous when *AB* is long enough to compensate higher terminal costs.

Unless *O*, *A*, *B* and *D* are aligned, Figure 2 only accounts for economic conditions and not for geographic conditions when competition is being considered. To find out the combination of economic (transport and terminal costs) and geographic variables (land and intermodal distances) which jointly account for SSS competitiveness, a land transport *OD* by mode m_1 (e.g. road haulage) and an alternative *OABD* based on mode m_1 for *OA* and *BD* and on SSS indicated as mode m_2 for *AB* must be compared. Ports *A* and *B* are not aligned with *OD*.

If *x* is the maritime distance between ports *A* and *B*; T the transhipment generalised cost in ports; tm_1, tm_2 transport rates per mile of a given cargo unit; and *C* and *S* terminal costs in *O* and *D*; then total transport costs are:

$$C + tm_1 \cdot OD + S \qquad (1)$$

for road transport *OD*, and:

$$C + tm_1 \cdot OA + T + tm_2 \cdot AB + T + tm_1 \cdot BD + S \qquad (2)$$

for intermodal transport OABD. The competitiveness of the latter is then given by (1) > (2):

$$tm_1 \cdot (OD - OA - BD) - tm_2 \cdot AB - 2T > 0 \qquad (3)$$

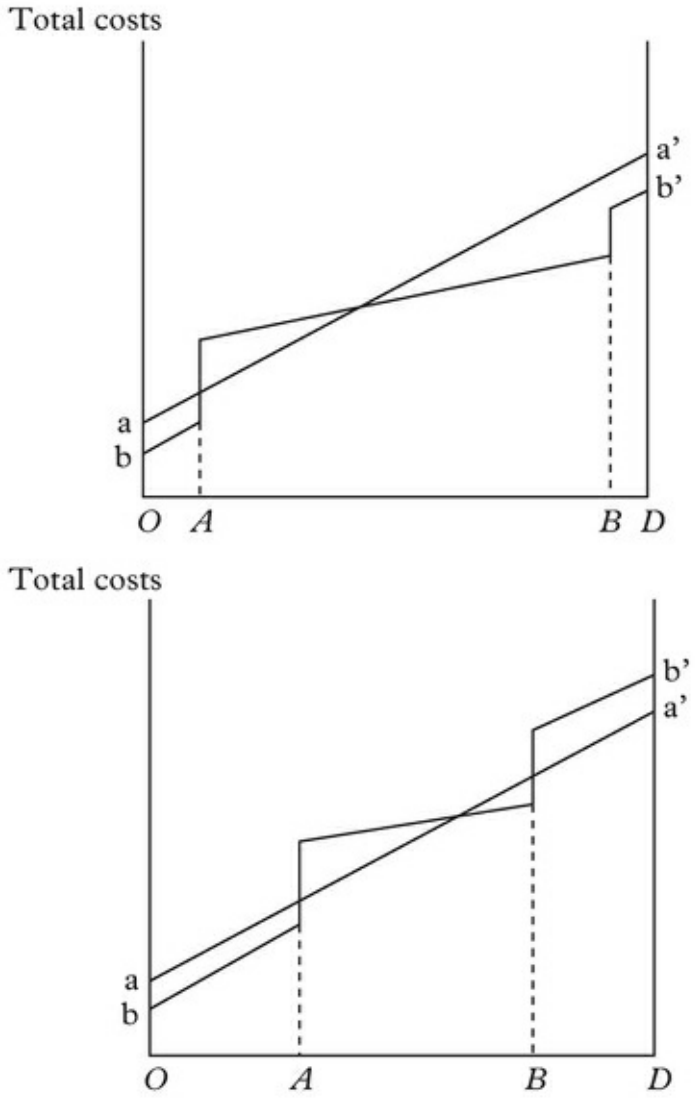

Figure 2: Total transport costs: all road vs. SSS

If y is the difference between road distance OD and feeder road legs OA and BD of SSS transport, the (3) can be written as:

$$y > \frac{tm_2}{tm_1}.x + \frac{2T}{tm_1} \qquad (4)$$

setting the combination of geographic and economic conditions for competitiveness of SSS, as in Figure 3. Each journey OD identifies a set of (x, y) satisfying or not the condition (4), according to transhipment costs, and rates per mile of modes $m2$ and $m1$. Obviously the competitiveness increases by reducing T or $tm2$, or by increasing $tm1$.

A key point is that if $m2$ allows more relevant economies of scale than $m1$, as is normally the case for short sea compared to road transport, the increase in traffic flows reduces the slope of the (4), thus increasing competitiveness of the former. This is just a joint representation of geographic and economic conditions which make viable a SSS-based alternative to land transport. The approach *à la* Hoover allows finding out each transport mode economic distance since (i) terminal and transport costs weight

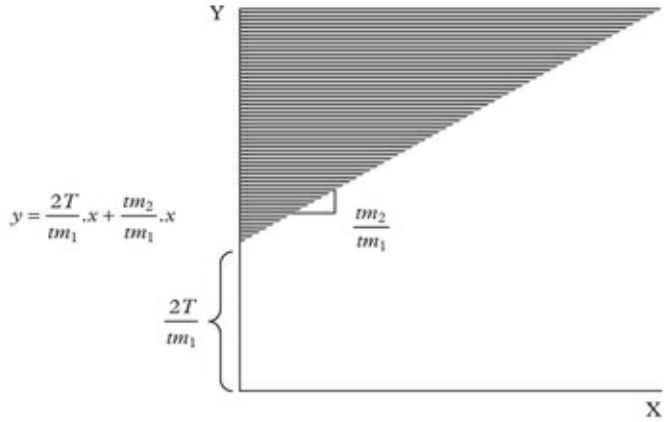

Figure 3: Geographic and economic conditions for competitiveness of SSS

differently in different modes; (ii) costs in different modes are a function of cargoes and cargo units characteristics; (iii) reducing terminal costs in ports lowers the threshold distance for SSS, as it moves downwards the (4); and (iv) higher returns to scale in SSS cause a growth in traffic to reduce SSS threshold distance, by a rotation of (4).

Thus, SSS economic competitiveness relies upon the contemporaneous occurrence of five conditions which are: (1) cargo volumes involved cause pure transport costs for sea transport lower than for road transport; (2) different origins and/or destinations do not allow to employ the sole maritime transport (since cargo volumes do not fulfil the condition (1)); (3) distances involved are longer than the threshold distances for sea transport; (4) location of origins/destinations of single shipments allow the unification of parcels on some legs in order to satisfy condition (1); and (5) lower generalised costs of using the best transport mode on each leg are higher than additional generalised costs deriving from transhipment. According to Baird (1997) for a coastal service in the UK to be successful, it would need to guarantee that the costs were competitive, goods delivery times were maintained, and the service was reliable relatively road transport alone (see endnote 35).

When referred to SSS as feeder traffic, different returns to scale account for the hub-and-spoke organisation. Limits to economies of scale are now on the demand side, and increasing returns to scale can be pursued only by grouping cargoes on the main leg. Volumes and costs per mile being equal, the longest is the main leg AB, the most competitive is the hub-and-spoke solution using SSS. Conditions (1), (2) and (5) will be here referred to thresholds for ships of different sizes. Condition (5) will refer to transhipment from SSS to DSS.

As for competition between SSS and road transport for the feeder service, since a haulage feeder service is normally needed for the final part of the journey, the comparison is between savings allowed by maritime feeder and costs of an additional transhipment (from the feeder to the deep-sea ship), that is:

$$(tm_1 - tm_2) \cdot OA - T > 0 \qquad (5)$$

The same conditions apply, since there are combined effects of economic distance, size of shipments and location of origins/destinations.

This approach outlines the conditions that make SSS competitive, even when not forced by geographical (or, in the short run, infrastructural) constraints. The same framework applies to both main current strategic areas of SSS: an intermodal transport competing with land transport, or a feeder traffic competing with road/rail feeders. As already noted, this framework allows both a

microeconomic and a macroeconomic approach, with different implications. In the former, short term generalised cost (given the infrastructure) account for behaviour of transport operators and consequent modal split. In the latter, total direct and external long run costs (including infrastructure and energy) account for a macroeconomic comparison, resulting in a cost-benefit assessment which pursues a higher welfare.

In its microeconomic approach, the proposed framework refers to generalised, not to out-of-pocket costs. Generalised costs correspond to production costs only in perfect competition. In freight transport, shippers happen not to decide transport mode neither select the route, and multimodal transport operators (MTOs) are likely to choose modes/routes according to their convenience. Monopoly, or collusion between providers (e.g. due to horizontal and vertical integration of the supply chain) can cause a substitution between time and cost, reducing costs and increasing times without (or with little) reduction of prices for shippers. The case for passenger transport is different, since users directly choose the mix of modes by comparing the generalised cost of each solution, and their preference will thus account for their choice. It is probably no accident that intermodality is barely chosen unless forced by geographical constraints or by huge savings in monetary costs, or unless other options are totally congested or restricted.

In other words, intermodality allows increasing productivity, but may cause a decreasing quality (for the cargo, not necessarily for the vehicle) with higher time and lower reliability, punctuality and safety. If there is not a high level of competition this trade off may encompass a transfer of costs from the producer to the consumer. The market organisation is then crucial for the benefits to spread on the demand side, allowing higher accessibility of regional markets, specialisation of production, and cumulative growth of regions involved.

3.2 Factors influencing the competitiveness of SSS

According to Sub-section 3.1, the more SSS will be competitive, the more substantial reduction in generalised port costs is attained; the longer is the maritime leg with respect to the total length of the journey; the higher is the ratio of y to x in (4); the bigger are cargo volumes; the higher is the ratio of land transport generalised costs to sea trans port ones.

Besides these key issues, some additional remarks are worthwhile. First, the growing importance of ports and their performance/efficiency involves not only efficient modal change and handling, but logistic and distribution functions. Choices concerning number and location of ports and logistic platforms on which the SSS network will hinge are strategic, since they pursue the optimal trade off between economies of density, pushing for concentration of flows which reduce the ratio tm_2/tm_1 in (4); and minimisation of road feeders, pushing for dispersion of flows which cause higher values of y and positively affects (4). Case-by-case search for optimal equilibrium is a major operational research issue, and a key issue for SSS development strategies. It is notable that virtually all issues highlighted – threshold distances, demand volumes and their origin/destinations, returns to scale in competing modes, number and location of intermodal nodes, etc. – have been addressed so far in a largely empirical way, frustrating most of the potential of SSS. There has been no strategy at all, and SSS nodes have followed, more often than not, strategies of big transport operators.

Another point implicit in (4) is that implementing SSS should not result in fragmentation and complications of relations between shippers and transport operators, difficulties in organising and

controlling the logistic chain, problems arising from liabilities, damages or losses, among other issues. This means that implementing SSS requires the integrated management of the entire SSS-based logistic chain. On one side the risk is that economies of scale/scope related to the management of the whole logistic cycle can set relevant barriers to entry, issue of alliances and co-operation strategies. On the other side, if the control of the chain is taken up outside the maritime link, this may squeeze profitability and limit operational control of SSS operator, who faces, in a door-to-door cycle, relevant fixed costs, and does not enjoy any spatial protection of its market, thus coupling high competition and low profitability. Moreover, by operating on one link of the chain, there is no influence/control over the quality of the door-to-door service, and no control on key factors influencing the demand; comparison between SSS and competing modes requires that the whole cycles are compared.

The above mentioned factors, although not explicitly modelled in the proposed approach, are likely to influence deeply the cost elements of (4), which can vary with high levels of uncertainty, not proportionally to distance, and change rapidly over time. In this context, Paixão Casaca and Marlow (2005) investigated the service attributes required by shippers when making use of multimodal transport chains comprising a sea leg. The authors found out eight dimensions which differed from the ones advocated in the several policy documents of the Commission and which comprised by decreasing order of importance (i) carrier's logistic network design and speed; (ii) cost of door-to-door service, its reliability/quality; (iii) the carrier's behaviour during sales and after-sales; (iv) carrier's involvement in the forwarding industry; (v) service guarantee; (vi) carriers' corporate image; (vii) carriers' commercial/operational policies and their relationship with shippers and finally (viii) investment policy.[55]

3.3 Putting short sea shipping in operation: obstacles and challenges

Any further SSS development will necessarily rely upon its possible microeconomic competitiveness (in terms of generalised costs), more than upon its macroeconomic desirability. Yet, since most researcher and policy makers agree on the need of enhancing SSS, it is useful to resume a checklist of main benefits and costs from the macroeconomic and political viewpoint. Paixão and Marlow (2002) have listed SSS strengths and weaknesses (see endnote 16) and a summary of the benefits offered by SSS can be summarised as follows:

- low environmental costs: it generates much less emissions per tonne-km (tkm) caused by the average transport (average goods, average road and rail gradient, average energy split) in Europe than road and rail transport, as shown in Table 7.

Table 7: Polluting emissions (grams for tonne-km)

Transport	Energy consumption EC (kJ/tkm)	Carbon dioxide CO_2 (g/tkm)	Nitrogen oxide emissions NO_x (mg/tkm)	Sulphur dioxide emissions SO_2 (mg/tkm)	Non-methane hydro carbons NMHC (mg/tkm)	Dust‡ (mg/tkm)
Road traffic* (>34-40 t; Euro 3)	1082	72	553	90	54	16
Rail transport†						
average electric train	456	18	32	64	4	4,6
average diesel train	530	35	549	44	62	17
Air transport	9,876	656	3,253	864	389	46
Waterway (upstream/ downstream)	727/438	49/29	839/506	82/49	84/51	26/16

Source: Knörr and Kutzner (2008)[56]
* for additional data see Table 10 in Knörr and Kutzner (2008).
† based on the EU-27 energy split.
‡ By dust is meant "*total exhaust particles from vehicles and from energy production and provision (mainly power plants, refineries, sea transport of primary energy carriers), composition: all particle sizes, about 80% PM 2.5, 90% PM 10 (by mass)*".

- fewer accidents, namely for human life safety: in 2007, 42,448 fatalities occurred in road accidents within the EU-27 corresponding to 99.8%, and 76 losses of lives were registered in rail transport (excluding suicides); air transport was responsible for four losses, but this figure increased up to 181 in 2008.[57] Data provided by EUROSTAT does not include sea losses, however according to Lloyd's Register Fairplay data provided by the International Chamber of Shipping and the International Shipping Federation Website sea transport was responsible for about 260 losses of life worldwide, which shows how safe this mode of transport is.[58]
- lowering congestion of land transport networks: presently 7,500 km of roads are congestioned on a daily basis;
- low energy consumption;
- larger economies of scale;
- higher flexibility of transport costs to shifts in demand, and low need for new infrastructure;
- more competitive environment than for (rather monopolistic) land transport networks;
- advantages for maritime economy and namely for shipyards;
- development of peripherals and isolated regions (of difficult or impossible access with other transport modes), and enhanced competitiveness of hinterlands economies facing international markets.

On the other side, the development of SSS also brings about some disadvantages, such as:

- partial increase of pollution: unlike other emissions, sulphur dioxide (SO_2) emissions are much higher than in other modes (see above);
- partial increase of accidents, namely with major environmental damages;
- congestion in port nodes;
- negative impact on other transport sectors, as well as on the industry of infrastructure construction and related sectors;
- low flexibility in service times, due to larger unit capacity and consequent lower frequency of service for any origin/destination (O/D) link;
- lower reliability of scheduled departure and arrival times (mainly due to weather conditions);

- higher risk of damages and loss.

It is not sure a *priori* that the comparison between costs and benefits is always positive, even if most policy makers consider costs largely exceeded by benefits since to absorb road traffic a minimum distance of 1,500 km is required.[59] Nevertheless, some points should be highlighted:

1. As for environmental effects, the balance is likely to be positive, since SO_2 higher emissions can be reduced (see below). Nevertheless, nobody can extrapolate this statement on a long term, as no forecasts on future levels of polluting emissions are highly reliable, namely for land transport, where a major research effort is being done to attain propulsion systems environmentally friendly.
2. As for congestion of transport infrastructure, the congestion of land transport network is clearly more damaging and less remediable, for the economy as a whole, than the congestion of existing port nodes.
3. Under the viewpoint of economic effects, namely in total production costs of transport, clearly the lower flexibility of land transport costs is replaced by a lower flexibility in transit times and a lower punctuality; there is a trade off between quality and cost, and the effects on demand are likely to be different for different segments of the market (as for types of cargoes and cargo units), due to different values of price-elasticity and time-elasticity.
4. As for macroeconomic Keynesian impact, the replacement of a demand in land transport and infrastructure construction with a demand in maritime transport, shipyards and port infrastructure construction, needs to be carefully investigated and quantified; yet it does not appear a reason to stop a possible change if otherwise desirable.

Even if case-by-case assessments and surveys can lead to results sometimes different, it seems acceptable that in a macroeconomic vision SSS should develop further, and that policies aiming at implementing it are consequently well founded.

3.4 Possible policies for short sea shipping in a multimodal context

If previous paragraphs showed that some conditions influencing SSS are given (on the geographical side, land and sea distances; as for demand, the nature of cargoes, and, to some extent, their volumes), most other elements influencing competitiveness of SSS can be changed through suitable policies. Nevertheless, it must be clear that what jeopardises the competitiveness of SSS is the unfair competition played by land transport, namely road haulage, in terms of much higher environmental costs, and much higher public financing of infrastructure. Strictly speaking, equalising environmental and fiscal externalities of all transport modes should be the ultimate goal of any policy aiming at a fair modal split (and not simply at the growth of SSS, which might well be not desirable). As a consequence, first best policies for SSS do not concern necessarily SSS, but should focus on internalising major external costs of land transport.

In the light of the above paragraphs, and taking into account the framework outlined above, a number of actions which apply to different areas can be identified. Firstly, ports are key nodes for the effectiveness of SSS, since ships' times in port are high and amount to more than 60% of ships' total voyage time and represents 70 to 80% of waterborne transport services total cost or more than half of maritime freight (see endnote 21).[60] A well-defined port strategy can greatly influence a modal shift towards the use of SSS. Instead of focusing only on inter-port competition, ports should determine

their SSS hinterland, look at shippers' requirements in order to facilitate short sea operators. The actions listed below to promote modal shift should increase fluidity of transit in ports, reliability and on time delivery, by minimising quality components of generalised cost.

Second, comparisons between transport rates highlight two areas where positive actions can be deployed: internalising all costs following the user pays principle, or at least equalise the level of external costs. These actions, involve infrastructure, turn to land use/planning policies, developed either for optimising transport performance, or for reinforcing the cohesion and economic proximity of different regional economies. Finally, policies can involve the transport industry and providers of transport services, by inducing changes both into the market and technical/industrial organisation, and on cargoes and shippers' organisation. Policies and actions appear to fall into seven main strategic areas namely infrastructure policies, law and regulations, commercial actions, organisational actions and policies, pricing policies, technological actions and logistics strategies. The paragraphs that follow describe each of these policies.

Infrastructure policies. Infrastructure policies address both planning/construction and location of infrastructure that influence SSS competitiveness. Main actions include:

- improvement of ports to the needs of SSS, namely widening space for SSS traffic (most present terminals would be inadequate if SSS attracted relevant traffic flows), modification of ports' layout and creation of dedicated terminals/areas;
- improvement of handling plants in ports, namely through a further diffusion of containerisation in SSS;
- enhancement of port accessibility and connections between ports and land networks (road and rail); since competition between road and rail has been estimated around 170-250 km,[61] connections with rail networks are crucial for expanding ports' market areas;
- IWW development and promotion of a better balanced modal split between land transport and IWW, whose integration with SSS is easier and more efficient than for land transport;
- redesign port procedures to eliminate activities that create costs;
- make use ofVTMIS to continuously monitor vessel arrival in port and as such introduce just-in-time procedures to improve port capacity management.

Law and regulations. These aim at enhancing competition to increase the efficiency and attract further investment and at eliminating distortions caused by excess of regulations for SSS, and lack of environmental regulations (or of their enforcement) on road transport. Main actions should include measures targeting at:

- liberalising access to market, namely abolishing flag reservations on domestic traffic, including the concept of public service;
- integrating bureaucratic (customs/administrative) procedures in order to simplify/reduce difficulties and times (the MarNIS EU research project output can be a means to achieve this end);
- equalising external costs;
- integrating different contracts and liabilities;
- regulating port services and their inputs, thus allowing a higher efficiency of port operations.

Commercial actions. They seek to overcome the perception of SSS as an obsolete, not transparent, and

not suitable mode of transport for the present needs of production and logistics, with low flexibility, reliability, frequency and speed. Measures needed include:

- restoring the image of SSS from that of an old-fashioned, slow and complex transport mode to a modern element in the logistic chain, characterised by high speed, reliability, flexibility, regularity, frequency, and cargo safety;
- clearly show the difference between SSS and other modes of transport, in particularly road;
- information aimed at restoring trust; logistic operators and shipowners should fight for market transparency and to promote information on conditions of supply;[62]
- specific information on safety (see above) helping to promote a positive image;
- define and publicise key performance indicators.

Organisational actions and policies. These actions involve either the industrial or the technical organisation with the purpose of reorganising SSS-related operators. Such actions should:

- reorganise and allow a better modal integration to fulfil just-in-time requirements and compensate the additional breaks of bulk; frequency and reliability of scheduled times are the key issues, which implies the existence of 24/7 port services, and a better organisation of storage/distribution areas;
- stimulate co-operation and collaboration of SSS operators as suggested by Corres and Psaraftis (see endnote 48), stimulate co-operation of SSS operators with shippers and forwarders to offer comprehensive networks and door-to-door services at competitive prices, thus integrating the strengths of different modes into seamless customer-oriented services. Either SSS operators need partners to carry out the land legs of intermodal chain, or land operators must be ready to use SSS for a relevant part of their journeys at the expense of short sea operators losing control over the market. A good example is the Turkish company UN Ro-Ro that operates several trade routes between Turkey and Italy;
- concentrate SSS flows on a limited number of ports, in order to achieve higher economies of density and provide more frequent services; possibly locate them close to major metropolitan areas in order to be more competitive in delivery times; the MoS concept is an opportunity to achieve this objective so that a guaranteed service quality and frequency is obtained;
- promote specialisation of terminals and alliances between port operators;
- promote concentration in the road haulage industry, to incentive road-SSS intermodal journeys which are more competitive for non-accompanied trailers;
- promote standardisation of cargo units (e.g. "europallets" do not allow a standard ISOl maritime container to be filled with two rows of pallets) in order to reduce costs of modal change in those trades where these standardised cargo units are possible;
- locate value-added services (VAS) in SSS ports to better integrate port functions with logistical services provided by forwarders and MTOs.

Pricing policies. Since the quality component of generalised cost is comparatively high, SSS must be cheaper in monetary costs.[63] Some possible price-based actions are:

- compensating lower quality (higher times for ships and cargoes) by lower prices; Pettersen Strandenes and Marlow (2000) suggest a two-parts port tariffs partly related to port stay and waiting time: prices inversely related to quality should enhance competitiveness of SSS and

incentive port operators to improve quality[64];

- pricing policies promoting fair competition between transport modes by: charging for the cost of building infrastructure in all modes (the user pays principle); harmonising financing and pricing policies in different ports; internalising external costs,, particularly in road haulage;
- lowering port taxes (which, unlike pricing for using infrastructure, does not correspond to a real recovery of production cost) indirectly to attain the same results.

Technological actions. The age and the low specialisation of SSS ships are consequences, rather than causes, of low profitability. Higher investments in new ships and R&D, and generally in technological advance, are needed. Some useful action can be:

- development of high speed ships, to reduce the gap with road in terms of time; even if competition between faster and more expensive road haulage and a slower and cheaper SSS rely solely on the value of time for the user;
- new vessels and advanced flexible ship designs to better integrate SSS (namely with high speed ships) within logistic chains;
- harmonisation of standards for information and communication technologies (ICT) and development of "community systems" to reduce costs of information input;
- harmonisation of standards concerning cargo units (see above), to achieve higher occupancy rates and highly or fully automated handling techniques;
- research reducing polluting emissions of ships, like SO_2, namely by lowering the sulphur content in bunker fuel oils or equipping the ships with exhaust gas cleaning systems (see endnote 21).

Logistics strategies. The following logistics strategies can be considered to implement SSS in a multimodal context and which meet the findings of Paixão Casaca and Marlow (2005):

- adoption of a total quality-management philosophy;
- consider the transport chain from an integrative perspective;
- consider freight-forwarding a core competency;
- develop partnerships and alliances to provide door-to-door transport;
- think about the importance of inland clearance depots and terminals in order to create networks;
- make use of outsourcing and adopt a time-management strategies to comply with shippers' requirements.[65]

4. The European Short Sea Shipping Policy

4.1 European Union short sea shipping policies

Road increased modal share and its continued growth in freight (see Section 2) is leading European road transport systems into serious problems with regard to congestion and safety, and as a consequence environmental impact of road transport is causing public concern. Under the given conditions, the EU has been developing and supporting a more sustainable transport policy from economic, social and environmental viewpoints.[66]

Although the Commission addressed the issue of SSS in 1985 when proposing freedom in providing maritime transport services for cabotage and intra-EU trades, the matter was left behind until 1992. The 1992 White Paper released by the Commission considered that transport should adopt a holistic

approach rather than one based on the individual characteristics of the modes especially when road freight transport is expected to grow by 60% until 2013. What was being asked was the development of collaborative attitudes between the different transport modes so that each one complemented the other in such a way that the efficient running of transport services was being promoted. Through this action, the Commission was trying to promote the development of multimodal transport services over the long distances in opposition to unimodal transport, namely road transport. However, if these actions are not truthfully supported by all actors, and in the absence of new policy measures, growth will be concentrated on road transport for both goods and passengers. Road is the only mode capable of offering the tailored logistics needs of transport users, and because stricter environmental rules regarding road transport are being implemented up to 2014 (the Euro V and Euro VI) to reduce the impact of road transport on the environment.

The shift of goods from road to underused transport capacity, in particular rail, SSS and IWW, became one the objectives of the European Common Transport Policy (see endnote 19). The Commission outlined future priorities based on the need to reconcile the demand for mobility with the requirements of the environment, in line with the principle of sustainable mobility. This Communication examines SSS potential contribution to the achievement of sustainable mobility. It includes a series of recommendations addressed to Member States, their regional and local authorities as well as the maritime industries themselves. It also includes ideas for actions which can most appropriately be undertaken at Union level. It is intended to seek the political support of the Council for these recommendations. In what concerns the revitalisation of SSS, the Commission embarked on a promotion programme.

In 1995, the first communication on SSS was presented by the Commission and it targets at bringing SSS to an equal footing with other modes of transport by focusing on three important areas: (i) improving the quality and efficiency of SSS services; (ii) improving port infrastructure and port efficiency; and (iii) preparing SSS for a wider Europe. The Communication presented an action programme embracing a comprehensive list of measures to be undertaken by the Commission, Member States government, local/regional authorities, port authorities and maritime industries players (see endnote 21). The reasons for enhancing SSS in the EU are (i) promoting the general sustainability and safety of transport, by providing an alternative to congested road transport, also in order to reach CO_2 target under the Kyoto Protocol; (ii) strengthening the cohesion of the community, facilitating connections between Member States and European regions, and revitalising peripherals regions; and (iii) increasing the efficiency of transport in order to meet current and future demand arising from economic growth.

A progress report from the Commission was presented in 1997 following a Council resolution on SSS. This report showed that improvements to SSS roundtables should be organised at a national level with the participation of all interested stakeholders so that the peculiar problems that affect SSS could be sorted out.[67] The 1999 Communication on SSS examined its potential in the framework of sustainable and safe mobility, its integration in European logistic transport chains, its image and existing barriers to the development of SSS. It recommends further action and identified three main reasons why SSS should be promoted at a Community level: (i) to promote the general sustainability of transport; (ii) to strengthen the cohesion of the community; and (iii) to increase the efficiency of

transport in order to meet current and future demands arising from economic growth. In this regard, the Commission published a list of further actions (see endnote 13).

As an environmentally friendlier alternative to road transport, SSS must be integrated into the logistics chain, its links with other modes must be improved, and the quality of service must be closer to the customer's needs. Port installations should be organised in such a way so that they can match better the requirements of SSS. According to the Commission, firms should integrate SSS into door-to-door services; intermodal logistic chains should be created to attract cargo in the long term. The success of SSS relies on the cooperation and coordination of all stakeholders (i.e. public authorities, shipping operators, ports, forwarders, freight consolidators and logistics companies). Actions towards standardisation/simplification in administrative procedures of Member States are needed, and ports are encouraged to promote SSS within their commercial strategies.

In June 1999 the Commission acknowledged that SSS needed to become a truly intermodal door-to-door concept; an essential element in its development was its integration in the European logistic supply chains to fulfil its users' requirements and be perceived with a new dynamic image (see endnote 13). This second two-yearly progress report underlines that turnaround delays, infrastructure constraints and non-transparent charges are a relevant problem for SSS. It also suggests that (i) ports should consider to set up dedicated short sea terminals in larger ports and providing other specialised services to SSS; (ii) the obligations in some ports to use separate pilots could be re-examined where the ship's master is certified to carry out the pilotage on his own; (iii) administrative procedures should be standardised and simplified, since documentation required in SSS is more than for road transport; improvements are possible namely in a uniform acceptance of IMO FAL forms, delegation of tasks to one authority or to a third part, permission to start unloading ships before reporting procedures have been finalised, increased use of electronic data interchange; and (iv) incentives to research aiming at reducing polluting emissions of ships are recommended.

The 2001 White Paper on European transport policy for 2010 highlights the role that SSS can play in curbing the growth of heavy goods vehicle traffic, rebalancing the modal split and bypassing land bottlenecks and its development can also help to reduce the growth of road transport, restore the balance between modes of transport, bypass bottlenecks and contribute to sustainable development and safety.[68] The entire the strategy underlying the 2001 White Paper is based on the need to shift the balance between modes since road transport growth caused high congestion and environmental costs (see endnote 68). A specific chapter is dedicated to the development of MoS, where it is stressed once more that SSS is a real alternative to land transport, and that (i) certain shipping links, providing a way around major bottlenecks in land transport networks, should be made part of the TEN-T; (ii) regulated competition in ports must be implemented, through clearer rules for access to the port service market;[69] (iii) rules governing operation of ports must be simplified; (iv) one-stop-shops should be created to bring together all links in the logistics chain (consignors, shipowners, shipping, road, rail and IWW operators); and (v) advanced telematic services in ports should be developed in order to improve operational reliability and safety. Fortunately work has been done in this direction; electronic port clearance for vessels and goods is now possible at some ports and there is also an SSS guide to customs procedures. If the outcome of the MarNIS EU research project is implemented, much of the informational constraints that take place will disappear and most important it will be a valuable

tool to implement just-in-time strategies in a port environmental level since ports will be able to manage much better the flow of ships arriving in port, and consequently, their capacity.

In response to the 2001 White Paper on the European Transport Policy and to the June 2002 informal meeting of the EU Transport Ministers held in Gijón (dedicated to SSS), the European Commission presented in 2003 an action programme for the promotion of SSS and to remove obstacles to its development. SSS has a high priority in the European agenda and therefore, barriers have been clearly identified, requiring different levels of actions at community, regional and national level. The action programme as presented by the European Commission in April 2003 consisted of 14 individual actions grouped into three broad categories, namely legislative, technical and operational categories.[70]

To monitor the progress achieved since 1999 in the light of the 2003 Programme for the Promotion of SSS, the Commission presented in 2004 a new Communication. While highlighting the obstacles it presented the achievements reached so far in the light of the 2003 action programme.[71] It is the view of the Commission that SSS has proven its ability to reach competitiveness levels normally attributed to road alone and pressure is being exerted on SSS to expand its full contribution towards alleviating current and future transport problems in Europe. While listing the most significant SSS developments at Community and national levels, it also lists the obstacles that still hinder SSS development faster. Like the 2003 communication, this one also refers to the MoS concept.

On 13 July 2006, the Commission adopted a mid-term review of the programme for the promotion of SSS. The review evaluates the results of the 14 actions introduced in 2003 to enhance the efficiency of SSS in Europe and mentions that SSS is still growing, that numerous obstacles still hinder SSS and that some of the original measures should be retargeted to put the MoS concept in operation by 2010. It examines the possibility of extending the scope of SSS promotion through its integration in multimodal logistics supply chains in order to maintain the modern image that SSS has already acquired.[72]

The Blue Book on maritime transport released in October 2007, states that the Marco Polo and the TEN-T programmes will go on supporting the creation of MoS/ SSS networks.[73] The MoS/SSS differs from DSS, given the competition it suffers from land transport despite having lower externalities than land transport, having a high potential for maintaining European technological know-how in maritime transport and being a source of job creation.[74] In January 2009, the Commission updated its strategic goals and recommendations relatively its maritime transport strategy up to 2018 and once more reinforced its importance at a European level.[75] Reference is made to the adoption of positive measures that support SSS to increase sea exchanges in all the European maritime façades. These measures will include the creation of a European maritime transport space without barriers the full deployment of the MoS but also the implementation of measures for port investment and performance.

In this regard and in sequence of the 2006 mid-term review the Commission presented a Communication and an action plan to establish a European maritime transport space without barriers, whose objective is to eliminate or simplify administrative procedures in the intra-EU maritime transport, given the role that short sea shipping can play in the intermodal freight logistics chain[76] and a proposal for a Directive on reporting formalities for ships arriving in and/or departing from ports of

the *Member State*s, thereby repealing Directive 2002/6/EC which met the changes of Community legislation and the FAL Convention.[77] More recently, in March 2009, the Commission reviewed the 14 actions presented in the 2003 Programme for the Promotion of SSS and its main conclusion is that SSS is far from being fully integrated in the door-to-door supply chain.

4.2 European Union general transport policies

Besides the dedicated SSS policy released by the Commission, the EU has been releasing some general transport policies that influence SSS. The liberalisation of domestic transport markets which allows free access to EU operators in cabotage transport of all Member States is certainly the most relevant concrete action that caused higher competition at lower prices. With the relevant exception of the Greek Islands, the internal market has been liberalised since 1 January 1999 under Regulations 4055/1986 and 3577/1992.[78–79] Other guidelines that have been developed are potentially relevant to SSS. The trans-European transport network (TEN-T) approved in 1996,[80] concerning infrastructure planning is a tool to enhance the domestic market and the perspectives of the EU enlargement: ports, originally not included in the TEN-T framework, have been subsequently integrated[81] and today, the TEN-T framework is ruled by Decision 884/2004/EC.[82] The regulations on infrastructure financing and pricing should limit distortions favouring road transport and push for a fair competition between transport modes. The liberalisation of the IWW market is expected to help SSS to become a link of the intermodal chain. The implementation of equitable behaviours in the field of environment and safety are expected to create a level playing field. The harmonisation/ liberalisation processes should increase the efficiency in all transport modes, proportionally more for those less liberalised so far (such as rail and sea transport), compared to road haulage.

The 2007 Commission's Communication on a European ports policy[83] within the broad European strategy of keeping freight moving aims at a creating a port system capable of coping with the future challenges of European transport needs. The 1997 Green Paper on ports and maritime infrastructure had already urged some measures, *inter alia*, links between ports and TEN-T, enhancement of ports' role in the intermodal chain, transparency of prices, and the adoption of a strategy based on the user pays principle, which are relevant to the development of SSS.[84] From another viewpoint, other political and environmental options, such as the goal of reducing road congestion and external costs of road haulage, are clearly able to positively influence the market for SSS. Also Psaraftis quoted in Papadimitriou (2001) acknowledges that SSS is regarded as a key factor of European economic cohesion and proximity between regions, namely between West and East Europe and highlights the importance of setting rules for a fair competition between transport modes, through infrastructure pricing and financing, and internalisation of external costs (see endnote 12). Papadimitriou also underlines the well-known and already mentioned problems in developing SSS (costs and times of ports nodes, inadequate intermodal integration, complexity of procedures, costs of the additional breaks of bulks, lack of transparency, inadequacy to requirements of just-in-time) (see endnote 12).

5. Conclusion and Further Comments

Even though the worldwide coastal shipping is very important and plays a key role in the distribution of goods, the European SSS has reached a high development stage in the world, and other geographical areas such as the United States, Canada, and Australia countries are looking at what is being done at the European level. A significant share of the European SSS traffic is concentrated in the Baltic and

North Sea, but it is in the Mediterranean that the best examples of SSS can be found. Despite this, there are still opportunities for further development in the Ro-Ro and container market segments. SSS growth is mainly related to captive markets caused by geographic/infrastructure constraints, by feeder traffic for hub-and-spoke deep-sea transport, by smaller ports' hinterland and in this regard it can hardly compete with surface transport, namely road haulage, when both land and sea links are available between origin and destination. Nevertheless, this business area is the most important one for policy makers facing the problems of growing congestion and high environmental and infrastructure costs of land transport.

Nevertheless, the European SSS fleet has a big problem concerning its high average age, which the absence of legislative measures enforcing the renewal of the fleet has contributed to it. Short sea operators do not possess sufficient funds to embark on a short sea fleet renewal programme, – the costs of building a small ship are high, and bank credit is very expensive. The resultant reduced profitability is a serious strategic concern in capital intensive companies planning for growth and the renewals that have taken place result more often than not from the existing rivalry between shipowners operating in this market, from port state control inspections and the enforcement of important legislation to protect the environment. The point is that new ships are needed to compete with road transport on cost, speed, flexibility, reliability without jeopardising safety and the environment, attractive sailing times, maintained transit times, and guarantee of delivery.

There is wide interest about critical factors in competition between SSS and land transport. As shown in Sections 2 and 3, low competitiveness is sometimes due to geographic characteristics (too-short distances between origin and destination, a bad ratio of maritime distance to land transport distance) or to demand characteristics (types of goods, volumes, etc.). Yet, low competitiveness is often due to supply factors concerning either SSS or competing modes where it is both possible and desirable to intervene, since they do not come from a fair competition between modes, but from imbalances in the costs of different modes, namely external costs; infrastructure costs, pricing and subsidisation; and transaction costs due to conditions outside the market (e.g. administrative/custom regulations, etc.).

Actions are being planned by a few Member States, where the domestic market is more relevant and where the sector is important from a national policy perspective, and by the EU, to the extent that efforts are being undertaken by experts and policy makers to remove distortions that prevent fair competition between modes, or at least to attain a more balanced modal split. The proposed measures include those outlined in Section 3 (including infrastructural, organisational, pricing, commercial, regulatory technological and logistics measures) which aim at ensuring a smooth transit of goods in ports; integrate SSS in intermodal logistic chains; draw generalised costs as near as possible to the real cost of transport (including external costs, energy and infrastructure), equalising the level of cost externalisation in the different modes, through both internalisation of environmental costs and the financing of infrastructure. However, so far, researchers and policy makers have just agreed, with few exceptions, that developing SSS is desirable and the first effective actions are now being implemented. The remarks that follow about changing scenarios might be useful to assess the potential effectiveness of future policies.

The huge outsourcing of logistic functions shows that logistics, while remaining highly strategic for firms, become more and more specialised. Its complexity in the era of globalisation requires higher

quality and efficiency in transport activities. The need for distribution networks and the consequent, relevant scale/networks economies should be favourable to SSS only if it is able to fulfil higher and higher requirements in terms of quality standards (speed, punctuality, reliability). Otherwise, the need for speedy door-to-door, just-in-time services will be better matched by road haulage, despite higher transport costs per unit. Transport monetary costs are just a (small) part of the overall logistic cost, what makes it difficult to attract traffic flows on a low price basis (see endnote 3).[85] The strategic role of logistics implies that the quality elasticity of the demand (for logistic/transport services) is much higher than price elasticity. The outsourcing of logistic functions can be for SSS either an opportunity or a threat.

In the global market, control of logistic flows has become a crucial competitive advantage. Transport is part of a set of services that must match the logistic needs of the shippers. Network economies influence the geographic organisation of logistic operators. This means that potential for SSS is also related to the ability of ports to act not only as transhipment sites but as nodes of value-added services and logistic functions. The integration of a port within a (infrastructure and service) network becomes more important than the traditional concept of port hinterland. A proactive role of ports in integrating different links of logistic chains clearly becomes a key issue for SSS.

With fair competition between modes, there would be opportunities for a further growth of SSS, since its overall costs are comparatively low. The goal must be internalising both environmental and infrastructure costs in the prices paid by the users (user pays principle). Higher regard for the environment may lead to policies on road transport which will make the ratio of costs for users more favourable to maritime transport, so that relevant flows would shift from road to sea, starting with dangerous goods. The ongoing research is producing significant results in reducing pollution and noise and increasing the safety of road transport. Therefore, it is not sure that road transport will still be so little sustainable as it has been so far. Dire problems in the public finances of most developed countries (which normally have both a developed infrastructure network, and high levels of public expenditure for social/welfare issues) should result in lower public aids to infrastructure financing. Besides, improving land networks becomes more and more difficult because of territorial and environmental problems. The growing rigidity and cost of transport infrastructure is thus a major opportunity for developing SSS (apart for the need to increase port capacity). Regulations on infrastructure public financing and pricing should reduce present inequalities.

Too much attention may have been paid on SSS competitiveness relatively to road haulage. In the future not only SSS-based intermodality will compete with road transport, but also rail-based intermodality, namely with the development of high-speed railways. SSS and rail can be direct competitors, unlike today where low competitiveness of rail is due to technologic and managerial backwardness. Also, international integration, namely in the EU context, could promote easier procedures and techniques in land transport (harmonisation of railways technologies and standards, development of rail freeways). It may be meaningful that among new intermodal technologies which are being developed in order to reduce costs and times of transit in intermodal nodes, most are tailored on road-rail intermodality (swapbodies, piggyback, bimodalism) and only a few can help SSS-based intermodality (e.g. palletwide containers).

It has been shown that SSS market contestability is crucial. Strictly speaking, the market appears to

be contestable since there are no barriers to entry or to exit, and incursions are possible from new entrants operating on other SSS routes (although slightly less from DSS because of differing ships' size). Thus, liberalisation should be desirable. Yet within logistic networks contestability can be jeopardised by operators with dominant position on the whole chain (see endnote 3). Big maritime carriers influence more and more intermodal networks, ports and logistic platforms at the regional/continental level. Vertical integration may give, namely in the feeder traffic, a low level of competition, which could spread on the infra-regional SSS market, because of probable economies of scope. Also, vertical integration of supply chains will require alliances/mergers between SSS operators and other carrier or terminal operators, particularly if the MoS concept is put in operation by 2010 as desired by the Commission.

It is presently highly uncertain if the elasticity of transport demand to gross domestic product (GDP) will still be so high in the near future. The potential for a revival of regional development/trade patterns is presently being investigated, namely after that (i) some excesses of globalisation bring about relevant externalities and inequalities; (ii) diffusion of economic growth makes it more and more difficult to exploit cheap inputs, and firms' requirements are shifting from cheap inputs to efficient infrastructure and public utilities, technological skills, legal and political reliability, etc.; and (iii) the present financial and economic crisis is showing the social problems that a globalised economy can cause. A possible revival of intra-regional growth and trade patterns would be an opportunity for SSS.

It is very difficult to forecast whether SSS opportunities will overcome the threats, and if policy guidelines will be effective and helpful. The potential for SSS will depend both on the growth of transport and on the possible modal shift from land transport, which is in turn a function of a number of elements which are restraining its uninterrupted growth, like congestion and long-run capacity limits. Once developed beyond some relevant thresholds, the growth of SSS is likely to develop cumulative effects since average costs should decrease more than in land transport. As described in Section 4, the key issue in ensuring a fair level of SSS development is to neutralise the effect on modal shift of different levels of market failures, namely in the fields of external costs, public expenditure on a natural monopoly such as infrastructure networks, and oligopoly/monopoly within the maritime transport industry.

Consequently, a paramount role of economic policy has to be developed by states, unions of states and international organisations, not only in ensuring fair competition and free access to the market of SSS, but also in order to equalise the level of cost externalisation in different modes. Thus, there should be three major guidelines on the agenda of policy makers to fair competition within sea transport, through liberalising access to the market and harmonising regulations; between transport modes, through the harmonisation of regulations concerning public aids to transport (namely in financing infrastructure); and between transport modes, through the internalisation of external costs of transport.

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Endnotes

1. EUROSTAT (2000): *EU Transport in Figures. Statistical Pocket Book*. Luxembourg: Office for Official Publications of the European Communities. http://europa.eu.int/comm/transport/tif/tif_july2000.pdf, accessed 4 October 2000.
2. European Conference of Ministers of Transport (2001): *Short-sea Shipping in Europe* (Paris, OECD/ECMT).
3. Van de Voorde, E. and Viegas, J. (1995): "Trans-European Networks: Short-sea Shipping", In *European Transport and Communication Networks: Policy Evolution and Change*, David Banister, Roberta Capello and Peter Nijkamp (eds) (New York, John Wiley & Sons).
4. Marlow, P.B., Petitt, S.J. and Scorza, A.D. (1997): *Short-sea Shipping in Europe: Analysis of the UK and Italian Markets* (Cardiff, Department of Maritime Studies and International Transport, University of Wales).
5. Balduini, G. (1982): "Short-sea Shipping in the economy of inland transport in Europe: Italy". *Proceedings of the European Conference of Ministers of Transport, Gothenburg, 1–2 April* (Paris, OECD/ECMT).
6. Williamson, M. (1982): "Short-sea Shipping in the economy of inland transport in Europe: Sweden". *Proceedings of the European Conference of Ministers of Transport, Gothenburg, 1–2 April* (Paris, OECD/ECMT).
7. Peeters, C., Verbeke, A., Declercq, E. and Wijnolst, N. (1995): *Analysis of the Competitive Position of Short-sea Shipping* (Delft, Delft University Press).
8. Stopford, M. (1997): *Maritime Economics* (London, Routledge).
9. Bjornland, D. (1993): "The importance of Short-sea shipping in European transport", *Short-sea Shipping* (Paris, OECD/ECMT), pp. 59–93.
10. Rich, C.A. (1982): "Short-sea Shipping in the economy of inland transport in Europe: United Kingdom". *Proceedings of the European Conference of Ministers of Transport, Gothenburg, 1–2 April*.
11. Wijnolst, N., Sjobris, A., Peeters, C., Verbeke, A., Declercq, E. and Schmitter T.J.N. (1994): Multimodal Shortsea Transport. Coastal Superhighway (Delft, Delft University Press).
12. Papadimitriou, S. (2001): "Short-sea Shipping in Europe: Experience and prospects", *Short-sea Shipping in Europe* (Paris, OECD/ECMT), pp. 8–19.
13. Commission of the European Communities (1999): *Communication from the Commission to the Council to the European Parliament, the Economic and Social Committee and the Committee of the Regions. The development of SSS in Europe. A dynamic alternative in sustainable transport chain. A second two yearly progress report*, COM (99) 317 Final (Luxembourg, Office for Official Publications of the European Communities).
14. Linde, H. (1993): "Status and perspectives of technological development in European Short-sea shipping", in *European Short-sea Shipping. Proceedings from the First European Research RoundTable Conference on Short-sea Shipping, Delft, 26–27 November 1992*, N. Wijnolst, C. Peeters and P. Liebman (eds.) (London, Lloyd's of London Press), pp. 66–78.
15. Voionmaa, T. (1997): Short-sea Shipping. *The 17th Nordic Maritime Law Conference, 2–4 September 1996,* H.J. Bull and H. Stemshaug (eds.) (Oslo, Juridisk Forlag), pp. 169–181.

16. Paixão, A.C. and Marlow, P. B. (2002): "Strengths and weaknesses of Short-sea shipping", *Marine Policy*, 26(3), 167–178.
17. Dibner, B. (1993): "Short-sea shipping in Europe and the Americas: Status and Prospects", in *European Short-sea Shipping. Proceedings from the First European Research RoundTable Conference on Short-sea Shipping, Delft, 26–27 November 1992*, N. Wijnolst, C. Peeters and P. Liebman (eds.) (London, Lloyd's of London Press), pp. 289–300.
18. Bagchus, R.C. and Kuipers, B. (1993): "Autostrada del mare", in *European Short-sea Shipping. Proceedings from the First European Research RoundTable Conference on Short -sea Shipping, Delft, 26–27 November 1992*, N. Wijnolst, C. Peeters and P. Liebman (eds.) (London, Lloyd's of London Press), pp. 52–65.
19. Commission of the European Communities (1992): *Communication from the Commission. The Future Development of the Common Transport Policy: a global approach to the construction of a Community framework for sustainable mobility*, COM (1992) 494 Final (Luxembourg, Office for Official Publications of the European Communities).
20. European Commission (1992): Council Regulation (EEC) No. 3577/1992, applying the principle of freedom to provide services to maritime transport within Member States (maritime cabotage). *Official Journal L 364* (Luxembourg, Office for Official Publications of the European Communities).
21. Commission of the European Communities (1995): *Communication from the Commission on the Development of Short-sea Shipping in Europe – Prospects and Challenges*, COM (1995) 317 Final (Luxembourg, Office for Official Publications of the European Communities).
22. United Nations (Economic Commission for Europe), European Conference of Ministers of Transport (ECMT), and the European Commission (EC) (2001): Terminology on Combined Transport. (New York and Geneva, United Nations).
23. Revel, A. (2005): Motorways of the sea. Moving cargo from road to sea. *NMC International Conference: The seaway serving the regions of Northern Europe, Bodoe, 1–2 September*. irogaland.no/ir/file_public/download/Nmc/Reports/NMC%20 Conference%20Bodo%201-2%20Sep%202005/Arnaud%20Revel.ppt Accessed 20 July 2009.
24. Baird, A.J. (2007): "The economics of motorways of the sea", *Maritime Policy and Management*, 34(4), 287–310.
25. Øvrebø, S. (1969): *Short-sea and Coastal Tramp Shipping in Europe* (Bergen, Institute for Shipping Research).
26. Wijnolst, N., Peeters, C. and Liebman, P. (1993): *European Short-sea Shipping. Proceedings from the First European Research RoundTable Conference on Short-sea Shipping, Delft, 26–27 November 1992*, N. Wijnolst, C. Peeters and P. Liebman (eds.) (London, Lloyd's of London Press).
27. McKinnon, A.C. (2000): "Sustainable distribution: opportunities to improve vehicle loading", *UNEP Industry and Environment*, 23(4), 26–30.
28. Centrum voor Energiebesparing en Schone Technologie, (1999): Beter aanbod, meer goederenvervoer [better supply, more freight transport] (Delft, Centrum voor Energiebesparing en Schone Technologie).

29. Tavasszy, L.A., Ruijgrok, C.J. and Thissen, M. J . P. M . (2003): "Emerging global logistics networks: Implications for transport systems and policies", *Growth and Change. A Journal of Urban and Regional Policy*, 34(4), 456–472.
30. Commission of the European Communities (2001): *White Paper. European transport policy for 2010: time to decide*, COM (2001) 370 Final (Luxembourg, Office for Official Publications of the European Communities).
31. Drewry Shipping Consultants (1993): *Feeder and Short-sea Container Services. Regional Market Structures, Modal Competition and Economics* (London, Drewry Shipping Consultants).
32. Amerini, G. (2008): Short-sea Shipping of Goods 2000–2006. Statistics in Focus (Luxembourg, EUROSTAT).
33. Gardiner, N. (2008): Global Freight Flows Affect on the Short-sea Market. *European Short-sea Congress*, Dublin, 24–25 June. www.navigateconferences.com/downloads/Shortsea%20Nigel%20Gardiner.pdf, accessed 21 July 2009.
34. Lowry, T. (2008): Obstacles and Opportunities. *European Short-sea Congress*, Dublin, 24–25 June 2008. www.navigateconferences.com/downloads/Shortsea%20Tim%20Lowry.pdf, accessed 21 July 2009.
35. Baird, A. J. (1997): "Coastal Ro-Ro freight services: An alternative to trunk road haulage in the UK", *Transport Logistics*, 1(2), 103–113.
36. Styhre, L. and Lumsden, K. (2007): "Resource utilisation in Short-sea shipping. The bridge substitute dilemma", *Journal of Maritime Research*, 4(3), 55–56.
37. Drewry (1997): *Short-sea Container Markets – The Feeder and Regional Trade Dynamo* (London, Drewry Shipping Consultants).
38. Hoogerbeets, J. and Melissen, P. (1993): "Facilitation of shortsea shipping: improvement in the sea/land interface (the Dutch Case)". In *European Short-sea Shipping. Proceedings from the First European Research RoundTable Conference on Short-sea Shipping, Delft, 26–27 November 1992*, N. Wijnolst, C. Peeters and P. Liebman (eds.) (London, Lloyd's of London Press), pp. 346–350.
39. Crilley, J. and Dean, C.J. (1993): "Shortsea shipping and the world cargo carrying fleet – a statistical summary", in *European Short-sea Shipping. Proceedings from the First European Research RoundTable Conference on Short-sea Shipping, Delft, 26–27 November 1992*, N. Wijnolst, C. Peeters and P. Liebman (eds.) (London, Lloyd's of London Press), pp.1–21.
40. Verlaat, S. van't (2008): *Development of Integrated Door-to-door Shortsea Services.* www.shortsea.nl/main/attachments/VENICE100608INTEGRATED.pdf, accessed 21 July 2009.
41. Becker, J.F.F., Burgess, A. and Henstra, D.A. (2004): "No need for speed in Short-sea shipping", *Maritime Economics and Logistics*, 6(2), 236–251.
42. The Colton Company (1997): *Arguments for coastal shipping 5. How other countries do it.* www.coltoncompany.com/index/coastal/coastal5.htm, accessed 5 December 1997.
43. Commission of the European Communities (2000): *Report from the Commission – Third Report on the Implementation of Council Regulation 3577/92 applying the principle of freedom to provide services to maritime cabotage (1997–1998)*, COM (2000) 99 Final (Luxembourg,

Office for Official Publications of the European Communities).
44. Wijnolst, N. (2005): Triggering European Shortsea Fleet Renewal. Opportunity for European Maritime Clusters. *Maritime Industries Forum, Bremen, 25–26 January*. www.mif-eu.org/Wijnolst_opportunity.ppt, accessed 29 July 2009.
45. Smits, K.A.J. (2007): *Design and feasibility analysis of an innovative logistic Short-sea shipping concept*, Unpublished MSc Thesis (Delft, Delft University of Technology). http://keilir.samskip.is/QuickPlace/create3s/main.nsf/h_FBDEBB33DC9B8EDB002573320052 OpenDocument, accessed 21 July 2009.
46. Nitsopoulos, S.C. and Psaraftis, H.N. (2008): "The role of mediterranean Short-sea shipping in the EU transport chain: The case of Greece", *The World Maritime University Journal of Maritime Affairs*, 7(1), 17–30.
47. Lindstad, H. (2008): "Shipping and carbon footprint, methodology to for developing a fair and descent system", *International Maritime Statistics Forum, Gdansk, 28–30 April*. www.imsf.info/papers/Gdansk_2008/Presentation-IMSF_%2029_2008%20-%20Haakon.ppt, accessed 31 July 2009.
48. Corres, A.J. and Psaraftis, H.N. (2005): A generic ship for the Short-sea trades of the EU. *First International Symposium on Ship Operations, Management and Economics, The Greek Section of the Society of Naval Architects and Marine Engineers (SNAME), Athens, 12–13 May*. www.martrans.org/documents/2005/sss/SNAME2005a.pdf, accessed 21 July 2009.
49. Landamore, M., Cabezas-Basurko, O., Wright, P., Birmingham, R., Reichel, M. and Kremer F., (2009): "CREATE3S: an outline of the concept and overview of possible solution routes for the hull form", *Journal of Maritime Research*, 6(1), 3–14.
50. Lindstad, H. and Uthaug, E. (2003): "Innovative technology: Ro-Ro vessel, terminal, and barge design that will improve the cost position and lead-time for the logistic chain", *International Marine Design Conference, Athens, 3–5 June*. www.sintef.no/upload/MARINTEK/PDF-filer/Papers-Articles/Avd%2028/Innovative%20technology.pdf, accessed 21 July 2009.
51. Wijnolst, N., Sjöbris, A., Peeters, C., Verbeke, A., Declercq, E. and Schmitter, T.J.N. (1994): *Coastal Superhighway: Multimodal Shortsea Transport* (Delft, Delft University Press).
52. European Commission (1996): *Transport Research APAS , Short-sea Shipping* (Luxembourg, Directorate Generale VII).
53. Hoover, E.M. (1948): *The Location of Economic Activity* (New York, Seymour E. Harris, (ed.)). www.archive.org/details/locationofeconom029874mbp, accessed 30 July 2009.
54. According to the European Commission, the average distance of a tonne transported in the 1990s has been 100 km for road, 270 km for inland waterways, 300 km for rail, and 1385 km for short sea shipping. Source: Endnote 13.
55. Paixão Casaca, A.C. and Marlow, P.B. (2005): "The competitiveness of short-sea shipping in multimodal logistics supply chains: service attributes", *Maritime Policy and Management*, 32(4), 363–382.
56. Knörr, W. and Kutzner, F. (2008): *EcoTransIT: Ecological Transport Information Tool – Environmental Methodology and Data. IFEU Update Heidelberg 2008* (Heidelberg, IFEU). www.ecotransit.org/download/ecotransit_background_report.pdf, accessed 31 July 2009.
57. European Commission (2009): *EU Energy and Transport in Figures. Statistical Pocket Book*

(Luxembourg, Office for the Official Publications of the European Communities).

58. International Chamber of Shipping and the International Shipping Federation (2009): *Safety and Regulation – Lives lost at sea, Shipping Facts*. www.marisec.org/shippingfacts/safety/lives-lost-at-sea.php, accessed 16 August 2009.

59. Martínez, F.X. and Olivella, J. (2005): "Short-sea shipping opportunities for the Pyrenean cargo flows", *Journal of Maritime Research*, 2(2), 65–80.

60. Blonk, W. A.G. (1994): "Short-sea shipping and inland waterways as part of a sustainable transportation system", *Marine Pollution Bulletin*, 29(6), 389–392.

61. Schiffer, E. (1996): "Competition between European ports and the effect on intermodal development", *Transport Research Circular*, No.459.

62. Zachcial, M. (2001): "Short-sea shipping and intermodal transport", in *Short-sea Shipping in Europe* (Paris, OECD/ECMT), pp. 21–36.

63. ISL estimated in 1996 that on the route Lisbona–Germany a reduction of 267 DM would have allowed them to get 50% of the market. Source: Endnote 62.

64. Pettersen, Strandenes S. and Marlow, P. B. (2000): "Port pricing and competitiveness in short-sea shipping", *International Journal of Transport Economics*, XXVII(3), 315–334.

65. Paixão Casaca, A.C. and Marlow, P.B. (2009): "Logistics strategies for short-sea shipping operating as part of multimodal transport chains", *Maritime Policy and Management*, 36(1), 1–19.

66. Grosso, M., Lynce, A.-R., Silla, A. and Vaggelas, G. (2009): Short-sea Shipping, intermodality and parameters influencing pricing policies: the Mediterranean case, NETNOMICS: Economic Research and Electronic Networking. www.springerlink.com/content/y414022653782103/?p=d8183c36aaa24ac8b019f591d846fc3d&pi=4, accessed 16 August 2009.

67. Commission of the European Communities (1997): *Commission StaffWorking Paper: Progress Report from the Commission Services following the Council Resolution on Short-sea Shipping of 11 March 1996*, SEC (1997) 877 (Luxembourg, Office for Official Publications of the European Communities).

68.Commission of the European Communities (2001): *White Paper. European Ttransport Policy for 2010: Time to Decide*, COM (2001) 370 Final (Luxembourg, Office for Official Publications of the European Communities).

69. Object of a proposal of Directive in May 2001.

70. Commission of the European Communities (2003): *Communication from the Commission-Programme for the Promotion of Short-sea Shipping & Proposal for a Directive of the European Parliament and of the Council on Intermodal Loading Units*, COM (2003) 155 Final (Luxembourg, Office for Official Publications of the European Communities).

71. Commission of the European Communities (2004): *Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions on Short-sea Shipping*, COM (2004) 453 Final (Luxembourg, Office for Official Publications of the European Communities).

72. Commission of the European Communities (2006): *Communication from the Commission to the Council, The European Parliament, the European Economic and Social Committee and the*

Committee of the Regions. Mid-Term Review of the Programme for the Promotion of Short-sea Shipping (COM (2003) 155 final), COM (2006) 380 Final (Luxembourg, Office for Official Publications of the European Communities).

73. Commission of the European Communities (2007): *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. An Integrated Maritime Policy for the European Union*, COM (2007) 575 Final, (Luxembourg, Office for Official Publications of the European Communities).

74. Commission of the European Communities (2007): *Commission Staff Working Document. Accompanying Document to the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: An Integrated Maritime Policy for the European Union*, SEC (2007) 1278 Final, (Luxembourg, Office for Official Publications of the European Communities).

75. Commission of the European Communities (2009): *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Strategic Goals and Recommendations for the EU's Maritime Transport Policy until 2018*, COM (2009) 8 Final (Luxembourg, Office for Official Publications of the European Communities).

76. Commission of the European Communities (2009): *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Communication and Action Plan with a View to establishing a European Maritime Transport Space without Barriers*, COM (2009) 10 Final (Luxembourg, Office for Official Publications of the European Communities).

77. Commission of the European Communities (2009): *Proposal for a Directive of the European Parliament and of the Council on Reporting Formalities for Ships Arriving in and/or Departing from Ports of the Member States of the Community and repealing Directive 2002/6/EC, COM* (2009) 11 Final (Luxembourg, Office for Official Publications of the European Communities).

78. Council of the European Communities (1986): *Council Regulation 4055/1986/EC of 22 December 1986 Applying the Principle of Freedom to Provide Maritime Transport between Member States and between Member States and Third Countries* (Luxembourg, Office for Official Publications of the European Communities). http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31986R4055:EN:HTML, accessed 21 July 2009.

79. Council of the European Communities (1992): *Council Regulation (EEC) No 3577/92 of 7 December 1992 applying the Principle of Freedom to Provide Services to Maritime Transport within Member States (Maritime Cabotage)* (Luxembourg, Office for Official Publications of the European Communities). http://eur-lex.europa.eu/- LexUriServ/LexUriServ.do?uri=CELEX:31992R3577:EN:HTML, accessed 21 July 2009.

80. European Parliament and the Council (1996): Decision No 1692/96/EC of the European Parliament and of the Council of 23 July 1996 on Community guidelines for the development of the trans-European transport network. *Official Journal L 228* (Luxembourg, Office for

Official Publications of the European Communities).

81. European Parliament and the Council (2001): Decision No 1346/2001/EC of the European Parliament and of the Council of 22 May 2001 amending Decision No 1692/96/EC as regards seaports, inland ports and intermodal terminals as well as project No 8 in Annex III. *Official Journal L 185* (Luxembourg, Office for Official Publications of the European Communities).

82. European Parliament and the Council of the European Union (2004): Decision No 884/2004/EC of the European Parliament and of the Council of 29 April 2004 amending Decision No 1692/96/EC on Community guidelines for the development of the trans-European transport network (Text with EEA relevance). *Official Journal L 167* (Luxembourg, Office for Official Publications of the European Communities).

83. Commission of the European Communities (2007): *Communication from the Commission. Communication on a European Ports Policy*, COM (2007) 616 Final (Luxembourg, Office for Official Publications of the European Communities).

84. Commission of the European Communities (1997). Green Paper on Sea Ports and Maritime Infrastructure, COM (1997) 678 Final (Luxembourg, Office for Official Publications of the European Communities).

85. Stuchtey, R.W. and Zachcial, M. (1993): "Perspectives and trends of the European short-sea shipping industry", in *Current Issues in Maritime Economics*, K.M. Gwilliam (ed.) (Dordrecht, Kluwer Academic Publishers).

Part Five
Issues in Liner Shipping

Chapter 14
Competition and Cooperation in Liner Shipping

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1. Introduction

Liner shipping is the business of offering common carrier ocean shipping services in international trade. Since it became an important industry in the 1870s, it has been characterised by various agreements between firms. Historically, since the formation in 1875 of the Calcutta Conference, the conference system was the primary form of agreement in liner shipping. Variously called liner conferences, shipping conferences, and ocean shipping conferences, they are formal agreements between liner shipping lines on a route, always setting (possibly discriminatory) prices, and sometimes pooling profits or revenues, managing capacity, allocating routes, and offering loyalty discounts. Conferences agreements were quite successful and in many cases have lasted for years. In the last two decades, conferences have begun to be supplanted by alliances (particularly in the American and European trades, where legislative changes have been unfavourable to them), which are less complete (they do not, for example, set prices) but encompass more broadly defined trade routes.

Section 1 will review cooperative agreements in the liner industry, including conferences and alliances, as well as the historical origins of that cooperation. Section 2 reviews the primary models that have been used to explain the conference system, including models of monopolizing cartels, contestability, destructive competition, and the empty core. Section 3 reviews a variety of practices and alleged practices in liner shipping, including predatory pricing, loyalty contracts, price discrimination, and price and output fixing. Finally, section 4 offers a brief conclusion.

1.1 Cooperation

International liner shipping has long been dominated by collusive agreements, originally conferences and more recently alliances. Conferences have been used since at least the 1870s, when the industry was being established. In recent years, these agreements have been supplemented and replaced by other kinds of agreements such as consortia and alliances. The focus of this chapter is on explaining the economic models of competition used to analyse cooperation in liner shipping for purposes of competition policy.

Conferences are organisations of shipping lines operating on a particular route. At different times, subject to various regulations, they have set tariffs, employing policing agencies to check on adherence to the tariff. Members have been fined out of the membership bonds they post.[1] They may also allocate output among their members, by either cargo quotas or more commonly sailing quotas. If ships always sailed at the same capacity, which they do not, cargo and sailing quotas would be identical. Sailing quotas are, however, probably easier to enforce. They may also pool revenues and allocate particular ports on a given route.[2] All of these practices have been used by conferences throughout their history. For example, in the late nineteenth century and into the beginning of the twentieth century, as part of the Calcutta Conference, the P&O, the BI, and the Hansa line had an agreement about the number of sailings each would make out of Hamburg.[3]

In the 1970s, liner consortia were formed by conference members as a supplementary means of

conference enforcement.[4] They are essentially a system of common agency. More significant has been the rise of the strategic alliance. They were first used in the 1990s,[5] and there is some evidence that conferences are being displaced by alliances, perhaps because of the declining antitrust immunity of conferences. Alliances engage in cross route rationalisation, and there is some evidence that the rationalisation reduces costs by taking advantage of economies of density.[6] Unlike conferences, they do not issue a common tariff, but they cover much broader trade routes. Only recently have economists begun to examine them. Unfortunately, the state of research is limited to a lot of speculation about their functions and effects, and a few facts, without substantial testing of models of alliances.

Speculation on the reasons for alliances has focused on risk reduction and scale economies. The claims about risk reduction focus on two issues. First, alliances give liners companies access to other routes without investing in ships, thereby reducing the risk of new investment.[7] Second, by reserving slots on ships from other members of the alliance working other routes, liner companies reduce risk by diversifying into multiple routes.[8]

Although no evidence has been produced in support of the expansion explanation of risk, there is cross-industry evidence that firms use strategic alliances for this reason.[9] Explanations that focus on diversifying through multiple routes face the problem that investors can already diversify their portfolios by investing in multiple lines on different routes. If there is evidence for this explanation, it will likely have to come from focusing on managerial risk. There is cross-industry evidence that managers with specialised skills diversify to protect themselves against bankruptcy and job loss.[10]

The claims about scale economies[11] focus on economies in marketing and allocating ships to ports to reduce shipping time. The evidence available supports these explanations, with evidence that alliances reduce costs[12] and raise capacity utilisation.[13] How well these explanations work will, however, have to address the evidence that alliances are in decline over the last decade.[14]

1.2 Historical origins

Because sailing ships are subject to the vagaries of the wind, liner shipping offering regular scheduled service had to wait for the arrival of the steam vessel,[15] although the thirteenth century Venetians operated what can be interpreted as a liner service to the eastern Mediterranean using a combination of oar and sail.[16] Steam did not begin to be a competitor to the sailing ship until the development of the compound engine in the late 1860s and the triple expansion engine in the early 1880s.[17] These developments substantially improved fuel economy and increased speed to about 10–12 knots. The compound engine cut fuel consumption by over half compared to a single cylinder steam engine. Essentially, it involved adding additional cylinders to the steam engine, each additional cylinder reusing steam before it cooled. The increase in fuel economy also expanded the space available for cargo. Steam vessels began to offer regular, scheduled service, i.e. liner service. It is in liner shipping that conferences have thrived.

Curiously, sailing vessels belonged to conferences operating on the UK–Australia route and the Germany–South America route,[18] and there were early British coastal conferences involving sailing vessels as well.[19] By and large, however, these were exceptions.

The UK–Calcutta conference is usually described as the first conference, and it is certainly the first modern conference. It started in 1875, consisting of five carriers: the P&O (Peninsular and Oriental

Steam Navigation Co), the BI (British India), and the City, Clan, and Anchor Lines. Within a decade or so, the conference extended its coverage of ports of origin from only the UK to the rest of northern Europe.

It was followed quickly by the development of other conferences. In the 30 years following the formation of the UK–Calcutta conference, conferences were formed on most of the major trade routes out of the UK and northern Europe. The Australia conference was started in 1884, the South African conference in 1886, the West African and northern Brazil conferences in 1895, the River Plate conference in 1896, the west coast of South America conference in 1904, and a conference covering the North Atlantic trade around 1900.[20] Most of these conferences covered the outbound trade from Europe, leaving the inbound trades of mostly bulk commodities to tramp vessels.[21]

There were precursors, however. A conference from 1850 to 1856 on the North Atlantic involved the British and North American Steam Packet Company (the Cunard Line) and the New York and Liverpool United States Mail Steamship Company (the Collins Line).[22] Glasgow ship owners may have fixed rates with a conference system in the 1860s.[23] In addition, the Transatlantic Shipping Conference was formed in 1868. It was concerned, however, with issues such as uniform bills of lading and improving methods for inspecting cargo, and did not become involved in rate setting until 1902.[24] Although conferences are generally associated with international shipping, there were precursors in British coastal shipping as early as the 1830s.[25]

Conferences were limited to the liner trades, without any success in the bulk trades.[26] There were also conferences in the passenger shipping trade.[27]

It is commonly assumed by historians of shipping conferences that they were formed in response to excess capacity, typically based on documents produced by participants in the trade.[28] A common version of this argument is that the opening of the Suez Canal, by shortening the distance between Europe and Asia, created excess capacity, but this version is not supported by the evidence.[29] Sailing vessels could not use the Canal. Existing steamships had been built for short routes through the Mediterranean Sea or the Red Sea, and most of them were scrapped after the opening of the Canal. Moreover, after the opening of the Canal, there were increases in net steamship production, which increased later in the 1870s with the introduction of the double expansion engine. The continued steamship production is inconsistent with excess capacity.

One alternative to cooperation would be merger. Merger is generally a substitute for collusion, but it is not a perfect substitute because merger increases agency costs.[30] The only known attempt to explicitly replace a conference with a merger was the largely unsuccessful International Mercantile Marine Company.[31]

The Ocean Shipping Reform Act of 1998 changed the treatment of conferences under American antitrust law, effectively eliminating the ability of conferences to control their members by mandating secret and independent action. EC regulation 4056/86, which gave conferences an exemption from EC competition law, was repealed effective October 2008. Given that agreements and mergers are substitutes, we should expect an increase in industry concentration. Sys[32] shows that mergers have increased worldwide industry concentration, using a wide variety of measures, including the Gini coefficient and the Herfindahl index.

2. Alternative Models of Agreements

Most work on shipping conferences has involved four kinds of models: monopolistic cartels; contestable markets; destructive competitive; and empty cores.[33] The argument that conferences are monopolistic cartels is at least as old as Alfred Marshall,[34] who argued that conferences could act as monopolists because there were substantial scale economies in the industry that led to a small number of firms. Lenin and the Marxist historian J.A. Hobson described shipping conferences as vivid examples of the tendency toward the concentration of capital.[35] The other explanations arose largely as responses to the cartel model. Destructive competition and its modern variant, the empty core, are alternative explanations of why conferences exist. Contestable markets have been used to criticise the proposition that conferences can usefully be described as monopolistic cartels. This matters for competition policy, because if conferences are not monopolising cartels, then competition policy need not address them.

Models of competition are important for making sense of the role agreements play in liner shipping, and seeing whether those insights can be generalised to other industries. They are also important for competition policy. Assuming that competition authorities are attempting to increase competition,[36] it is important to establish whether a particular practice reduces competition rather than having an alternative purpose. If it can be established that a practice does not reduce competition, it needs no further analysis for purposes of competition policy.

The term "competition" is routinely used vaguely, with differing and sometimes inconsistent meanings. Sometimes it used simply to mean the number of sellers (both as a measure of concentration and as a measure of how far to the right the supply curve lies). Sometimes it is used to mean low measured profitability,[37] which is taken to mean the absence of monopoly and monopoly profit. Sometimes it is used to mean that buyers have good substitutes; sometimes it is used simply to mean that the seller faces a downward sloping, rather than perfectly inelastic demand curve.

Rather than getting absorbed in a semantic debate, it is simpler and more useful to think about competition by the outcome: the mark-up of price over marginal cost.

2.1 Non-cooperative game-theoretic models of collusion: cartel enforcement

It is easy to get involved in pointless and unproductive discussions about what it "really" means to be a cartel. It is simpler to simply define a cartel, following the conventional practice of economists, as an agreement that attempts to get its members to act jointly as a monopolist. Agreements that serve other purposes, such as preventing destructive competition, reducing risk, or trade promotion, should simply be referred to as such.

In perfect competition, output allocation is simple and automatic. Each seller produces an output such that its marginal cost is equal to the market price. In a cartel, prices are increased, but output must be reduced. Therefore, each firm's output must be centrally directed. Each firm produces an output such that marginal cost is less than the price, giving each firm an incentive to raise output and upset the cartel arrangement. The primary problem for any monopolising cartel is therefore enforcement. Enforcement means that output increases must be punished,[38] but first they must be detected.[39]

One argument disputing the cartel explanation should be dispensed with quickly. A seller with market power will raise price until its rivals' products are good substitutes. (It will raise price until marginal cost equals marginal revenue. Positive marginal cost implies positive marginal revenue, and

positive marginal revenue implies an elastic demand.) The frequent assertion that conferences cannot be monopolies or monopolistic cartels because they face too many good substitutes[40] may be the opposite: they face good substitutes because they act monopolistically.

A number of attempts have been made to test whether shipping conferences can be explained by cartel models. Fox measured the effect of the number of firms in a conference and a conference's market share on freight rates.[41] She finds that freight rates fall when the conference market share falls. She also finds that as the number of conference members rises, freight rates also fall, which is consistent with Stigler's theory of oligopoly,[42] specifically that increased numbers in a cartel increase the cost of coordination and therefore lower price.

In a separate paper, Fox looked at the provision in the US Shipping Act of 1984 that allows conference members to deviate from conference rates on ten days, notice.[43] A cartel model would predict that allowing independent action, even though it is public rather than secret price cutting, should undercut conferences because it makes enforcing the conference tariff more difficult. She fails, however, to find evidence that the Act made any difference at all to conferences.

Paul Clyde and James Reitzes, in an ingenious study, distinguished between increased freight rates because of increased conference market share and because of increased market concentration.[44] They find statistically significant but economically insignificant effects of increased market concentration on freight rates, but, contrary to the results in Fox, no effect of increased conference market shares on freight rates.

It is worth emphasising that focusing on price can be misleading. Conferences can raise price because they restrict output (making shippers worse off) or because they add value, thereby raising demand and raising output. A better test would be to focus on the effect of conferences on output. Some insight can be gained from a study of trans-Atlantic passenger shipping cartels in the first decade of the twentieth century.[45] The authors estimated that westward migration fell by 20–25% because of the passenger cartels operating that decade.

Deltas, Serfes, and Sicotte took a historical approach, using a sample of 47 pre-World War I conferences.[46] They looked for reasons why a cartel might be easier to negotiate and enforce, arguing that a cartel can then successfully impose stricter, less flexible terms on its members. Enforcement is easier if there is multi-market contact. The basic intuition is that punishment for deviations from a cartel agreement in one market can be carried out in several markets. It also argues that enforcement is also easier if one or more of the firms has a large global market share. In that case, it is easier for the large firm to transfer ships to a market to carry out punishment. Agreements are easier to negotiate if there are a small number of firms and if there is heterogeneity in size, allowing a large firm to dominate the agreement. A strict, inflexible agreement is also more sustainable if entry is less likely.

This argument should not be confused with the idea that a firm operating in multiple markets can cross-subsidise predatory pricing to prevent destabilising entry. Gordon Boyce[47] argues that because the International Mercantile Marine (a combination of five transatlantic lines sponsored by J.P. Morgan formed in the period 1900–1902) ran diversified lines from the UK to Canada, the US, and Australasia, it could use cross-subsidization to harm smaller, single route firms. Boyce's argument requires highly inefficient capital markets, because both the predator and its victim are borrowing for a price war. The predator is merely borrowing from its own income stream.[48]

A different approach is to use developments in what has been called the New Empirical Industrial Organization. The approach can be seen in Figures 1 and 2. In models of monopoly and of perfect competition, an increase in demand raises price and output, and a decrease in demand lowers both, as shown in Figure 1. Therefore, the consequences of a rise or fall in demand cannot separate the two models. Suppose instead that

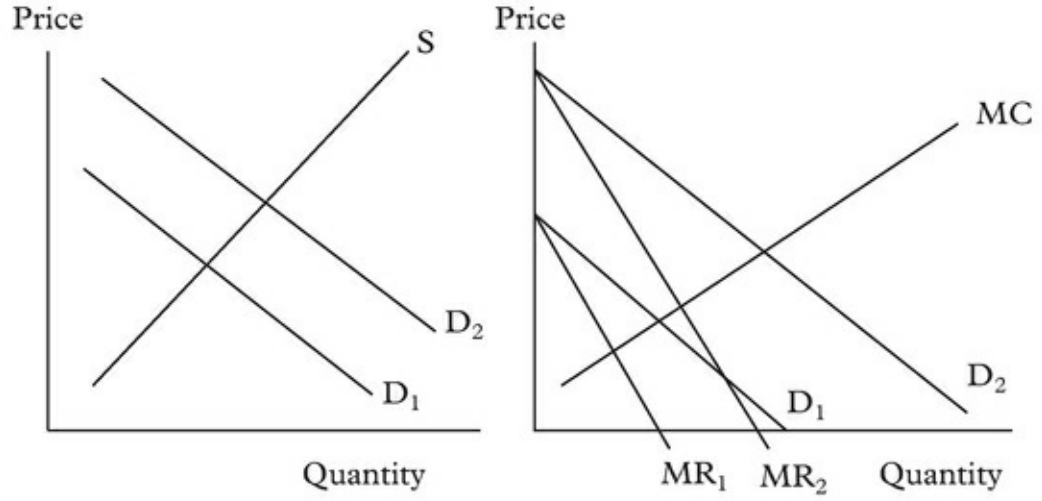

Figure 1

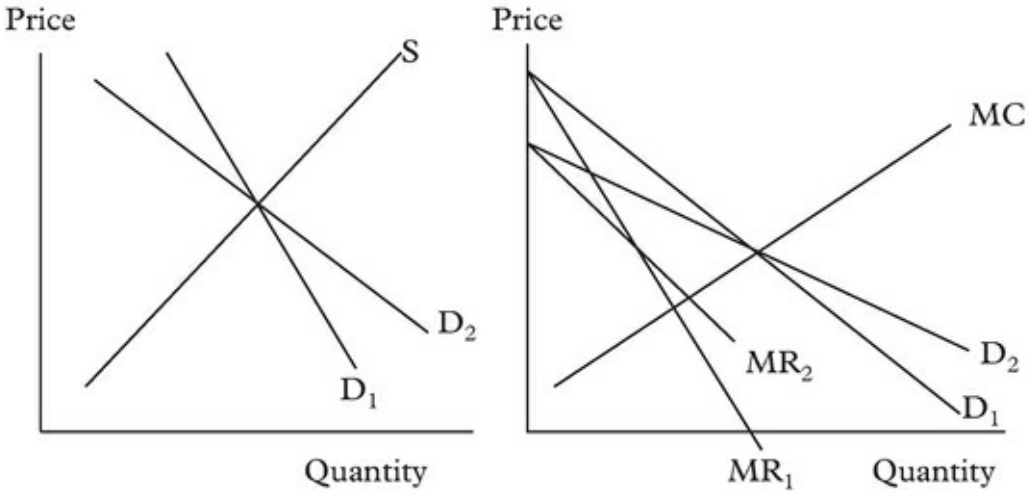

Figure 2

the demand rotates (becoming steeper or flatter). In a model of perfect competition, this does not raise or lower price or output. In a model of monopoly, however, flattening the demand curve raises marginal revenue relative to demand, thereby lowering price and raising output. Making demand steeper lowers marginal revenue relative to demand, thereby raising price and lowering output. This can be seen in Figure 2.

Start by writing the market demand curve as $P(Q)$, so that price depends on quantity sold. The slope of the demand curve is $\Delta P/\Delta Q$. Marginal revenue is $P + (\Delta P/\Delta Q)Q$. The second term is the difference between marginal revenue and price. Static oligopoly models predict how much of that difference is *perceived* by sellers. Let λ be the fraction of that difference that is perceived by sellers. The marginal revenue as perceived by sellers is $P + \lambda(\Delta P/\Delta Q)Q$.

Different oligopoly models imply different values of λ. In monopoly, the whole marginal revenue is perceived, so $\lambda = 1$. In perfect competition (or Bertrand Nash equilibrium), none of the marginal revenue is perceived (marginal revenue is simply market price), so $\lambda = 0$. In Cournot Nash, the economist's standard model of noncooperative equilibrium, λ is the Hirshman-Herfindahl index (the

sum of the squared market shares).[49]

The value of λ is found by equating perceived marginal revenue to marginal cost. As a simple example, suppose the demand curve is:

$$P = \beta_0 + \beta_1 Q + \beta_2 ZQ + \beta_3 Z \qquad (1)$$

where P is price, Q is output, and Z is a demand shifter. Note that the slope of the demand curve is $\beta_1 + \beta_2 Z$, so that Z can also rotate the demand curve, as in Figure 2 above.

Given the demand equation, marginal revenue can be written as $P + (\beta_1 + \beta_2 Z)Q$, and therefore perceived marginal revenue can be written as $P + \lambda(\beta_1 + \beta_2 Z)Q$. Write industry marginal cost as:

$$MC = \delta_0 + \delta_1 Q + \delta_2 W$$

where W measures some input price.[50] (If $\delta_1 = 0$, then marginal cost is constant.) Profit is maximised when perceived marginal revenue equals marginal cost, that is, when:

$$P + \lambda(\beta_1 + \beta_2 Z)Q = \delta_0 + \delta_1 Q + \delta_2 W, \text{ or equivalently, when}$$

$$P = \delta_0 + (\delta_1 - \lambda\beta_1)Q - \lambda\beta_2 ZQ + \delta_2 W \qquad (2)$$

Equation 1 (the demand function) and equation 2 (the profit maximisation condition), can be estimated jointly, and λ can be estimated from the ratio of the coefficient of ZQ in equation 2 ($-\lambda\beta_2$) to its coefficient in equation 1 (β_2).[51]

One important drawback to this approach is that the value of λ is not clearly specified in a cartel model, and that poses a problem for measuring whether agreements in liner shipping are cartel arrangements. A costlessly enforced cartel would have $\lambda = 1$, that is, it would behave like a monopolist. It would equate industry marginal revenue to industry marginal cost. Note that equating marginal revenue to marginal cost is the same as setting marginal revenue minus marginal cost (i.e. marginal profit) equal to zero. At the industry profit maximum, a small increase in output costs roughly zero in profits. Cartel enforcement is not costless, however, because setting price above marginal cost gives cartel members an incentive to cheat. At the industry profit maximum, a small increase in output does not lower profits, but preventing it incurs positive enforcement costs. It follows that the cartel equilibrium involves higher output and lower price than the monopoly equilibrium.[52] The economic theory of cartels tells us λ will be less than one and greater than its non-cooperative equilibrium value, but little beyond that. Where it lies in between those two values depends on the costs of cartel enforcement.

These techniques allow both a measure of the extent of competition in the market and a way to test alternative theories of markets. Even though cartel models do not make a specific prediction about the value of λ, the models are good for estimating how, for example, various legislative changes alter the value of λ. Using these techniques, Wilson and Casavant[53] offered evidence that the US Shipping Act of 1984 raised the value of λ (in other words, raised prices), except where the Act explicitly allowed conference members to independently deviate from conference rates, in which case it lowered λ (in other words, lowered prices). Unfortunately, although this approach could tell us a lot about the effect of regulation in the industry, Wilson and Casavant are the only authors I am aware of who apply these techniques to liner shipping.

Now that these techniques are laid out in detail, there is scope for more formal testing of a variety of questions about competition, including the assumption that bulk shipping is best explained by models of perfect competition.[54]

2.2 Non-cooperative game-theoretic models of collusion: contestable markets

The theory of contestable markets focuses heavily on sunk costs. It draws on the insight that potential competitors are a constraint on pricing behaviour as much as actual competitors. Suppose in a market there are no sunk costs and incumbent firms do not respond to entry by lowering prices. Then entry is costless in the sense that all costs of entry can be recovered on exit. Entry is therefore riskless. Moreover, the entrant can make its entry decision without regard to strategic decisions by the incumbent.

Suppose a market had only one seller. The seller could not act as a monopolist because an entrant would undercut it. If entry is costless, schemes to exclude entry do not work because the entrant cannot be threatened with losses on entry. Should the entrant face the prospect of losses, it can always costlessly depart until the problem goes away.

John Davies has focused attention on the degree to which liner firms face sunk costs, and the risks of retaliatory price-cutting.[55] He has provided evidence that sunk costs are low, and that retaliation is slow. That is, he has shown that the assumptions of contestability are *roughly* satisfied by the liner market. If the liner market is contestable, then conferences may have difficulty acting like monopolising cartels. Whatever service they provide, they must do so at (economic) cost, lest they are uncut by entry.[56]

An important, unresolved difficulty is how sensitive contestable markets to deviations from the assumptions of zero fixed costs and no retaliatory pricing. There are theoretical grounds for believing that very small deviations from these assumptions can have large consequences for contestability,[57] but little effort has been made to empirically quantify the problem.

2.3 Destructive competition

Destructive competition arguments come in two forms. The usual form among maritime economists focuses on high sunk costs, inelastic demand, and the risks to carriers of “overtonnaging” or excess capacity. (The next section discusses another version, the theory of the core.) Daniel Marx is the primary early exponent,[58] and the argument has been made by industry practitioners.[59] Maritime historians have tended to favour this argument as well.[60] In this argument, because a large proportion of costs is sunk, it follows that price would have to fall substantially before sellers would leave the market. Brooks argues:

“The high barriers to exit give shipowners reasons to delay capacity reduction; unless prices are good for scrap or the second-hand market is buoyant, there is a tendency to hope that a redeployment opportunity will materialise or be created. This results in an industry with an almost perpetual state of capacity oversupply.”[61]

The assertion of high exit barriers implies inelastic short run market supply. It is frequently asserted that the demand for liner shipping services is highly inelastic. A combination of inelastic supply and demand leads to a highly unstable price. Therefore, carriers are exposed to increased risk of losses, and shippers face substantial uncertainty about freight rates. On this explanation, conferences offer reduced risk to both carriers and shippers.

This explanation suffers from two serious flaws.[62] First, if fluctuating prices lead to periods of losses, then they must also lead to periods of offsetting gains. Carriers will not enter unless the risk-adjusted present value of profits is positive. If long run changes in the market occur such that the present value of profits is negative, firms will (efficiently) leave the market, and the losses are their signal to do so.[63] Second, if shippers valued rate stability, they could write forward contracts.

2.4 Cooperative game-theoretic models of collusion: the empty core

A more recent and theoretically coherent revival of the idea of destructive competition is the theory of the core,[64] which has been applied several times to conferences[65] and alliances.[66]

The theory of the core focuses on avoidable fixed costs and the integer problem (the number of firms in an industry must be an integer). With avoidable fixed costs and rising marginal cost, the relevant average cost curve is U-shaped. No output will be produced at any price below minimum average cost. When price rises to a firm's minimum average cost (p^*), that firm will enter at the output q^* where average cost is minimised. The firm will produce $q \geq q^*$ if $p \geq p^*$. Under perfect competition, the firm's output will therefore be either 0 or $q \geq q^*$. Suppose firms are identical. Then at p^*, industry output must be an integer multiple of q^* (the integer problem). It would be only by chance that demand at p^* would be an integer multiple of q^*. It is therefore possible that demand and supply would not intersect. The problem would go away if a firm were willing to produce a fraction of q^*, but avoidable fixed costs mean that no firm could profitably do so.

If inventories were inexpensive, a firm could produce only part of the time and provide a fraction of q^* with inventories. In transportation industries especially, however, output is cargo or passenger space. Once the ship or airplane leaves, empty space is gone, so inventories are impossible.[67] The only way to create inventories is to have excess capacity, which can lead to an empty core.

The integer problem does not necessarily lead to an empty core, but is likely to under some circumstances. Consider an example attributable to George Bittlingmayer.[68] Suppose taxis can carry at most two passengers, and that the cost of a taxi trip is independent of whether there are zero, one, or two passengers. Admittedly, these assumptions are likely to be factually inaccurate. Most taxis can squeeze in an extra passenger in a pinch, and extra passengers reduce mileage. These assumptions, however, capture the same points that a more realistic but also more complex model would. First, there are some scale economies: once a taxi carries one passenger, the marginal cost of a second is less than the average cost. Second, there are capacity constraints: marginal cost exceeds average cost beyond some output.

Assume each taxi's cost of a trip to the airport is £5, and that there are no sunk costs, so the competitive supply of taxi trips is constant at £5 per trip. Assume as well, for simplicity, that each possible passenger is willing to pay £10 for a taxi trip, so a taxi trip is efficient (relative to no trip) even if there is only one passenger. Suppose four people want to make a trip to the airport. They will take two cabs, each with two passengers, and each pair of passengers will pay £5. How they divide the £5 cost between them is irrelevant to the problem.

Suppose instead that only three people, imaginatively named A, B, and C, want to make the trip. The efficient solution is for the three to take two taxis, generating a surplus of $3 \times £10 - 2 \times £5 = £20$. In this case, however, the problem of dividing the £10 cost of the two taxis eliminates the possibility of a competitive equilibrium. One possibility is that A and B travel together, pay £2.50 each, and let C

travel alone and pay £5. C, however, could offer to let A travel with him if A pays £1. C is better off, paying only £4 instead of £5, and A is better off, paying only £1 instead of £2.50. B is left, however, paying £5 instead of £2.50, leaving B in the same position as C was originally to upset the allocation.

An equilibrium allocation has to ensure that no coalition (A, B, or C alone, pairs of A and B, A and C, or B and C, or the grand coalition of A, B, and C) can do better by upsetting the existing allocation. If X_i is the surplus to customer i, i=A,B,C, then an equilibrium allocation has to satisfy the following constraints:

$$X_A + X_B \geq £15; X_A + X_C \geq £15; X_B + X_C \geq £15$$

$$\Sigma X_i = X_A + X_B + X_C \leq £20$$

The first constraint states that any two passengers travelling together can get a combined surplus of £15. The second constraint states that the best all three passengers can get is the surplus from the efficient solution of travelling in two taxis. Summing all three terms in the first constraint implies that $\Sigma X_i \geq$ £22.50, which is inconsistent with the second constraint. There is no equilibrium allocation. In this example, q*=2, and if demand is not a multiple of two, there is no equilibrium.

The absence of equilibrium in market exchange poses a problem for the participants in the market, both buyers and sellers, because it necessarily raises the costs of contracting. Sellers will try to protect themselves from the consequences of the integer problem by selecting technology with lower capacity and higher costs.[69] It is therefore in the mutual interests of buyers and sellers to find a way to achieve an allocation through non-market means. It remains true that an individual buyer or seller has an incentive to disrupt the allocation, just as in a cartel model. Unlike a cartel model, however, buyers as a group do not have an incentive to assist the deviating party.

The example suggests two of the more interesting implications of the model of the empty core. First, it is worth noting that there are ways of resolving the problem. For example, if the three passengers were friends, they might simply split the cost three ways because an attempt by two of them to exclude the third would result in the loss of a valuable friendship. Alternatively, there might be a social custom, the violation of which would result in being ostracised, dictating that in such cases there be some fair division of the cost. It is important, however, to recognise that these methods of resolving the problem are not market solutions. This implies that collusion may be a means of resolving the problem of an empty core, although merger and vertical integration may be alternatives. Archibald, *et al.*[70] provide laboratory evidence that with high avoidable costs, players formed cartels, and that those cartels produced more efficient results than competition.

Second, suppose there were sunk entry costs. Then the necessity of earning a return on the initial sunk investment, aggravated by the prospect of facing the costs of an empty core, would limit entry. In the example, suppose there are only three taxis. Then there is an empty core if demand is three or five, but not otherwise. If demand were seven or greater, because capacity is only six, competition would drive the price up to the reservation price of £10, and only six passengers would travel. The empty core would only occur when demand was low, for example if the industry were in decline or if demand were a low draw from a high variance distribution.

Two systematic tests of the empty core model have been made. Sjostrom[71] focused primarily on demand conditions. Two important results are that increased conference market share raises output

and that conferences are more dominant when demand is more variable, both consistent with an empty core and contrary to a monopoly model. Sjostrom does not specify the precise mechanism whereby increased share increases output. Given the results in the study by Clyde and Reitzes[72] that increased market share has trivially positive effect on freight rates, the increased output presumably comes from less costly contracting and more efficient production.

Pirrong[73] focuses on measuring the assumptions of the model, providing evidence of rising marginal cost and U-shaped average cost curves (implying fixed costs). With cost data from the routes to Europe from the North and South Atlantic ports of the US, he estimates alternative cost functions. Of particular interest is his successful use of the semi-logarithmic cost function, with the form (simplifying from Pirrong) $\ln C = \beta_0 + \beta_1 Q$, where C is total cost and Q is output. With $\beta_1 > 0$, the marginal cost function is rising ($\partial^2 C/\partial Q^2 = \beta_1\ ^2C > 0$) and the average cost function is U-shaped [$\partial(C/Q)/\partial Q = (C/Q)(\beta_1 Q-1)$, which is negative if $Q < 1/\beta_1$ and positive if $Q < 1/\beta_1$] . Pirrong's empirical results imply falling average cost over a substantial range of output, which in turn implies that the integer problem is significant. He also discusses why the model implies the absence of conferences in tramp shipping, which is consistent with only two attempts, both unsuccessful, to form conferences in tramp shipping.[74]

Empty core models have been successfully applied to other industries as well, from airlines,[75] to cast iron pipe,[76] to the Australian tomato industry.[77] It has also been successfully applied more generally to the problems of merger and trusts,[78] although there has been some empirical dissent.[79]

3. Liner Shipping Practices

Three liner practices have generated some controversy. Predatory pricing and loyalty contracts are ways in which liners may have attempted to preclude entry. The effect of price discrimination on cartel stability is more problematic. In a cartel model, it is destabilising because it attracts entry. In an empty core model, it is a way of increasing output when there are falling average costs.

3.1 Predatory pricing

The most common allegations of predatory pricing, especially in the early years of conferences, revolved around the use of "fighting ships". The conference would, in response to an entrant, allegedly lower the rates on one of its vessels to compete with the entrant until the entrant lost money and left the market. John McGee casts doubt on the use of fighting ships,[80] describing them as instances of normal competition, but Basil Yamey[81] cites the opinion in the 1891 decision by the law lords in the House of Lords in the case of *Mogul Steamship Co. v McGregor, Gow & Co. et al*.[82] for an example of the use of fighting ships.[83] It is not clear, however, from Yamey's discussion whether predatory pricing was successful in this instance. When, in 1885, Mogul sent two ships to Hankow, an inland port on the Yang-tse River (another non-conference firm sent a ship as well), the China conference responded by sending ships to Hankow, inducing a fall in rates, which the Court in *Mogul* described as unprofitable. On the other hand, the two Mogul ships and the third independent ship sailed sufficiently full that they did not have to carry ballast (effectively garbage carried to stabilise the ship when there is too little cargo), whereas some of the conference ships sailed empty. Although Mogul was not admitted to the China conference, it was given some landing rights on the Yang-tse.

wwo more recent contributions have improved our understanding of the ways in which conferences may have used predatory pricing to control entry. Fiona Scott Morton, studying pre-World War I

conferences, finds evidence supporting the “long purse” theory of predation, whereby firms can profitably engage in predation if their financial resources are large relative to the prey.[84] A long purse theory requires that capital markets are sufficiently costly that the prey cannot gain access to capital to survive the price war, whereas the predator can, most likely because the predator already owns larger liquid assets before the war starts.[85]

In a later study with the sociologist Joel Podolny,[86] Scott Morton extended her earlier results primarily by finding that entrants with high social status were less likely to be preyed upon. The social status of an entrant is used as a measure of the extent to which an entrant could be relied upon to cooperate with the conference. They also show that the effect of social status declined with the age of the entering firm. This is consistent with the idea that information about a firm becomes more public over time and therefore the conference had less need to rely on social status as a proxy.

These results are consistent with Gordon Boyce’s discussion[87] of the International Mercantile Marine (IMM), a combination of five transatlantic lines sponsored by J.P. Morgan and formed in the period 1900–1902. The IMM had alliances with two German lines, Norddeutscher Lloyd (NDL) and the Hamburg Amerika Line (HAPAG), with whom it had a ten-year route allocation agreement. Boyce argued that IMM’s connection to Morgan gave it access to “abundant capital”.

3.2 Loyalty contracts

Conferences used two kinds of loyalty contracts: the deferred rebate and the dual rate contract (sometimes called contract rates). Under a dual rate system, the shipper signs an agreement to deal exclusively with the conference, and in turn receives a discount on the freight rate. If the shipper uses a non-conference carrier, the conference imposes a fine. Under a deferred rebate system, if the shipper deals exclusively with the conference for, say, six months (the typically length of time), and then deals exclusively with the conference for next six months, the shipper receives a rebate of an agreed proportion of his freight bill from the first six months. The deferred rebate was a novel contract first introduced successfully by the UK–Calcutta Conference in 1877[88] after being proposed in 1873 on the Yang-tse River trade.[89] The deferred rebate system was prohibited in US trades by the 1916 Shipping Act.

There are two important distinctions between the two systems. First, under the deferred rebate system, the shipper loses interest on the price cut. Second, the conference incurs lower enforcement costs with the deferred rebate because it does not have to enforce the fine by going to court.[90] Perhaps because of these differences, discounts under deferred rebates tended to be larger than under dual rate contracts, typically double the size.[91] Under both systems, the conference must incur the costs of determining whether the contract has been broken, giving rise to estimates of violations of the loyalty agreements of 5–15% of shippers.[92] In a recent study, however, Pedro Marín and Richard Sicotte used the event study technique to show that loyalty agreements made significant contributions to profitability.[93]

Whichever system a conference used, deferred rebate and dual rate systems usually applied to only certain commodities. For example, the Far East Conference introduced the deferred rebate when it was formed in 1879, but certain bulk commodities such as rice and silk were excluded from the loyalty arrangement.[94] Moreover, the loyalty requirement was typically waived if the conference were unable to provide sufficient capacity within a reasonable time.[95]

Loyalty contracts are designed to encourage customers to use a particular seller exclusively. The shipper is charged a lower price in exchange for dealing exclusively with the conference. One question is whether they serve to exclude new entry, or whether they serve to reduce costs by gaining economies of regularity, such as easier planning. A second question is, assuming they serve to exclude entry, whether such exclusion is efficient.

Under constant marginal costs, loyalty contracts are an unprofitable method of deterring entry. Moreover, the customers who are most deterred from dealing with the entrant are those the conference least wants to deter, i.e. those owed the largest rebate.[96] Nevertheless, they can exclude an entrant constrained in its ability to offer a service of sufficiently high frequency to satisfy shipper demand.[97] Loyalty contracts reduce uncertainty for conference members by ensuring them a less variable flow of cargo, which is particularly valuable given the cost structure that makes full ships particularly attractive.[98] Because reduced uncertainty lowers costs and prices, these arguments are consistent with evidence that shippers were favourable to dual rate contracts.[99] The pre-World War I West Africa Conference used a deferred rebate system, which small shippers favoured but large shippers, who had better options to charter an entire ship, opposed.[100]

3.3 Price discrimination

Conference freight tariffs for a long time were detailed and lengthy, with different freight rates for each commodity shipped. An important issue of contention is the extent to which those differing rates are the consequence of cost differences or price discrimination. Differences in cost could arise from, *inter alia*, differences in density (called the stowage factor), difficulties in handling the cargo, insurance, and the need for refrigeration. Differences in transport demand elasticities could arise from differences in the costs of waiting: more valuable and more readily perishable goods would bear a higher freight rate for quick service. Even after the widespread use of containers, which have made cargoes more homogeneous, these tariffs have remained in effect.

Allegations that conferences price discriminate by charging higher freight rates to higher valued commodities are of long standing. One claim is that they are simply attempts to extract additional profits from a monopoly position.[101] The alternative view is that conferences price discriminate because the large element of fixed common costs requires price discrimination to cover costs.[102]

On the monopoly interpretation, price discrimination is destabilising for the conference. Price discrimination makes entry more attractive because entrants are encouraged to focus on the high priced end of the market. The conference sacrifices stability and durability in exchange for higher profits now.

On the common cost interpretation, price discrimination increases the stability and durability of the conference because it allows the conference to expand output and therefore is in the joint interests of the conference and shippers as a form of Ramsey pricing.[103]

An important difficulty is that Ramsey pricing is necessary only if marginal cost prices do not cover costs, which means that firms are operating under falling average costs. This seems inconsistent with several firms in a conference. Having several firms all operating in the region of falling average costs may be consistent with efficiency, although not with perfect competition. With U-shaped average cost curves, it is usually efficient to bring in an additional producer at a level of demand lower than that level necessary to bring the additional producer into the market under competition.[104]

U-shaped average cost curves capture the technology problem, because they imply a range of output over which marginal cost is less than average cost, so that marginal cost prices do not cover total costs.

Figure 3[105] is the easiest way to see this result. Demand is BB'. MC_1 is industry marginal cost with one producer, and MC_2 is industry marginal cost with two identical cal producers (which assumes a cost minimising division of output between the two producers). Average cost is U-shaped and reaches a minimum at average cost AA' and output L. With one producer, efficient output is K. At that output, total value (the area under the demand curve) is OBCK. The cost of output L is OADL, and the cost of the extra output K-L is LDCK. Therefore, total surplus is ABCD.

With two producers, efficient output is J, where demand intersects MC_2. Perfect competition cannot sustain that outcome because with two producers, price would be below A, and price would not cover average cost. To see whether it is efficient to have two producers rather than just one, first calculate total cost if output is J. With output H (equal to 2L, because average cost is minimised for one producer at L and for two producers at 2L = H), cost is OAGH (average cost times output). If output is reduced from H to J, costs fall by JFGH (the area under the marginal curve between

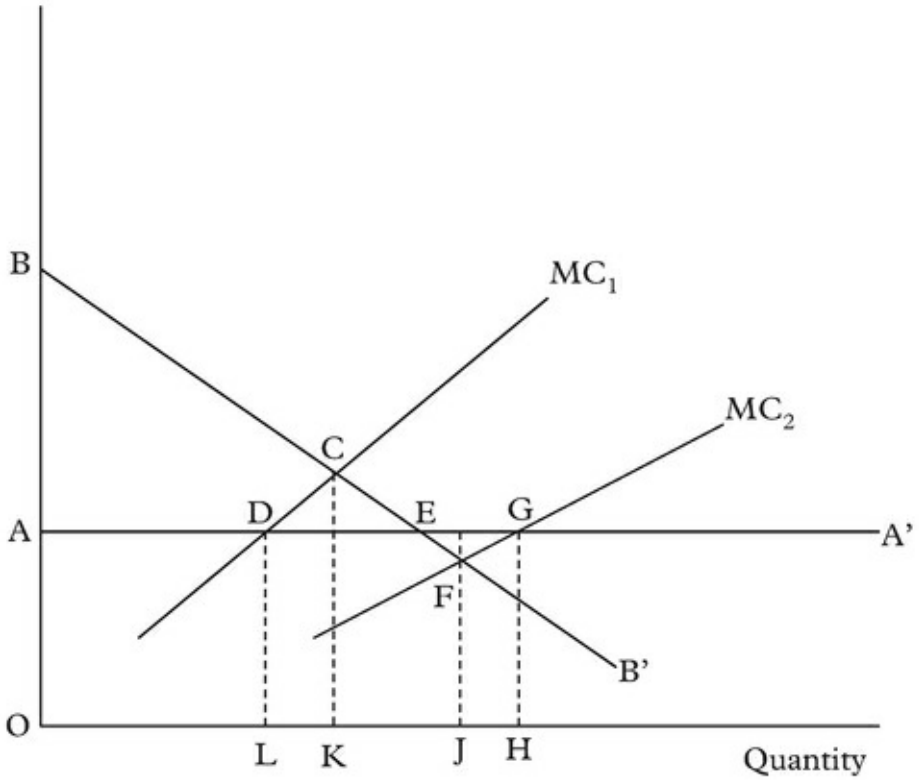

Figure 3

J and H). Therefore, the cost of output J is OAGFJ. Total value is OBFJ (the area under the demand curve), so net surplus is ABE – EFG. The net gain in surplus from switching from one to two producers is therefore CDE – EFG. It is efficient to add a second producer if CDE > EFG. To sustain a second producer under perfect competition, demand must intersect MC_2 at point G, and the area EFG equals zero. It follows that it is efficient to bring in an additional producer at a lower level of demand than would be supported by perfect competition.

A number of attempts have been made to find out whether conferences practice price discrimination. A number of attempts have been made to measure price discrimination by regressing the freight rate for different commodities against the price of the commodity and a group of variables

intended to capture differences in transport costs. The fundamental difficulty is identifying variables that capture differences in demand elasticities without also identifying differences in costs. A statistically significant regression coefficient on commodity price is usually asserted to be evidence of price discrimination. Unfortunately, higher priced goods usually carry higher insurance costs and frequently require more delicate handling. To identify price discrimination, we would have to know the (unknown) coefficient implied by these higher costs and look for evidence of a higher coefficient. The cost variables, moreover, might include price discrimination elements. For example, refrigerated goods usually carry a higher freight rate. The higher rate may the result of the extra costs of refrigeration, or the result of the less elastic demand implied by the perishability of the goods. To complicate matters, it could easily include both elements, so the model cannot identify the separate effects. A long series of papers[106] have failed to answer this question because they failed to tackle the identification problem. Two papers have made attempts to solve this identification problem.

Clyde and Reitzes[107] have made an innovative attempt to separate the effects of market power from cost differences by using panel data (different commodities on fourteen routes over four years) in a fixed effects model. By using dummy variables for each commodity, they try to control for cost differences. The relevant part of their regression is $r_{ij} = \beta_1 s_j + \beta_2 s_j p_{ij}$, where r_{ij} is the freight rate for commodity i on route j, s_j is the conference market share on route j, and p_{ij} is the price of commodity i on route j. It follows that $\partial r_{ij}/\partial s_j = \beta_1 + \beta_2 p_{ij}$. If conferences are price discriminating, then a drop in competition from independent carriers (an increase in s_j) will not only raise freight rates ($\beta_1 > 0$), but will raise them more for higher valued commodities ($\beta_2 > 0$). Clyde and Reitzes find no evidence for discriminatory pricing.

A recent paper by Hummels, Lugovskyy, and Skiba[108] tries to solve the problem by looking at changes in import duties. As product price rises, a given increase in the freight rate produces a smaller proportional change in product price, so a higher product price implies a less elastic transport demand. Changes in import duties change the elasticity of transport demand without changing transport costs, so they become a way to identify price discrimination. They find substantial price discrimination, with a 1% increase in an import duty raising freight rates 1–2%, and consequent substantial effects on developing country trade.

3.4 Price and output fixing

Conferences not only fix prices, they set both minimum and maximum outputs. It is much easier to make sense of the role of maximum output rules. In a cartel model, maximum output rules prevent price from falling to competitive levels. In an empty core model, a maximum output rule allows for efficient use of capacity.[109]

Why though a minimum output rule? One explanation consistent with both cartel and empty core models is entry deterrence. Entry deterrence is important in both cartel and monopoly models. In cartel models, entry lowers price; in empty core models, entry destroys equilibrium. Fusillo[110] and Wu[111] offer evidence that conference liners create excess capacity for strategic entry deterrence. In an open conference system, if conferences are successful in imposing entry barriers to non-conference lines, the entrant may attempt to by-pass those barriers by joining the conference. If the minimum output is set high enough, the entrant may end up expanding capacity on the route to unprofitable levels. This limit-pricing strategy requires the conference to commit to the minimum output rules by

guaranteeing its sailing schedules. As with any irreversible commitment, however, this would expose the conference to the risks of a mistake. An entrant might overestimate demand and therefore mistakenly enter, leaving the conference with excess capacity.[112]

Minimum output rules are also consistent with the efficiency argument, raised in Figure 1 in the previous section, that with large fixed costs, it may be efficient to operate where marginal cost is below average cost.

Alternatively, consistent with a cartel model, the minimum output rule may be a way of excluding small, high cost sellers from the conference. The willingness to adhere to a minimum output may be a way of signaling low costs. Every agreement has to ensure it is not eroded by attracting high cost entrants.

Albert Ballin, the managing director of the Hamburg-America Line (Hapag) wrote in 1914:
"Especially a very strong and powerful party must continuously bear in mind the question, whether the advantages of relying on the free interplay of market forces would not be far greater than the benefits from inhibiting influence of a conference, which after all flow more to its weaker than its stronger members."
Hapag was at the time the world's largest shipping line. Although Ballin was implying that Hapag was among the stronger, there is some evidence that it was by no means the most profitable, which is counter-evidence to the idea that minimum output quotas were about excluding high cost entrants.[113]

Revenue pooling can be a method of sustaining price discrimination and preventing internal cheating in a cartel. It can also be a means of ensuring low cost production by separating the decision about efficient output allocation from individual firm profitability.[114]

4. Concluding Remarks

Although our understanding of cooperation in liner shipping has improved in recent years, there is still much that remains a mystery. In particular, research on strategic alliances remains largely descriptive and has not expanded to the careful testing applied to other industries. Maritime economists have much to keep them busy.

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Endnotes

1. Jansson, J.O. and Shneerson, D. (1987): *Liner Shipping Economics* (London, Chapman & Hall). For historical evidence on this point, see also Greenhill, R. (1977): "Shipping, 1850–1914", in Platt, D.C.M. (ed.), *Business Imperialism, 1840–1930: An Inquiry Based on British Experience in Latin America* (Oxford, Oxford University Press), pp. 119–155.
2. Bennathan, E. and Walters, A.A. (1969): *The Economics of Ocean Freight Rates* (New York, Praeger); Jansson, J.O. and Shneerson, D. (1987): *Liner Shipping Economics* (London, Chapman & Hall).
3. Smith, J.R. (1906): "Ocean freight rates and their control by line carriers", *Journal of Political Economy*, 14, 525–541. The range of detail in conference agreements is described in Deltas, G., Serfes, K. and Sicotte, R. (1999): "American shipping cartels in the pre-World War I era", *Research in Economic History*, 16, 1–38.
4. Farthing, B. (1993): *International Shipping* (2nd edn.) (London, Lloyd's of London Press);

Clarke, R.L. (1997): “An analysis of the international ocean shipping conferences system”, *Transportation Journal*, 36, 17–29.

5. OECD (2001): Regulatory Issues in International Maritime Transport, Paris: Organisation for Economic Co-operation and Development www.oecd.org/dataoecd/0/63/2065436.pdf

6. Bergantino, A.S. and Veenstra, A.W. (2000): “Interconnection and Co-ordination: An application of network theory to liner shipping”, *International Journal of Maritime Economics*, 4, 231–248.

7. Ryoo, D-K. and Thanopoulou, H.A. (1999): “Liner alliances in the globalisation era: a strategic tool for Asian container carriers”, *Maritime Policy and Management*, 26, 349–367; Midoro, R. and Pitto, A. (2000): “A critical evaluation of strategic alliances in liner shipping”, *Maritime Policy and Management*, 27, 31–40.

8. Sheppard, E. and Seidman, D. (2001): “Ocean shipping alliances: the wave of the future?” *International Journal of Maritime Economics*, 3, 351–367.

9. Robinson, D.T. (2008): “Strategic alliances and the boundaries of the firm”, *Review of Financial Studies*, 21, 649–681.

10. May, D. (1995): “Do managerial motives influence firm risk reduction strategies?” *Journal of Finance*, 50, 1291–1308.

11. Ryoo, D-K. and Thanopoulou, H.A. (1999): “Liner alliances in the globalization era: a strategic tool for Asian container carriers”, *Maritime Policy and Management*, 26, 349–367; Midoro, R. and Pitto, A. (2000): “A critical evaluation of strategic alliances in liner shipping”, *Maritime Policy and Management*, 27, 31–40; Sheppard, E. and Seidman, D. (2001): “Ocean shipping alliances: the wave of the future?”, *International Journal of Maritime Economics*, 3, 351–367.

12. Bergantino, A. and Veenstra, A. (2002): “Interconnection and co-ordination: an application of network theory to liner shipping”, *International Journal of Maritime Economics*, 4, 231–248.

13. Fusillo, M. (2006): “Some notes on structure and stability in liner shipping”, *Maritime Policy and Management*, 33, 463–475.

14. Parola, F. and Musso, E. (2007): “Market structures and competitive strategies: the carrier – stevedore arm – wrestling in northern European ports”, *Maritime Policy and Management*, 34, 259–278.

15. Boyce, G.H. (1995): *Information, Mediation and Institutional Development: The Rise of Large-Scale Enterprise in British Shipping, 1870–1919* (Manchester, Manchester University Press).

16. Fleming, D.K. (2002): “Reflections on the history of US cargo liner service (Part I)”, *International Journal of Maritime Economics*, 4, 369–389.

17. Harley, C.K. (1971): “The shift from sailing ships to steamships, 1850–1890: a study in technological change and its diffusion”, in McCloskey, D.N. (ed.), *Essays on a Mature Economy: Britain after 1840* (Princeton, Princeton University Press), pp. 215–234.

18. Burley, K. (1968): *British Shipping and Australia, 1920–1939* (Cambridge, Cambridge University Press).

19. Armstrong, J. (1991): “Conferences in British nineteenth-century coastal shipping”, *Mariner’s Mirror*, 77, 55–65.

20. Kirkaldy, A. (1914): *British Shipping* (London, Kegan Paul, Trench, Trubner); Dyos, H.J. and Aldcroft, D.H. (1969): *British Transport: An Economic Survey from the Seventeenth Century to*

Twentieth (Leicester: Leicester University Press).

21. Marx, D. (1953): *International Shipping Cartels* (Princeton, Princeton University Press); Dyos, H.J. and Aldcroft, D.H. (1969): *British Transport: An Economic Survey from the Seventeenth Century to Twentieth* (Leicester, Leicester University Press).
22. Sloan, E.W. (1998): "The first (and very secret) international steamship cartel, 1850–1856", *Research in Maritime History*, 14, 29–52.
23. Dyos, H.J. and Aldcroft, D.H. (1969): *British Transport: An Economic Survey from the Seventeenth Century to Twentieth* (Leicester, Leicester University Press).
24. Smith, J.R. (1906): "Ocean freight rates and their control through combinations", *Political Science Quarterly*, 21, 237–263.
25. Armstrong, J. (1991): "Conferences in British nineteenth-century coastal shipping", *Mariner's Mirror*, 77, 55–65.
26. McGee, J.S. (1960): "Ocean freight conferences and American merchant marine", *University of Chicago Law Review*, 27, 191–314; Abrahamsson, B.J. (1980): *International Ocean Shipping: Current Concepts and Principles* (Boulder, Colorado, Westview).
27. Deltas, G., Sicotte, R. and Tomczak, P. (2008): "Passenger shipping cartels and their effect on trans-Atlantic migration" *Review of Economics and Statistics*, 90, 119–133.
28. Greenhill, R. (1998): "Competition or co-operation in the global shipping industry: the origins and impact of the conference system for British ship owners before 1914", *Research in Maritime History*, 14, 53–80.
29. Sjostrom, W. (1989): "On the origin of shipping conferences: excess capacity and the opening of the Suez Canal", *International Journal of Transport Economics*, 16, 329–335.
30. Bittlingmay, G. (1985): "Did antitrust policy cause the great merger wave?" *Journal of Law and Economics*, 28, 77–118.
31. Livermore, S. (1935): "The success of industrial mergers", *Quarterly Journal of Economics*, 50, 68–96; Navin, T. and Sears. M. (1954): A study in merger: formation of the International Mercantile Marine Company", *Business History Review*, 28, 291–328; Boyce, G.H. (1995): *Information, Mediation and Institutional Development: The Rise of Large-Scale Enterprise in British Shipping, 1870–1919* (Manchester, Manchester University Press).
32. Sys, C. (2009): "Is the container liner shipping industry an oligopoly?" *Transport Policy*, 16, 259–270.
33. An innovative attempt was made to apply monopolistic competition models to conferences, but was not followed up. See Officer, L. (1971): "Monopoly and monopolistic competition in the international transportation industry", *Western Economic Journal*, 9, 134–156.
34. Marshall, A. (1921): *Industry and Trade* (London, Macmillan).
35. Cafruny, A.W. (1987): *Ruling the Waves: The Political Economy of International Shipping* (Berkeley, University of California Press).
36. A point disputed with respect to both the US and Europe in McChesney, F.S. and Shughart, W.F. (1995): *The Causes and Consequences of Antitrust: the Public-Choice Perspective* (Chicago, University of Chicago Press) and Sjostrom, W. (1998): Competition law in the European Union and the United States, in *The New Palgrave Dictionary of Economics and the Law*, Vol 1, (ed.)

P. Newman (London, Macmillan), pp. 370–377.
37. Productivity Commission. (1999): *International Liner Cargo Shipping: A Review of Part X of the Trade Practices Act 1974. Report No. 9* (Canberra, Australia: AusInfo).
38. The basic models of punishment are Green, E.J. and Porter, R.H. (1984): "Noncooperative collusion under imperfect price information", *Econometrica*, 52, 87–100, and Rotemberg, J.J. and Saloner, G. (1986): "A supergame-theoretic model of price wars during booms", *American Economic Review*, 76, 390–407.
39. Stigler, G.J. (1964): "A theory of oligopoly", *Journal of Political Economy*, 72, 41–61.
40. Sletmo, G. and Williams, E. (1981): *Liner Conferences in the Container Age: US Policy at Sea* (New York, Macmillan).
41. Fox, N.R. (1992): "An empirical analysis of ocean liner shipping", *International Journal of Transportation Economics*, 19, 205–225.
42. Stigler, G.J. (1964): "A Theory of oligopoly", *Journal of Political Economy*, 72, 44–61.
43. Fox, N.R. (1995): "Some effects of the U.S. Shipping Act of 1984 on ocean liner shipping conferences", *Journal of Maritime Law and Commerce*, 26, 531–544.
44. Clyde, P.S. and Reitzes, J.D. (1998): "Market power and collusion in the ocean shipping industry: is a bigger cartel a better cartel?" *Economic Inquiry*, 36, 292–304.
45. Deltas, G., Sicotte, R. and Tomczak, P. (2008): "Passenger shipping cartels and their effect on trans-Atlantic migration", *Review of Economics and Statistics*, 90, 119–133.
46. Deltas, G., Serfes, K. and Sicotte, R. (1999): "American shipping cartels in the pre-World War I era", *Research in Economic History*, 16, 1–38.
47. Boyce, G.H. (1995): *Information, Mediation and Institutional Development: The Rise of Large-Scale Enterprise in British Shipping, 1870–1919* (Manchester, Manchester University Press).
48. McGee, J.S. (1980): "Predatory pricing revisited", *Journal of Law and Economics*, 23, 289–330.
49. Perloff, J., Karp, L. and Golan, A. (2007): *Estimating Market Power and Strategies* (Cambridge, Cambridge University Press), pp. 43–47.
50. The extremely parsimonious descriptions of demand and marginal cost are for illustration, not a guide to actual empirical work.
51. The econometric issues in measuring λ are discussed in detail in Perloff, J., Karp, L. and Golan, A. (2007): *Estimating Market Power and Strategies* (Cambridge, Cambridge University Press), chapter 2.
52. Johnsen, D. Bruce. (1991): "Property rights to cartel rents: The Socony-Vacuum story", *Journal of Law and Economics*, 43, 177–203.
53. Wilson, W. and Casavant, K. (1991): "Some market power implications of the Shipping Act of 1984", *Western Journal of Agricultural Economics*, 16, 427–434.
54. Pirrong, S.C. (1993): "Contracting practices in bulk shipping markets: a transactions cost explanation", *Journal of Law and Economics*, 36, 937–976.
55. Davies, J.E. (1983): Pricing in the liner shipping industry: a survey of conceptual models. Canadian Transport Commission, Report No. 1983/04E; Davies, J.E. (1989): "Impediments to contestability in liner markets", *Logistics and Transportation Review*, 25, 325–342.
56. Further evidence is offered by Lam, J., Yap, W. and Cullinane, K. (2007): "Structure, conduct, and performance on the major liner shipping routes", *Maritime Policy and Management*, 34,

359–381.

57. Farrell, J. (1986): "How effective is potential competition?" *Economics Letters*, 20, 67–70; Gilbert R. (1989): "The role of potential competition in industrial organization", *Journal of Economic Perspectives*, 3, 107–127.

58. Marx, D. (1953): *International Shipping Cartels* (Princeton, Princeton University Press).

59. Graham, M.G. (1998): "Stability and competition in intermodal container shipping: finding a balance", *Maritime Policy and Management*, 25, 129–147.

60. Hyde, F.E. (1967): *Shipping Enterprise and Management 1830–1939* (Liverpool, Liverpool University Press).

61. Brooks, M. (2000): *Sea Change in Liner Shipping* (Amsterdam, Pergamon), p. 62; see also Sagers, C. (2006): "The demise of regulation in ocean shipping: A study in the evolution of competition policy and the predictive power of microeconomics", *Vanderbilt Journal of Transnational Law*, 39, 779–818, at p. 803, n. 110.

62. McGee, J.S. (1960): "Ocean freight conferences and American merchant marine", *University of Chicago Law Review*, 27, 191–314; Bennathan, E. and Walters, A.A. (1969): *The Economics of Ocean Freight Rates* (New York, Praeger); Officer, L. (1971): "Monopoly and monopolistic competition in the international transportation industry", *Western Economic Journal*, 9, 134–156.

63. Fusillo finds evidence of low supply elasticities, but finds evidence that conferences *reduced* supply elasticities. See Fusillo, M. (2004): "Is liner shipping supply fixed?" *Maritime Economics & Logistics*, 6, 220–235.

64. Surveyed in Telser, L. (1994): "The usefulness of core theory in economics", *Journal of Economic Perspectives*, 8, 151–164.

65. Sjostrom, W. (1989): "Collusion in ocean shipping: a test of monopoly and empty core models", *Journal of Political Economy*, 97, 1160–1179; Pirrong, S.C. (1992): "An application of core theory to the analysis of ocean shipping markets", *Journal of Law and Economics*, 35, 89–131; Sjostrom, W. (1993): "Antitrust immunity for shipping conferences: an empty core approach", *Antitrust Bulletin*, 38, 419–423; Davies, J., Pirrong, C., Sjostrom, W. and Yarrow, G. (1995): "Stability and related problems in liner shipping: an economic overview", *Hearings before the Committee on Commerce, Science, and Transportation*. US Senate, 104th Congress, first session.

66. Button, K. (1999): "Shipping alliances: Are they at the 'core' of solving instability problems in shipping?", *Liner Shipping: What's Next, Proceedings of the 1999 Halifax Conference, International Association of Maritime Economists*, Halifax, Canada, September, pp. 58–88.

67. The accounts in Smith, T.K. (1995): "Why air travel doesn't work", *Fortune*, 3 April, of conversations with airline executives are similar to the views routinely expressed by people in the liner shipping business, particularly the problem that inventories are extremely expensive.

68. Bittlingmayer, G. (1989): "The economic problem of fixed costs and what legal research can contribute", *Law and Social Inquiry*, 14, 739–762.

69. On this point, see Telser, L. (1978): *Economic Theory and the Core* (Chicago, University of Chicago Press), especially chapter 3, and McWilliams, A. (1990): "Rethinking horizontal

market restrictions" in defense of cooperation in empty core markets", *Quarterly Review of Economics and Business*, 30, 3–14.

70. Archibald, G., van Boening, M. and Wilcox, N. (2002): "Avoidable cost: can collusion succeed where competition fails?" *Research in Experimental Economics*, 9, 217–242.

71. Sjostrom, W. (1989): "Collusion in ocean shipping: a test of monopoly and empty core models", *Journal of Political Economy*, 97, 1160–1179.

72. Clyde, P.S. and Reitzes, J.D. (1998): "Market power and collusion in the ocean shipping industry: is a bigger cartel a better cartel?" *Economic Inquiry*, 36, 292–304.

73. Pirrong, S.C. (1992): "An application of core theory to the analysis of ocean shipping markets", *Journal of Law and Economics*, 35, 89–131.

74. McGee, J.S. (1960): "Ocean freight conferences and American merchant marine", *University of Chicago Law Review*, 27, 191–314; Abrahamsson, B.J. (1980), *International Ocean Shipping: Current Concepts and Principles* (Boulder, Colorado, Westview).

75. Antoniou, A. (1998): "The status of the core in the airline industry: the case of the European market", *Managerial and Decision Economics* 19, 43–54; Button, K. (2003): "Does the theory of the 'core' explain why airlines fail to cover their long-run costs of capital?" *Journal of Air Transport Management*, 9, 5–14. For an opposing view, see Domanico, F. (2007): "The European airline industry: law and economics of low cost carriers", 23, 199–221.

76. Bittlingmayer, G. (1982): "Decreasing average cost and competition: a new look at the Addyston Pipe case", *Journal of Law and Economics*, 25, 201–229; Bittlingmayer, G. (1983): "Price fixing and the Addyston Pipe case", *Research in Law and Economics*, 5, 57–128.

77. Hone, P. (1997): "Market power and contestability in factor markets: the case of tomato pricing", *Economic Analysis & Policy*, 27, 59–73.

78. Bittlingmayer, G. (1985): "Did antitrust policy cause the great merger wave?", *Journal of Law and Economics*, 28, 77–118; McWilliams, A. and Keith, K. (1994): "The genesis of the trusts: rationalization in empty core markets", *International Journal of Industrial Organization*, 12, 245–267; Bittlingmayer, G. (1995): "Output and stock prices when antitrust is suspended: experience under the NIRA", in McChesney, F.S. and Shughart, W. II (eds.), *The Causes and Consequences of Antitrust: A Public Choice Perspective* (Chicago, University of Chicago Press), pp. 287–318.

79. Taylor, J.E. (2002): "The output effects of government sponsored cartels during the New Deal", *Journal of Industrial Economics*, 50, 1–10.

80. McGee, J.S. (1960): "Ocean freight conferences and American merchant marine", *University of Chicago Law Review*, 27, 191–314.

81. Yamey, B.S. (1972): "Predatory price cutting: notes and comments", *Journal of Law and Economics*, 15, 129–142.

82. [1892] App Cas 25.

83. *Mogul Steamship Co.* is the most well known instance of a claim of predatory pricing in liner shipping. Useful discussions can be found in Letwin, W. (1965): *Law and Economic Policy in America: The Evolution of the Sherman Antitrust Act* (Chicago, University of Chicago Press) and Yamey, B.S. (1972): "Predatory price cutting: notes and comments", *Journal of Law and Economics*, 15, 129–142. Its legal fame rests on the Court's decision that under common law,

agreements in restraint of trade (which the Court judged the conference to be) are unenforceable but *not* actionable.

84. Scott Morton, F. (1979): "Entry and predation: British shipping cartels, 1879– 1929", *Journal of Economics and Management Strategy*, 6, 679–724.

85. McGee, J.S. (1960): "Ocean freight conferences and American merchant marine", *University of Chicago Law Review*, 27, 191–314; Bork, R.H. (1980): *The Antitrust Paradox* (New York, Basic Books).

86. Podolny, J.M. and Scott Morton, F.M. (1999): "Social status, entry, and predation: the case of British shipping cartels 1879–1929", *Journal of Industrial Economics*, 47, 41–67.

87. Boyce, G.H. (1995): *Information, Mediation and Institutional Development: The Rise of Large-Scale Enterprise in British Shipping, 1870–1919* (Manchester, Manchester University Press).

88. Marshall, A. (1921): *Industry and Trade* (London, Macmillan); Marx, D. (1953): *International Shipping Cartels* (Princeton, Princeton University Press).

89. Marriner, S. and Hyde, F.E. (1967): *The Senior: John Samuel Swire, 1825–1898, Management in the Far Eastern Shipping Trades* (Liverpool, Liverpool University Press).

90. McGee, J.S. (1960): "Ocean freight conferences and American merchant marine", *University of Chicago Law Review*, 27, 191–314.

91. Marx, D. (1953): *International Shipping Cartels* (Princeton, Princeton University Press).

92. Grossman, W.L. (1956): *Ocean Freight Rates* (Cambridge, Cornell Maritime Press).

93. Marín, P.L. and Sicotte, R. (2003): "Exclusive contracts and market power: evidence from ocean shipping", *Journal of Industrial Economics*. 51, 193–213.

94. Hyde, F.E. (1957): *Blue Funnel: A History of Alfred Holt and Company of Liverpool from 1865 to 1914* (Liverpool, Liverpool University Press).

95. Marx, D. (1953): *International Shipping Cartels* (Princeton, Princeton University Press).

96. Bork, R.H. (1980): *The Antitrust Paradox* (New York, Basic Books).

97. Sjostrom, W. (1988): "Monopoly exclusion of lower cost entry: loyalty contracts in ocean shipping conferences", *Journal of Transport Economics and Policy*, 22, 339–344; Yong, J-S. (1996): "Excluding capacity-constrained entrants through exclusive dealing: theory and an application to ocean shipping", *Journal of Industrial Economics*, 44, 115–129.

98. Lewis, W.A. (1949): *Overhead Costs: Some Essays in Economic Analysis* (New York, Rinehart); Boyce, G.H. (1995): *Information, Mediation and Institutional Development: The Rise of Large-Scale Enterprise in British Shipping, 1870–1919* (Manchester, Manchester University Press).

99. Gordon, J.S. (1969): "Shipping regulation and the Federal Maritime Commission, Part 1", *University of Chicago Law Review*, 37, 90–158.

100. Davies, P.N. (1973): *The Trade Makers: Elder Dempster in West Africa* (London, George Allen & Unwin).

101. McGee, J.S. (1960): "Ocean freight conferences and American merchant marine", *University of Chicago Law Review*, 27, 191–314; Bennathan, E. and Walters, A.A. (1969): *The Economics of Ocean Freight Rates* (New York, Praeger).

102. Jansson, J.O., and Shneerson, D. (1987): *Liner Shipping Economics* (London, Chapman & Hall); Sjostrom, W. (1992): "Price discrimination by shipping conferences", *Logistics and*

Transportation Review, 28, 207–215.

103. For a detailed description of Ramsey pricing, see Brown, S.J. and Sibley, D.S. (1986): *The Theory of Public Utility Pricing* (Cambridge, Cambridge University Press).

104. Telser, L. (1978): *Economic Theory and the Core* (Chicago, University of Chicago Press).

105. Simplified from Telser, L. (1987): *A Theory of Efficient Cooperation and Competition* (Cambridge, Cambridge University Press), p. 114.

106. Surveyed and critiqued in Sjostrom, W. (1992): "Price discrimination by shipping conferences", *Logistics and Transportation Review*, 28, 207–215.

107. Clyde, P.S. and Reitzes, J.D. (1998): "Market power and collusion in the ocean shipping industry: is a bigger cartel a better cartel?", *Economic Inquiry*, 36, 292–304.

108. Hummels, D., Lugovskyy, V. and Skiba, A. (2009): "The trade reducing effects of market power in international shipping", *Journal of Development Economics*, 89, 84–97.

109. See Telser, L. (1987): *A Theory of Efficient Cooperation and Competition* (Cambridge, Cambridge University Press), chapter 5, for a rigorous proof.

110. Fusillo, M. (2003): "Excess capacity and entry deterrence: the case of ocean liner shipping markets", *Maritime Economics & Logistics*, 5, 100–115.

111. Wu, W. (2009): "An approach for measuring the optimal fleet capacity: evidence from the container shipping lines in Taiwan", *International Journal of Production Economics*, 122, 118–126.

112. McGee, J.S. (1980): "Predatory pricing revisited", *Journal of Law and Economics*, 23, 289–330.

113. Broeze, F. (1993): "Shipping policy and social-darwinism: Albert Ballin and the weltpolitik of the Hamburg-America Line 1886–1914", *The Mariner's Mirror*, 79, 419–436.

114. Letwin, W. (1965): *Law and Economic Policy in America: The Evolution of the Sherman Antitrust Act* (Chicago: University of Chicago Press); Wilson, T. (1962): "Restrictive Practices" in Miller, J.P. (ed.), *Competition, Cartels and their Regulation* (Amsterdam, North Holland).

Chapter 15

The Response of Liner Shipping Companies to the Evolution of Global Supply Chain Management

Trevor D. Heaver *

1. Introduction

The purpose of this chapter is to review developments in liner shipping in the light of the evolution of concepts and practices associated with supply chain and logistics management. The long-term developments have featured the shift in management philosophy away from managing functions individually to managing them as linked components of supply chain business processes (Lambert, 2001). This has had important implications for the expectations of shippers and the service decisions of shipping companies. Recently, shippers have shifted their strategies and priorities as a result of challenges in international logistics associated first with the congested conditions in container trades, especially in 2004–2005, and then with the recession of 2008 and 2009.

For many years, shipping lines were encouraged by their cost structure and the service interests of shippers to extend their services through horizontal and vertical corporate integration. The horizontal integration was pursued through internal growth, mergers and acquisitions and the on-going evolution of alliances. The vertical integration was achieved through shipping companies or the corporations of which they are a part extending their services through internal growth and acquisitions in three main areas. They are the management of container terminals, the provision of intermodal services and the provision of logistics services. The relationship of each of these services with the shipping activities deserves individual attention.

The extent and forms of integration have varied over the years as the challenges and opportunities for service suppliers have changed in the light of economic conditions and the interests of shippers. For example, the trade boom and congested conditions of 2004–2005 brought to light discontinuities in logistics management practices and in transportation capabilities associated, in particular, with port hinterland connections. As a result, attention has focused more than previously on the effective coordination among operations in and related to ports irrespective of ownership. This makes it appropriate to distinguish between the use of ‘integration’ referring to corporate and related organisational relationships and “coordination” referring to communication and operating relationships. This is to avoid the use of “integration” for both common ownership and the coordination of services and to give greater recognition to the challenges of achieving effective coordination along logistics chains.

In this chapter the evolving conditions in supply chain management and logistics are reviewed. This sets the stage to describe the responses of lines. Both the horizontal and vertical restructuring of lines are covered but the emphasis is on the latter. This part of the chapter draws, in particular, on Evangelista *et al*. (2001) and Heaver (2002). Interpretation of the patterns of relationships draws on the literature dealing with supply chain management, out-sourcing and transaction cost economics. The evolving organisational relationship between the shipping and logistics services of lines is explored in the concluding part of the chapter. The interests and conduct of shippers in the allocation

of traffic among lines and in the negotiation of liner rates and services appear vital to the relationships of shipping with logistics services.

2. Evolving Conditions in Supply Chain Management and Logistics

Liner shipping is but one of the myriads of service and product activities that are necessary for the delivery of the goods and services required by consumers. The opportunities and challenges faced by the lines are affected by the network environment in which they operate. As the environment changes under technological, economic and political conditions, so the lines have opportunities to follow strategies that give them an advantage in serving customers needs. These strategies have implications for the organisational structure of the liner industry. This section of the chapter starts by defining the concepts of supply chain and logistics management and then proceeds to examine the implications of customer needs and the associated challenges and opportunities for shipping. It concludes by describing some of the changes in the logistics industry that affect the position of liner shipping companies.

2.1 The definition of supply chain management and logistics management

The advance of more integrated approaches to the management of intra-corporate and inter-corporate relationships is well documented (Hall and Braithwaite, 2001). Even though Hall and Braithwaite suggest "there is little point in seeking to document a perfect definition for supply chain management", a definition is useful as it captures the importance of coordination. Mentzer *et al*. (2001) define supply chain management as: "the systematic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole."[1] That the "chains" referred to are more likely "networks" of private and public goods and services providers distributed globally is one of the possible shifts in the terminology that, fortunately, is generally treated as too esoteric to worry about.

Supply chain management is the wide framework within which logistics functions. The definition of logistics by the US Council of Supply Chain Management Professionals, formerly the Council of Logistics Management, reflects this. The definition is: "Logistics is that part of the supply chain process that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services, and related information between the point of origin and the point-of-consumption in order to meet customers' requirements."[2] It recognises that logistics management is only a part of the supply chain.

2.2 Customer needs and the challenges and opportunities for liner shipping

Global improvements in logistics performance have contributed to and been required by increased competition in product markets. The reduction of tariff and other trade barriers, improvements in the efficiency of transport services and the increased value and reduced weight of many products have all contributed to the ability of products from distant locations to compete locally. Multi-national firms that used to be organised with regional marketing and production divisions switched to product-based supply chains that source and market globally. Spatial competition (the competition in common markets for products from far away) is more important now than ever before.

Increased competition heightens pressures for the redesign of supply chains and logistics systems. The competition drives the need to reduce costs while, at the same time, maintaining or improving

service levels. While the actions taken to reduce costs and to improve services work concurrently and dynamically, it is convenient to describe them individually. Such actions are considered next, prior to considering their implications for shipping lines.

2.2.1 Developments in logistics

Four strategies provide examples of the central role for logistics in improving supply chain performance. They are: sourcing in low-cost locations; just-in-time delivery; postponement; and improving supply chain visibility.

Sourcing in low-cost locations: Industries have always made trade-offs among alternate locations based on the benefits of locating close to low cost resource inputs compared with the benefits of proximity to markets. Typically, industries in which labour costs are high gravitate to low wage-cost locations. The ability of firms to do this is dependent on efficient logistics services to get products to where they are needed. Examples of the pull of low cost production are the shift of manufacturing textile, footwear, automobile, electronic and toy products to Asia, particularly China. However, the attractiveness of shifting to low-cost production locations has decreased recently if logistics conditions for those locations have not been compatible with the operation of manufacturing and retailing with low inventories. For example, the changing pattern of activities in the hard disk drive industry in Asia has been affected by various aspects of time responsiveness, including transit and order cycle times (McKendrick *et al*., 2000). Similarly, the location and role of facilities of the Taiwanese computer manufacturer Acer reflects the trade off between costs of manufacture and assembly in Asia and the time of delivering product to consumers (Nemoto and Kawashima, 2000). The congestion experienced in ports in 2005 and the need for quicker responsiveness in supply chains made evident during the 2008–2009 recession have increased the value placed on shorter and more diversified supply chains. Shippers remain attracted to low cost locations but have become more alert to the logistics disadvantages that they may imply for their supply chains.

Just-in-time delivery: The concept of just-in-time delivery (JIT) has been a major reason for the redesign of logistics systems. The successful use of the *kanban* system in the Japanese automobile industry had a major influence on all industries around the world as they have shifted to new delivery systems. JIT is just one approach to reducing inventories in supply chains through frequent, small quantity and highly reliable deliveries. These deliveries are timed to respond to immediate user needs; the products are pulled through the supply chain by demand. This is a major difference to the time when goods were produced in long, low-cost runs based on forecasts well ahead of demand. When manufacturers are the immediate recipients of goods, terms such as lean manufacturing are used to describe the new environment. When the recipients are retailers, the term lean retailing may be used.

For these systems to work effectively transportation services must be reliable; delivery is required at precise times. Many systems are also built on short lead times, thereby placing requirements for premium transportation or geographical proximity of the supplier to the user. However, the benefits of reliability as an attribute of transportation which reduces inventory costs are fundamental in logistics. The consequences of relatively low reliability and the long transit times generally associated with liner shipping have received heightened attention as a result of the congestion of 2004–2005 and then the need for agile responses to the recession of 2008–2009.

Postponement: The strategy of postponement involves the delay of processes. Manufacture of

products may be delayed until a customer places an order; this is most likely when product manufacture or assembly can be done quickly. More frequently, undifferentiated products are held in a centralised inventory, thereby reducing the total inventory held and the costs built into it. When more information is obtained about demand, differentiating processes can be performed whether the final manufacture of a product, the labelling to national market requirements or simply shipping to one market rather than another.

For products with highly uncertain demand, the ability to defer production until as much as possible is known about demand is especially advantageous. Thus, the geographical shifts of manufacturing in the textile industry reflect the predictability of demand for particular product groups. For example, increased manufacture of fashion textiles has taken place in the Caribbean and Central America at the expense of Asia as time to North American customer has assumed greater importance (Abernathy *et al*., 2001). Similarly, the efforts of the automobile industry to provide individual car buyers with the style, colour and options they desire within ever-shorter times and at reasonable cost requires a responsive supply chain. The nature of trade-offs can be illustrated with an example.

Car seats are usually assembled close to the auto assembly plants, for the obvious reason that their bulk makes them expensive to transport. However, the manufacture of components of seats may be more widely distributed, for example in the manufacture of leather seat covers. This manufacturing is labour intensive. As a result, production is found in Asia often using imported materials. The finished covers may be shipped back by sea container. Products of good quality have been produced in systems that have had long though precise round-trip cycles. However, the pressures to give car buyers choice and fast delivery, at reasonable cost, is difficult for such a supply chain. To achieve the responsiveness to meet variable demands without excessive inventory close to auto markets requires a much more flexible logistics system. In the absence of forecasts of demand long enough in advance, some seat covers, at least, may have to be sent by airfreight. The difference in costs between sea and airfreight is such that the viability of exports from Asia is threatened. The challenge increases the competitiveness of alternate locations with low labour costs closer to the major markets, for example, Eastern Europe for Western Europe and Mexico or the Caribbean for North America. A general consequence for consumers if effective supply solutions are not found is that the range of options available in short times becomes limited.

Supply chain visibility: Reductions in the order cycle and delivery lead times have been achieved through many changes in the design and operation of supply chains and logistics systems. Vital contributions to the changes have been made by the developments in information and communications technologies (ICT). Notable has been the transfer of data and other information resulting in reduced order cycle times. However, another vital benefit of ICT systems is enhanced supply chain visibility.

Firms are striving to achieve better visibility, forwards and backwards, along their supply chains. Forward information reveals point of sale information from bar code scanning, shared real time or frequently through automatic electronic transmission. This allows members of supply chains to make quick and consistent decisions (with different levels of sophistication among supply chains) about replenishment based on common information. It enables the use of cost-effective methods such as Manufacturing Resource Planning or Continuous Replenishment Planning and avoids the violent fluctuations of inventories associated with sequential and delayed information provided along disjointed supply chains (Forrester, 1958). Visibility backward along supply chains enables receivers

to be fully aware of the status of orders so that early actions can be taken to minimise costs associated with delays in supplies or with changes in requirements. The visibility of the status of purchase orders from the time they are placed until goods are delivered is one of the competitive services offered by major logistics service companies. Visibility is a key benefit at the heart of increasingly sophisticated supply chain software.

2.2.2 Challenges and opportunities for liner shipping

Each of the strategies described above is associated with a range of changes in the characteristics of supply chains and logistics systems. These create challenges and opportunities for shipping lines.

Relationships among supply chain participants tend to be closer. To achieve this, buyers seek to use fewer suppliers of particular goods and services. For shipping lines and other carriers, this means that shares of shippers' business are larger but go to fewer firms. One of the attributes desired by shippers as they develop closer relationships with fewer lines is that those lines have an extensive service network able, therefore, to serve them in various trade lanes. The pressure on lines is to develop more extensive service networks.

The reduction of time is becoming a more important logistics strategy to reduce costs and to improve customer service. Hummels estimates that for manufactured goods imported into the US each day of travel is worth an average of 0.8% of the value of the good and that each day in transit reduces the probability of a country as a source by 1.5% (Hummels, 2001). The related feature is the greater attention to reliability of products and processes. The costs of "disruptions," whether associated with variations in demand, logistics or supplier performance warrant close attention (Levy, 1995). The effects of disruptions are particularly great when lead times are long, even with good information systems, hence the importance of the unanticipated congestion in 2005. Greater recognition of the costs of disruptions discourages strategies of reliance on low-cost long supply chains and encourages the use of a variety of sources and the use of, at least, some shorter, faster supply chains. More local sourcing, the use of improved IT and of expedited logistics services are encouraged. The liner shipping industry faces prospects of a diminishing role, at least in percentage terms, in international trade if the threat of congestion were to remain. The competitive advantages accruing to lines offering short reliable transit times would increase. These are lines on short routes, with fast ships and with related services that ensure fast and reliable door-to-door service. Whether the heightened value of short transit times would be sufficient to create a market to support new fast ships in ocean services remains to be seen.

In pricing their services, lines face heightened competitive conditions. The competition for market share is increased by the traffic allocation strategies of shippers, the legislative weakening of conferences and the rapid increase in capacity resulting from the new generations of larger ships. The competitive mix has also been affected by the entrance into international logistics, including the services using liner shipping, of the integrated carriers such as United Parcel Service (UPS) and FedEx. Also, shippers have available to them a widening range of manufacturing locations and logistics strategies that place limits on the rates chargeable by lines on particular routes.

These changed conditions create opportunities for the lines that respond well. Notably, the strategies of lines to ensure faster, more reliable services are resulting in greater attention to the coordination of operations along the logistics chain and to on-going shifts in the span of activities in

which the shipping lines are engaged. Striving to provide enhanced customer service is taking lines into additional service areas and redefining relationships in international logistics service. Before examining the position of shipping companies in other services, it is appropriate to examine developments in the logistics services sector.

2.3 Changes in the logistics industry

It is customary for firms with small volumes of international traffic destined for or originating in a foreign country to use a freight forwarder. Freight forwarders have long been specialists in arranging the transportation, storage and handling of goods along with associated documentation activities between and within countries.[3] They manage the activities through their own offices and through those of partners. They may act as agents in arranging transportation or act as a non-vessel owning common carrier (NVOCC) co-loading freight onto a shipping line's vessel and issuing their own bill of lading. For example, DHL provides this service as Danmar Lines. In the trade of countries with highly specialised logistics and transportation conditions, even large firms with substantial volumes of trade into the country have traditionally sought the assistance of such specialists.

The increased demand for logistics services in the last 20 years has arisen with the growth of global supply chains and the greater use of outsourcing for logistics services. The result has been the creation of a multi-faceted, large and complex logistics services industry. It has evolved from various bases the most important of which has been the traditional freight forwarding firms, the largest of which commenced from European roots and had a wide international presence for most of the twentieth century. They were present in most continents but had varied intensities and relied on partners in some countries. In the last two decades they have increased the number of countries in which they have a direct presence and have increased the intensity of their presence in most countries. They have generally done this by acquisitions and mergers. In 2008, the Swiss-based Kuehne & Nagel had an invoiced turnover of US$20.3 billion (CHF21.6 at CHF1 is US$.94) of which US$9.4 billion was for sea freight services. In 2008, Panalpina also Swiss-based, had revenue from its forwarding services of US$10.0 billion (CHF10.6 at CHF1 is US$.94). The other leading European forwarders Danzas and Schenker are now owned by Deutsche Post and Deutsche Bahn respectively. Deutsche Post acquired Danzas in 1998 and branded its forwarding and logistics services as the Danzas Group but following the acquisition of DHL (and Exel) in 2005, it branded the services as DHL Global Forwarding and DHL Freight. In 2008, Deutsche Post World Net reported revenue from forwarding, freight and supply chain services as US$41 billion (€27.9 billion at €1 is US$1.47). Express services had revenue of US$20.0 billion. Deutsche Bahn acquired Schenker in 2002 (and Bax Global in 2005) and conducts its global business under DB Schenker Logistics. In 2008, DB Schenker Logistics had revenue of US$21.6 billion (€14.7 billion at €1 is US$1.47).

The logistics services industry has also experienced growth from firms with previously more specialised businesses. They include domestic transportation and warehousing companies, courier and parcel services and liner shipping companies. Particularly in North America, changes occurred in transportation and logistics services in response to the opportunities and challenges associated with the growth of companies, the deregulation of the transportation industry and the heightened service demands of evolving supply chain management practices. Contract logistics suppliers have developed to take advantage of the interests of some large companies to out-source logistics activities. The best

examples of these new third party logistics providers in the US are Schneider Logistics and Ryder Logistics, which expanded into logistics from trucking operations, and C.H. Robinson that had a produce warehousing base. These companies have subsequently expanded into international logistics and supply chain services. However, while the firms are substantial in total, as public companies Ryder System and C.H. Robinson Worldwide reported revenues of US$6.2 billion and US$8.6 billion respectively, their international revenues are still modest. This is identifiable for Ryder in 2008 as US$800 million, which is one half of the company's Supply Chain Solutions revenue.

Companies in the express and parcel businesses have also added logistics and freight services. UPS expanded into international logistics services rapidly since it acquired Menlo Worldwide Forwarding in 2004 and incorporated it into a newly formed UPS Supply Chain Solutions. In 2008, the revenue from Supply Chain Solutions and Freight was US$8.9 billion and from the international package business was US$11.3 billion. (Revenue from domestic packages was US$31.3 billion.) FedEx has also expanded its portfolio of services. In 2000, FedEx acquired Tower Group International, a leader in the business of international logistics and trade information technology and used this as the core of its new FedEx Trade Networks. In 2008, FedEx Trade Networks initiated its first ocean-ground distribution service with a service from Asia to the US West Coast. (In 2008, the total value of FedEx international business was US$8.5 billion compared with US$27 billion of domestic revenue.)

Finally, shipping lines have made a significant entry into logistics services. Responding to the interests of shippers to deal with fewer suppliers and to outsource logistics activities, most liner companies had introduced some logistics services. However, the lines providing the most substantial logistics service remain those that were the entry leaders between 1970 and 1980 serving the interests of importers of manufactured goods from Asia. Importers of Asian goods felt the need for better assistance in managing the flow of imports. The value of imports from Asia was increasing and the shipping lines were interested in extending their range of services to customers. The result was the development of consolidation services, most notably initially by Sea-Land (1970, known as Buyers), Maersk (1977, known as Mercantile), and American President Lines (1980, known as American Consolidation Services [ACS]). The services differed in some important respects from the balanced directional services offered by freight forwarders. They were focused on the needs of importers from Asia for monitoring the movement of goods to consolidation points, managing the consolidation of goods and shipping according to the specifications of the buyers. The companies were aided in the development of these services by existing familiarity with the buyers' needs through their shipping services. They were able to offer consolidation services with high visibility by utilizing their existing links with the shipping lines' documentation processes.

Subsequently, these and other shipping lines entered into logistics services with optimism for a greater rate of growth of logistics than liner shipping; however, they have remained a modest part of the companies' business. The development of these businesses is reviewed later.

For all of the logistics services companies, growth has also been marked by a shift of suppliers' strategies from being asset driven to being knowledge driven. An essential component of the knowledge base is built around ICT. Traditional freight forwarders have generally lagged behind new logistics service companies in the use of ICT technologies. However, increasingly, all logistics companies are introducing web-based capabilities so that shippers can perform activities on line, including arranging shipments and accessing information about the status of their shipments. In

addition to the benefits for shippers of being able to track their shipments, the resulting database becomes an integral tool for them to plan, budget, forecast, negotiate, and manage their businesses. The capabilities are being provided through proprietary systems and through shared portals. The trade literature is replete with logistics companies adding to their ICT capabilities.

Utilising their information-based systems and specialised knowledge, the logistics service companies have assumed greater supply chain and logistics chain design and management responsibilities characteristic of 3PL services.

3. The Horizontal and Vertical Restructuring of Lines

Shipping lines have faced pressures in the changing market place to expand their services geographically and to widen the range of services offered. The response of lines has differed depending on their views of market opportunities, their resource base in terms of their financial resources, the initial geographical extent of their services, the range and level of supporting services, especially in information technology, and the depth and breadth of their human resources.

3.1 The horizontal restructuring of liner shipping

As large shippers have followed supply chain strategies involving the use of fewer suppliers, they have placed heightened value on the extent of the network of services offered by liner companies. This is the primary reason given by American President Line (APL) in 1995 for the introduction of its first service from Asia to Europe through a slot-charter agreement. The new service was a significant shift in APL's policy as up to that time it had a Pacific-only service strategy. The shift of major lines to global networks is a major reason for the increased concentration in liner shipping on a global basis. However, on a route basis, the actual markets for shipping services, there has not been an increased concentration although the 2008–2009 recession has led to more vessel sharing agreements between lines.

The strategies of lines in extending the network of their services have been covered extensively in the literature and feature prominently elsewhere in this book. The addition of routes by lines has been dominantly by slot charter, alliance and merger or acquisition rather than the extension of own services. These methods limit the need for new investments while extending route networks and avoid reductions in the density of traffic in relation to infrastructure costs by route, an important consideration in network industries.

There has been speculation that the growth of global carriers will lead to the development of global contracting for services by major shippers. However, it does not appear that global contracts are common even though shippers have a preference for dealing with fewer carriers and, therefore, with carriers with large networks. Contracts still appear to be related mainly to traffic volumes and service conditions by route. This is not to say that in negotiations, traffic volumes and conditions across routes are irrelevant. Simply, there is no evidence so far that the more global orientation of logistics is having a major effect on shipping beyond encouraging the geographical expansion of companies' services. It is possible that the legal end of liner conferences in European trades on 18 October, 2008 may lead to greater interest in multi-route contracts, but given the prior existence of confidential contracts, the influence is not likely to be strong. Also, the interest in many global companies in 2009 to increase responsiveness in their business by shifting to regional rather than global responsibilities is consistent with route rather than global negotiations. The effects of logistics on the vertical

structure of the industry are more prominent.

3.2 The vertical restructuring of liner shipping

The vertical structure of liner shipping has been affected by developments in logistics in a number of ways. The interests of shippers in dealing with fewer suppliers have influenced lines to extend the vertical reach of their services. The interests of shippers in faster and more reliable services have not only affected the design of shipping services but also the relationship among the services necessary to deliver value to shippers, for example, by door-to-door services. The interests of shippers in outsourcing logistics services have created an opportunity for shipping lines (and others) to expand their third-party logistics services. The expansion of lines into services beyond shipping has lead to greater vertical integration in the industry but the organisational relationships vary with the nature of activities and the interests of shippers in those activities. The added services common in shipping are divided into three. They are terminal operations, intermodal services and logistics services.

3.2.1 Involvement in terminal management

Container terminals are providing mainly intermediate services in international logistics. They are designed to ensure the fast and efficient transfer of containers at hub terminals in shipping networks and at throughput terminals for transfer to inland carriers. On-dock cargo-handling services, such as container stuffing and de-stuffing, that might be requested by shippers have become an insignificant part of the modern terminal business. The terminals view their main customers as the shipping lines as the contracts with them are the single largest determinant of their business volume. However, in the long run, the success of terminals is dependent not only on how efficiently they serve the ships but also the efficiency of the closely related on-dock operations and the connections with inland carriers. Efficient terminal operation is measured by the speed and reliability with which containers can be moved through terminals at a competitive cost in order to meet the logistics needs of shippers. Terminals must have levels of capacity and performance compatible with the same-day-of-the-week services of shipping lines. Increasingly, they need to be able to tailor their operations to serve the differentiated needs of shippers for expedited movement inland, including boxes moving in time-defined services.

Traditionally, the port authority or a stevedoring company local to the port or region managed port terminals. However, starting with the introduction of containerisation and the focus on customer service by Malcolm McLean of Sea-Land Services in the US in the 1970s, the interest of large lines in dedicated terminals has increased. For companies with a sufficient volume of traffic, dedicated terminals were seen to provide better opportunities to coordinate the operating philosophy and day-to-day operations of vessels, terminals and inland transportation. Sea-Land, for example, required containers to be placed on chassis on terminals and not grounded. Dedicated terminals are intended to serve the vessels of a parent company. However, when surplus capacity exists (berth time slots and on-dock capacity) other lines may be served.

Dedicated terminals became common first in the US, in part because of the philosophy of Sea-Land. Elsewhere, concerns of governments and public port authorities about the effects of dedicated terminals on competition led to policies that inhibited dedicated terminals. In the 1990s, the shortage of capital available to port authorities, the general increase in privatisation and greater interest in intermodal developments, resulted in a change in attitudes so that dedicated terminals are now

commonplace. Given the importance of a close operating philosophy and of operating practices between a line and its terminal, it is not surprising that lines with dedicated terminals often began by managing those terminals as units integrated with the shipping line. Only occasionally did some lines contract with specialised terminal management companies for the management of their terminals leased long-term to them by port authorities.

The rapid growth of container shipping and the concurrent need for more capital investment in ports created new opportunities in terminal management. In part, the need was met by shipping lines entering into the terminal management business, initially to serve primarily their own needs. Companies such as Sea-Land, APL and Maersk continued for a number of years to manage these terminals within the framework of their shipping lines. However, some lines, as they developed their expertise, soon sought advantage for these terminal enterprises as successful profit centres by expanding into the terminal operating business serving others. For example, P&O Steam Navigation Co., which had a 50% interest in P&O Nedlloyd, established P&O Ports. Orient Overseas International Ltd (OOIL), which owns Orient Overseas Container Line (OOCL) managed four ports through a Terminal Investment unit (the terminals were in Vancouver, New Jersey, New York and Venice) although it retained two container terminals operated as a part of and for OOCL. These were in Kaohsiung and Long Beach.

Subsequently, other shipping companies have increased the separation of their lines from terminal management. In 2001, A.P. Moller made its Maersk Ports, which was the terminal operating company for the dedicated terminals of Maersk Sealand (Maersk acquired Sea-Land in 1999) a stand alone unit known as APM Terminals (Economics Intelligence Unit, 2001). The objective of APM Terminals was "to strive for excellence in terminal management while actively seeking new opportunities in port and terminal development" (Economics Intelligence Unit, 2001). A.P. Moller saw its terminal management business as having a scale warranting a stand alone status and it anticipated that its substantial business with Maersk Sealand (then 90% of its throughput) would not jeopardise its position with other lines. APM Terminals subsequent growth and the growth of traffic of other carriers to 38% in 2008 attests to the validity of the A.P. Moller position. In 2008, APM Terminals was the fourth largest container terminal operator in the world with 34 million TEUs handled.

More recently, other shipping lines have separated off their terminal businesses. In 2006, OOIL announced the sale of its four container terminals to Ontario Teachers' Pension Plan Board (The Standard, 2006). It saw the US$2.35 billion as yielding benefits greater than those of ownership. In 2008, Neptune Orient Lines established three separate business units, APL (the container line), APL Logistics and APL Terminals to facilitate Terminals expanding its business in new locations (Container Management, 2008). The implications of these changed relationships are considered later.

The greatest change in terminal management has been the growth of terminal management companies as these firms have responded to the need for more capital investment in ports to serve the growth in port businesses. Some companies, such as Seattle-based SSA Marine, formerly Stevedoring Services of America, provide terminal management services to a variety of types of terminals, although container terminals are important to the company. However, the dominant global companies in the industry focus on container terminal management as the container business has been the leading growth sector in ports.

The leading container terminal management companies today are Hutchison Port Holdings of

Hutchison Whampoa, PSA International (PSA) and DP World which handled 67.6 million, 63.2 million and 46.8 million TEUs respectively in 2008. DP World's sudden emergence as a global player after the founding of Dubai Ports International only in 1999 is largely the result of acquisitions, CSX World Terminals in 2005 and P&O Ports in 2006.

3.2.2 Involvement in intermodal services

Traditionally, the business of shipping lines was the movement of cargo on a port-to-port basis. This may still be true of smaller lines competing on a low-cost strategy and is necessary for most or all lines in regions in which intermodal movements are impractical. However, in Europe and in North America all the major lines now offer door-to-door service. The door-to-door services are designed to make available to shippers reliable fast service through a single supplier.

Shipping lines have largely provided inland transport, so called carrier haulage, (the alternative is 'merchant haulage' whether arranged by a shipper or freight forwarder) through the purchase of inland transport. It has been done mainly through a combination of long-term contracts and short-term purchases under the responsibility of a group within the shipping business, such as Maersk Intermodal at Maersk. Some lines own some trucking capacity. The incidence of carrier haulage varies from region to region depending on the length of the inland movement, the characteristics of the inland transport industry and the role of freight forwarders in the trade.

Shipping lines were leaders in the development of rail intermodal services in North America and are now playing leading roles in Europe and China because they have been in a better position than freight forwarders to commit for the volume of traffic necessary to make dedicated rail service viable under long-term contracts. The need for direct ownership of rail services is greater in Europe than elsewhere because of the domination of that industry by state-owned passenger-oriented railways. However, under the current deregulated environment in Europe, there are more opportunities for services such as the Maersk-owned European Rail Shuttle (ERS), started by other shipping lines in 1994, to play key roles in intermodal services.

The extension of shipping lines into intermodal services was consistent with the logistics needs of shippers and facilitated by the transaction economies enjoyed by the lines and the effectiveness for coordinating operations. Shippers remain free to select the port-to-port or the door-to-door service.

3.2.3 Involvement in logistics services

Unlike intermodal services which are managed within the shipping business, the conduct of logistics services is largely done in independent business units, although these are frequently branded to carry the group name. For example, Mercantile and Buyers were joined as Maersk Logistics and ACS became APL Logistics. Other shipping companies added such units, for example Cosco Logistics and NYK Logistics, but not all lines have adopted this as a global initiative. For example, Evergreen which had formerly focused its strategy on excellence in meeting shippers' requirements through their shipping and door-to-door service capabilities, announced, in June 2002, that it would invest in forwarding and logistics in Asia and South America. In 2007, it established Evergreen Logistics Corp offering a full range of logistics services in China, North America and Europe.

The early development of logistics services by lines was in locations in which the lines had particular knowledge. For P&O, Nedlloyd and Maersk, the early services were developed to serve mainly European shippers, for APL and Sea-Land to serve the needs of US shippers. Subsequently,

however, the lines saw value-added services in logistics as offering faster growth and better profitability than shipping. The developments at APL, P&O Nedlloyd and Maersk Sealand reflect the past and current interests of these lines in logistics. There has been a great change in expectations in less than ten years.

Following its acquisition of APL in 1997, NOL reorganised its logistics services into APL Logistics (APLL) to advance its strategy of rapid growth in the logistics area. APLL was then the fastest-growing business unit in the NOL Group. Its growth in 2001 was 72% reflecting the acquisition of GATX Logistics, the second largest warehouse-based contract logistics company in the US. The acquisition enabled APLL to serve customers more effectively through the primary (importing) and secondary (national) distribution phases of the supply chain. Flemming Jacobs, the President of NOL stated that he wanted "the logistics business to challenge the Liner business as a major breadwinner of the Group". In 2001, liner revenues were US$3.6 billion, logistics revenues were US$723 millions. The Annual report for 2008 shows APL revenue as US$7.9 billion and APL Logistics revenue as US$1.3 billion, so that the percentage of logistics to shipping revenue has declined from 20.1 to 16.5%.

With the acquisition of Sea-Land, A. P. Moller also re-branded its logistics services, naming it Maersk Logistics (ML) but it left the management independent of the shipping line. ML's mission was to be an independent organisation operating worldwide through locally incorporated companies. It is engaged in satisfying customers' expectations in respect of competitive, international export and import management services. It is largely a non-asset-owning company managing its quality through the careful selection of subcontractors. It has offices in 93 countries.

The A. P. Moller Group has been less open than NOL about the role expected of ML within the Group. However, Soren Brandt, the head of ML, noted, "the logistics activity could grow to outperform those of the liner, but it will take a while" (Le Lloyd, 2001). He also characterised the shipping and logistics businesses "as distinct businesses." ML made a number of acquisitions during 2001 of which the largest was the US-based Distribution Services Limited (DSL) which had offices in 60 countries and 1,500 employees, compared with ML's 3,500 employees. Wal-Mart was one of DSL's major clients (Maersk Logistics, 2001).

In 2005, Maersk acquired the freight forwarding business Damco as a part of the acquisition of P&O Nedlloyd. In 2007, Maersk Logistics' air freight and landside services and its DSL Star Express was renamed "Damco". In its 5 June 2009 News Release, Maersk announced that it will merge its supply chain management activities branded as Maersk Logistics and its freight forwarding activities branded as Damco, under the single brand name "Damco". Thus Maersk has returned to the strategy of a separate branding for its shipping and logistics-related businesses.

The experience of the now defunct P&O Steam Navigation Co. (P&O), the senior company that held the 50% interest in P&O Nedlloyd, with logistics management is still instructive. Most of the logistics services of P&O were in different businesses from P&O Nedlloyd but one was integral to the shipping business. When P&O Nedlloyd was created by the merger, it brought together the previously separately identified Global Logistics and some logistics services that had evolved as ancillary to shipping activities. The new group was named Value Added Services. It was intended to work with P&O Nedlloyd customers in providing advanced logistics or supply chain management services. Intermodal transport arrangements were not the responsibility of VAS; they were managed within

shipping services. P&O Nedlloyd was attempting to bridge the gaps of different personnel skills and backgrounds among its own employees in shipping and VAS. It had one sales force, which it hoped would develop effective contact levels with clients to deal with shipping and logistics interests. It expected to identify effectively those clients for whom an integrated approach of a line with its logistics service was practical and attractive.

P&O did not follow this model only. It had three other logistics service groups that operated quite separately from the shipping services. Damco, a separate but wholly-owned subsidiary of P&O Nedlloyd, engaged in freight forwarding with its own offices in nine countries in NW Europe and the Far East and with partnerships with local forwarding agents in a further 40 countries. P&O also owned P&O Trans European, a European-based logistics service company, and Cold Logistics, which specialised in serving the cold-product sector globally. The Chairman of P&O in his message to shareholders in the 1999 Annual Report notes that the company's logistics services are "high growth, high return businesses" and that "the ongoing P&O would focus on its high return logistics activities."

With the exception of VAS, the logistics businesses of these companies were organised as corporate units quite separate from shipping. A major reason for this was the expectation of shippers that logistics service providers (LSPs) act independently of interests in carriers when choosing modes of transport and carriers to meet shippers' logistics needs. Thus, even though logistics units may be branded with the name of the shipping corporation, their executives pointed to the independence of those units in selecting carriers.

There were also operating conditions relevant to the level of integration. Executives of VAS recognised that the skills and outlooks of managers in consignor and consignee firms generally differed between those responsible for the management of transportation services and those responsible for the management of supply chains. VAS hoped that the differences would lessen and an integrated approach would become possible. However, in June 2002, P&O Nedlloyd announced the reorganisation of VAS into P&O Nedlloyd Logistics. The experiment was over.

In spite of the organisation of logistics units as separate structures, the actual level and ways of sharing resources and information between the business units remains uncertain. The utilisation of common information systems provides economies. However, it is in the sharing of market intelligence that uncertainty about relationships exists.

4. Assessment of the Organisational Structure

Examination of the attributes of the relationships of shipping with each of the three services described above provides insights into the probable future of the organisational structures. The structure of each of the services is considered in turn.

4.1 The organisation structure for terminal management

A line may prefer a dedicated terminal so that it can ensure harmonisation of operating practices through its network of operations. This was the original reason that Sea-Land operated with dedicated terminals. Similarly, Maersk's interest in a dedicated terminal in Rotterdam in 2000 is believed to have been based on its preference for operating practices that allow for the flexibility in throughput rates it expects of its terminals. Also, the development of well-integrated ICT can be facilitated through dedicated terminals. Thus, terminal management by a line can be efficient when a line has a sufficient volume of traffic to achieve an economic utilisation of the terminal capacity and the line

has a network of routes and terminals to achieve economies of scale and proficiency in terminal management. Alternatively, a line may contract a terminal management company to operate a terminal on its behalf.

Therefore, it can be argued that dedicated terminals operated as a component of the shipping line can be consistent with efficiency and coordination between the shipping and terminal operations. Benefits can be achieved without raising conflicts with the immediate interests of shippers as terminals provide intermediate services in the process of moving containers between inland and ocean transport. Shippers retain the choice of arrangements for the movement of goods to and from terminals.

Concerns that dedicated terminals may reduce competition between shipping services have diminished as overall trade has grown and competition among lines and routings has increased. Lines and shippers have effective choices as long as one or two of the major terminal management companies do not gain too much control in a port range. The protection of competition is not about dedicated terminals but about the number of terminals controlled by one or two terminal companies in a port range.

While dedicated terminals remain common, recent experience, for example APL and Mearsk, has been for the management of lines and terminals to be treated as separate businesses. This allows the terminal management to focus more effectively on commercial opportunities in its business. Further, the evolution of terminal management has been associated with increased sophistication and in many ways more standardised basic approaches as terminals strive to increase throughputs through space-restricted terminals. The result is that the benefits for a line of operating its own terminals in close association with its line may be less now than formerly.

4.2 The organisation structure for intermodal services

The case for the close involvement of a shipping line in intermodal services is comparable to that for terminals, except for two factors. First, the diversity of traffic flows and modes would make it difficult for a single agent to invest in, contract for and arrange all inland moves. The business is heterogeneous so that control of all inland movements by lines is impractical. Second, the diversity of shipper interests in the nature of inland transport arrangements means that the right of choice is important for shippers to ensure that the right mix of service, control and cost are preserved. Whether the efficient coordination of the inland transportation into the supply chain processes is achieved best by use of carrier or merchant haulage (a “traditional” freight forwarding function) is best left to the choice of shippers.

However, shipping lines can have an advantage over shippers and freight forwarders in arranging intermodal transport services when the ability to commit volumes of traffic is important to the viability of a service. This has been the case with the introduction of dedicated trains and certain barge services where reliable volume commitments are important. These are situations in which there are economies of scale.

The arrangement of intermodal services by shipping lines has been a way for them to provide door-to-door pricing and to provide a single responsibility along logistics chains with good visibility. It has provided a competitive service to the freight forwarders offering door-to-door services as NVOCCs. However, the needs of shippers have changed over time with the evolution of global supply chain

management. The result has been some new responses from the lines to coordinate shipping and inland transport services.

The recession of 2001 resulted in surplus liner capacity and pressure on freight rates. It came at a time when there was concern that container shipping service had become so commoditised, so similar among lines, that competition was based on price. In March 2002, C.C. Tung, the chief executive office of OOCL, expressed concern about competition among "commoditised" shipping services as contributing to the reduction of rates. To avoid "over-commoditization" he urged "offering value-added products" (American Shipper, 2002). Earlier in 2001, the president of NOL, Flemming Jacobs, said that "Shippers and ocean carriers are 'confused' when they focus on narrow yearly negotiations on freight rates, instead of looking for opportunities to increase overall supply chain efficiencies" (American Shipper, 2001). He went on "I am going to give a wake-up call to those who still get their kicks from yearly, or even more frequent, fights over freight rates with their ocean carriers – those who just cannot wait for the 1st of May to come around and who derive the greatest satisfaction from succeeding in squeezing another $50 from the carriers, even though in the process they miss tons of opportunities in the total supply chain."

The subsequent expansion of global supply chains gave rise to the congestion problems of 2004–2005. The pressures on shipping capacity were severely aggravated by congestion inland from ports. Traffic was backed up so that terminals became congested. Shippers responded subsequently by adopting new strategies to reduce the risks of service failures. They included extending the peak by shipping earlier, using a greater number of shipping routes and negotiating new provisions in confidential contracts with lines.

One of the responses of lines has been to consider services publicised with guaranteed delivery times, an approach made more relevant in the international market by the presence of the international package and freight services and their logistics services such as UPS Supply Chain Solutions and FedEx Trade Networks. However, the provision of a truly guaranteed service requires priority treatment for freight at port terminals, for vessel space and for intermodal connections. In 2006, APL Logistics was the first line to offer a port-to-door time guaranteed less-than-container (LCL) service from China into the USA, with Con-way Freight performing the inland carriage in the USA. The ocean carrier is APL (Shippingline.biz, 2009). Japan, South Korea, Singapore and Taiwan were added as origins in 2007 and Mexico was added as a destination in 2009. In 2008, a full-container guaranteed service was introduced from China to the USA (3PL wire, 2008). The services require not only new segmented operating practise in terminals and for container handling on and off vessels but, also, new types of agreements with specific intermodal carriers. In 2009, Hanjin and MOL have introduced time-guaranteed services on routes from Asia to the US West Coast with distribution in the USA being handled by Old Dominion Freight Line and the railway company BNSF, respectively.

The time-guaranteed services are the latest evidence of lines and their associated businesses working together to design and operate services that can provide more reliable services to shippers. However, the examples also show that the design and operation of a well-coordinated service does not require common ownership.

Concurrently, other lines have increased their attention to service reliability without the introduction of service guarantees. Whether the costs of differentiation turn out to be worthwhile and appropriate for more lines depends on the size of the market segment for the premium service. A

study by Kouvelis and Li (2009) identifies that there is a market niche but its size and profitability remains to be determined. Whether this form of service differentiation becomes a major strategy of lines in the future, as suggested in a report by IBM Institute for Business Value (2005), remains to be seen.

4.3 The organisation structure for logistics services

The organisation structure appropriate to the relationships of logistics services with shipping lines involves more issues than the relationships considered so far for terminals and intermodal services. The range and scale of logistics functions affect the potential for economies from integrated management and the interests of shippers in dealing with integrated or separate service providers. The appropriate market structure is one that reflects the potential for economies of scale and scope in integrated management and the interests of shippers in their management of logistics and shipping service purchases.

Small shippers have long used freight forwarders because of the rate and service benefits that forwarders can provide through the consolidated volume they control. New LSPs can offer similar services. For small shippers, then, that do not have the volume of traffic to negotiate effectively with shipping lines, the relationship of the LSP with the shipping line is not important. They have the ability to choose among the different types of service offerings.

Large shippers are in a different position. They have become more interested in outsourcing more aspects of logistics to LSPs. The LSPs may be relatively new to the logistics business, as are some of the new “independents”, or they may be linked to transportation companies or they may have a long history in freight forwarding. Large shippers do have volumes of traffic that enable them to negotiate contract rates with lines so that the choice of negotiating separate logistics and shipping services is relevant to them. Therefore, it is appropriate to ask do large shippers negotiate rates and traffic allocations with shipping lines or do they use LSPs offering integrated logistics and transportation services at integrated rates?

It appears, based on discussions with a few shippers, carriers and writers on the liner shipping business that large shippers prefer to retain responsibility for the negotiation of liner rates and the allocation of traffic among lines. Although there are undoubtedly exceptions to this, they appear to be very infrequent and their incidence has been little affected by the trade uncertainties of recent years. The reason for shippers retaining responsibility for negotiating rates with lines can be accounted for by four factors. They are: the quality of the logistics chain; the value transportation services negotiated; the nature of the negotiations; and tradition.

4.3.1 The quality of the logistics chain

The value of the quality of service required in a logistics chain is important to the structure of the chain. Chains in which time-sensitivity is high may require “managed delivery” under tightly prescribed conditions. The efficiency of delivering time-sensitive products may be improved by placing the transport and inventory management with a single management and with a single price for the services. Examples are: the just-in-time delivery of automobile parts to an assembly plant involving both trucking and parts management; and the international delivery and inventory management of computer components by a courier company. In these cases, the design of separate functions into an integrated service is the business equivalent of the creation of a mixture in

chemistry. The characteristics of the mixture can be varied through different proportions to serve particular purposes but the mixture is more valuable than the component parts separately.

The liner shipping function by its nature is not as tightly bound to other logistics activities as trucking or air transport in the examples above. The length and uncertainty of time involved in the movement of goods by sea prevents such tight coordination of transport and logistics operations. A result is that a liner service between ports or extending inland through intermodal services may be as readily provided by one line as another. Indeed, in this sense, the service is commoditised although this is not to deny the existence of important differences in service attributes among lines. Consequently, shippers are unlikely to bundle the design and pricing of logistics and shipping services together in the way that is done for more time-sensitive services.

The recent marketing of the LCL and, more recently, CL guaranteed fast service by three lines and associated companies offers differentiated premium intermodal transportation services. However, the services do not involve the service providers assuming responsibility for logistics decisions of when and how much to ship.

4.3.2 The value of transportation services

Confidential independent contracts between shippers and lines became the norm for large shippers subsequent to the US Ocean Shipping Reform Act, 1998. The elimination of conferences from European trades in October 2008 and their expected demise elsewhere boost the importance of shipper negotiation. Shippers consider the negotiation of liner contracts as important to them because of their financial value. Negotiations are also often complex.

4.3.3 The nature of negotiations

The negotiation of rate and service conditions by a shipper is usually the responsibility of a specialised management group. Such an internal organisation structure tends to preserve the negotiation role with shippers, but it appears to do so for good reason and not just resistance to change.

Large shippers negotiate on the basis of their traffic volume on single as well as on multiple routes although volume is only a powerful argument when the shipper has choices of other carriers and routes. Shippers negotiate, therefore, on the basis of a range of competitive and logistical alternatives actually or potentially available to them. For example, a new plant or a new sourcing or marketing alternative that may shift traffic from one region to another and from one carrier to another or diminish the amount of ocean shipping needed in total can be arguments for improved rate or service conditions. These are not arguments that can be effectively executed by LSPs. However, subsequent to the conclusion of shipper-carrier contracts, the administration of the logistics activities, cargo tracking from the time of purchase order, maintaining cargo allocations among lines and monitoring freight charges are readily and commonly undertaken by LSPs under contract to shippers.

Therefore, although new dimensions of service have become important in confidential rate contracts between lines and shippers, the negotiation of shipping rates and services by shippers has been conducted separately from the negotiation of logistics services. The separability and substitutability of shipping services, the importance attached to the negotiations by shippers and the advantages that shippers have over LSPs in the negotiating process indicate that this structure is likely to persist.

5. Overview of Responses of Lines to Supply Chain Management

The relationships discussed in this chapter are evolving as lines respond to the challenges and opportunities associated with the growth of trade and greater emphasis on SCM. Greater horizontal integration in the industry is one of the major developments in liner shipping, discussed in some detail elsewhere in this book. This chapter deals with the addition of added value services by lines or their parent companies.

The advantages of integrating terminal management closely with shipping services gave rise to the entry of shipping lines into terminal management. They were initially generally managed by a unit closely related to the line or may be managed by a contracted terminal operating company. However, subsequently, the organisation of APM Terminals and APL Terminals as profit centres separate from the lines and the sale of terminals by OOIL suggest a weaker case today for integrated ownership and operations than was previously the case. The stronger opportunities to pursue terminal management as a separate business and the need and opportunities for close coordination between lines and terminals irrespective of ownership have weakened the case for lines and terminals to be under the same management.

The ownership of terminals by lines is not detrimental to the public interest. Terminal operations are one of the intermediate services needed to deliver goods to shippers. There is no direct conflict for shippers in closer relationship of terminal management with the lines. Shippers and the public do have an interest in making sure that the terminal management business continues to operate in a competitive environment.

The development of intermodal transport capability is one of the inherent advantages introduced with containerisation. The advantages of lines in their ability to commit volumes of traffic to warrant specialised inland rail and water services has been important to the success of intermodal services. The carrier haulage arranged by the lines is provided largely through contracts although lines participate in the ownership of some trucking and, in Europe, of rail services. It is important that shippers have available the option of port-to-port service so that they or their agents can arrange merchant haulage. The congestion experience in 2004–2005 has made all parties aware of the critical nature of the port-inland connection and the capacity of inland routes. Shippers have spread their shipping peak, diversified routes and made some changes to their supply patterns. Shipping lines have learned to pay more attention to coordination with their inland carriers.

Development of logistics services by corporations with shipping lines is an important aspect of the vertical integration in shipping. Some shipping lines commenced their consolidation services during the early days of containerisation and these have expanded through internal growth and acquisitions to be substantial LSPs. They are operated mainly as stand alone business units. They are important units to the parent corporations but have grown less rapidly than the companies hoped during the last decade. They remain small relative to the LSPs that have expanded from freight forwarder origins. The existence of the lines' LSPs is somewhat controversial with this latter group. The freight forwarders see the lines as competing directly against them.

The lines' LSPs have enjoyed an advantage in the integration of their ICT capability with that of their related line, but this advantage appears to be diminishing with the general development of ICT capabilities. On the other hand, the line-related LSPs have been at a disadvantage in that some

shippers are concerned about a possible bias to the related shipping line. Large shippers have preferred to negotiate liner rates and traffic volumes quite separately from logistics services, no matter who the LSP. The position of large shippers appears rational in the light of the separability of the shipping service from logistics services and the substitutability among shipping lines. Further, large shippers are likely to regard the negotiation of rates and traffic allocations as of a size and character to be of strategic importance. They are unlikely to see the interests of LSPs sufficiently aligned with their own and they have better and sometimes confidential grounds for the negotiation of rate and service conditions. It is likely, then, that the lines' logistics services will remain in quite separate entities for most lines.

The recent development of defined delivery dates as a guaranteed service is a significant initiative to add service differentiation to lines' services. It remains to be seen whether the size of the market and the rates supported will cover the added costs of the processes required. However, the services go to the core of a major interest of shippers; greater service reliability. This type of service is unlikely to change the structure of the managerial relationship of lines with the terminals, inland carriers or logistics providers. However, improved coordination will be paramount.

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Endnotes

1. I consider this definition to be better than the definition used for its business by the US Council of Supply Chain Management Professionals.
2. At http://cscmp.org/aboutcscmp/definitions.asp, p. 79, July 2009.
3. Freight forwarders formed to serve growing nineteenth century trade among European countries that was faced with the problems of many border crossings. The leading European forwarders went on to become the major international firms, for example, Danzas, Kuehne & Nagel, Panalpina and Schenker.
4. NOL News Release, 19 June 2000.
5. NOL News Release, 27 March 2002.
6. Maersle Logistics News Release, 5 June 2009.

References

Abernathy, Frederic H. *et al*. (2001): *Globalization in the Apparel and Textile Industries: What is New and What is Not*, Harvard University, Center for Textile and Apparel Research, mimeo.

American Shipper (2001): APL's Jacobs calls for wider, long-term logistics contracts, *Shipper Newswire*, ShippersNewsWire@shippers.com, 8 March.

American Shipper (2002): OOCL's Tung warns against "consolidation and commoditization", *Shipper Newswire*, ShippersNewsWire@shippers.com, 7 March.

Container Management (2008): "NOL launches container terminals unit", accessed 23 July 2009 at www.container-mag.com/displaynews.php?NewsID=880

Economist Intelligence Unit Briefs (2001): Maersk Ports poised for rapid growth, 30 August, http://biz.yahoo.com/ifc/dk/news/83001-1.html

Evangelista, P., Heaver, T.D. and Morvillo, A. (2001): "Liner Shipping Strategies for Supply Chain

Management." A paper to be presented to the World Conference on Transport Research, Seoul, July, p. 9.
Forrester, Jay W. (1958): "Industrial Dynamics: A Major Breakthrough for Decision Makers", *Harvard Business Review*, 36:4, 37–66.
Hall, Darren and Braithwaite, Alan (2001): "The development of thinking in supply chain and logistics management", in Brewer, A.M., Button, K.J. and Hensher, D.A. (eds.) *Handbook of Logistics and Supply-Chain Management* (London, Pergamon Press).
Heaver, Trevor D. (2002): "The evolving roles of shipping lines in international logistics", *International Journal of Maritime Economics*, 4:3, 210–230.
Hingorani, Naresh, Moore, Derek and Tornqvist, Keld (2005): "Setting a New Course in the Liner Shipping Industry", IBM Global Business Services, Institute for Business Value, p. 10.
Hummels, David (2001): *Time as a trade barrier*, Purdue University, Department of Economics, Mimeo, p. 27.
Kouvelis, Panos and Li, Jian (2009): "Managing the New Uncertainty", Washington University in St Louis, The Boeing Center for Technology, Information and Manufacturing, Olin Business School, p. 9.
Kuehne and Nagel, *News Release*, 5 September 2001.
Lambert, Douglas M. 2001: "The Supply Chain Management and Logistics Controversy", in Brewer, A.M., Button, K.J. and Hensher, D.A. (eds.) *Handbook of Logistics and Supply-Chain Management* (London, Pergamon Press).
Levy, David (1995): "International sourcing and supply chain stability", *Journal of International Business Studies*, 26:2, 343–360.
Maersk Logistics (2001): Maersk Logistics bolsters market position, *Press Release*, 1 August, www.maersk.com/press_releases.asp?nav=5&subnav=51&press_id=172&year=2001.
McKendrick, David G., Doner, Richard F. and Haggard, Stephan (2000): *From Silicon V alley To Singapore* (Stanford, Stanford University Press).
Menzter, John E., *et al.* (2001): "Defining supply chain management", *Journal of Business Logsitics*, 22:2, 1–25.
Nemoto, Toshinori and Kawashima, Hironao (eds.) (2000): *Logistics Integration in the Asia-Pacific Region*, Report Prepared by The OECD TRILOG Asia-Pacific Task Force, Tokyo: Institute of Highway Economics, p. 122.
Shippingline.biz 2009, APL Logistics and Con-way Freight Launch "OceanGuaranteedSM" Service. Accessed 25 July 2009 at www.shippingline.biz/Sea/APL-Logistics-and-Con-way-Freight-Launch-OceanGuaranteedSMService.html
The Standard (2006): OOIL sells terminals to Ontario teachers for US$2.35b. Accessed 25 July, 2009 at www.thestandard.com.hk/news_detail.asp?pp_cat=1&art_id=32688&sid=11044977&con_type=1
3PL Wire, 2008, "APL announces guaranteed full-container service", accessed 4 August 2009 at www.3plwire.com/2008/02/13/apl-announces-guaranteed-fullcontainer-service/

Part Six
Pollution and Vessel Safety

Chapter 16

Using Economic Measures for Global Control of Air Pollution from Ships

*Shuo Ma**

1. Introduction

It is claimed that maritime transport is environmentally friendly due to the fact that the CO_2 emission to transport one tonne of cargo for one kilometre is 15 grams for a 8,000 dwt vessel; 50 grams for a heavy truck, and 540 grams for a Boeing 747 freighter.[1] However there is no guarantee that this "green" image will always be associated with shipping since great efforts have been made in recent years to reduce the emission levels of other modes of transport, with higher standards continuously being introduced, while no corresponding improvements have been evident in the maritime transport sector. It is estimated that should the current development trends continue shipping will become a major source of air pollution. For example, it has been reported that before 2020, international shipping would overtake all land-based transport to be the biggest emitter of both NOx and SOx in Europe (Friedrich, Heinen and Kamakaté, 2007). It is clear that specific and bold actions have to be taken urgently if the shipping sector is to massively reduce air pollution levels. Given the growth perspective of seaborne trade, the environmental challenges faced by the international shipping community are enormous.

To address the air pollution problems caused by the shipping industry, traditional approaches are insufficient. As far as international shipping is concerned, the International Maritime Organisation (IMO) is the main regulatory body. Here the control method is to set up technical standards then leave the enforcement to the IMO Member States. This approach is often referred to as the "command-and-control" method which has the advantage of being clear, flexible and enforceable. However, it may be argued that such approaches lack efficiency because by using uniform standards the differences in pollution control costs between polluters are ignored. Economic approaches, which are also called market-based instruments, take these costs into consideration by giving economic incentives to those polluters whose control costs are low, and consequently encouraging the employment of new and more advanced control technologies. Market-based instruments have been successfully used in a number of non-maritime situations. It is therefore time for the maritime community, within the framework of the IMO, to embrace these economic approaches and use them as supplementary tools in reducing emissions from ships and achieving overall environmental objectives.

At the IMO, the market-based instrument is a relatively new concept which has not been fully understood or appreciated. This chapter has three objectives: first, to explain why economic approaches can lead to a better and more cost efficient emission control; second, to analyse the two major market-based instruments and their application to the reduction of ship-originated emissions; and third, to suggest an integrated approach using both standards and market-based instruments for the control of emissions from ships. The chapter is divided into six sections. After the introduction, Section 2 presents the theoretical framework and analyses the features of the economic control

method; Section 3 discusses the reasons that economic approaches have not been used in shipping related environmental regulations; Section 4 looks into the necessity of introducing market-based instruments in maritime environmental regulations; Section 5 concentrates on the application of market-based instruments in shipping; and finally, Section 6 presents the conclusion.

2. For Environmental Protection, Public Intervention is Necessary

One of the cornerstones of the market economy is the clearly defined *property rights*, which are exclusive, transferable and protected. In the absence of such property rights, markets will fail. This actually is the case of environmental goods. These goods (i.e. environment benefits or damages) have the characteristics of public goods. For instance, there is no individual person who can be identified as the exclusive victim of air pollution incurred in a harbour. Contrary to exclusive property rights, which imply private and individual ownership, public goods are characterised as non-exclusive in consumption. This means that the damage caused to one person does not increase or reduce the amount of damage to another person. Expressed in another economic concept, environmental products have a zero marginal cost. Such a weakness or absence of property rights may result in an inefficient allocation of resources and a failure to achieve environmental objectives, as there is a lack of any incentive for a rational person to make an investment since s/he cannot own, and transfer, the full benefits.

Marine environmental products, which are the same as any environmental product, create an external cost or externality. Because of this, public intervention is desired to internalise such a cost. A ship, for example, emits exhaust air into the atmosphere during operations either on the high sea or close to the coast. Such emission travels and may harm the health of a population far away. Obviously the ship owner and the sufferers do not have any contractual relationship between them and the environmental product, or the emission, is not priced and stays outside the market. Often it is practically impossible for the sufferer to identify the exact polluter who has caused the damage. Consequently, the production cost incurred to the producer, who uses this to determine the production level in order to maximise profit, is incomplete and in the case of negative externality it is at a lower level than it actually should be. Such a

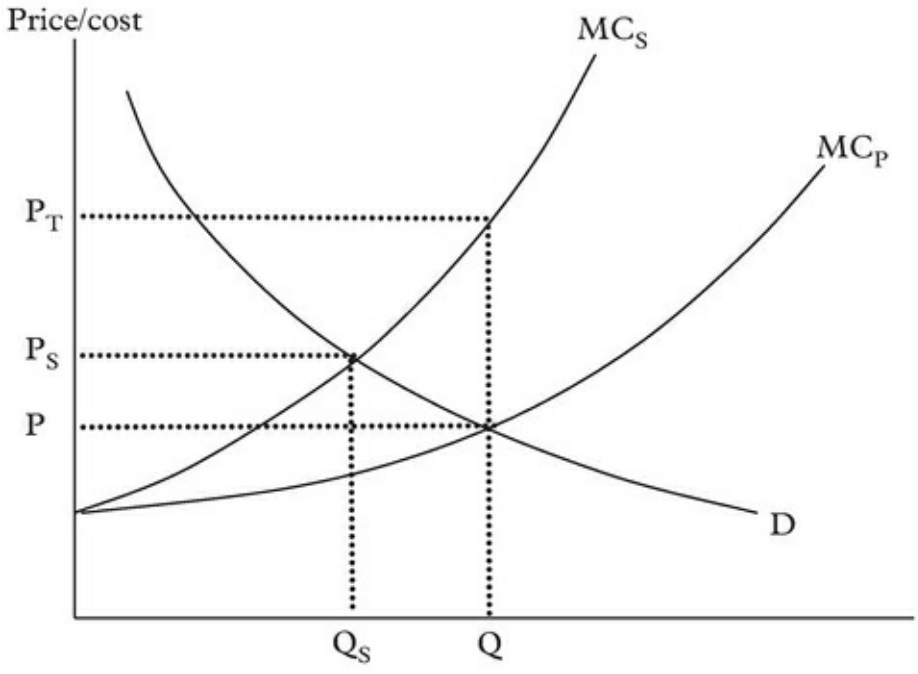

Figure 1: The effect of externality in a competitive market

distorted cost curve leads to the ship owners to produce more than they should, resulting in badly allocated resources.

This situation is illustrated in Figure 1 where the demand curve for the port service, as represented by D, is also the curve for marginal revenue in the case of a competitive market. MC_P is the marginal cost for the shipping company and MC is the marginal social cost which includes the environmental cost associated with the shipping operation. In this case MC_S is always higher than MC_P since the externality is negative and the society bears both the costs of production and the environment-related costs resulting from the production. However, with unpriced environmental costs, the company considers only its direct marginal cost and it will maximise its surplus by keeping the transport production at Q. Such a production level will incur a marginal production cost at P and a marginal social cost at P_T, creating a net externality cost (P_T – P). In the above case such external costs are therefore paid by the victims of the pollution, their families, insurance and the social security system whenever applicable. The figure indicates further that if such externality is internalised, i.e. the shipping company is made to cover the social cost P_T, then the producer will reduce the production to arrive at new demand–supply equilibrium. The production is therefore reduced to Q_S, at which point the company has to raise its price, which is based on the marginal social cost curve, to P_S. Also, at this reduces the production level, the external cost diminishes and the total social cost decreases too, to P_S.

Since the market fails to reflect an important part of the production cost in the final price of transactions, the social cost is unfairly paid for by society rather than by those who benefit from the transaction. To correct this, government intervention is required for the purpose of internalising the external costs.

2.1 Economic instruments are better than regulatory instruments

As far as government intervention is concerned, there are generally two approaches. The first is to use economic instruments such as emission tax or emission trading

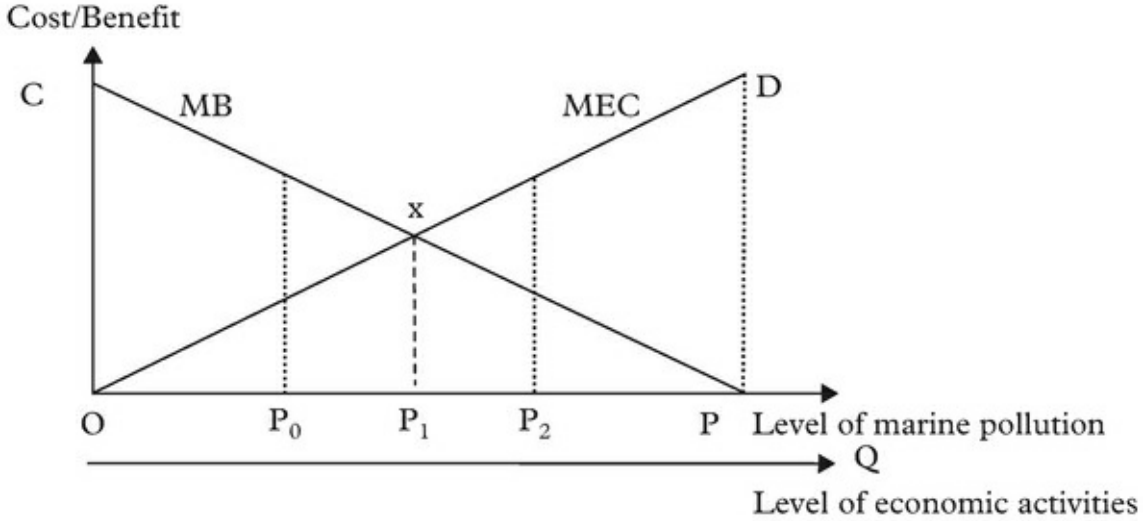

Figure 2: The effect of command and control method

schemes. The second is to use rules and regulations in the form of compulsory emission standards which are often referred to as the “command-and-control” (CAC) method. This approach consists of the promulgation of laws, rules and regulations with the specification of objectives, standards, technologies and operational procedures that polluters must comply with. In the broad context of such

laws and regulations, specific rules and standards are normally established aiming at agreed objectives. From both the theoretical and practical viewpoints, each of the regulatory and economic approaches has advantages and disadvantages.

Using the "command-and-control" method, pollution could be controlled to its optimal level through a "bargaining" process. This is because the optimal pollution level is achieved when the marginal benefit (MB) (or marginal control cost – MCC) and marginal external cost (MEC) are identical. While the MB or MCC can be measured, the calculation of the level of MEC in a precise manner is difficult. The method commonly used for the measurement is called "willingness to pay" (Ma, 2002) where the equilibrium of the two costs is normally achieved by a process of "competition". This means that under the pressure of the public opinion, which can be represented by, say, two opposing interest groups, such as pro-business versus pro-environment groups, the emission standard would then be negotiated and moved, mostly by the government or similar public authorities, towards the optimal level of pollution.

This phenomenon can be seen in Figure 2 above. If the initial standard is set at P_0 which is stricter than the optimal level for the society at P_1, such a policy would generate strong opposition from the producers who would request for the standard to be revised. Then a re-evaluation of the pollution damage and pollution control costs would reveal that the initial standard is too stringent and as a consequence an adjustment is likely to be undertaken in such a way that more pollution would be allowed. By the same token, if the emission standard is too relaxed at P_2, which is below the optimal level of pollution, public opinion would lean towards the advocates of the environment which would lead to a strengthening of the rules with the amount of pollution being permitted at a lower level.

Such a pollution standard setting mechanism can also be seen in the establishment of maritime legislation at, for example, the IMO. At any given time and for a particular item of maritime regulation, optimal standards are sought through consultation, negotiation, debate and discussion; a "competitive process" amongst various interest groups which are most often countries or groups of countries. As an outcome of such policy making, or standard-setting process, the optimal pollution level, which is also the optimal regulation level, is realised. An important implication of this analysis is that the bigger the differences between the interest groups, the harder the process will be and the longer time it will take to reach a compromise. It is also true that the bigger the divergence, the lower the average satisfactory level of all the stakeholders, due to the fact that the "optimal" standards please neither business-minded nor environment-minded people.

The "command-and-control" method has several advantages, which have made it appealing and become the principal way of pollution control of most governments. Firstly, it is straightforward and with often an explicit target and clearly defined technical or numerical norms; Secondly, when a substance is known to be extremely harmful, e.g. a particular type of paint used on ships, it can effectively limit or eliminate the substance from the market; Thirdly, the producers may like this method partly because the industry input is often called for when the standard is set and partly because it may be perceived as being a fair treatment to all producers; Fourthly, this approach is quite attractive to both the environmentalists and the politicians because emission standards, which may well be in the form of strong statements, have an symbolic value to demonstrate the activeness of a decision maker in response to the expectations of specific interest groups or the general public (Stavins, 1998). The regulatory instruments or the "command-and-control" approach have a number of

shortcomings too. One of the most important weaknesses is that when the technological level of different producers is not the same, which in most cases is the reality, a single uniform emission standard will prove to be ineffective, as shown in Figure 3 below.

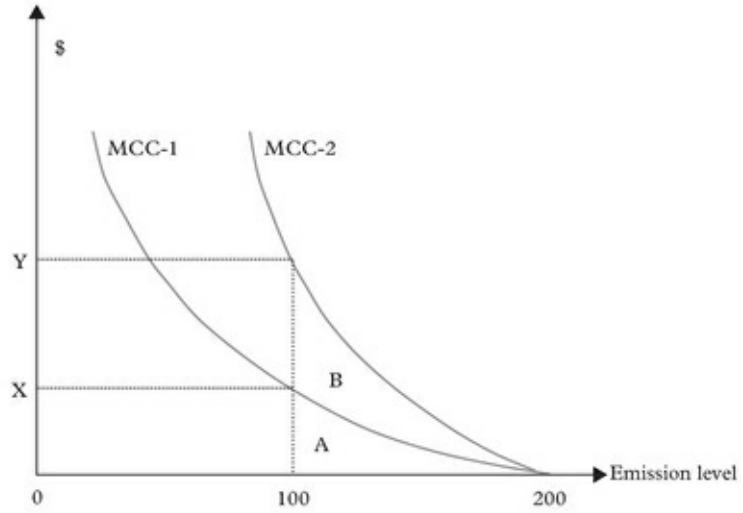

Figure 3: The ineffectiveness of the regulatory method when firms have different MCCs

In Figure 3, two ships are operating in a market and they each use a different pollution control technology, with ship 1 using a better technology and thus having a lower marginal pollution control cost (MCC-1) than ship 2 (MCC-2). Supposing an environment mandate is fixed to control the total amount of emission up to 200 units and consequently, the public authority sets a uniform emission standard of 100 units for each of the two ships, the pollution control cost for ship 1 would be represented by area A and that for ship 2 would be represented by area A + B. From the figure, it can be clearly seen that to control the level of emission to 100 units, ship 1 spends much less than ship 2 (Y – X). The total pollution control cost would have been much lower if ship 1 had controlled more than 100 units while ship 2 had been allowed to control less, correspondingly, than 100 units. Obviously, it is when the marginal control cost is the same for both ships that the lowest total control cost would be achieved. When single emission standards are applied, no distinction is made between the ships in terms of the type of technology they use. So, by the uniform emission standard the most cost-effective pollution control can only be achieved if all the ships in question are using identical emission processing technology, therefore having the same pollution control costs. The reality is that in maritime transport, as in most other sectors, such a condition does not exist.

Another important shortcoming of regulatory instruments is that the very principle of determining the emission standard level may well become a counterproductive factor to discourage shipping companies to invest in new technology. We can use Figure 4 below to illustrate this point. As explained above, the optimal pollution level at which an emission standard is established by the public authority is generally achieved through a competitive bargaining process and such a standard is stabilised and generally accepted when it is close or at the intersection of the marginal control cost (MCC) and the marginal external cost (MEC). Such a principle however implies that when costs change, either the MCC or MEC or both, the emission standard ought to be re-established against the point of the new equilibrium. This is, in fact, where the problem arises. Assuming that without regulation, a shipping company would not have taken any pollution processing measures and would have emitted all waste at point P,

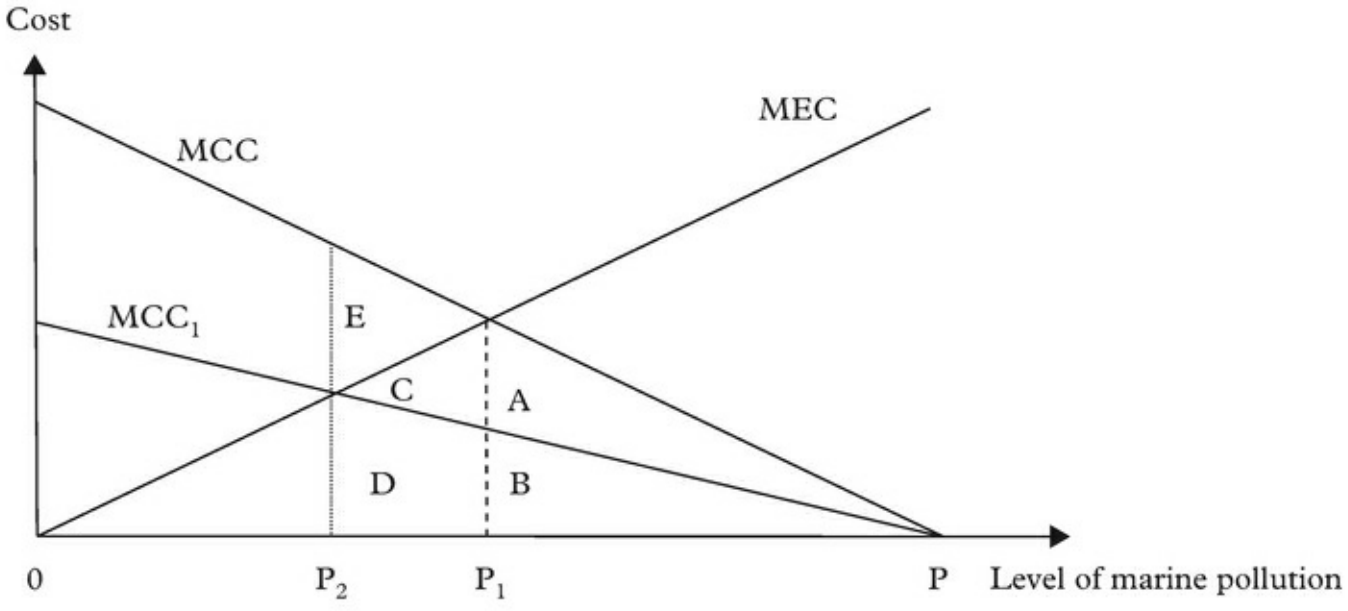

Figure 4: The effect of the regulatory instrument on the use of new technology

whereas, with a proper regulation, the initial emission standard was set at P_1. At this point, the ship's pollution control cost is A+B. By regulation, the ship cannot emit more than P_1, but theoretically, it can improve its profitability by reducing the control cost if new technology is introduced. For the ship owner to invest in this nonetheless, s/he has to be convinced that the cost savings from the use of the new technology will be big enough to recover the investment. Assuming the use of the new technology would enable the ship owner to shift the marginal control cost from MCC to MCC_1, and given that the emission standard is always at P_1, the new control cost would be B, the area below the MCC_1 curve, and the net cost saving would be area A. However, the ship owner knows very well that such an investment would lead to a reduction of the marginal control cost to MCC_1 and consequently provide the regulatory authorities and advocates of the environment with an argument to revise the emission standard by making it more stringent. In such a case, to satisfy the principle of equilibrium of MCC and MEC, the emission standard would be set at P_2 and the cost savings for the ship owner from the use of the new technology would only be A–D.

From the above analysis, we can see an important implication that the bigger the technological innovation is, the larger the reduction in the pollution control cost will be. Given the increasing public awareness and global concern about the environment, the marginal external cost curve (MEC) would unlikely to be higher in the future. So a reduction in the control cost would drive the balance of the two costs to the left, which means the likelihood of more demanding regulations. With regard to the use of new ship technology, a break-even point exists beyond which the extra cost represented by area D will be bigger than the cost savings represented by area A. This in itself constitutes a disincentive for ship owners to adopt new technology. In addition, there are often high financial and technical risks associated with the application of many major maritime technological innovations. As a result, a ship owner might rather refuse, delay or hide the use of a new technology.[2]

2.2 The main features of economic instruments

In contrast to the above, economic instruments for pollution control have a number of advantages over the "command-and-control" or regulatory approach. By properly employing a market solution, the

public authority can effectively achieve the objective of pollution control with minimum abatement costs. As indicated earlier, economic instruments usually come in the form of emission charges (or pollution levy or tax) or tradable emission permits where, for example, shipping companies receive an incentive for pollution abatement on a sustainable basis. As a result, government intervention is minimal, and, most important of all, producers are encouraged to adopt new and better technologies of pollution abatement.

What is an emission charge? It is a kind of levy expressed in per unit money terms on pollutants, for example USD xx/tonne of CO_2. It is generally imposed by a public authority on producers for the effluent generated from the production. The tax actually represents a message that "pollution is not free". We can see, with the help of Figure 5, how an emission charge would encourage a shipowner to invest in a better method of pollution control and in the use of new technology. Without a pollution tax, the shipowner has no incentive to control pollution and the emission level would be at point P. With an emission charge *t* imposed and given the marginal emission control cost being MCC, it is in the ship owner's interest to control the emission to P_1 as it

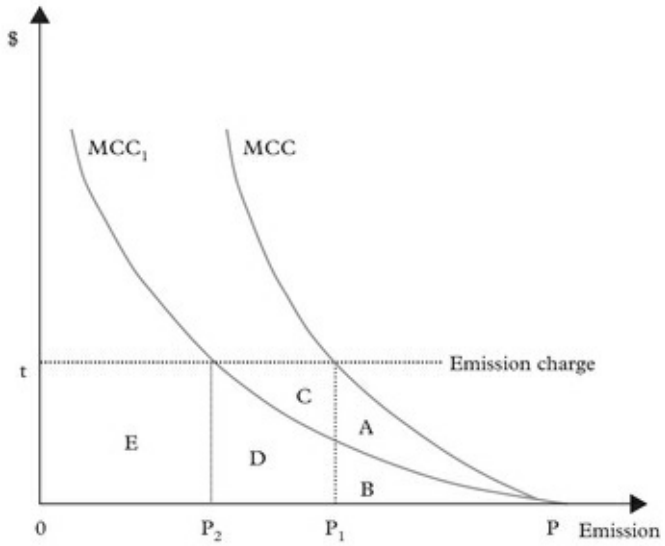

Figure 5: The effect of emission charges on the use of new technology

would cost less to control the emission than to pay the tax. For the ship, keeping the emission level at P_1, the total emission control cost would be the area represented by A + B and the total emission charge payment would be C + D + E. Assuming there is new technology available, its use will enable the ship to reduce its marginal control cost from MCC to MMC_1. Should such a technology be employed, the total control cost would be the area B + D and the tax payment would be E. So the net cost savings would be A + C with A as control cost savings and C as tax cost savings. Note that in the same situation the total cost savings would only be area A if the regulatory instrument with uniform emission standard is applied. Therefore, area C represents an extra incentive for the shipowner to invest in new technology.

Other advantages of emission charge, apart from the positive impact on the use of new technology, are the following: it provides more opportunities to be a fair as the chances for special interest groups to influence standards is limited. It requires less government intervention than the regulatory approach. It rewards environmentally efficient ships and penalises the inefficient ones. It generates an income, which can be used to support the administration of the system. The emission charge as a pollution control instrument is not perfect. Its major weaknesses are: first of all it is difficult and

costly to determine the right charge level, to monitor the pollution and to exercise policy enforcement; Secondly, as a tax, it represents a financial burden on producers. It may therefore create an unfairness between producers if the tax is not levied universally; Thirdly, with market fluctuation, in the short-term, when the market is high, producers, short of sufficient control capability, may prefer to pollute more even by paying higher emission charges.

The idea of tradable emission permits finds its origin in the Coase theorem on property rights (Coase, 1960). When first proposed in the 1960s, it was considered as

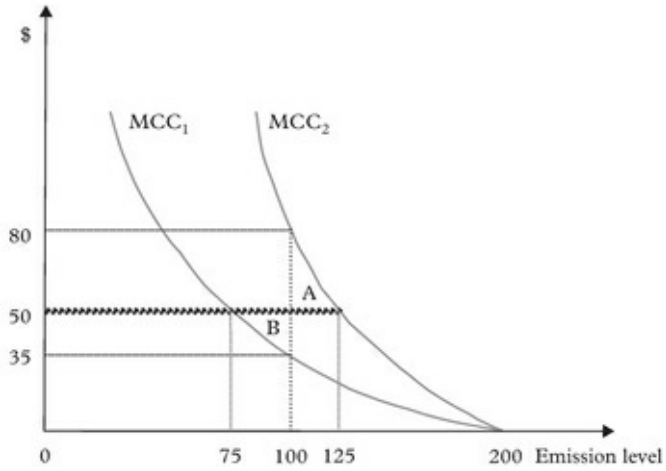

Figure 6: Two producers in the "emission permit trading" market

an improvement to the emission standard instrument whereby the public authority, instead of simply decides on pollution standards, defines the total amount of allowable emission which corresponds to the total amount of tolerable pollution (Dale, 2002) and leaves the market to decide on who can pollute how much. The tradable emission permit is in essence designed to create a market for pollution rights. What is specific with the emission trading instrument is that the public authority also allocates the initial pollution rights or permits among polluters and allows them to trade such permits freely. For tradable emission permits instruments to function, the following conditions have to be satisfied.

- a polluter, a ship for example, has a legal right, in the form of permits, to pollute;
- such rights are clearly defined; any excess of permitted amount is subject to penalty;
- public authorities define the total amount of permits and distribute or sell initial permits to polluters;
- pollution permits are freely tradable in the market place.

Given the above conditions, an emission permit trading system can achieve the environmental objectives with cost efficiency. This is illustrated in Figure 6 where, for the sake of simplicity, we assume that two ships are independently operating in the market. Without any environmental regulation, each ship would discharge 200 tonnes of sulphur dioxide per year into the air from the operation. The public authority, after a consideration of all the relevant aspects and information decides to cut the SOx emission level by half and thus issues a total of 200 emission permits representing 200 tonnes of sulphur dioxide per year. The permits are equally distributed to the two ships, which means that each ship is allowed to emit 100 tonnes of SOx per year into the atmosphere. Supposing that the two ships are employing different technologies for emission control, Ship 1 which is using a more efficient technology, has a marginal control cost represented by curve MCC-1 or $35 per tonne at the one-hundredth tonne of SOx emission level. Whilst for Ship 2, which is using a less

efficient pollution control technology, the marginal control cost, represented by MCC-2, is $80 per tonne at the one-hundredth tonne of emission level. Since the emission permits are transferable, the two ships would engage in mutually beneficial negotiations of permit trading. For Ship 1, it is in its best interest to control more pollution and at the same time sell some of the permits to Ship 2 as long as the extra control cost is less than the income for the transfer. Similarly, Ship 2 would also find it beneficial to control less pollution and at the same time buy the corresponding emission permits from Ship 1, so long as the control cost savings is more than the price paid for the extra permits. From Figure 6, we can see clearly that this is exactly the case. The two ships would continue their negotiations and transactions until the marginal control cost curves of the two ships are the same, the point at which no more benefits can be drawn from the trading. This point of equilibrium corresponds to the price of the permit at $50 per tonne. Ship 1 has a total benefit from selling permits equivalent to area A and Ship 2 has a total benefit saving in control cost equivalent to area B. From the above analysis we can conclude that, by using tradable emission permit instrument, while the total emission level remains the same at 200 tonnes, both ships are better off and so is the society since the total pollution control cost is reduced. The positive impact of this tradable pollution permit on the use of new technology is similar to the pollution tax as shown in Figure 5.

Other important implications of emission trading can be derived from the above discussions.

1. Under the condition of freely tradable permits the initial distribution of pollution permits, which is often considered to be a critical and difficult activity of the public authority, has no effect on how the permits are finally allocated among polluters through the market mechanism. Obviously the fair allocation of initial permits is an important issue.
2. The example in Figure 6 is a simple case of only two ships. However, the tradable pollution permit instrument works even better in a bigger market with larger number of parties involved in the transaction of emission permits.
3. By free trading, the best allocation of environmental resources is achieved, which means that efficient technology is rewarded by being utilised to the maximum while inefficient technology is discouraged through minimal use.
4. Thanks to the free emission trading market, environmental products have a price; for example in Figure 6, the equilibrium price is $50 per permit.
5. The amount of transactions is positively correlated with the differences of marginal pollution control cost, or the technology level, among the ships: the bigger the divergence of technological levels among ships, the more the trading will be and vice versa.
6. The permit price level is negatively correlated with the average marginal control cost or the average level of technology: the higher the average level of technology, the lower the permit price, and vice versa.
7. There is no limit to newcomers, even when the maximum emission level has been attained in a market. The emission permit trading policy encourages new and more efficient ships to enter the market by purchasing the emission needed.

From the analysis of pollution tax and emission permit trading, as illustrated in Figures 4 and 5, we can see clearly that the two approaches have the same effect with regard to cost efficiency. Using either of these approaches, the total control costs can be minimised and the positive impact on

incentives to use new technology is also similar. The ultimate choice by the authority between the two methods depends on the following aspects. First, the non-economic factors, such as political acceptability, are very important influential elements, effluent tax being often rejected because of the political sensitivity. Secondly, aspects concerned with implementation costs; this includes the transaction cost, for example in the case of emission permit trading, or control cost. Thirdly, are the case-specific factors.

3. For the Prevention of Pollution from Ships, Economic Instruments have not been Used

Given the nature of the sector, the environmental regulation of maritime transport has a unique character that it is more regulated at the international level rather than at national levels. In 1958, the International Maritime Organisation (IMO), which is a specialised agency of the United Nations, was created

"to provide machinery for cooperation among Governments in the field of governmental regulation and practices relating to technical matters of all kinds affecting shipping engaged in international trade; to encourage and facilitate the general adoption of the highest practicable standards in matters concerning maritime safety, efficiency of navigation and prevention and control of marine pollution from ships"(UN, 1948).

Since then, the IMO has produced many international treaties, conventions and agreements. The current number of IMO conventions totals 29, seven of which are in the area of marine environment protection; six being in force and one, the convention adopted in 2004 on ballast water management, not yet in force. These conventions are summarised in Table 1. Among the seven IMO environmental conventions, MARPOL 73/78 is the most important covering a wide range of aspects of ship-originated pollution. This convention addresses different aspects of pollution from ships through its six annexes which have been amended several times according to the need. These Annexes have entered into force on various dates with the latest, Annex VI on air pollution from ships, entering into force in 2005.

3.1 Accidental versus operational pollution from ships

There are many similarities between maritime safety and marine environment protection regulations. This is because when an incident or accident occurs, it very often presents a threat to both the humans on board the ship and to the surrounding environment. However, there is a remarkable difference between maritime safety and environmental protection; while maritime safety related regulations exclusively deal with *accidental* cases, environmental regulations deal with both accidental and *operational* cases. If maritime safety and environmental products can be measured by their occurrence and consequences, in other words by the frequency and severity of the safety and/or pollution events, then for all maritime safety and part of marine environmental products, the outcomes are

Table 1: IMO marine environmental conventions

	Main IMO Environmental Conventions	Acronym	Adopted in	In Force from
1	International Convention for the Prevention of Pollution from Ships (1973), as modified by the Protocol of 1978 relating thereto (6 Annexes)	MARPOL 73/78	1973/78	1983, 1988, 1992, 2003, 2005
2	International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties	INTERVENTION	1969	1975
3	Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter	LDC	1972	1975
4	International Convention on Oil Pollution Preparedness, Response and Co-operation	OPRC	1990	1995
5	Protocol on Preparedness, Response and Co-operation to pollution Incidents by Hazardous and Noxious Substances	OPRC/HNS Protocol	2000	2007
6	International Convention on the Control of Harmful Anti-fouling Systems on Ships	AFS	2001	2008
7	International Convention for the Control and Management of Ships' Ballast Water and Sediments	BWM	2004	–

Source: IMO (IMO, 2009j) *Summary of status of conventions*

uncertain. So these products are accidental such as, for example, a ship grounding causing casualties and oil spills. For some environmental products, both occurrences and consequences are fairly predictable. For example, to legally discharge waste oil into the ocean or emit harmful exhausts from the operating engine into the atmosphere. Such discharges are allowed and are deliberately undertaken and are referred to as operational.

Obviously, because of the differences in the nature of maritime safety and marine environmental products, the corresponding regulations should have different characteristics as well. For accidental cases, the political objective might be a total elimination,[3] and the statistical objective for the IMO regulations is normally what is called ALARP or *As Low As Reasonably Practicable*. For operational cases, the objectives are to identify the optimal

Table 2: Characteristics of maritime safety and environmental regulations

	Safety & Environmental Products			Safety & Environmental Regulations	
	Occurrence	**Consequence**	**Nature**	**Objectives**	**Measures**
Maritime safety	Uncertain	Uncertain	Accidental	ALARP	Risk control
Marine Environment	Uncertain	Uncertain	Accidental	ALARP	Risk control
	Certain	Certain	Operational	Optimal level	Waste control

Source: Shuo Ma

pollution conditions and levels and to make sure that these conditions and levels are properly met. Referring to the discussions of the earlier section, this means to find out the marginal environmental

damage cost curve and the marginal pollution control cost curve. The type of measures to take in order to implement the regulations is different too. For accidental cases, risk management principles should be followed and techniques should be employed. The IMO conventions such as OPRC and INTERVENTION or double hull requirements for tanker ships in MARPOL Annex I are examples of this type of measures. With regard to operational environmental cases, waste management principles and techniques should be utilised. This may include, for example, setting up the conditions and limits for the discharge of waste, such as oil or sewage into the sea.

To conclude, we can say that the distinction of maritime safety and environmental regulations between accidental and operational categories, as shown in Table 2, is very important in understanding the objectives of the regulations and the appropriate measures to implement.

Given the above distinction, a discussion of regulation instruments can be done based on the basic requirements of the IMO marine pollution prevention conventions. These conventions, in the form of regulations, can be broadly divided into three categories.[4]

1. *Pollution standards:* These concern the conditions and levels of pollution from ships. Some pollution is totally forbidden, such as TBT-based contents in paint. Some pollution is allowed to take place but with conditions, such as not discharging noxious substances within 12 miles of the nearest shore, or air pollution according to the NOx Code.
2. *Technical norms:* The availability and technical standards of equipment may be required. Most technical norms are imposed on ships such as double-hull tankers, or segregated ballast tanks. Shore-based equipment may also be required, such as reception facilities.
3. *Procedural requirements:* These are standards of operational processes; for example, keeping a bunkering book or a ballast management record on board, the packing, marking, documentation, stowage and notification of harmful substances on board.

Table 3: Basic requirements and nature of control measures of IMO environmental conventions

Convention	Pollution	Main requirements	Category
MARPOL – 1	Oil	Discharge oil < 1/15,000 of cargo (1/30,000 for new tankers), max 60 litres/mile > 50 miles to shore; Double-hull for C-1:tankers by 2005, C-2 & C-3 tankers by 2010, engine room oil, segregated ballast tank	*Pollution and Technical*
MARPOL – 2	Noxious liquid	Discharge x substances to reception facilities only No discharge of noxious substance within 12 miles to shore	*Pollution and Procedure*
MARPOL – 3	Packed harmful substances	Standards on packing, marking, labelling, documentation, stowage, quantity limitation, exceptions and notifications of harmful substances	*Procedure*
MARPOL – 4	Sewage	Discharge only with on board sewage treatment plant or comminuting disinfecting system or sewage tank > 3 miles, or > 12 miles without disinfecting system to land	*Pollution and Procedure*
MARPOL – 5	Garbage	Port reception facilities, no disposal of plastics Garbage record book on board	*Procedure and Technical*
MARPOL – 6	Air pollution	Standards for particulate matters and SOx, NOx technical Code	*Pollution*

Source: Compiled from IMO conventions

Since the sub ject of this chapter concerns the use of economic instruments for ship pollution control, the scope of the discussion should therefore be limited to *operational* environmental products only. This is because one of the pre-conditions, as discussed in the previous section, is that pollution has to be legal and voluntary.[5] This means that a ship should have the legal right to pollute, which is the case of operational pollution, which is mostly addressed by the MARPOL Convention.

Table 3 summarises the MARPOL Convention with an outline of the basic requirements of each of the six Annexes. Each of these regulatory instruments can then be grouped into one of the three categories of pollution standards, technical norms or procedural requirements, as discussed above. All these methods are regulatory instruments coming under the sphere of the “command-and-control” approach.

3.2 Why are "command-and-control" instruments favoured at the IMO?

So far, the IMO has never used an economic approach or market-based instrument in its environmental regulations. As discussed above, the “command-and-control” instruments have been a favourable choice for most public authorities around the world in their environmental policies, and it is only recently that economic approaches have become an option. At the IMO, there are good reasons and powerful arguments in favour of the “command-and-control” approach since a multinational and international maritime regulatory body, using a regulatory or “command-and-control” approach rather than economic method is always considered to be politically more acceptable. Such a situation can be examined from the angles of three groups of people: (1) the maritime industry or the polluters; (2) the governments or the regulators and (3) public opinion.

The shipping industry, such as the shipping companies, shipbuilders, marine engine makers, classification societies, marine insurers, etc. can be considered as the recipients of marine

environmental regulations. For them, “command-and-control” instruments are often preferred.[6] This is partly because they are relatively simple and less resource demanding than, for instance, an economic solution like pollution tax or tradable permits. This is partly also because pollution standards are almost always made with substantial inputs, in one way or another, directly or indirectly, from the existing industry and large companies. At the IMO, many countries’ delegates include representatives of the leading maritime firms of the country, or clos e consultation and other similar efforts are made so that the leading industry’s opinions are sufficiently represented and their interests adequately reflected in the country’s position *vis-à-vis* a particular piece of international maritime regulation. The industry’s influence on the regulation setting tends to push the regulation in the direction so as to give advantages for existing companies and constitute some sorts of barriers to newcomers. If an economic instrument is used, only the total amount of pollution is decided by the regulator; the choices of control technology as well as who is allowed to generate how much pollution being totally left to the market to decide. Consequently, the lobbying efforts, the influence and special relationship would be much undermined.

With regard to the government side, the IMO has 170 Member States and territories. These are the makers of international maritime regulations and conventions. When it comes to marine environmental regulations, the governments have also a preference for “command-and-control” instruments, due mainly to three reasons. First, most governments have a tendency to avoid all sorts of risks; agreeing to a new type of tax on, for example, marine bunkers, might be seen as a risky move in the context of the internal politics of a country. It is also because the effects of economic instruments are not always directly presented; as they are more difficult to see, they are seemingly less certain than that of the standards. For example, a bunker tax should encourage operators to control pollution and eliminate inefficient ships from the market, thus improving the environmental performance as a whole. However, the effects of economic driven pollution control measures are only seen in the level of final consumption aggregates, and ship inefficiency may be caused by numerous factors. It may appear to be uncertain as to how much pollution has been reduced and whether or not the most polluting ships have been driven out of the market by the tax. On the other hand, the effects of pollution standards are more certain; such instruments therefore being less risky. Secondly, at the IMO, a UN agency, decisions are made by consensus and resolutions are formulated based on the votes of the member states. It is normal that, in case a choice has to be made, “equality” is generally given much more weight than “efficiency”. Since the efficiency gap between the shipping industries of the various countries can be quite large, economic instruments, which by definition “discriminate” ship operators based on cost efficiency, are generally seen as less “fair” than pollution standards which are applicable equally to all. Pollution permit trading is also seen by some as an instrument favouring a few strong shipping countries at the expense of other countries in which the shipping industry is relatively small and weak. Thirdly, most governments are responsive to voters and public opinion. Given the increasing public concern about climate change, global warming and the general deterioration of the environment, many governments are choosing an active environment policy as a top priority on their political agenda. They need strong statements, concrete objectives and visible targets to demonstrate a strong commitment and active engagement. This is particularly true when a serious marine environmental disaster occurs. For example, shortly following the Erika oil spill, some

European governments were under tremendous pressure from public opinion to take bold actions and concrete measures to prevent future accidents. Such an urgent need for tangible results is then brought to the IMO and often leads to more stringent pollution prevention standards.

For the general public, "command-and-control" methods in the form of pollution standards are also favorable solutions. Firstly, the idea of using economic methods to internalise environmental externality, which happened in the first place due to the failure of the economic system, is difficult to sell. Therefore using a regulatory method to mend market failure seems to be a natural choice. Secondly, public opinion is generally hostile to taxes. We saw in the later discussion that when a bunker tax was first proposed at an IMO meeting, it was seen as an international taxation and met with strong and immediate objections from a number of countries.[7] The "command-and-control" instruments have a function to help disguise pollution control costs as compared to a market approach by which these costs are directly placed on the surface for someone to pay for. Thirdly, the IMO has to make sure that its regulations are generally understandable not only to the member states, but also to the world maritime community as a whole and to the general public at large. The "command-and-control" instruments are straightforward, explicit and unambiguous with clearly stated targets and specific requirements, which are easy to explain. Take for example, the obligation of the Member States to provide reception facilities at ports, or 3.5% sulphur content of the fuel from 1 January 2012. On the other hand, for the general public, the objectives and the expected outcomes of pollution tax or tradable emission permits are more difficult to grasp.

4. A New Case for a Different Approach — Air Emission from Ships

We have seen the main reasons, as discussed above, for only "command-and-control" instruments to have been used at IMO for its international regulations regarding the prevention of pollution from ships. It is important to note that to use economic instruments, a number of specific conditions, particularly the following two, have to be fulfilled: (1) economic instruments are only for the control of operational pollution, not accidental pollution; and (2) there must be different ways of pollution control available, which means that the control technologies not only should be different, they should also be dynamic or progressing with new technologies being continuously introduced.

Between regulation-based and market-based approaches, there are two most important aspects to observe: on the one hand, the two approaches are entirely in common, on the other, the two are fundamentally different. The common point they share is that for both approaches, the optimal pollution control level is the same and is based on the equilibrium of the marginal pollution damage cost and the marginal pollution control cost. So both approaches face the same challenge, which is to identify the exact levels of the two cost elements. The fundamental difference between the two approaches is that regarding pollution damage costs, regulatory instruments do not care about who spends how much, while economic instruments do focus on individual pollution control costs; another difference is that regarding the pollution damage costs where regulatory instruments concentrate on individual pollution levels, while economic instruments do not mind who pollutes how much. Take marine pollution from ships as an example: as long as the total amount of pollution is within the requested level, the IMO, using pollution standards, focuses on the uniform pollution level of each individual ship and never pays attention to the differences in the control costs between ships. However, should a market-based approach be used by the IMO, such as a pollution tax or permit

trading, the market would function so that an equal amount of pollution control cost exists for each ship, never minding the differences in pollution levels between the ships. These two aspects are illustrated in Figure 6.

4.1 Air pollution from ships has become a major global concern

It was relatively recently that air pollution from ships started to draw the public's attention when certain well publicised investigations revealed the growing gap between the air pollution control efforts of land-based transport and maritime transport. Previously, since ships sail mostly in international waters, operational pollution from ships in the form of air emissions, was not considered to be such a serious problem as air pollution from land-based transport which more directly and immediately affects a populations's health. Over the years, land-based transport has introduced various control measures, with increasingly stricter standards, whilst little has happened within shipping.

Air pollution emissions from ships include components emitted to the atmosphere as exhausts due to fossil fuel consumption. These components are carbon dioxide (CO_2), nitrogen oxides (NOx), sulphur dioxide (SOx), particulate matters (PM) and some other polluting substances. Such emissions also indirectly influence the concentration of greenhouse gases and cause climate change. In order to determine the appropriate control level and methods, it is important to have an idea of the inventory of ship generated emissions.

A number of studies have been undertaken recently to quantify present and future air emissions from ships, often in the context of global air pollution or emission situations of other modes of transport. Many of these studies concentrate on the estimates of the amount of greenhouse gas emissions from ships and their environmental impact (Davies *et al.*, 2000), (Corbett *et al.*, 2003), (Endersen, 2003), (Eyring, Kohler, Aardenne *et al.*, 2005), (Eyring, Kohler, Lauer *et al.*, 2005) or the impact on economic costs (Gallagher and Taylor, 2003). Some recent studies provide up-dated information on the inventory of greenhouse gases and air emissions from ships (Eyring *et al.*, 2007), (Lauer *et al.*, 2007), (Dalsoren *et al.*, 2009). Other investigations have been carried out about the impact of ship emission on local and regional environment (Hammingh *et al.*, 2007), (Cofala *et al.*, 2007), for example, one estimate suggests that in Europe, ship-originated SOx and NOx will overtake that from land in 2018 (Friedrich *et al.*, 2007), while another study says that shipping contributes 33% of all air pollution in Hong Kong (Lloyd's List, 23 March 2007, p. 1).

Further studies have investigated the special impact of SOx, NOx and PM emissions from shipping (Swedish NGO Secretariat on Acid Rain *et al.*, 2007). One study discussed the potential growth of the maritime trade and the necessity to massively reduce the SOx content of fuel to 0.5% and the NOx emission level by 60% to maintain the emissions from global shipping at the level of 2002 (Corbett, Wang *et al.*, 2007). However, other research argued that the additional costs, particularly the additional consumption and subsequent negative environmental impact for producing higher quality of fuel at the refineries, for example with 0.5% sulphur content, would be so important that it could largely offset or totally reduce the emissions intended (Leister and Tallett, 2007). With regard to PM, Colbett *et al.* (2007) studied their increased ambient concentrations due to ships' emissions and the impact on human health and premature mortality. It was found that shipping-related PM emissions are responsible for about 60,000 deaths annually and this could increase by 40% by 2012 if no radical

actions are implemented to massively reduce emissions (Corbett, Vinebrake *et al.*, 2007).

All these studies have used similar research methodology by deriving the emission level from fuel consumption estimates based on information of internationally registered ships. To date, the most comprehensive study of the inventory of GHG emissions from ships is the "Second IMO GHG Study 2009" (IMO, 2009e). This study shows that "shipping is estimated to have emitted 1,046 million tonnes of CO_2 in 2007, which corresponds to 3.3% of the global emissions during 2007. International shipping is estimated to have emitted 870 million tonnes, or about 2.7% of the global emissions of CO_2 in 2007". The report also says that "by 2050, in the absence of policies, ship emissions may grow by 150% to 250% compared to the emissions in 2007 as a result of the growth in shipping".

4.2 Problems with regulatory methods in marine pollution regulations

When using the "command-and-control" method, the regulators often have to decide, directly or indirectly, on the types of pollution prevention technologies. This has attracted a lot of criticism as to whether the regulators and bureaucrats have the adequate knowledge to select the most appropriate techniques for pollution control. Even if a decision is made by so-called experts, there is always a limitation to personal knowledge in finding the most suitable solution to the problems which exist in a diversified background. At the IMO, such situations are frequently seen; for example, the rule required for a particular oil pollution prevention technical standard to be adopted regardless of the environment in which a ship is trading. The "double hull" requirement for tankers is believed to have a much limited effect for the intended purpose (Brown and Savage, 1996). The choice of a suitable pollution control instrument depends on many location-specific factors, in the areas of, for instance, natural conditions and social-economic environments. Given the enormous variety of situations among IMO Member States, many technical standards selected under the "command-and-control" approach are often found to be incompatible or unsuitable to local conditions. As countries are reluctant to ratify an inappropriate rule, extensive delays are routinely experienced at the IMO for many important environmental regulations to enter into force. Recognising such deficiencies, "*goal-based*" standards were introduced at the IMO for a general applications in its regulations.[8]

Another major deficiency of the "command-and-control" instrument is that with this method it is difficult to cope with the development dynamism of pollution control technologies. Choosing a specific technology at a particular point in time will always come with the risk of technological obsolescence. New or improved technologies may emerge at any time and when and how to start using them is often a highly complex question which has rarely a uniform answer. Given the fact that the establishment of IMO regulations is characterised by extensive delays in the process and a divergence of national interests, along with the pursuit of the principle of consensus meaning compromises have to be accepted and the best choices have to be sacrificed, the chances are that by the time a convention has finally entered into force, the pollution control technology required may have already become long out-dated.

The "command-and-control" methods focus on environmental costs but ignore the control costs. It looks "fair" to the polluters as all sources of pollution have to comply with the uniform emission standards, but it is socially "unfair" and ineffective because the cheapest means of control are not aimed at. Today, under increasing economic pressure, it has become a general understanding that both pollution damage cost and pollution control cost have to be minimised so that the marine environment

is better protected, shipping development is more sustainable and the use of new technology is more effectively promoted. It is now a matter of urgency that the international maritime community agrees on the principles and an action plan with a clear emission reduction objective and timetable by using both regulatory and market instruments.[9] Should multi-national bodies such as the IMO fail to live up to the environmental challenge and the measures put in place do not deliver the expected outcome, it is highly likely that regional solutions will take the lead and the prevention of air pollution from ships will be undertaken in a fragmented fashion (Torvanger *et al.*, 2007).

Air pollution from ships is operational pollution, therefore the location, time and quantity of emissions are predicable and controllable. Consequently, the basic conditions of using economic pollution control instruments are available. When making marine environmental regulations two types of decisions have to be made by the public authority, whether "command-and-control" or "market-based" instruments are to be used. The first decision concerns the pollution control level, or the goal. For either "regulatory" or "economic" approaches, a goal has to be determined, although, it can be explicit or implicit. In the case of accidental pollution, the goal may be a reduced risk level, while for operational pollution, explicit objectives are often given. The second type of decision concerns how to achieve the goal, or the means to employ. Here the two approaches, regulatory and economic, are different. While in the case of the former, the means of pollution control are specified by the authority, in the case of the latter, the question of "how to control" is left to the market. It is obvious that when there are alternative control technologies available, using market-based instruments would lead to cost efficiency. This is the case for the prevention of air pollution from ships.

4.3 The availability of different air pollution control technologies for ships

The analysis of the previous section implies that availability of the assumed advantage of market-based instruments for pollution control over regulatory instruments depends on the divergence of the marginal pollution control costs incurred by different polluters. This means that if all polluters have the same marginal control costs represented by a single marginal cost curve, the two instruments, economic and regulatory, would lead to the same results and efficiency.

As far as the prevention of pollution from ships is concerned, the differences in pollution control cost come, to a large extent, from the different control technologies used by various ships. Therefore, the control cost difference can broadly be represented and reflected by technology differences. At the IMO's MEPC meeting in 2005, a number of European countries presented a proposal for the revision of the air pollution Annex of the MARPOL Convention (IMO, 2005a). The proposal outlined the major technologies available for the control of air pollution from ships. According to this document, there are mainly three types of technologies available to control the level of NOx emissions, namely, water in combustion; catalytic absorbers; and selective catalytic reduction. The first method involves injecting water into the combustion process, with 0.3 to 0.4 water fuel ratios, to reduce the maximum combustion temperature, thus decreasing the NOx formation up to 30 to 40%. It is claimed that such a method would only insignificantly increase fuel consumption. The second method uses a catalyst to absorb NOx during the operation of diesel engines, which can reduce NOx emissions by an additional 90%. The third method, "selective catalytic reduction", is also catalyst based and uses ammonia to reduce NOx from the exhaust. This method can also reduce NOx emissions by over 90%.

With regard to SOx emissions from ships, the most effective and approved means of control is to

reduce the sulphur content of the fuel. Another method which is already being used in land-based SOx emission sources is also allowed under Regulation 14 of Annex VI and is under experimentation on ships. This method involves the use of an exhaust gas scrubber where the exhaust is mixed with sea water which can absorb about 80% of the SOx in the exhaust.

The primary technology for reducing particulate matters from diesel engines involves a diesel particulate filter (DPF). By using the DPF, the soot portion of particulate matters are captured in a filter media then burned. The use of this technology can reduce PM up to 99%. However, it is reported that the efficiency of DPF is considerably affected by the sulphur content of fuel, since sulphur degrades catalyst oxidation efficiency and forms sulphate particulate matters.

The different technologies available to control emissions from ships result in large cost differences. For instance, it is reported that the difference in cost between different measures taken for reducing emissions of SOx from ships is more than eight times ranging from 0.3 to 2.5 €/kg and for reducing emissions of NOx from ships is as much as 60 times ranking from 0.1 to 6 €/kg (Swedish NGO Secretariat on Acid Rain *et al.*, 2007). It is believed that such enormous divergences in control costs are due to the fact that in shipping, air pollution control is still at an early stage compared to other sectors, therefore, a whole range of control measures is available, whereas in the land-based sectors, the most cost-effective technologies have already been employed. According to a recent estimate (IMO, 2009d), by using various technologies in ship design, for example with new design concepts, better hull and superstructure, better power and propulsion systems, renewable energy, low carbon fuel, exhaust gas reduction technology, etc, 10– 50% of CO_2 reduction could be realised. This, combined with another 10–50% emission reduction through the operational improvement of ships, which is potentially possible, could reduce the total CO_2 from ships by as much as 20–75% in 2050.[10]

Summarising the above, we conclude that there are numerous control technologies for limiting the air pollution from ships with different cost structures and varying effectiveness. It is therefore up to the ship owners to choose and use a particular technology. It is believed that in the future new control technologies may well be developed continuously as more investment is made into pollution prevention research. Consequently, it is possible that a market-based instrument can be used. Recent research shows that by using economic approaches, shipping companies that have met all the emission requirements can realise substantial savings from pollution control costs (Wang, Corbett and Winebrake, 2007).

5. Economic Instruments for the Control of Air Pollution from Ships

Since entering into force in May 2005, the MARPOL Convention Annex VI on air pollution from ships has provoked many discussions and debates at IMO, in particular concerning the use of "unconventional" economic instruments to achieve its intended objectives.[11] Of course, such discussions and debates have been going on in the broad context of global environmental development such as the Kyoto Protocol, the UN Framework Convention on Climate Change (UNFCCC) and the general public concern about climate change caused by the activities of human beings.

Using economic instruments to deal with environmental problems is a proven solution and an internationally recommended approach. Emission permit trading, for example, is one of the three key mechanisms of the Kyoto Protocol, and an accepted practice with a positive record in a number of countries. The first practical example of nationwide emission trading scheme was in the United States

under the 1990 Clean Air Act. It was a large-scale and long-term environmental programme relying on tradable emission permits with emission of sulphur dioxide as its target and acid rain as its major precursor.[12] Because of the nature of most air pollution, which is operational, market-based approaches have been mostly applied in this area. However, the applications are largely found in land-based pollution sources including transportation activities and they are mostly on a national or regional basis rather than global basis. In the Kyoto protocol it is stated that the "parties included in Annex I (i.e. industrialised countries) shall pursue limitation or reduction of emissions of greenhouse gases not controlled by the Montreal Protocol from aviation and marine bunker fuels, working through the International Civil Aviation Organisation and the International Maritime Organisation, respectively".[13] Emissions from international shipping are excluded in the UN Climate Change Convention, and the IMO is expected to coordinate joint efforts to address GHG emission issues. To date market-based instruments have not been applied to the prevention of air pollution from international shipping.

5.1 Fundamental issues and concerns about using market-based instruments

At the IMO since the entering into force of Annex VI of the MARPOL Convention, there have been seven Maritime Environment Protection Committee meetings, with the most recent one (59th session) being held in July 2009. At each of the MEPC session, market-based instruments have been on the discussion agenda, although the discussions were at a low level at the beginning. At the MEPC53 in July 2005 for example, there no submission was received regarding market-based instruments, but at the 59th session in July 2009, there were more than 10 submissions from delegations on the subject.[14] As this was close to the COP15 in Copenhagen in December 2009, there has been a growing interest and intensified efforts have been made. In June 2008 the first Intersessional Meeting of the Working Group on Green House Gas Emissions from Ships was held in Oslo, Norway. As an item on the agenda, the air pollution reduction mechanism was debated. During the same time period since 2005, a number of other studies or proposals have also been published in Europe and North America, some of which have been referred to at various IMO meetings. At the IMO, the first and fundamental issue under discussion and debate is whether market-based instruments should or should not be used.

One of the early studies in the subject area was commissioned by the European Commission in 2000 (BMT, 2000) and in this study, economic approaches such as incentives in the form of rebate or a levy based on ships' SOx emission levels at ports were recommended for wider use. In the latest release of the Second IMO GHG Study 2009, the following statement was made "The report finds that market-based instruments are cost-effective policy instruments with a high environmental effectiveness. These instruments capture the largest amount of emissions under the scope, allow both technical and operational measures in the shipping sector to be used, and can offset emissions in other sectors." (IMO, 2009d). Despite a general recognition and, seemingly, an acceptance in principle of market-based instruments, various concerns and reservations have been expressed at IMO on both the substance and the practicality aspects.

At the IMO First Intersessional Working Group Meeting on GHG Emissions from Ships in June 2008, the members were divided on the issue of introducing market-based instruments. Regarding, for example, the suggested introduction of a pollution tax on marine bunkers, the major reservations have been in the following areas: an international levy on bunker would represent a tax on international

trade; it is not clear whether the IMO has the mandate to create such a tax and the IMO does not have the possibility to implement it; such a tax on all ships may not be compatible with the requirements of the UNFCCC; the tax may benefit a few countries at the expense of some other countries, etc.[15] As for all global environmental negotiations, the discussions at IMO turn often into a politically sensitive debate. The dilemma confronted by the marine environmental regulator is that on the one hand air pollution from ships is a truly global problem and only global solutions which are non-discriminatory and applicable to all ships are meaningful; on the other, due to the huge gap in the development level between countries, affordability and fairness are critical issues which can not be avoided or ignored. To solve this dilemma, a principle of "*common but differentiated responsibilities*" was adopted by several UN bodies, particularly in the area of the reduction of GHG.[16]

One of the critical issues that divides the IMO membership is whether or not market-based instruments should be applicable to all ships, regardless of their flags.[17] On the surface, this looks to be an irrelevant question, since all IMO Regulations, whether on the marine environment or not, have been non-flag-discriminatory. Not only has non-flag-discrimination been a matter of principle for international maritime regulations, known as "*no more favourable treatment*" principle, it is practically impossible to do otherwise, given the very nature of the global shipping industry today. The nationality of a ship involved in international trade cannot be defined easily in a straightforward and definite manner. Legally every ship has a nationality symbolised by the flag of the State the ship flies. However, changing the flag from one State to another is simple, easy and inexpensive, and is common practice within the international shipping industry. As a matter of fact, as of January 2008, 67% of the world total fleet in DWT was under foreign flags, or open registry flags (UNCTAD, 2008). If the flag of a ship is not used for a differentiated regulation, the so-called "effective or genuine control" of a ship might be another way to identify the State a ship should belong to. However, there again, it is never a clear-cut business, since on the one hand, merger, acquisition and stock market listing have made modern shipping an increasingly globalised business with a multinational ownership structure that is often very complex and changing all the time. On the other hand, the location of the headquarters or the principle management of shipping companies has also become today quite mobile across borders. Should a new regulation be applied with a flag differentiation or with "effective control", it is highly possible that deliberate changes of nationality of ships, or location of management, or even the nationality of ship owners, would occur to the extent that serious distortion would result and the intended objectives of the regulations would fail.

Because of the above-mentioned features of international shipping, flag-differentiation does not look to be an option for international maritime regulations, unlike some environmental regulations implemented in other sectors, including those under the framework of the Kyoto Protocol, which have differentiated applications between industrialised and developing countries. The IMO regulations have been so far generally considered as purely technical standards and requirements. Such a technical characteristic has made maritime safety and environmental regulations less politically sensitive. Since market-based instruments have been brought to the table, the economic implications have become more direct, as to continue with ship operations, one will have to buy emission permits or pay bunker taxes. Obviously, a higher environmental standard always means more abatement costs for all ships concerned; either such a standard is implemented through regulation-based instruments or market-

based instruments. Actually the difference is, as explained in earlier sections, the total abatement costs of all ships would be lower if market-based instruments were to be chosen.

The reaction from the shipping industry to the introduction of market-based instruments for air pollution is rather mixed. While many, for example the Scandinavian shipping companies, have been in support, others have expressed reservations. The main concerns are related to the complexity regarding the implementation of market-based instruments. For example, high-transaction costs are expected to be associated with an emission permit trading scheme. Unnecessary and cumbersome procedures may undermine the efficiency and productivity of shipping operations. Some industry leaders believe that a standard regulation would still be the most effective and appropriate way to control air pollution from ships,[18] while others think that there are better, simpler and more effective ways to achieve the intended objectives than tax or emission permit trading.[19]

5.2 Pollution tax or emission trading or both?

As discussed in the preceding section, pollution tax and emission trading should have the same cost effectiveness. Since marginal pollution control costs increase when more stringent emission control standards are applied, the marginal control cost is thus represented by a negative sloping curve to the amount of pollution. The main differences between the two instruments are that pollution tax is "*price based*" while emission trading is "*quantity based*". In the case of the former, the price or tax is fixed based on the marginal environmental cost and the marginal control costs and then the quantity of emission is left to adjust to the price. In the case of the latter, the total amount of emission is fixed, based also on both the marginal environmental and the marginal control costs, and the prices of the permits, which correspond to the total amount of emission, are allowed to change to market forces. Due to the above basic characteristics of the two approaches, the choice between them should be made on a case-by-case basis. There is also the possibility of using a hybrid solution, that is a combination of both pollution tax and emission trading.[20]

There have been proposals for numerous principles or criteria for international regulations on the control of air pollution from ships. At the 57th session of the IMO's MEPC, the following nine-point principles were suggested (IMO, 2008b)[21] for any future IMO regulations in this regard: such a regulation should be:

"(1) effective in contributing to the reduction of total global greenhouse gas emissions; (2) binding and equally applicable to all flag States in order to avoid evasion; (3) cost-effective; (4) able to limit – or at least – effectively minimise competitive distortion; (5) based on sustainable environmental development without penalizing global trade and growth; (6) based on a goal-based approach and not prescribe specific methods; (7) supportive of promoting and facilitating technical innovation and R&D in the entire shipping sector; (8) accommodating to leading technologies in the field of energy efficiency; and C (9) practical, transparent, fraud free and easy to administer."

The above principles are general criteria proposed for any solution to be considered. Most of those principles have already been discussed in previous sections when analysing market-based instruments with standard-based instruments. As far as the choice between the two market-based instruments is concerned, there are essentially two major and important practical conditions or criteria to be considered: the *acceptability* and the *implementability*. Each of these two criteria can be further divided into three sub-criteria. With regard to the acceptability of an instrument, the political,

economic and technical aspects should be examined. With regard to the implementability of an instrument, the aspects of simplicity, cost and time delay should be looked into. These are now examined as follows.

1. *Political acceptability:* This means whether the philosophy or the concept of an instrument is politically acceptable. At the IMO, when two market-based instruments were discussed in 2008, some States expressed a strong reservation against the introduction of a levy on fuel which they regarded to be an international tax imposed on shipping rather than a means to reduce pollution (IMO, 2008d). A solution might be to have a specific plan on how to use the funds collected. For example, if the majority of the fund could be used for research and development projects on new environmental technologies and/or for assistant projects in favour of the countries lacking financial means for implementing pollution control from ships and/or for acquisition of CO_2 allowances.[22] Concerns were also expressed that a tradable permit scheme would lead to unfair competition by disfavouring less developed countries whose vessels were generally less-efficient. They further argued that a flag-differentiated method should be adopted. As discussed above, the impracticability of the flag-differentiated rule for international shipping makes it unacceptable. Generally speaking, a pollution tax has a lower acceptability.
2. *Economic acceptability:* This means the financial burden would fall on the shipping industry if such market-based instruments were implemented. Depending on the actual level of fuel tax, the extra cost to the shipping industry may be high. For example, if USD30 per tonne of fuel is charged, it would be a 6% increase when the bunker is priced at USD500/tonne. The cost for the tradable permit option may be relatively low since, as an option, initial distribution of emission permits can be free of charge. When it comes to the trading of permits, less efficient vessels would have to incur higher costs to buy emission allowance from more efficient vessels. The possibility of modal shifting from maritime to other modes of transport is not big due to the large cost competitive edge of shipping. However, the fluctuation of the maritime freight market may have an important impact. In the case of a high freight market, while a fuel tax would most probably stable in the short and medium terms, the trading prices of emission permits might be traded at a high price.
3. *Technical acceptability:* This means whether the required technology advancement would be acceptable or technically possible. For example, now some ambitious goals are expected from international shipping to reduce the climate impact below the 2005 level by 2020 and below the 1990 level by 2050. Should international seaborne trade be allowed to grow in the future, such objectives would require a reduction of emission levels by too big a margin which is not achievable with the predictable technological improvement of today in the areas of ship design and operation (IMO, 2009h). Another aspect of difficulty to consider is the lack of an all-sector global emission trading scheme. If such a system is to be established for international shipping, it would be a single sector scheme at global level. However, it is generally believed that an open emission trading system (all sectors inclusive) is much more effective in pollution reduction than a closed (single sector) system. In view of the above, pollution tax has a higher acceptability over emission trading.

4. *Simplicity of implementation:* Both options would need a special legal framework to be established at the IMO. As for emission trading, the level of simplicity depends on whether the initial distribution of allowance is made through auction or by free allocation since while free allocation is believed to compromise efficiency, auctioning has normally higher transaction costs. The trading itself requires a specific market mechanism and monitoring capability. In the absence of a global cross-sector emission trading scheme, a trading mechanism for international shipping alone has to be set up and maintained. As for the tax option, a levy on marine bunker can be executed by direct contribution of ships when taking the bunker (IMO, 2009g). The aspect of effectiveness of the implementation should also be considered. Some recent studies and experiences in other sectors have shown that it is more likely to achieve a fair, generally applicable and thus effective emission control by introducing a pollution tax rather than through a cap-and-trade system.[23]
5. *Cost of implementation:* Although both options incur transaction costs, as far as international shipping is concerned a cap-and-trade system would be more expensive to operate than an emission tax system. With regard to taxation, the expected cost for the tax collected, which is directly based on the quantity of bunker taken, is predictable and straightforward (IMO, 2009g). As for the cap-and-trade option, the transaction cost should include market and handling expenses. The initial distribution of emission permits as well as the trading of pollution permits would also involve some costs. These should include: search costs, negotiation costs, contact costs, even insurance costs and probably emission trading brokers might need to be involved.
6. *Time-delay of implementation:* An existing scheme of similar nature would provide an important precedent and thus a good basis for the successful implementation of a market-based instrument in emission control from ships. With regard to emission trading, there are regional examples such as the EU Green House Emission Trading Scheme (EU ETS) which started in 2005.[24] However, there has been no experience of a truly global scheme, so if this was to be established for international shipping, it will have to start from scratch and would most probably be a time-consuming process. With regard to a levy on fuel, the IMO's International Oil Pollution Compensation (IOPC) Fund is often cited as an example, or a valuable and well-functioning model, for a possible new fund on shipping related GHG.[25]

Based on the above analysis, Table 4 below is proposed. In the table, both the criteria of *acceptability* and *implementability* are divided into three levels: high, medium and low. Three points are allocated for high acceptability and high implementability cases; two points are allocated for medium acceptability and medium implementability cases; one point is allocated for low acceptability and low implementability cases. In addition, a weighting factor is introduced. Given the equal importance of acceptability and implementability for a successful introduction of market-based instruments, the same weight factors are given to the two criteria. However, within each criterion, different weighting is allocated to the three aspects for each of acceptability and implementability.

Table 4: A comparison between the two market-based instruments for international shipping

	Acceptability			Implementability			
	Political (20%)	Economic (15%)	Technical (15%)	Simplicity (15%)	Costs (20%)	Time delay (15%)	Total (100%)
Emission trading	2	2	2	1	1	2	1.65
Pollution tax	1	1	3	2	2	3	1.95

High acceptability: 3; Medium acceptability: 2; Low acceptability: 1
High implementability: 3; Medium implementability: 2; Low implementability: 1

We believe that at IMO the political acceptability is slightly more important than the economic and technical acceptability, therefore 20% is allocated to political acceptability, and 15% each to economic and technical acceptability. As for the three aspects of implementability, we consider that the cost implication of a scheme is somewhat more important than the aspects of simplicity or time delays, therefore 20% is allocated to the costs of implementation and 15% each to the aspects of simplicity and time-delays.

To summarise, we conclude that emission trading is better on *acceptability* than pollution tax, mainly due to the political preference of trading over a tax solution and the perceived lower costs of emission trading to the industry, given that all or most emission permits may be allocated free of charge to shipping companies. However, when it comes to *implementability*, the overall score for pollution tax is much higher than that for emission trading. The main reasons are that there is no appropriate truly global cap-and-trade system available, the current systems under the Kyoto Protocol or regional, such as the EU ETS, or national schemes are not entirely effective, and the transaction costs of such a scheme for international shipping are expected to be high. On the other hand, regarding the emission levy option, the IMO's International Oil Pollution Compensation (IOPC) Fund, which is a well-functioning system, provides a good precedent for the proposed IMO International GHG Fund under which an emission-reduction-aimed marine bunker levy scheme would be introduced. Despite various differences between the existing IOPC Fund and the suggested GHG Fund, there are sufficient commonalities which may enhance the likelihood of a successful pollution tax option being introduced.

5.3 Amount of emission to reduce: level of tax or cap for emission trading

One of the important aspects regarding the amount of emission for reduction is whether the standard should be a relative ratio or an absolute number. This is because the production, which is the source of pollution, is not static; it normally grows with time. Obviously, a relative standard can be more easily achievable, but if shipping activities, i.e. the pollution base, increases quickly, as it has been and will most probably continue to do, the environmental objectives may fail. On the other hand, an absolute standard guarantees the achievement of the environmental goal, but this is often technically very challenging and can undermine economic development.

One compromising approach is to use a relative standard but with a progressively more stringent requirement based on the prediction of future technology. The IMO has so far been using this method for its regulations regarding the prevention of air pollution from ships. As part of MARPOL VI, the 2008 IMO SOx Standards and NOx Technical Code as shown in Table 5 is an example. The requirements for SOx and NOx emissions are many times more stringent for future ships.

The relative standards, even with progressively tougher requirements, still carry much uncertainty with regard to both the environmental impact as well as future technology. So the general trend, as demonstrated by the Kyoto Protocol, is to use absolute standards. Since both tax and cap are marginal cost based, the critical issue becomes the measurement of the marginal environmental costs and marginal control cost. However, as discussed above, it is difficult to calculate the marginal environmental damage costs of emissions from ships. Alternatively, the global objective CO_2 emission level can be used as a benchmark for calculating the tax rate and cap for trading. Such an objective

Table 6: IMO SOx Standards and NOx Technical Code 2008

SOx	**Starting time**	**Content norms**
Sulphur content of fuel – Global cap	1 January 2012	3.5%
	1 January 2020	0.5%
Sulphur content of fuel – within "emission control areas"	1 July 2010	1.0%
	1 January 2015	0.1%
NOx	**Rated engine speed**	**Emission norms**
Ships built between 1 January 2000 and 1 January 2011 *(Tier I)*	Less than 130 rpm	17.0 g/kWh
	130 to < 2,000 rpm	$45 \cdot n^{(-0.2)}$ g/kWh
	2,000 rpm and more	9.8 g/kWh
Ships built on/after 1 January 2011 *(Tier II)*	Less than 130 rpm	14.4 g/kWh
	130 to < 2,000 rpm	$44 \cdot n^{(-0.23)}$ g/kWh
	2,000 rpm and more	7.7 g/kWh
Ships built on/after 1 January 2016 *(Tier III)*	Less than 130 rpm	3.4 g/kWh
	130 to < 2,000 rpm	$9 \cdot n^{(-0.2)}$ g/kWh
	2,000 rpm and more	2.0 g/kWh

Source: Compiled from IMO (2008) Resolution MEPC.176 (58) MEPC58/23/Add.1.

Table 6: IMO SOx Standards and NOx Technical Code 2008

CO_2 emission level is the one that is necessary to limit global warming to within 2o*C*. Big differences exist between estimates of how much the reduction of GHG emission is needed, with amounts varying from 20% by 2020 of the baseline value in 2020 (IMO, 2009i) to 50% by 2050 relative to 1990 levels (Meinshausen *et al.*, 2009).

At the IMO, shipping specific emission standards for market-based instruments have been proposed. For example, based on a dedicated study, a suggestion was made on bunker fuel tax which is within the range US$15–US$45 per tonne of bunker fuel based on different conditions and aiming at different objectives (IMO, 2009g). Also as a result of another special research on the emission permit trading scheme, a total CO_2 emission cap of *740 million tonnes* in 2020 was proposed (IMO, 2009i). These tax or cap standard proposals, which have been made within the IMO framework as results of extensive discussions and investigations, are considered at the IMO as both challenging and realistic. However, they are not necessarily perceived as sufficient or bold enough by many people outside shipping.

Given the seriousness of the current environmental challenge and the growing general concerns and consciousness of global climate change, high expectations from the maritime transport industry and a sort of "shipping-has-to-change" attitude are being formed. As a consequence, some very ambitious emission reduction objectives are also suggested for the shipping industry. The European Commission requested that an agreement should be reached in 2009 to reduce the climate impact of maritime

transport below 2005 levels by 2020, and significantly below 1990 levels by 2050 (EC, 2009). A proposal put forward to the IMO by a group of NGOs urged the shipping industry to reduce GHG emissions from ships to at least 40% below the 1990 levels by 2020 and at least 80% below the 1990 levels by 2050 (IMO, 2009f). Let us take a brief look to see if such objectives are achievable or not. Based on the Second IMO GHG Study 2009 (IMO, 2009e), in 1990, the total amount of CO_2 emissions from international shipping was 468 million tonnes. With regard to the CO_2 emissions from international shipping in 2050, there are several scenarios with different patterns of economic, demographic growth and efficiency of transport. If we take a rounded balanced scenario at the base level, the estimated CO_2 emission by international shipping would be around 3,400 million tonnes in 2050. To bring such "business as usual" 2050 CO_2 emission to the 1990 levels already means a reduction by as much as 86%, or by 97% to reach 80% below the 1990 levels. This is certainly much higher than the most optimistic estimate of 75% of possible CO_2 reduction based on the combined improvement measures taken in ship design and operation. So if the real objective is for international shipping originated CO_2 emissions in 2050 to be *significantly* or *80%* below the 1990 levels, then the answer will have to be either a complete and revolutionary change of the energy pattern for most ships or, alternatively, a huge sacrifice in the form of a substantial reduction of international seaborne trade. The first alternative is, obviously, a relatively remote possibility, while the second alternative is not seen as a valid option.[26] Certainly, shipping is not alone; many other sectors are facing similar challenges.

5.4 Limitations of market-based instruments

As discussed at the beginning of this chapter, "command-and-control" methods have the advantages of simplicity, effectiveness and political attractiveness, though with a lower cost efficiency. Yet market-based instruments have also some major disadvantages which may undermine the effectiveness of pollution control. In a way, all the strengths of the "command-and-control" methods could be considered as the weaknesses of the "market-based" methods, yet the most important limitations of both cap-and-trade and emission tax instruments are related to the effectiveness of application and to the fluctuation of the market.

With regard to the first concern, which is the effectiveness of application, unlike a technical standard, which can be clearly defined and relatively easily monitored, for a cap-and-trade scheme it is hard to impose a strict, general application. Yet, without a same-to-all application, the system will not succeed. The Kyoto Protocol offers exemptions to developing countries, and the EU ETS does not include some new member States and many "special" sectors are also outside the scheme. With regard to international shipping, it is generally envisaged that not all countries would join when a shipping emission trading system is established (Torvanger *et al.*, 2007).

The pollution tax solution has not been a favourable option since taxation normally relies on a country's fiscal regime, which can only be effectively implemented at the national level. Air pollution, however, is an international problem without borders, and would require international taxation that could be very difficult to implement. Nevertheless, international shipping might just be a rare exception in this regard. All ships, the emission from which should be taxed, are operating in international waters. As a matter of fact, a strong argument expressed at the IMO is that a pollution tax addressing emissions from ships should be paid by all ships *regardless* of their nationality.

With regard to the second concern, which is the effect of market fluctuation, the situation for emission trading is different from the situation of emission tax. There are two problems with emission trading systems. The first concerns price fluctuation. It has been reported that the EU ETS which started in 2005, has seen recently that the carbon price dropped to about €10 per tonne from €30 per tonne in the middle of 2008 (PriceWaterHouseCoopers, 2009). This is believed to be much below the marginal control cost of even a low efficient polluter. With this low price, the incentive for pollution control is much reduced. The fact that carbon prices fluctuate so much is not good for encouraging long-term investment in new control technologies. Another problem with fluctuating carbon prices is that it invites speculators to buy and sell large amounts of permits and therefore there is a possibility of market manipulation.

The problem of market fluctuation for pollution tax is different. In international shipping, the freight markets develop in cycles, where the level of freight can fluctuate during a short period of time, particularly in dry bulk markets which can be highly volatile. A pollution tax, which is defined as a fixed amount to each tonne of bunker taken has to be relatively stable. It therefore would represent a variable percentage of the ship's marginal benefit. When the market is high, a shipowner would not hesitate to pollute more even if this involved paying more tax. So in the short run, with a booming freight market the amount of pollution may well pass the expected level. During the shipping market boom of 2003–mid-2008, the scraping of old ships was delayed and all ships were sailing at full speed, even when the oil price was as high as US$140 per barrel. To solve such kinds of problems, a system with variable tax levels should be introduced.

Given the shortcomings of market-based instruments, an integrated approach should be considered. There are two levels of integration. If only market-based methods are to be used, a *hybrid* system could produce better outcomes than using either emission trading or emission tax alone. This is because a combined system could prevent trading price fluctuation by setting the emission tax as the floor, which becomes the minimum amount a ship has to pay. At the same time, some monitoring and an operational mechanism can be established by selling additional permits at a ceiling price when the prices of emission permits reach the ceiling. On the other hand, a *hybrid* system could overcome the difficulties of containing the level of pollution when the market is high by introducing a "cap", the maximum amount of emission allowed. Another level of integration is to combine traditional regulatory and relatively new economic approaches, or in other words, applying pollution standards supplemented by market-based instruments.[27] In a complex sector such as international shipping, an integrated policy could enhance the overall effectiveness of pollution control and thus have a better chance of meeting ambitious environmental objectives.

6. Conclusion

So far, efforts to reduce marine pollution from international shipping within the framework of the IMO have exclusively employed the so-called "command-and-control" approach which means setting up pollution standards and regulations that are to be complied with. However, today pressure is mounting to include international shipping into the global climate change programme. The stakes are high and objectives ambitious. Traditional methods are unable to adequately deliver the desired results due to their lack of efficiency. The biggest deficiency of the "command-and-control" approach is that it cannot find an optimal way to control pollution since such a policy takes only the pollution

damage cost into account, and not the control cost. Market-based instruments such as pollution tax or emission permit trading can solve efficiency problems by enabling shipping companies to use the most appropriate control methods, providing incentives to those with lower control costs and consequently encouraging the employment of more advanced control technologies. Since 2005, discussions have been on-going at IMO's MEPC concerning the introduction of market-based instruments for the prevention of GHG emissions from international shipping. Much progress has been made in spite of some serious difficulties and reservations, mainly regarding whether or not all States should assume the same responsibility, but given the nature of international shipping, it is inconceivable to have a differentiated policy based on ships' flags. For the time being international shipping still has the reputation of being the most environment friendly mode of transport. However, as land-based transport modes are continuously making significant improvements to their environmental performances, shipping may well lose its reputation if the current situation is not rectified. Setting up realistic but high environmental standards and exploring all the potentials of market-based instruments will ensure the healthy growth of international shipping along a sustainable path. While emission tax and emission trading are two approaches with the same theoretical efficiency, the emission tax option prevails as a more suitable market-based instrument to use due to its higher implementability, while a combination of the two instruments would most probably produce even better outcomes. Finally, the international maritime community should continue to work within the framework of the International Maritime Organisation where market-based instruments should be used as supplementary methods to the technical and operational standards in order to achieve the agreed environmental objectives.

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Endnotes

1. The International Chamber of Shipping (ICS), which represents the shipping industry, released this information in July 2009 (ICS, 23 July 2009), four months prior to the UNFCCC Copenhagen meeting to be held in December 2009, on which a new global agreement on climate change might be concluded. The ICS emphasised that the shipping industry will take its due responsibilities and make all necessary efforts for the global fight against climate change.
2. It is reported that lacking motivation, and/or incentives, the shipping industry seemed uninterested in some of the latest and more advanced pollution control technologies. As remarked by the ship engine manufacturer Wärtsilä's President of Finnish operations, Juha Kytölä, "a lot of the technologies have been available for years, and have been proven to work in land-based power plants for which tougher emission rules, but lack of demand from the owners" (Eason, 15 July 2008).
3. Sweden promotes a "vision zero" policy with an objective of zero road accident fatality. "The Vision Zero policy", as explained by Mr Claes Tingvall, the Traffic Safety Director of the Swedish Road Administration, "is not a figure; it is a shift in philosophy. Normal traffic policy is a balancing act between mobility benefits and safety problems. The Vision Zero policy refuses to use human life and health as part of that balancing act; they are non negotiable."
4. A recent Norwegian report (Torvanger *et al.*, 2007) suggested to divide the standards into two

parts: design emission standards and operational emission standards. In addition, the operational emission standards are with an associated fee which should be paid by the polluter in case the emission exceeds the limit. Procedural standards were not specifically considered.

5. To use economic methods for environmental pollution control, the market mechanism is to be utilised based on economic choices. For this reason, the pollution has to be of a voluntarily and intentionally committed nature (Hussen, 2004).

6. When a proposal on ship emission control was made that the IMO should concentrate on the environmental outcome required, and encourage different ways of achieving the agreed emission reduction goals, the Hong Kong Shipowners' Association rejected it and argued that "regulation was the only way to ensure the industry used distillate fuels with a global sulphur content cap of 1%" (*Lloyd's List*, 2007).

7. At the meeting of an IMO Working Group on GHG Emission from Ships held in June 2008 in Oslo, Norway, hot discussions took place on the proposal of a global levy on marine bunker fuel. Delegates from some major shipping nations expressed strong objection to the proposal (IMO, 2008d).

8. At the 80th session of the IMO's MSC in May 2005, a five-tier system of "goal-based standards" was agreed and it was also agreed that the principles of IMO Goal-based Standards were "broad, over-arching safety, environmental and/or security standards that ships are required to meeting during their lifecycle; the required level to be achieved by the requirements applied by class societies and other recognised organisations, administrations and IMO; clear demonstrable, verifiable, long standing, implementable and achievable, irrespective of ship design and technology; and specific enough in order not to be open to differing interpretations" (IMO, 2005c).

9. In the preparation for the 15th UNFCCC meeting in December 2009 in Copenhagen, pressures have increased. Strong voices are heard from the EC (European Commission, 2009) as well as from some NGOs (IMO, 2009b). The objective is to either have maritime transport included in the forthcoming global emission control package after 2012, or for international shipping to come up with a GHG reduction plan within the framework of the IMO which should be in line with the global package.

10. At IMO's MEPC 59th Session, 13–17 July 2009, it was agreed that a package of interim and voluntary technical and operational measures were to be used on trial purposes to reduce greenhouse gases (GHGs) from international shipping (IMO, 2009a). These measures include: (a) interim guidelines on the method of calculation, and voluntary verification, of the Energy Efficiency Design Index for new ships, which is intended to stimulate innovation and technical development of all the elements influencing the energy efficiency of a ship from its design phase; (b) guidance on the development of a Ship Energy Efficiency Management Plan, for new and existing ships, which incorporates best practices for the fuel efficient operation of ships; as well as guidelines for voluntary use of the Ship Energy Efficiency Operational Indicator for new and existing ships, which enables operators to measure the fuel efficiency of a ship.

11. Shortly after MARPOL Annex VI entered into force, at the 54th session of IMO's Marine Environment Protection Committee in December 2005, the United Kingdom made a proposal

on “the potential of emissions trading to reduce carbon dioxide emissions from ships” (IMO, 2005b). The document introduced the concept of emission trading, the benefits of it and the possibilities as well as challenges of applying carbon dioxide emission trading for shipping. This was the start, at the IMO, of discussions on the possible use of economic instruments in marine environmental regulations.

12. Although a theory well accepted, the use of economic instruments to deal with environment protection had not been attempted until 1990. Under Title IV of the 1990 Clean Air Act Amendments (1990 CAAA Public Law 101-549), a tradable SO_2 emission permit system was created in the USA. Such a program has been 2 implemented in two phases, 1995–1999 and 2000–2009 respectively (Joskow and Schmalensee, 2000).

13. The Kyoto Protocol was adopted in 1997 in Kyoto, Japan and entered into force on February 2005. It requires industrialised countries to reduce their collective GHG emissions by 5.2% compared to the year 1990. *Emission trading* is one of the Protocol’s “flexible mechanisms” to allow the parties to meet their GHG emission targets.

14. At the MEPC 54th session in March 2006, the submissions by the UK (MEPC54/4/2) and Norway (MEPC/4/7) were the first proposals to use a market-based instrument. At the MEPC 55th session in October 2006, 1 submission was received; at the 56th session in July 2007, two submissions were received (EC and Norway); at the 57th session, in March 2008, five submissions were received (Sweden x 2, Denmark, x 2, Norway), in the 58th session in October 2008, four submissions were received (IMarEst, Denmark, France/Germany/Norway, WWF) and in the 59th session 11 submissions were received (Denmark, Norway, France/Germany/Norway x 2, Japan x 3, OCIMF x 2, CLIA, ICS).

15. At the Intersessional Meeting of the GHG Working Group held in May 2008 in Oslo, Norway, the delegates were divided into the industrialised countries and the developing countries, particularly the so-called “emerging economies”, respectively (IMO, 2008d). On the one hand, Denmark, Norway and most other European countries, except Greece, all supported the use of market-based instruments, either in the form of a tax on bunkers or emission trading schemes. Such an opinion was also supported by Japan, the USA and Australia. On the other hand, countries like Saudi Arabia, India, China, Brazil, South Africa were against the introduction of market-based instruments. One of the arguments was that under the Kyoto Protocol, only Annex 1 (i.e. industrialised) countries were requested to commit on pollution reductions. An across the board type of solution, either a bunker tax or emission trading, would violate such a UNFCCC principle.

16. It is generally accepted that despite their common responsibilities, important differences exist between the stated responsibilities of developed and developing countries. The *Rio Declaration* states: “In view of the different contributions to global environmental degradation, States have common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command.” Similar language exists in the UN *Framework Convention on Climate Change* that parties should act to protect the climate system “on the basis of

equality and in accordance with their common but differentiated responsibilities and respective capabilities." In recent interpretations of WTO law, there is movement towards an obligation to consider the particular economic, social and environmental situation of developing countries when adopting environmental measures. The WTO dispute settlement panel in the *Shrimp* case expressly mentions the principle of "common but differentiated responsibilities" in its conclusions.

17. At the 58th session of the IMO MEPC meeting in August 2008, some delegates argued that the Kyoto Protocol requests the countries listed in Annex I (i.e. industrialised countries) to the UNFCCC to work through IMO to pursue the limitation or reduction of GHG emissions from marine bunker fuels and the principle of *common but differentiated responsibilities*, which is the fundamental principle accepted by the UNFCCC in fighting climate change globally, should also be the guiding principle of IMO's efforts in addressing GHG emissions from international shipping (IMO, 2008a).

18. It is reported in *Lloyd's List* (2007) that "the Hong Kong Shipowners' Association largely rejected the Chamber's (ICS) holistic approach and said regulation was the only way to ensure the industry used distillate fuels with a global sulphur content cap of 1%." The International Chamber of Shipping (ICS) was advocating that the IMO should set up a cap and let the industry choose the most appropriate way of controlling pollution.

19. It was reported that some shipping industry leaders in such shipping capitals as Hong Kong, Oslo and Piraeus expressed concerns about emission trade or bunker tax. They thought that using a low sulphur fuel would be a much better solution to achieve the goal (*Lloyd's List*, 17 June 2008; *Lloyd's List*, 25 June 2008). Some concerns were also expressed on whether market-based instruments would be a hindrance to world trade (*Lloyd's List*, 28 November 2007).

20. At the IMO GHG Working Group meeting held in Oslo 2008, the Norwegian Government made a Hybrid system proposal (IMO, 2008c) as one of the market-based instrument options for the reduction of ship-originated emissions. The basic principle of a Hybrid system is to restrict the price fluctuations of the emission permits by setting up a floor which might be equivalent to the emission tax and a ceiling at which additional permits would be issued. It is also important that this "band" of allowed prices should increase over time with economic growth to achieve the required carbon emission objectives (PriceWaterHouseCoopers, 2009).

21. Although the 11-point principles were accepted at MEPC 57, reservations were expressed by some member countries. The disagreement was on the second point which reads "binding and equally applicable to all flag States in order to avoid evasion". It was considered that such a provision was in conflict with the Kyoto Protocol notion of "*common but differentiated responsibilities and respective capabilities*".

22. Between 1990 and 2007, world seaborne trade increased from 4,008 million tonnes to 8,022 million tonnes or 100% in 17 years (UNCTAD, 1991–2008). Unless a completely new energy source has been found and economically adopted in the shipping industry, by 2050, the growth of seaborne trade predicted would be much higher than the most optimistic expected fuel efficiency improvement by 75% of the current level by then. Consequently, shipping would most probably have to buy CO_2 allowances from other sectors in the future.

23. Many believe that both the Kyoto Protocol and the European Emission Trading Scheme have not

effectively achieved their intended objectives. Some leading experts in the area demonstrated recently that under the Kyoto Protocol, and using the cap-and-trade method, even countries that accepted the toughest emission reduction targets, such as Japan, have seen their emissions actually increase (Hansen, 2009); and emissions under the ETS have actually increased by 10% (Shapiro, 2009). One of the reasons is claimed to be the lack of fair and general applications: the systems are flawed due to their openness to make all sorts of exemptions. In international shipping, it is highly unlikely that all shipping nations would join the cap-and-trade scheme. If so, unfairness would occur and objectives would not be achieved.

24. The EU ETS, started in 2005, is the largest multinational and multi-sector emission trading scheme in the world. A suggestion (Kågeson, 2007) was made to include international shipping into the EU ETS, despite the fact that the EU ETS is only a regional scheme.

25. The IOPC Fund is an intergovernmental compensation scheme for pollution damage for oil spills from tankers. It is suggested that a GHG Fund could be established based on the IOPC Fund. However, there are differences in a number of areas between the two schemes with regard to the application, administration and management of the funds (IMO, 2009c). On a national level, Norway introduced a pollution tax from 2007 on NOx emissions, where domestic shipping is included in the system.

26. Referring to the EC request for shipping originated CO_2 to be significantly below the 1990 levels, Japan expressed its reservations and called this “not imaginable” (IMO, 2009h).

27. In a recent study of the European Commission (CE Delft, 2006), an integrated solution was suggested in the form of three policy options to reduce the climate impact of shipping which are: (1) to include shipping into the EU ETS, which means a market-based instrument; (2) to use a sort of “green tariff” at ports, which offers an incentive to shipping companies based on their environmental performances; and (3) to impose emission standards on ships calling at European ports.

References

BMT (2000): “Study on the Economic, Legal, Environmental and Practical Implications of An EU system to reduce ship emission of SOx and NOx” (No. 3623). EU Document 3623.

Brown, R.S. and Savage, I. (1996): “The economics of double-hulled tankers”, *Maritime Policy and Management*, 23(2), 167–175.

CE Delft, *et al.* (2006): “Greenhouse Gas Emissions for Shipping and Implementation Guidance for the Marine Fuel Sulphur Directive”. EU Document: 06.4103.61.

Coase, R. (1960): “The problem of social cost”, *The Journal of Law and Economics*. October 1960.

Cofala, J., Amann, M., Heyes, C., Wagner, F., *et al.* (2007): “Analysis of Policy Measures to Reduce Ship Emissions in the Context of the Revision of the National Emissions Ceilings Directive”. Brussels: EC DG Environment. No. 06–107.

Corbett, J., *et al.*, (2003): “Updated emission from ocean shipping”, *Journal of Geophysical Research*, 108 (D20), 4650.

Corbett, J., Vinebrake, J., Green, E., Kasibhatla, P., *et al.* (2007): “Mortality from ship emission: a global assessment”, *Environmental Science and Technology*, 41(24), 8512-8518.

Corbett, J., Wang, C., Winebrake, J. and Green, E. (2007): “Allocation and Forecasting of Global Ship

Emissions: Clean Air Task Force and Friends of the Earth International". CATF. International.
Dale, J. (2002): *Pollution, Property and Prices – An Essay in Policy-Making and Economics* (Cheltenham, Edward Elgar Publishing).
Dalsoren, S.B., Eide, M.S., Endresen, O., Mjelde, A., *et al*. (2009): "Update on emission and environmental impacts from the international fleet of ships: the contribution from major ship types and ports", *Atmospheric Chemistry and Physics*, 9, 2171–2194.
Davies, M.-E., Plant, G., Cosslett, C., Harrop, O., *et al*. (2000): "Study on the Economic, Legal, Environmental and Practical Implications of an EU system to Reduce Ship Emission of SOx and NOx", BMT. EU Document No. 3623.
Eason, C. (15 July 2008). "Technology 'available for years' is shunned", *Lloyd's List*, 7.
Endersen, O., *et al*. (2003): "Emission from international sea transportation and environmental Impact", *Journal of Geophysical Research*, 108 (D17), 4560.
European Commission (2009): "Communication from the Commission – Towards a Comprehensive Climate Change Agreement in Copenhagen". EC13 COM (2009), 38.
Eyring, Kohler, H.W., Aardenne, J. V., and Lauer, A. (2005): "Emissions from international shipping: 1. The Last 50 Years", *Journal of Geophysical Research*, 110(D17), 305.
Eyring, Kohler, H.W., Lauer, A. and Lemper, B. (2005): "Emissions from international shipping: 2. Impact of Future Technologies on Scenarios until 2050", *Journal of Geophysical Research*, 110 (D17).
Eyring, Stevenson, D.S., Lauer, A., Dentener, F.J., *et al*. (2007): "Multi-model simulations of the impact of international shipping on atmospheric chemistry and climate in 2000 and 2030", *Atmospheric Chemistry and Physics*, 7, 757–780.
Friedrich, A., Heinen, F. and Kamakaté, F. (2007): "Air Pollution and Greenhouse Gas Emissions from Ocean-going Ships: Impacts, Mitigation Options and Opportunities for Managing Growth" (No. ICCT): International Council on Clean Transportation.
Gallagher, K.P. and Taylor, R. (2003): "International Trade and Air Pollution: The Economic Costs of Air Emissions from Waterborne Commerce Vessels in the United States". Medford MA 02155, USA: Global Development and Environment Institute. (Working Paper 03/08)
Hammingh, P., *et al*. (2007): "Effectiveness of International Emission Control Measures for North Sea Shipping on Dutch Air Quality" (No. MNP Report 500092004/2007). Bilthoven, Netherland Environmental Assessment Agency. NEA Agency.
Hansen, J. (2009): "Carbon Tax and 100% Dividend vs Tax and Trade": Committee on Ways & Means, US House of Representatives, February 2009.
Hussen, A. (2004): *Principles of Environmental Economics* (2nd edn.) (London, Routledge Taylor & Francis Group).
ICS (2009): "Shipping, World Trade and the Reduction of CO_2 Emissions" 23 July, 2005.
IMO (2005a): "MARPOL Annex VI – Proposal to initiate a revision process", MEPC 53/4/4. MEPC 12 MEPC 53/4/4.
IMO (2005b): "The potential of emission trading to reduce carbon dioxide emission from ships". MEPC. 1–5. MEPC 54/4/2.
IMO (2005c): "Report of the Maritime Safety Committee on its 80th Session". MSC 55. MSC 80/24.
IMO (2008a): "Application of the Principle of 'Common but Differentiated Responsibilities' to the

Reduction of Greenhouse Gas Emissions from International Shipping", MEPC 1–3. MEPC 58/4/32.
IMO (2008b): "Future IMO Regulation Regarding Green House Gas Emissions from International Shipping – Submitted by Denmark, Marshall Island, Bimco, ICS, Intercargo, Intertanko and OCIMF", MEPC 1–3. MEPC 57/4/2.
IMO (2008c): "A Levy-Cap-and-Trade System for Reducing GHG Emission from Shipping – Submitted by Norway", MEPC GHG-WG 1/5/4.
IMO (2008d): "Report of the Outcome of the First Intersessional Meeting of the Working Group on Greenhouse Gas Emissions from Ships", 75 MEPC 58/4.
IMO (2009a): "IMO Briefing 27/2009 on MEPC – 59th Session: 13–17 July 2009", MEPC 2. IMO Briefing 27/2009.
IMO (2009b): "IMO must Act Decisively to Reduce GHG Emissions from Shipping if it is to Retain its Competence in Technical and Political Matters Related to Shipping and GHGs (submitted by Friends of the Earth International, Greenpeace International and World Wild Fund for Nature)", MEPC 5. MEPC 59/4/47.
IMO (2009c): "International Fund for Greenhouse Gas Emissions from Ships, submitted by Oil Companies International Marine Forum (OCIMF)", MEPC. MEPC 59/4/45.
IMO (2009d): "Second IMO GHG Study 2009 – Executive Summary", MEPC 1–16 MEPC 59/4/7.
IMO (2009e): "Second IMO GHG Study 2009 – The Report", MEPC 1–289. MEPC 59–Inf.10.
IMO (2009f): "Submitted by Friends of the Earth – IMO must Act Decisively to Reduce GHG Emissions from Shipping if it is to Retain its Competence in Technical and Political Matters Related to Shipping and GHGs", MEPC 1–5. MEPC 59/4/47.
IMO (2009g): "Submitted by Denmark – An International Fund for Greenhouse Gas Emissions from Ships", MEPC 1–19. MEPC 59/4/5.
IMO (2009h): "Submitted by Japan – Consideration of Appropriate Targets for Reducing CO_2 Emissions from International Shipping", MEPC 1–7. MEPC 59/4/35.
IMO (2009i): "Submitted by Norway – A Methodology for Establishing an Emission Cap in an ETS for International shipping", MEPC 1–7. MEPC 59/4/24.
IMO (2009j): Summary of Status of Convention. www.imo.org/Conventions/mainframe.asp?topic_id=247
Joskow, P.L. and Schmalensee, R. (2000): "The political economy of market-based environmental policy – the US acid rain program", in Stavins, R.N. (ed.) *Economics of the Environment* (4th edn.) (New York, W.W. Norton & Company) 603–645.
Kågeson, P. (2007): *Linking CO_2 Emission from International Shipping to the EU ETS* (No. UBA-FB), (Germany, The Federal Environment Agency).
Lauer, A., *et al*. (2007): "Global model simulations of the impact of ocean-going ships on aerosols, clouds and the radiation budget", *Atmospheric Chemistry and Physics*, 7, 9419.
Leister, M. and Tallett, M. (2007): "Deep Impact", *Bunkerspot*, 22–24, October/November.
Lloyd's List, L.S. (2008): "HK mulls incentives to reduce ship source emission to use low sulphur fuels and to steam slowly", *Lloyd's List*, 1, 17 June 2008.
Lloyd's List, L.S. (2007): "Emission tax could threaten world trade", *Lloyd's List*, 3, 28 November

2007.
Lloyd's List (2008): "DNV chief say speed limit is more effective than emission trading", *Lloyd's List*, 1, 25 June 2008.
Lloyd's List (2007): "Split widens as Hong Kong rejects ICS emissions agenda", *Lloyd's List*, 1, 12 February 2007.
Ma, S. (2002): "Economics of maritime safety and environmental regulations", in Grammenos, T .C. (ed.) *The Handbook of Maritime Economics and Business* (London, Lloyd's of London Press) 399–425.
Meinshausen, M., Meinshausen, N., Hare, W., Raper, S.C.B., *et al*. (2009): "Greenhouse gas emission targets for limiting global warming to 2 °C", *Nature* (458), 1158–1162.
PriceWaterHouseCoopers (2009): *Carbon Tax or Emission Trading*, March 2009.
Shapiro, R. J. (2009): The real choice between cap-and trade and carbon-based taxes. Roll Call, News, 15 January 2009, from www.rollcall.com/news/31397-1.html
Stavins, R. N. (1998): "What can we learn from the grand policy experiment? Lessons from SO_2 allowance trading", *Journal of Economic Perspectives*, 12(3), 69–88.
Swedish NGO Secretariat on Acid Rain, (2007): "Air Pollution from Ships", MILJÖINFORMATION ÅSTRÖM – NILSSON.
Torvanger, A., Bogstrand, B., Skeie, B.R. and Fuglestvedt, J. (2007): *Climate Regulation of Ships* (CICERO Report 2007–7) (Oslo: CICERO).
UNCTAD: *Review of Maritime Transport* UNCTAD/ RMT, Geneva (1991–2008).
Wang, C., Corbett, J.J. and Winebrake, J.J. (2007): "Cost-effectiveness of reducing sulfur emission from ships", *Environmental Science and Technology*, 41(24), 8233–8239.

Chapter 17
Vessel Safety and Accident Analysis

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1. Introduction

Vessel safety consists of the safety of a vessel and the safety in the operation of a vessel. The safety of a vessel is concerned with whether a vessel adheres to construction, design or technical standards and therefore is seaworthy. Since safety in the operation of a vessel is difficult to observe, input and outcome proxies for vessel operation safety are often used. Input proxies represent actions by shipping lines, ports and government to decrease the probability of unsafe vessel operation; outcome proxies represent unsafe outcomes of vessel operation. Vessel maintenance and operator training expenditures are examples of input proxies; ship accidents and fatalities and injuries from these accidents are examples of outcome proxies. Since little is known of the extent to which safety inputs translate into vessel operation safety, outcome rather than input proxies are often used as proxies for vessel operation safety.

A vessel accident is an unintended happening and may or may not result in damage to the vessel and injuries to individuals on board. The probability of a vessel sustaining damage in an accident is the product of two probabilities: (1) the probability of involvement in an accident (event probability), and (2) the probability of vessel damage given that an accident has occurred (damage conditional probability). Similarly, the probability of an injury in a vessel accident is the product of the event probability and the probability of an injury given that an accident has occurred (injury conditional probability). The severity of an accident may vary from: no vessel damage to the loss of the vessel, no injuries to fatalities, and no cargo damage to loss of cargo. A vessel may remain seaworthy following an accident or may be non-seaworthy.

The remainder of the chapter is structured as follows: Section 2 presents a discussion of vessel safety concerns. Causes of vessel accidents and related injuries are presented in Section 3 and vessel accident costs are discussed in Section 4. Determinants of vessel accident property damage costs, injuries and injury severity, and seaworthiness are discussed in Sections 5, 6 and 7, respectively. Statistics for world accident vessel losses are presented in Section 8. A summary of the above discussion is found in Section 9.

2. Vessel Safety Concerns

Prior to World War I the need for uniform international vessel safety rules and their enforcement became evident. Since vessels involved in international commerce must fly the flags of their countries of registry and obey laws of this registry, the flag states (or countries) were asked to adopt and enforce internationally agreed upon rules. The multilateral enforcement of multilateral vessel safety rules worked well until “flags of convenience” (FOCs) or open registries were adopted, i.e. the registration of vessels in countries other than those of its citizen owners (Goss, 1994). Prior to the 1950s, FOCs were insignificant in number. Today, over one-half of the world’s shipping fleet is registered with open registers – raising concern for enforcement of international safety rules, given that some FOCs confine their interests to collecting registration dues, having no interest in adopting or enforcing rules,

and can not be compelled to do so as sovereign powers. The major open-registry flag countries include Panama, Liberia, Cyprus and the Bahamas.

What determines whether a vessel will fly a foreign flag (FOC) or a national flag (the flag of the country of its citizen owner)? An investigation into the determinants of vessel flag (for vessels that trade internationally) is found in a study by Hoffmann, Sanchez and Talley (2005). The likelihood that the operator of a vessel will choose a foreign flag decreases with vessel age and if the vessel was built in the vessel operator's country, but increases with the size of the vessel, if the vessel is a container vessel, if the vessel operator's country is a developed country, and if the vessel is classed by a member of the International Association of Classification Societies (IACS).

The ineffective FOC enforcement of international vessel safety rules has been addressed by some countries establishing port state control (PSC) systems, i.e. systems that unilaterally enforce such rules (Payoyo, 1994). In 1982 12 European countries signed the Paris PSC Memorandum of Understanding, arranging to inspect safety and other certificates carried by vessels of all flags (including each other's) visiting their ports, and to insist, by detention if necessary, on deficiencies being rectified. The International Maritime Organization (IMO) defines PSC as "the inspection of foreign ships in national ports to verify that the condition of the ship and its equipment comply with the requirements of international regulations and that the ship is manned and operated in compliance with these rules" (IMO, 2009). In 1995 member countries inspected 8,834 vessels, of which almost half had deficiencies; vessels were detained in port when deficiencies were regarded as so serious that the vessel or those on board were in danger, or where the marine environment could be threatened (Porter, 1996).

During the years 2002 to 2006, member countries of the Indian MoU for PSC undertook 26,515 PSC vessel inspections, [1] 7.7% of the vessels involved in these inspections were detained. Determinants of the probability that a vessel would be detained based upon these data are found in a study by Cariou, Mejia and Wolff (2008). A strong positive relationship exists between this probability and the vessel's age at the time of the inspection. Also, the inspecting authorities in Iran, India and Australia have a higher probability of vessel detentions than inspecting authorities of other member countries. Further, general cargo/multi-purpose and chemical cargo vessels are more likely to be detained.

In addition to FOCs, doubts also exist about the vessel safety enforcement performance of classification societies. Classification societies which are generally privately owned inspect vessels to ensure that they are seaworthy, meet national-flag requirements and conform to international safety standards. Classification societies also produce vessel specification rules and supervise the construction and design of vessels to insure that these rules are followed. There are more than 50 classification societies worldwide with some having been in existence for more than 200 years. The five largest classification societies (based upon the number of vessels that they classify) are the Bureau Veritas (France), Det Norske Veritas (Norway), American Bureau of Shipping, Lloyd's Register of Shipping and Nippon Kaiji Kyokei.

Both existing and new vessels are classified. Although vessels are not required to be classified, vessel insurers must be confident that vessels are seaworthy and thereby will insure only vessels that have been classified. Further, charterers of vessels require that vessels be classed and owners of non-classified vessels cannot obtain the necessary trading certificates required by ports of call (Talley,

2005).

Since classification societies have no legal authority, they compete for vessel-owner clients. Consequently, an insoluble conflict of interest arises between themselves and vessel owners, since the latter hire classification societies to class vessels. In a competitive environment for vessel-owner clients and when vessel owners themselves are facing stiff competition, societies are under pressure to reduce their safety demands, possibly classing non-seaworthy vessels. By the end of the 1970s, the UK P&I Club, responding to the concern that classification societies could no longer provide an accurate evaluation of vessel quality, established its own vessel appraisal system. Protection and indemnity (P&I) clubs are vessel owners' organisations that provide liability insurance for the same vessel owners. The criticisms of classification societies include: (1) extreme variations recorded in the quality of services provided; (2) difficulty in obtaining vessel inspection reports given the contractual links between societies and vessel owner clients; (3) unwarranted extensions of the classification of older vessels; and (4) safety rules that do not consider the operational aspects of safety on board (e.g. crew quality and operating standards (Boisson, 1994). The major classification societies responded to their critics by establishing the International Association of Classification Societies (IACS), having the objectives of promoting the highest standards in vessel safety and preventing marine pollution. IACS members are bound to satisfy Quality System Certification Scheme (QSCS) standards.

Shrinking crew sizes are also a safety concern, since fewer crew members may be available for watch duties and on-board maintenance chores. Opponents of smaller crew sizes (e.g. labour organisations) argue that safety has deteriorated with smaller crews, (e.g. from increased fatigue from longer working hours, poor vessel maintenance practices and less time for on-the-job training). They further note that crew fatigue was cited as a major contributing factor to the Exxon Valdez oil spill in Alaska. Proponents (e.g. vessel operators) argue that smaller crews are more safety conscious and are better trained to operate automated systems. One study (National Research Council, 1990) that investigated the issue concludes that available information shows no link between crew size and commercial vessel safety. However, if crew sizes continue to shrink, they may fall below safety threshold levels; if so, vessel operation safety will deteriorate.

The construction and maintenance of vessels are also vessel safety concerns. New vessels are often constructed with lightweight high-tensile steel, which is thinner than plain steel and thus more likely to crack and suffer dangerous stresses. In a competitive environment, vessel operators are under pressure to decrease the time that their vessels are in port. Consequently, the maintenance of vessels in port is expected to decline as vessel time in port declines.

Nearly 80% of vessel accidents are caused by human error – a human action or omission identifiable as the immediate cause of the event from which the liability arises, including blame worthy behavior from simple mistakes in arithmetic, judgment, and deliberate risk taking (Goss, 1994). In the past, the focus of vessel safety regulation has been the vessel rather than human actions aboard the vessel. However, this focus has shifted: The International Safety Management Code for vessels became mandatory in 1998, requiring shipping lines to document their vessel management procedures for detecting and eliminating unsafe human behavior. "This code is at the heart of the industry's plan to switch toward regulating human factors instead of physical ones" (Abrams, 1996, p. 8B). The code was motivated by the fact that vessel accident insurance claims are often attributed to human error and it is less expensive to change human behavior than it is to redesign vessels for safety.

Older vessels are also a safety concern, especially older dry-bulk vessels. The overloading and the use of 30-tonne buckets, pneumatic hammers, and bulldozers to unload dry-bulk cargoes weakened the structures of older dry-bulk vessels. Inspections of older coal vessels, for example, reveal that corrosion of side shells is common; moisture in coal vaporises and re-condenses against side shells. The availability of experienced crew to man and repairmen to maintain and repair older vessels is also a safety concern.

Safety concerns for ferry vessels include insufficient fire protection and their instability. Roll-on roll-off ferries have giant holes that allow for the loading (roll-on) and the unloading (roll-off) of automobiles and other cargoes and preclude vertical watertight bulkheads that are standard features on most vessels. If water gets in and causes a pronounced list, the vessel will capsize and sink. If loading doors are breached, ferry vessels can sink without warning – approximately 60% of ro-ro ferries involved in accidents sink within 10 minutes (Talley, 2002). In September 1994 lock design flaws and a slow response by the crew were instrumental in the deaths of 852 people from the sinking of the Estonia ferry during a Baltic Sea storm. It was Europe's worst maritime passenger disaster since World War II.

3. Vessel Accident and Injury Causes

The US Coast Guard classifies the causes of vessel accidents into human, environmental and vessel causes. Human causes include stress, fatigue, carelessness, operator error, calculated risk, improper loading, lack of training, error in judgment, lack of knowledge, physical impairment, improper cargo stowage, inadequate supervision, improper mooring/towing, design criteria exceeded, psychological impairment, intoxication, failed to yield right of way, improper safety precautions, failed to keep proper lookout, and failed to proceed at safe speed. Environmental causes include debris, shoaling, lightning, adverse weather, submerged object, channel not maintained, unmarked channel hazard, hazardous bridge/dock/pier, and adverse current/sea conditions. Vessel causes include corrosion, cargo shift, dragging anchor, stress fracture, brittle fracture, fouled propeller, improper welding, steering failure, propulsion failure, static electricity, temperature stress, inadequate controls/displays/lighting, inadequate horsepower, inadequate lubrication, and auxiliary power failure.

A vessel accident seldom has a single unambiguous cause. Causes are often a sequence of causes (or events). For example, adverse weather, the initial (environmental) cause of an accident, may in turn contribute to operator error, a secondary (human) cause of accident. However, if a single accident cause is to be selected, the suggestions include either the initial cause or the last cause (beyond the initial cause) in the sequence of causes at which the accident could have been prevented (Oster and Zorn, 1989).

The market environment in which shipping lines operate can also affect vessel safety. The profit-safety argument (Loeb, Talley and Zlatoper, 1994) states that there is a positive relationship between profitability and safety in the shipping line industry. That is to say, adverse financial conditions in the industry are expected to lead to an increase in vessel accidents. The profit–safety argument opposes market forces for promoting vessel safety and therefore favors regulation and more stringent public-sector enforcement for such promotion.

An underlying argument of the profit–safety argument is that a positive relationship exists between shipping line profits and safety expenditures (e.g. vessel maintenance) and these expenditures, in turn,

have a positive influence on vessel safety – i.e. a decrease in profits will lead to a decrease in safety expenditures which, in turn, will reduce vessel safety, thereby resulting in an increase in vessel accidents. An investigation of this linkage for the airline industry is found in Talley (1993). A highly statistically significant positive relationship was found between airline operating margins, i.e. one minus operating costs/operating revenue, and relative maintenance expenditures (i.e. the ratio of maintenance expenditures to total operating costs) – thus implying that a decrease in profits will result in a decrease in maintenance expenditures. However, a significant statistical relationship was not found between relative maintenance expenditures and aircraft accidents. Thus, the profit–safety argument is only supported in part. A libewral interpretation of these results is that lower profits lower the safety margin (e.g. maintenance expenditures) of airlines but the lower safety margin may not lead to more aircraft accidents.

Market forces may also promote vessel safety. The market-response argument (Loeb, Talley and Zlatoper, 1994) states that shipping lines anticipating a deteriorating financial condition following a vessel accident will take safety precautions in a market environment. Shipping lines that are near bankruptcy might choose to reduce safety expenditures, thereby reducing costs and avoiding bankruptcy, but increasing the risk of vessel accidents. If vessel accidents increase as a consequence, the goodwill, however, of these lines will erode and their value to potential acquirers is likely to be lower. The market-response argument thus favors less regulation and public-sector enforcement for promoting vessel safety.

A test of the market-response argument for the airline industry is found in Mitchell and Maloney (1989). Specifically, Mitchell and Maloney (1989, p. 329) address the following question: “Are consumers reluctant to fly with airlines that have poor safety records or do they treat crashes merely as random events that bear no reflection on the quality of the airline?” If the former is true, the goodwill (or the value of the brand name) of the airline will decline, having an adverse effect on the performance of the airline’s stock; if the latter is true, a crash will not affect the performance of the stock. The authors investigated the abnormal stock market performance of airlines immediately following a crash. Two groups of crashes were considered – those caused by pilot error and those in which the airline was judged not to be at fault. Fifty-six such crashes between 1964 and 1987 were examined. For crashes caused by pilot error, the airline experienced statistically significant negative stock returns; for crashes for which the airline was not at fault, there was no stock market reaction. Mitchell and Maloney (1989, p. 355) conclude: “since our results suggest the market is quite efficient at punishing airlines for at-fault crashes, the need for increased airline safety regulation is not apparent.”

Alcohol consumption and intoxication of a vessel’s crew may not only cause the vessel to have an accident, resulting in crew injuries and deaths, but may also result in crew injuries and deaths without a vessel accident occurring. For passenger vessels, passenger intoxication can have similar results. It is well known that alcohol affects human performance. Specifically, alcohol affects human balance, increases risk-taking behavior, increases choice reaction time (the time a person needs to decide which of two responses is correct), has a detrimental effect on hand-eye coordination, and reduces one’s ability to make precise positioning movements of limbs (US Department of Transportation, 1988). Since alcohol affects balance, intoxicated crewmen and passengers are more likely to fall overboard than when sober. Further, given that water compounds the effects of alcohol on human

performance, intoxicated crewmen and passengers are thus less likely to recover from falling overboard than when sober.

When crew or passengers fall overboard, water may interact with alcohol and compound alcohol's effects on human performance. Specifically, alcohol can magnify the effects of caloric labyrinthitis – becoming disoriented, nauseous, or both, when water different from normal body temperature enters one's ears. An intoxicated person whose head is immersed may become so disoriented as to swim down to death instead of up to safety. Cold water can affect muscle control (peripheral hypothermia) and thus compound alcohol's effects on physical coordination, further impairing a swimmer's abilities. Also, cold water may further impair an intoxicated swimmer's air supply. The combination of inhalation (or gasp) response when suddenly placed in cold water and alcohol induced hyperventilation can result in aspiration of water and rapid drowning.

Safety regulation itself may cause a vessel accident – i.e. safety regulation may affect the allocation of resources by increasing the frequency of safety diminishing behavior (the safety offsetting behavior hypothesis). For example, the government regulation that automobiles must contain air bags may result in the drivers of such automobiles to be willing to undertake unsafe driving practices (e.g. driving aggressively), thereby resulting in automobile accidents (Peterson, Hoffer and Millner, 1995). Alternatively, as is often expected, safety regulation may have a safety compensating behavior effect – i.e. safety regulation will affect the allocation of resources by increasing the frequency of safety enhancing behavior. For example, in a study by McCarthy and Talley (1999) analysing recreational motorboat boating accidents, increases in boating safety training of boat operators increases the probability of the operators wearing safety floatation devices while boating.[2]

4. Vessel Accident Costs

When a vessel incurs an accident, not only may the vessel be damaged, but also its cargo and near-by properties (e.g. waterfront facilities and pier structures). Also, society may incur environmental costs (e.g. from oil spills) and cargo shippers and/or receivers may incur logistics costs (e.g. an increase in inventory costs from the delay in the delivery of shipments). Vessel and near by property damage costs are the costs (e.g. material and labour) of restoring damaged vessels and near by property to their service conditions that existed prior to a vessel accident.

A vessel accident may also result in the responsible party incurring liability and legal costs. In March 1989 the tanker vessel, the Exxon Valdez, ran aground in Alaska, spilling nearly 11 million gallons of oil into Prince William Sound. This spill was the largest vessel oil spill ever in US waters. The oil-polluted waters led to major losses in fisheries and wages to fisherman and business firms. The responsible party, Exxon, has expended $2.2 billion for cleanup, $1 billion to settle state and federal lawsuits, and $300 million for lost wages to 11,000 fisherman and business firms. In 1994 an Alaskan jury awarded an additional $5.3 billion in punitive and compensatory damages to those negatively affected by the Exxon Valdez oil spill. Exxon appealed, but its appeal was rejected by an Alaskan appeals court in March 2000.

Vessel insurance rates are likely to increase for vessels involved in accidents as well as for those parties that are responsible for the accidents. There are two major types of commercial vessel insurance: protection and indemnity insurance which protects vessel owners if their vessels incur liabilities (e.g. personal injury claims by seamen) and hull insurance which protects vessel owners if

their vessels are damaged or lost. Hull insurers are critical of classification societies that inspect and class vessels to be seaworthy but are subsequently found to be non-seaworthy, resulting in higher than expected hull insurance claims. As a consequence, hull insurers now routinely order their own vessel inspections which are then used with those of classification societies to determine hull insurance rates for particular vessels.

Do hull insurance rates reflect the accident vessel damage cost differentials among types of vessels? If not, the rate payments by owners of one type of vessel may be cross-subsidising the rate payments by owners of other types of vessels. Cross-subsidisation among insurance payees occurs when rate payments in excess of insurance claims by one group of payees are used to cover rate payment deficits (where rate payments are less than insurance claims) of another group. For example, are container and bulk vessel hull insurance rates such that the payees of the former cross-subsidise the payees of the latter?

Other related vessel accident costs include the revenues that are foregone (i.e. opportunity costs) by the vessel owner of a vessel involved in an accident (e.g. revenues foregone for the vessel itself if it is not operational and for other vessels of the vessel owner if they are perceived to be unsafe). The approach typically adopted in the literature for investigating reduced-demand accident-related costs borne by both carriers and vessel/vehicle manufacturers is to investigate the reaction of the stock market (i.e. to investigate the decline in the stock market value of carriers and vessel/vehicle manufacturers following an accident).

5. Determinants of Vessel Accident Property Damage Costs

Hypothesised determinants of the vessel damage cost to a vessel involved in an accident (VESSEL-DAM) include the type of accident (TA), cause of accident (CA), operating conditions (OC), and vessel characteristics (VC), i.e.:

$$\text{VESSEL-DAM} = f(\text{TA}, \text{CA}, \text{OC}, \text{VC}) \qquad (1)$$

A vessel's type of accident includes allision, collision, material/equipment failure, explosion, fire, flooding, grounding, capsize and sinking. An allision accident occurs when a vessel strikes a stationary object (not another vessel) on the water surface. A collision accident occurs when a vessel strikes or was struck by another vessel on the water surface. A grounding accident occurs when the vessel is in contact with the sea bottom or a bottom obstacle. The accident may also be a single (involving only one vessel) or a multi-vessel (involving two or more vessels) accident. A collision, capsise or sinking accident is expected to result in greater vessel damage severity than a grounding accident. Greater vessel damage is also expected for explosion and fire accidents, especially if the vessel's cargo (e.g. oil) could contribute to the explosion and/or fire. The relationships between VESSEL-DAM and the remaining types of accidents are unclear. The cause of an accident, as discussed previously, may be a human, an environmental, or a vessel cause. It is unclear, however, which cause will result in greater vessel damage.

Operating conditions describe the environment in which a vessel was operating at the time of an accident, e.g. the type of waterway where the accident occurred, weather/visibility characteristics, and phase of vessel operation. The type of waterway includes an inland (river, harbor, lake, or a bay), a coastal, or an ocean waterway. For collisions and groundings, it is likely that vessel damage severity will be less in inland than in coastal and ocean waterways, since vessels often travel at lower speeds in

the former.

Weather/visibility characteristics include: fog, precipitation, wind speed, and whether the accident occurred at nighttime versus daytime. Although adverse weather and visibility conditions are likely to increase the risk of a vessel accident, their impact on vessel damage severity is unclear.

The phase of vessel operation includes whether the vessel was underway, docked/moored, or adrift at the time of the accident. For collisions, the expected relationship between VESSEL-DAM and underway is positive – as speed increases, greater the force of impact and greater should be the vessel damage severity of an accident. The relationship involving explosion, fire, material/equipment failure, and grounding accidents is unclear.

Vessel characteristics include a vessel's age and size and vessel safety regulation and enforcement. The expected relationship between VESSEL-DAM and vessel age is positive, since vessel structural failure is expected to increase with age. The relationship for vessel size is unclear. On the one hand, larger vessels may sustain less damage in collisions and groundings, but on the other hand, may sustain greater damage in explosion, fire and material/equipment failure accidents. Greater the number of safety regulations for a vessel and greater the enforcement of these regulations (e.g. from vessel inspections), less will be VESSEL-DAM, especially from material/equipment failure accidents.

Hypothesised determinants of the damage cost to the cargo of a vessel involved in an accident (CARGO-DAM) include type of accident (TA), cause of accident (CA), operating conditions (OC), vessel characteristics (VC), and vessel damage cost (VESSEL-DAM), i.e.:

$$\text{CARGO-DAM} = g(\text{TA}, \text{CA}, \text{OC}, \text{VC}, \text{VESSEL-DAM}) \qquad (2)$$

The expected signs of the relationships for the TA, CA, and OC variables with respect to CARGO-DAM are the same as in equation (1). Regarding the vessel characteristic, vessel size, larger vessels are generally more seaworthy, less susceptible to hazardous weather and waterway conditions and thus should incur less accident cargo damage costs than smaller vessels. Since a damaged vessel does not necessarily result in cargo damage, a non-negative relationship is expected between VESSEL-DAM and CARGO-DAM.

Hypothesised determinants of the damage cost to other property (other than vessel and cargo) of a vessel involved in an accident (OTHER-DAM) include type of accident (TA), cause of accident (CA), operating conditions (OC), vessel characteristics (VC), vessel damage cost (VESSEL-DAM), and cargo damage cost (CARGO-DAM), i.e.:

$$\text{OTHER-DAM} = h(\text{TA}, \text{CA}, \text{OC}, \text{VC}, \text{VESSEL-DAM}, \text{CARGO-DAM}) \qquad (3)$$

The expected signs of the relationships for the TA, CA, and OC variables with respect to OTHER-DAM are the same as in equation (1). The relationship between OTHER-DAM and the vessel characteristic, vessel size, is unclear. On the one hand, larger the size of the vessel, greater the expected damage from an accident on surrounding property. On the other hand, greater water depths required of larger vessels will restrict the accessibility of these vessels to surrounding property. A non-negative relationship is expected with respect to OTHER-DAM from VESSEL-DAM and CARGO-DAM, i.e. a vessel and its cargo may be damaged in an accident without causing damage to other property.

Support for (or lack thereof) for the above hypothesised determinants of vessel, cargo, and other-property damage costs of bulk barge, tank barge, and tanker accidents are found in studies by Talley

(2001, 2000, 1999a). Specifically, these studies estimate the above three-equation model using detailed data of individual bulk barge, tank barge, and tanker accidents that were investigated by the US Coast Guard. The barge (bulk and tank) accidents are US flag barge accidents that occurred in US inland waterways. The tanker accidents are non-US flag tanker accidents that occurred in US waters and US flag tanker accidents that occurred in both US and non-U.S. waterways. All three studies utilised accident data for the years 1981–1991. The costs are measured in real costs (i.e. damage costs were adjusted for inflation).

Statistically significant estimation results for the three-equation model for bulk barge accidents (Talley, 2001) suggest that: (1) vessel damage cost is less, but other-property damage cost is greater, when a bulk barge is involved in a multi-vessel accident; (2) vessel damage cost increases, but other-property damage cost decreases, with vessel age for explosion, fire, groundings, and material/equipment failures; and (3) vessel damage cost increases, but cargo and other-property damage costs decrease with barge size. Further, vessel damage cost is greater for collision, explosion, fire, and material/equipment failure accidents than for groundings and greater when the accident occurs in rivers, harbours, and lakes than in bays. Both vessel and cargo damage costs are greater when the accident occurs at night. Cargo damage cost is greater when the barge is docked or moored than when underway.

Collision and multi-vessel accidents increase the vessel damage cost and other-property damage cost of bulk barge accidents by $21,874 and $148,260, respectively. Vessel (other-property) damage cost increases (decreases) by $499 ($1,432) per year of barge age for explosion, fire and grounding accidents. Vessel damage cost is $25,137 greater if the accident occurs in a harbour than in a bay. The accident cargo damage cost is $1,230 greater when the barge is docked or moored than when underway. A dollar of vessel damage cost increases other-property damage cost by $1.38, while a dollar of cargo damage cost increases this cost by $6.90.

Statistically significant estimation results for the three-equation model for tank barge accidents (Talley, 2000) suggest that: (1) oil spillage and vessel damage costs are less but other-property damage cost is greater when a tank barge is involved in a multi-vessel accident; (2) oil spillage is less but vessel damage is greater for precipitation weather; (3) other-property damage cost decreases but vessel damage cost increases with vessel size; (4) vessel damage and other-property damage costs are greater for collision, explosion, fire and material/equipment failure accidents than for groundings; (5) oil spillage is greater for collision and material/equipment failure accidents than for explosion, fire and grounding accidents; (6) vessel damage and other-property damage costs are greater if the initial cause of the accident is a human rather than an environmental or vessel cause; and (7) oil spillage is greater if the accident occurs in a river, as opposed to other inland waterways, and increases with tank barge age.

Among types of tank barge accidents, a collision results in the largest increase in vessel damage cost ($27,983) as well as the largest increase in oil spillage cost ($863), whereas explosion and fire accidents result in the largest increase in other-property damage cost ($125,950). Further, a dollar of oil spillage results in greater other-property damage cost than a dollar of vessel damage cost (i.e. $9.13 in other-property damage cost for the former and $0.51 for the latter).

Statistically significant estimation results for the three-equation model for tanker accidents (Talley, 1999a) suggest that: (1) vessel damage (oil spillage) cost is greater (less) for collision, explosion, fire

and material/equipment failure accidents than for groundings; (2) vessel damage cost is less in inland waterways and if the tanker is underway, but greater if a vessel cause and if precipitation weather exist; (3) oil spillage cost is less for a US flag tanker, but increases with accident vessel damage; and (4) other-property damage cost is positively related to vessel damage and oil spillage costs of the accident.

Among types of tanker accidents, explosions and fires result in the largest unit (vessel gross ton) increase in vessel damage cost ($117), but the smallest unit increase in oil cargo spillage cost ($1.22). Alternatively, grounding accidents incur the smallest unit increase in vessel damage cost, but the largest unit increase in oil cargo spillage cost, reflecting the difficulty of controlling oil cargo spillage subsequent to such accidents. A dollar of oil spillage results in greater other-property damage cost than a dollar of vessel damage cost (i.e. $1.55 in other-property damage cost for the former and $0.06 for the latter).

Although oil spills from tanker accidents receive the most attention in the media, most vessel oil spills are not the result of vessel accidents but vessel-oil transfer activities (i.e. in the movement of oil cargo and/or fuel oil to and from vessels). Examples of such activities include the loading and unloading of oil cargoes, fueling, bilge pumping, cleaning tanks and ballasting. In a study by Talley *et al*. (2004) the vessel-oil-spill differences for vessel-oil transfers versus vessel-accident oil spills that were investigated by the US Coast Guard for the years 1991–1995 are analysed. The types of vessels utilised in the analysis include the oil cargo vessels – tankers and tank barges – and the non-oil-cargo vessels – freight ships, freight barges, passenger vessels, tug boats, fishing boats and recreational boats. The parameters of in-water and out-of-water transfer/vessel-accident accident oil spill equations were estimated. The estimation results suggest that transfer (vessel-accident) in-water oil spills are larger by 79 (4,217), 35 (9,585) and 37 (981) gallons for a tanker, a tank barge and a tug boat than for other non-oil-cargo vessels, respectively. For out-of-water vessel oil spillage, a transfer spill is larger than a vessel-accident spill by 120.[6] gallons, all else held constant, and tank barges incur larger out-of-water oil spills than other types of vessels. A study by Talley *et al*. (2005), utilising the same raw data but analysing only transfer oil spills, found that in-water vessel-oil transfer spillage per vessel gross ton is greater for passenger, fishing, recreational and older vessels and greater in high winds, but less in cold temperatures.

Talley *et al*. (2008a, 2008b) have investigated determinants of the vessel damage costs of cruise and ferry vessel accidents, utilising information collected by the US Coast Guard in the investigation of individual vessel accidents for the years 1991–2001. Unfortunately, the damage cost related to vessel accidents in these data are not separated by vessel, cargo and other-property damage costs of individual vessel accidents, but rather are summed to obtain the total damage cost. Consequently, Talley *et al*. (2008a, 2008b) investigate, utilising these data, determinants of vessel accident's real total damage cost per vessel gross tonne. The hypothesised determinants are the same as those found in equation (1).

The estimation results for cruise vessel accidents obtained by Talley *et al*. (2008b) suggest that the real total damage cost per vessel gross tonne for these accidents is greater for allision, collision, equipment failure, explosion, fire, flooding and grounding cruise vessel accidents than for other types of accidents. Also, the unit damage cost is greater when the cruise vessel accident is caused by a

human factor as opposed to environmental and vessel causes.

The estimation results for ferry vessel accidents obtained by Talley *et al.* (2008a) suggest that the real total damage cost per vessel gross ton for these accidents is greater for allision, collision and fire ferry vessel accidents than for other types of accidents. Also, the unit damage cost is greater for moored, docked and underway ferry vessel accidents than for other phases of vessel operation.

6. Determinants of Vessel Accident Injuries and Injury Severity

Hypothesised determinants of the number of individuals injured (fatal and non-fatal) in a vessel accident (NUMINJ) include the number of individuals on board the vessel (IOBD) and the accident damage to the vessel (VESSEL-DAM), i.e.:

$$\text{NUMINJ} = i(\text{IOBD}, \text{VESSEL-DAM}) \qquad (4)$$

A positive relationship is expected between IOBD and NUMINJ, i.e. as the number of individuals on board a vessel increases, greater the likelihood that one of these individuals will be injured when the vessel incurs an accident. Accident vessel damage should have a non-negative effect on NUMINJ, given that a damaged vessel does not necessarily result in injuries. IOBD, in turn, may be expressed as a function of vessel characteristics (VC) such as vessel size and age, i.e.:

$$\text{IOBD} = j(\text{VC}) \qquad (5)$$

Vessel size should have a non-negative effect on IOBD, since a larger-sized vessel does not necessarily have a larger number of individuals on board. A positive relationship is expected between IOBD and vessel age, since older vessels tend to be more crew labor intensive than newer ones. Substituting equation (5) for IOBD and equation (1) for VESSEL-DAM and rewriting, the reduced form equation for NUMINJ becomes:

$$\text{NUMINJ} = k(\text{VC}, \text{TA}, \text{CA}, \text{OC}) \qquad (6)$$

Separate estimates of equation (6) for fatal and non-fatal crew injuries in vessel accidents are found in a study by Talley (1999b). Detailed 1981–1991 data of individual container, tanker, and bulk vessel accidents that were investigated by the US Coast Guard were used in the estimations. The vessel accidents are non-US FLAG vessel accidents that occurred in US waters and US flag vessel accidents that occurred in both US and non-US waterways.

The estimation results for fatal injuries suggest that the number of fatal crew injuries are greater: (1) for tanker than for container or bulk vessels; (2) if the accident cause is human rather than an environmental or a vessel cause; (3) for explosion and fire than for collision, material/equipment failure or grounding accidents; and (4) for multi- than for single-vessel accidents. The estimation results for non-fatal injuries suggest that the number of non-fatal crew injuries are greater: (1) if the accident cause is human as opposed to an environmental or a vessel cause; (2) for explosion, fire and material/equipment failure than for collision or grounding accidents; and (3) for multi- than for single-vessel accidents.

The results provide strong evidence of a positive relationship between crew injuries and human causes of vessel accidents. Further, they predict that vessel human-action regulations will reduce (if they are effective in reducing human causes of ship accidents) the number of both fatal and non-fatal crew injuries. Further, policies that reduce explosion, fire and multiple-ship accidents are likely to be efficacious in reducing crew injuries.

Separate estimates of equation (6) for fatal and non-fatal crew and passenger injuries in ferry vessel accidents are found in a study by Talley (2002). Detailed 1981–1991 data of individual ferry vessel accidents that were investigated by the US Coast Guard were used in the estimations. Estimation results indicate that the average number of fatal injuries is 3.35% higher for explosion and fire than for collision, material/equipment failure or grounding accidents and 3.31% higher for multi-vessel than for single-vessel accidents. The average number of non-fatal injuries is 3.60% and 4.46% higher for collisions, explosion and fire than for material/equipment failure or grounding accidents and 3.38% higher for multi-vessel than for single-vessel accidents. Unlike the fatal injury results, non-fatal injuries are higher when the weather is foggy and fewer at night and the older the ferry vessel.

Among types of ferry accidents, explosions and fires result in the greatest number of fatal and non-fatal injuries: Every 100 explosion/fire accidents are expected to result in 6.1 fatal injuries, while each explosion/fire accident is expected to result in approximately one non-fatal injury. The results suggest that policies that reduce explosion/fire accidents are likely to be efficacious in reducing both fatal and nonfatal ferry injuries.

Talley *et al*. (2008a, 2008b) have investigated determinants of the injury severity of ferry and cruise vessel accidents, utilising information collected by the US Coast Guard in the investigation of individual vessel accidents for the time period 1991–2001. Vessel-accident injury severity (INJSEV) is hypothesised to be a function of VC, TA, CA, OC and DISTRICT, i.e.:

$$INJSEV = m\ (VC, TA, CA, OC, DISTRICT) \qquad (7)$$

Where, DISTRICT is the US Coast Guard District in which the vessel accident occurred. INJSEV takes on a value of: 0 if no vessel-accident injuries occur, 1 if non-fatal vessel-accident injuries occur, and 2 if fatal vessel-accident injuries occur in a given vessel accident.

The injury severity estimation results for ferry vessel accidents (Talley *et al.*, 2008a) suggest that injury severity is greater when the ferry vessel accident is caused by a human factor as opposed to vessel and environmental factors. Also, injury severity is less in Coast guard Districts 5 (the Mid-Atlantic coast) and 13 (the Pacific Northwest coast) than in other Coast Guard Districts and less in an ocean waterway than in other waterways.

The injury severity estimation results for cruise vessel accidents (Talley *et al.*, 2008b) suggest that injury severity is greater for ocean cruise than for inland waterway and harbour/dinner cruise vessel accidents and greater when the cruise vessel accident is caused by a human factor as opposed to vessel and environmental factors. The results also suggest that cruise vessel accident injury severity is greater in Coast Guard Districts 2 (the Midwest) and 8 (the Gulf Coast).

7. Determinants of Vessel Accident Seaworthiness

An alternative approach to investigating determinants of the damage to a vessel involved in an accident is to investigate determinants of its seaworthiness following an accident. Vessel seaworthiness is the ability of a vessel to adhere to intended operation requirements. The literature also refers to vessel seaworthiness as the trustworthiness of a vessel (see Boisson, 1994, p. 368). In a study by Talley (1999c) hypothesised determinants of the seaworthiness of a vessel following an accident (SEAWORTHY) include the type of accident (TA), cause of accident (CA), operating conditions (OC), vessel characteristics (VC), and type of vessel (TV), i.e.:

$$SEAWORTHY = n(TA, CA, OC, VC, TV) \quad (8)$$

Type of vessel includes container, tanker, and bulk vessels. Detailed 1981–1991 data of individual container, tanker, and bulk vessel accidents that were investigated by the US Coast Guard were used in the estimation of equation (8). Vessel accidents are non-US FLAG vessel accidents that occurred in US waters and US flag vessel accidents that occurred in both US and non-US waterways. In the data the seaworthiness of a vessel following an accident was described as seaworthiness not affected, vessel is not a total loss but seaworthiness is negatively affected, or the vessel is a total loss. Consequently, in the estimation of equation (8), SEAWORTHY was measured by an ordinal scale, i.e. equals to 2 if seaworthiness is not affected, equals to 1 if vessel is not a total loss but seaworthiness is negatively affected, and equals to 0 if vessel is a total loss.

Statistically significant estimation results suggest that the seaworthiness of a vessel involved in an accident: (1) increases with vessel size; (2) is greater if the vessel is manned by a licensed operator; (3) is less for a tanker than a container or bulk vessel; (4) is less for collision, fire/explosion and material/equipment failure accidents than for groundings; (5) is less if the weather is foggy; (6) decreases with wind speed; (7) is less when the vessel is underway but greater if the accident occurs in a harbour than in open waterways; and (8) is less if the vessel is involved in a multi-vessel accident.

The probability that a vessel will be a total lost from an accident decreases by .0053 if manned by a licensed operator. For an accident where seaworthiness is negatively affected but the vessel is not a total loss, the probability declines by .0841. If a vessel is involved in fire/explosion and material/equipment failure accidents, the probability that the vessel will be a total loss increases by .0231 and .0206, respectively; the probability that the vessel's seaworthiness is negatively affected but the vessel is not a total loss increases by .3680 and .3278, respectively. The results suggest that policies that reduce fire/explosion and material/equipment failure accidents and increase the manning of ships by licensed operators are likely to be efficacious in improving vessel accident seaworthiness.

8. Accident Vessel Losses

Statistics for world vessel accidents for which vessels were lost are generally accurate; vessel accident statistics for which vessels are not lost are less accurate – the non-reporting of the latter is more difficult to detect. For vessels 20 gross tons and larger, the statistics in Table 1 reveal that the number of world vessels involved in accidents that were lost was the highest in 2003, declined in 2004 and 2005, increased in 2006 and 2007, and then declined in 2008.

In Table 2 the statistics for world tanker vessel accidents for which tanker vessels were lost reveal that the highest number of tanker vessel losses, 22 losses, occurred in 2001. Thereafter, the losses ranged between 15 and 7 losses per year.

Table 1: World accident total vessel losses (20 gross tonne vessels and larger)

Year	Number	Year	Number
1999	204	2004	243
2000	230	2005	214
2001	232	2006	245
2002	251	2007	268
2003	282	2008	226

Source: Unpublished data provided by Informa Law, London, UK.

Table 2: World accident tanker vessel losses (20 gross tonne vessels and larger)

Year	Number	Year	Number
1999	13	2004	14
2000	15	2005	7
2001	22	2006	14
2002	10	2007	10
2003	15	2008	9

Source: Unpublished data provided by Informa Law, London, UK.

Table 3: World accident dry-bulk vessel losses (20 gross ton vessels and larger)

Year	Number	Year	Number
1999	15	2004	9
2000	21	2005	6
2001	10	2006	11
2002	7	2007	14
2003	10	2008	9

Source: Unpublished data provided by Informa Law, London, UK.

In Table 3 the statistics for world dry-bulk vessel accidents for which dry-bulk vessels were lost reveal that the highest number of dry-bulk vessel losses, 21 losses, occurred in 2000. Thereafter, the losses ranged between 14 and six losses per year.

9. Summary

Vessel safety consists of the safety of a vessel and the safety in the operation of a vessel. The safety of a vessel is concerned with whether a vessel adheres to construction, design or technical standards and therefore is seaworthy. Outcome rather than input proxies are often used as proxies for vessel operation safety. Vessel safety concerns include ineffective enforcement of international vessel safety rules by FOCs and classification societies, shrinking crew sizes, the decline in vessel maintenance in a competitive shipping environment, the use of lightweight high-tensile steel in vessel construction, the aging of the world's fleet of dry-bulk vessels, and insufficient fire protection for and the instability of ferry vessels.

Causes of vessel accidents have been classified into human, environmental, and vessel causes. However, a vessel accident seldom has a single unambiguous cause. Often there is a sequence of causes. The market environment in which shipping lines operate can also affect vessel safety. Adverse financial conditions for the shipping industry may lead to an increase in vessel accidents (the profit-safety argument). Alternatively, shipping lines anticipating a deteriorating financial condition

following a vessel accident may take safety precautions in a market environment (the market-response argument).

The costs of a vessel accident may include damage costs to the vessel, its cargo, and near by properties as well as environmental and logistics costs. The responsible party may also incur liability and legal costs. Hypothesised determinants of the damage costs, number of injuries, and vessel seaworthiness of vessel accidents include the type of accident (e.g. a collision and a grounding), cause of accident (e.g. human and environmental), operating conditions (e.g. weather/visibility characteristics and phase of vessel operation), and vessel characteristics (e.g. age and size). For bulk and tank barges, statistically significant results from estimated vessel accident damage cost equations suggest that vessel damage costs: (1) are less but other-property damage costs are greater when a barge is involved in a multi-vessel accident and (2) increase, but other-property damage costs decrease with barge size. For tankers, the vessel damage (oil spillage) cost is greater (less) for collision, fire/explosion and material/equipment failure accidents than for groundings.

For container, tanker, and bulk vessel accidents, the number of fatal and non-fatal crew injuries is greater if the accident cause is human rather than environmental or vessel related and for multi- than for single-vessel accidents. For ferry vessel accidents, a fire/explosion results in the greatest number of fatal and non-fatal injuries. For container, tanker, and bulk vessel accidents, the seaworthiness of the vessel is greater for larger-sized vessels and if the vessel is manned by a licensed operator.

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Endnotes

1. The 2007 members of the Indian MoU include: Australia, Bangladesh, Djibouti, Eritrea, India, Iran, Kenya, Maldives, Mauritius, Mozambique, Myanmar, Oman, Seychelles, South Africa, Sri Lanka, Sudan, Tanzania, and Yemen.
2. A study by McCarthy and Talley (2001) that analyses the same raw data of recreational motorboat boating accidents also found that greater the boating safety training of boat operators the less will be the injury severity of the operator and the passengers onboard a recreational motorboat that is involved in an accident.

References

Abrams, A. (1996): “New rules put focus on human factors”, *Journal of Commerce*, May 2, 8B.

Boisson, P. (1994): “Classification societies and safety at sea”, *Marine Policy*, Vol. 18, 363–377.

Cariou, P., Mejia, Jr., M.Q. and Wolff, F.-C. (2008): “Port state control inspection and vessel detention”, in Talley, W. (ed.) *Maritime Safety, Security and Piracy* (London, Informa), 153–168.

Goss, R. (1994): “Safety in sea transport”, *Journal of Transport Economics and Policy*, Vol. 28, 99–110.

Hoffman, J., Sanchez, R. and Talley, W.K. (2005): “Determinants of Vessel Flag”, in Cullinane, K. (ed.) *Shipping Economics: Research in Transportation Economics* (Amsterdam, Elsevier), 173–219.

International Maritime Organization (2009): Available online at www.imo.org (Accessed 3 July 2009).

Loeb, P. D., Talley, W. K. and Zlatoper, T. J. (1994): *Causes and Deterrents of Transportation*

Accidents: An Analysis by Mode (Westport, Connecticut, Quorum Books).
McCarthy, P. and Talley, W.K. (1999): "Evidence on risk compensation and safety behavior", *Economics Letters*, Vol. 62, 91–96.
McCarthy, P. and Talley, W.K. (2001): "Safety investments, behaviors and injury severity", *Applied Economics*, Vol. 33, 701–710.
Mitchell, M.L. and Maloney, M.T. (1989): "Crisis in the cockpit? The role of market forces in promoting air travel safety", *Journal of Law and Economics*, Vol. 32, 329–355.
National Research Council (1990): *Crew Size and Maritime Safety* (Washington, D.C., National Academy Press).
Oster, C.V. Jr. and Zorn, C.K. (1989): "Aviation safety: The experience of general aviation", *Journal of the Transportation Research Forum*, Vol. 30, 187–194.
Payoyo, P.B. (1994): "Implementation of international conventions through port state control: An assessment", *Marine Policy*, Vol. 18, 379–392.
Peterson, S., Hoffer, G. and Millner, E. (1995): "Are drivers of air-bag-equipped cars more aggressive? A test of the offsetting behaviour hypothesis", *Journal of Law and Economics*, Vol. 38, 251–264.
Porter, J. (1996): "Majority of ships detained in Asia in '95 were bulkers", *Journal of Commerce*, 13 October, p. 8B.
Talley, W.K. (1993): "The Impact of Deregulation on Airline Safety: Profit-Safety and Market-Response Arguments", in Beesley, M., Hensher, D. and Talvitie, A. (eds.) *Privatization and Deregulation in Passenger Transportation* (Forssa, Finland, Auranen Ltd), 205–211.
Talley, W.K. (1999a): "Determinants of the Property Damage Costs of Tanker Accidents", *Transportation Research Part D: Transport and Environment*, Vol. 4, 413–426.
Talley, W.K. (1999b): "The safety of sea transport: determinants of crew injuries", *Applied Economics*, Vol. 31, 1365–1372.
Talley, W.K. (1999c): "Determinants of ship accident seaworthiness", *International Journal of Maritime Economics*, Vol. 1, 1–14.
Talley, W.K. (2000): "Oil spillage and damage costs: US inland waterway tank barge accidents", *International Journal of Maritime Economics*, Vol. 2, 217–234.
Talley, W.K. (2001): "Determinants of the property damage costs of bulk barge accidents", *Maritime Policy and Management*, Vol. 28, 175–186.
Talley, W.K. (2002): "The safety of ferries: An accident injury perspective", in Cullinane, K. and Lee, T. (eds.) *Contemporary Research in Global Shipping and Logistics, Maritime Policy and Management*, Vol. 29, 331–338.
Talley, W.K. (2005): "Regulatory issues: the role of international maritime institutions", in Hensher, D.A. and Button, K.J. (eds.) *Handbook of Transport Strategy: Policy and Institutions* (Amsterdam, Elsevier Ltd), 421–433.
Talley, W.K., Jin, D., and Kite-Powell, H. (2004): "Post OPA-90 vessel oil spill differentials: Transfers versus vessel accidents", *Maritime Policy and Management*, Vol. 31, 225–240.
Talley, W.K., Jin, D. and Kite-Powell, H. (2005): "Post OPA-90 vessel oil transfer spill prevention: the effectiveness of coast guard enforcement", *Environmental and Resource Economics*, Vol. 30, 93–114.

Talley, W.K., Jin, D. and Kite-Powell, H. (2008a): “Determinants of the damage cost and injury severity of ferry vessel accidents”, *WMU Journal of Maritime Affairs*, Vol. 7, 175–188.
Talley, W.K., Jin, D. and Kite-Powell, H. (2008b): “Determinants of the severity of cruise vessel accidents”, *Transportation Research Part D: Transport and Environment*, Vol. 13, 86–94.
US Department of Transportation (1988): *Alcohol in Fatal Recreational Boating Accident* (Washington, D.C., US Government Printing Office).

Part Seven

National and International Shipping Policies

Chapter 18
Shipping Policy and Globalisation; Jurisdictions, Governance and Failure

Michael Roe[*]

1. Introduction

The shipping industry is characterised by a number of very specific features which make it unlike almost any other. In particular it is inherently mobile – both physically in that ships can be moved with relative ease to a very large number of world locations – and in terms of capital, which involves no physical movement of assets necessarily, but a transfer of ownership, registration or other features to wherever makes most financial sense. These two features are intrin sically linked in that the capital mobility of shipping is enhanced by the physical mobility of the assets which subsequently makes any sort of compulsory national, state association very difficult.

These two features of mobility are also fundamentally important when it comes to the issue of policy, and in this chapter we shall be examining the derivation of shipping policy and in particular the relationship between shipping policies at different levels of jurisdiction of origin and imposition – international, supra national, national, regional and local (Roe, 2007c, 2009c). The issues of mobility outlined above are the major feature of shipping which drives policy at all levels, although not to the exclusion of a large range of other factors which needs to be assessed.

This chapter will also place shipping policy in the context of the growth of glob alisation and its close relations, foreign direct investment and strategic alliances discussed in the recent works of Frankel (1999), Ryoo and Thanopoulou (1999), Thanopoulou *et al*. (1999), Peters (2001), Randay (2001), Sletmo (2001), Slack, Comtois and McCalla (2002) and Selkou and Roe (2004) – developments which the shipping industry has experienced often before any other and which are characteristic of the complexities that surround governance policy relationships in the industry. These issues have been further developed by Roe in a series of publications (2008a, 2008b, 2009a, 2009b, 2009c).

This chapter is structured into seven sections. The second section outlines the develop ment of research into shipping policy and examines the range of different studies that have taken place across the world and the common themes that have emerged.

The third section provides a model of the major themes that underlie shipping policy today and which are foremost in determining the detailed policy initiatives that have emerged in the late twentieth and early twenty-first centuries. It also incorporates the development of a new model of shipping policy that attempts to represent the more important influences that drive and direct policy-making at each level.

Using this new model, the fourth section introduces the concepts of spatial policy levels – international, supra-national, national, regional and local – and provides examples of activities at each jurisdiction. Here the specific problems associated with deriving effective and inter-linked policies for the shipping industry become apparent.

Policy can never emerge in any sector without interest groups – government, industry, employers

and employees, pressure groups etc – and shipping is no exception. Section five looks at the role of interest groups using the model provided by Aspinwall (1995) and other work by Lu (1999) and how these affect the interrelationships between the spatial levels of jurisdiction that exist.

Section six follows the work of Ledger and Roe (1993) and examines the contextual factors that affect the industry in the derivation of policies; this further illustrates the problems of linking policies in shipping between the jurisdictional levels outlined in section three.

The final section incorporates the role of globalisation and its impact upon shipping industry policies. In particular it focuses upon the problems of reconciling the linkages between the jurisdictions of policy that exist and an industry that works outside of many of the constraints that these policy jurisdictions assume. The chapter ends with a summary of the issues and conclusions including an assessment of future policy issues.

2. Shipping Policy - A Spatial Perspective

Shipping policy is an area of research that has attracted interest over many years focusing on issues from subsidies to safety, the environment to employment, from taxation to inter-modalism and more. The key theme of this chapter is the problems inherent in linking together the different spatial levels of policy-making across the variety of jurisdictions that exist. The discussion deliberately focuses upon the international, supranational and national levels as attempting to include regional and local issues would prove to be too specific and complex.

The literature noted here is not exhaustive but indicative of some of the trends in spatial shipping policy and jurisdictional concerns that exist. The international jurisdiction for policy-making has been well documented and important works include those by Gold (1981) and Li and Cheng (2007) on the international maritime sector in general, Schrier *et al*. (1985) on liberalisation in shipping, Benham (1994) on UNCTAD's role in the shipping sector, Moyer (1977) and his analysis of shipping subsidies, Frankel's works (1989, 1992) on shipping, logistics and ports, Yannopoulos (1989) on shipping policy in general, Ademuni-Odeke's (1984) work on protectionism and shipping, Li and Wonham's (2001) discussion of the specific policy issues relating to safety, and the earlier seminal work by Goss (1982).

Examples of work at the supra-national level can be found in the extensive literature concerning the European Union including the seminal works by Bredima-Savopoulou and Tzoannos (1990), Wang (1993), Hart *et al*. (1993), Peeters *et al*. (1995), Aspinwall (1995), Urrutia (2006) and Tongzon (2007) and the journal articles by Van Der Linden (2001), Paixao and Marlow (2001) and Marlow and Mitroussi (2008). In addition, the over-arching supra-national issues and their conflict with national priorities are discussed in Brooks (2000) in terms of liner shipping policies and the relationship between the USA, Canada and the EU. There is also a large number of other publications which dwell on the specifics of policy at the EU level and the complexities of imposing such policies on nation state members who may or may not be willing to co-operate. Aspinwall's work here is especially significant and will be referred to later in some depth.

In Eastern Europe, the work by Ledger and Roe (1995) and Roe (1998, 2007a, 2007b) dominates the discussion of shipping policy issues in a framework where there is no overriding authority (unlike in the European Union) but where regional commonalities are sufficient to suggest that a supra-national consideration of policies and policy implementation is appropriate. The authors stress the difficulties of intro ducing common-themed policies for the distressed shipping industries of Poland, Romania,

Bulgaria Ukraine, Russia, Latvia and Lithuania in the light of common approaches to EU accession and the need to meet a set of widely applied rules and requirements is clearly apparent. This is particularly the case where national demands (and even regional and local ones within a country) conflict with the more over-riding needs and demands of the newly adopted supra-national authority.

Other pseudo supra-national policy work is typified by that of Hawkins and Gray (1999, 2000), Sun and Zhang (2000) and Hawkins (2001) for the Asia-Pacific region which again lacks a supra-national authority to give it coherence and even less so than Eastern Europe, suffers from the absence of an over-riding driving force of potential EU membership which acts to compel national policies to work with each other and at different levels. Similar work in the Caribbean is provided by Wilmsmeier and Hoffmann (2008).

At a national policy-making level the published work is extensive and only a few sources can be noted here. In terms of UK policy much has been produced following the introduction of a tonnage tax system in 2001 – an issue itself that raises conflicting views with respect to the requirements of the EU, relations with neighbouring countries and the international (for e.g. through the effect on flags of convenience) and regional (for e.g. employment) implications. Particularly significant publications include Brownrigg, Dawe and Mann (2001), Selkou and Roe (2002) and broader policy discussions can also be found in Colvin and Marks (1984), Gardner (1999), and Gardner, Naim and Obando-Rojas (2001).

Discussion concerning policies and policy-making in other countries is extensive. For example, Poland receives attention from Walenciak, Constantinou, and Roe (2001) and Wrona and Roe (2002), Taiwan from Lu (1999), the USA from Whitehurst (1983)[3], Iran from Mirmiran (1994), the USA from Sletmo and Williams (1981), Nigeria from Omosun and Nasiru (1987), Japan from Goto (1984) and Managi (2007), Turkey from Yercan (1999), Yercan and Roe (1999) and Barla *et al.* (2001), China from Flynn (1999), and Sun and Zhang (1999), and Korea from Kokuryo (1985), Lee (1996, 1999) and Song, Cullinane and Roe (2001). There are many other discussions focusing upon other countries of the world emphasising the significance of the national level of policy-making that exists in shipping and its importance in relationship to other jurisdictional levels.

3. The Factors that Drive Shipping Policy

Hoyle and Knowles (1998) provide a basis for analysing the generic factors that underlie the emergence of transport policy at the end of the twentieth century. These factors can be used as a basis for understanding the development of shipping policy worldwide. From there we can go on to look at the development of shipping policy under different jurisdictions before analysing the problems manifest in linking these policy levels together and in achieving a meaningful and efficient governance framework.

The work of Hoyle and Knowles was directed essentially at understanding transport activity from a spatial perspective and for this reason is particularly suited to our discussion, although they were not considering policy making, governance and policy applications, nor the shipping sector specifically. Nevertheless, the structure they employed is useful consisting of five main factors that can be applied to the maritime sector:

1. *Historical perspective.* The shipping sector is partly at least, directed by its past, either immediate or more distant. Thus traditional trade routes, port locations and maritime seats of

power are all established features of the market place. Shipping policy tends to emerge from, or be associated with, the established network of trade patterns, centres of activity and centres of power. Any policy development – regardless of where it emanates from – has to take this into account as well as any changes to the world maritime scene such as the emergence of new routes, ports or maritime powers. Services associated with exploitation of North Sea oil, the development of the Port of Fos/Marseille and the rise of China in world shipping are all recent examples.

2. *Nodes, networks and systems.* The shipping sector is essentially a combination of nodes (ports), networks (trading routes) and systems (the organisation and infrastructure that connects the other two items together – including communications, financial agreements, a legal framework, shipbrokers, freight for warders etc.). Both governance and policy making ultimately is about all these elements and the environment it creates for them. This might be to encourage activity in a certain location, trade or at a certain time (e.g. favourable tax regimes in EU Member States for shipping), or to control unwanted activity (e.g. sub-standard environmental or safety practices). Policy-makers have to understand the series of inter-linkages that exist if the policies they create are to be specific, meaningful and to achieve what they are aimed to do. A suitable governance framework makes these linkages possible.
3. *Modal choice, intermodalism and flexibility.* Shipping works in a highly competitive environment, not just within the industry itself but also in competition with other modes. In Europe, short sea shipping faces intense competition from trucking across the whole continent, whilst even international rail services are increasingly competitive, as developments in East European infrastructure continue and new investments such as the Channel Tunnel and the Oresund link have become fully operational. Policy-makers need to have a full view of the choices available to shippers. In addition, the concept of intermodalism continues to expand with the support of the EU, so that shipping is now commonly seen as one link within a complex intermodal chain – including trucks and trailers on ferries, rail ferry operations, containerised services and the multitude of specialist facilities needed to ensure an adequate inter-linkage. Policy making in shipping has much to do here to ensure that developments are co-ordinated and that the shipping industry plays its full role.
4. *Deregulation and privatization.* Both deregulation (the reduction or removal of state control and influence) and privatisation (the partial or complete transfer of ownership from the state to the private sector) have been major trends worldwide in many economic sectors for some years now. Shipping is no exception. The substantial developments in Eastern Europe have resulted in many examples of both trends, but elsewhere the privatisation of ports, state shipping companies and ancillary activities coupled with the attempts by the EU to reduce state interference through relaxing cabotage rules and reducing state subsidies have been apparent also. Shipping policies have reflected these trends since the 1980s and will continue to do so although par adoxically, the need for tighter safety and environmental controls and the desire to see reduced state interference has raised government involvement at all jurisdictions in policing the industry's activities.

5. *Holism.* Shipping policies have to recognise that shipping is part of a much wider activity that is closely linked with a multitude of other economic, social, political and technological developments which both influence the ship ping environment and are influenced by it. Thus shipping policy-makers have to understand that any changes, for example, in financial policy in the EU will have substantial impact upon the shipping investment climate and may necessitate further action incorporated into shipping policy measures. Shipping is an holistic activity that cannot be separated out from the complexity of the real world but this makes policy making both difficult and at times, very slow.

4. Shipping Policy — Spatial Levels of Origin and Implementation

Policy in the shipping sector both emerges and is applied to the industry at different spatial levels. These are indicated in Figure 1 which attempts to summarise the shipping policy framework and the factors which influence the policies that emerge and the players involved in its development. They can be divided into five levels – in many ways a convenience as in real life there remains overlap between them – but at the same time there are clear distinguishing features of each which are significant for policy derivation and implementation. These different spatial policy levels (or jurisdictions) and the problems of co-ordinating and making consistent their policy initiatives is the central theme of this chapter and has been identified in earlier work by Cafruny (1987, 1991), and Aspinwall (1995). The following discussion focuses on the relationships between these levels and the difficulties this sometimes presents.

At the highest jurisdiction there are *international policies* derived by international organisations which should, at least in theory, provide an over-arching structure for the policies derived at lower levels. In the shipping sector, the most prominent international policy-making institutions include the United Nations International Maritime Organisation (IMO), responsible amongst others for policies towards safety, security and the environment in shipping generally, and the Organisation for Economic Co-operation and Development (OECD), which is made up of the developed countries of the world and which is active particularly in shipbuilding policy and issues relating to efficiency worldwide. In each case, there is no compulsory legal requirement for nation-states to abide by their policies and no direct powers of law-making rest with these organisations, but at the same time, membership by individual (and powerful) nations is extensive and requires that the policies and recommendations are followed. Hence in terms of influence they are some of the most significant organisations.

The policy framework set out at the international level provides the general agenda for that at the next – *supra-national* – which is typified by that of the European Union (EU) which generates policies that are applied to all Member States and in the case of the EU, is backed up by laws that are normally superior to national (Member State) laws where there may be conflict (Brooks and Button, 1992; Kiriazidis and Tzanidakis, 1995; Paixao and Marlow, 2001; Urrutia, 2006; Marlow and Mitroussi, 2008).

Alternative supra-national regimes include the North America Free Trade Association (NAFTA) with a series of maritime related policies but no law making powers, and in historical terms, the Council for Mutual Economic Assistance (CMEA) which represented the countries of the Former Soviet bloc but which again had no legislative powers (although considerable persuasive ones)

(Chrzanowski, Krzyzanowski and Luks, 1979; Ledger and Roe, 1996).

Taking the EU as an example, the policies which emanate from the deliberations of the Commission (DGVII), Council of Transport Ministers and the Parliament are normally designed to inter-act with international policies of (for example) the IMO, so that recent EU legislation on double-hulled tankers and other environmental and safety measures have avoided any conflict between jurisdictions. This may not necessarily be the case where the interests of the EU conflict with those of the wider global or national (Member State) framework and it is clear that divergences of policy-making from interjurisdictional consistency will produce tensions that are hard to reconcile. The agreement of policy over implementation of the UNC TAD 40/40/20 rule for liner shipping by the EU in 1979 reflected these tensions as the EU's commitment to free trade and liberalisation was tested by UNCTAD's demands for market interference on behalf of developing countries. An agreement was reached but the problems of achieving consistency of policies across spatial boundaries where the agendas were fundamentally different were apparent. Very recently, problems continue in relationships between the EU (supranational) and the IMO (international) over representation and policy-making reflecting greater governance inadequacies that exist.

This discussion of supra-national policy-making also needs to refer to the problems of compatibility with national policies, particularly with reference to the EU and the difficulties experienced in reconciling EU policies on (for example) state aids and cabotage with the desires and agendas that exist in individual member states. Aspinwall[8] referred to the prolonged discussion that took place before Greece agreed to the opening up of cabotage markets within the EU to all ships of the EU, an agreement that eventually contained safeguards for socially vulnerable markets and extended delays in implementation to give the industry time to adapt. A good example of this was the application of cabotage rules to the Greek Island trades where intense seasonality of demand could lead to some islands losing services altogether in winter as European shipowners from countries other than Greece creamed off summer profits. These concessions diluted the ambitions of the EU to open all shipping markets to all ships and operators that were both safe and environmentally friendly and reflected a divergence in policy ambitions between supra-national and national interests. The provision of shipping state aids have presented similar difficulties and the EU Commission has compromised on its leading

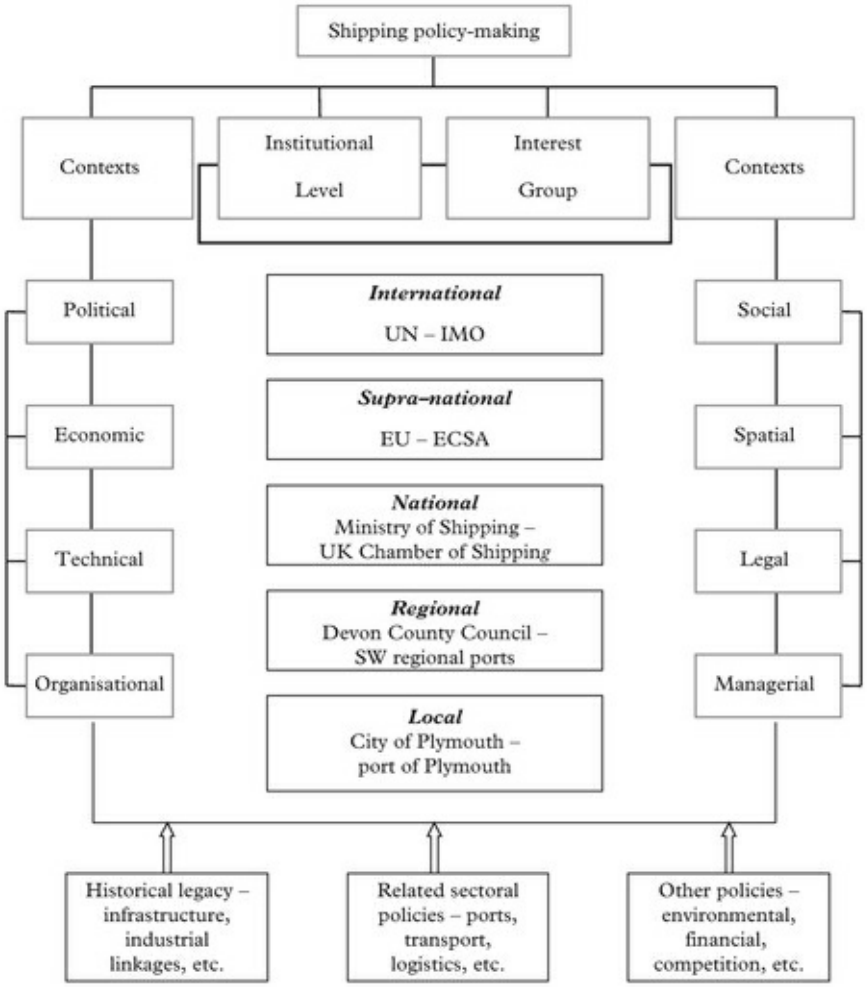

Figure 1: The context for shipping policy-making

principle of free markets and liberalisation so that some state aid remains in place at a national level, albeit controlled in amount and characteristics.

Figure 1 also notes the existence of two more levels of policy-making in the shipping sector upon which we shall not dwell here but which also play a part in the conflict between jurisdictions – *regional and local*. These two spatial levels, typified by regional governments (such as Devon County Council in the UK) and city governments (such as Plymouth in the UK) once again should derive policies that are compatible with the levels above them at national, supra-national and international level as not doing so leads to problems of implementation. Thus a regional authority within the EU might find problems in keeping to EU policies limiting state aid to shipping when the local, dominant ship operator needs regional support to remain financially solvent. Similarly, local city ports need to match their policies with the regions where they are located but at times political differences can interfere with this process.

5. Interest Groups and Stakeholders

The discussion above has focused upon the role of the state at each spatial level in the formation of shipping policy and has emphasised how important but also how difficult it is for these different levels to work together and to ensure that policy created at one level is co-ordinated with that at each of the others to generate meaningful and consistent initiatives.

Figure 1 also includes examples of interest groups or stakeholders that have a significant role to play in the creation and dissemination of shipping policy. These interest groups are those parts of the shipping industry with an active position in the sector and who are both the generators and those most

affected by the policies that are created; examples of them have been noted above. Thus at the international level, the IMO, Greenpeace and major charities are significant interest groups which both create and absorb international shipping policy measures. At the supra-national level, an organisations such as the European Community Shipowners Association, based in Brussels Belgium, and representing shipowners throughout the EU is a significant interest group that places pressure upon EU and national policy-makers to take account of their views. At a national level, the UK Chamber of Shipping plays a similar role in relation to the UK government, but also in discussion with other interest groups (e.g. the European Shippers Council or the UK seafarers labour union). Similar relationships exist at local and regional level for port authorities, environmetal pressure groups, local truck haulier associations etc. each of which has a voice feeding into the policy-making process.

These voices act across jurisdictions – thus the UK Chamber of Shipping might input policy initiatives directly to DGVII of the EU – and not just to their respective spatial policy-makers (in this case the UK government ministry responsible for shipping – the Department for Local Government, Transport and the Regions) or those directly above or below. The situation thus gets increasingly complicated as consistency and compatibility vertically up and down policy-making bodies at state level now has also to function horizontally with interest groups and also diagonally with groups at different levels. There is also a very large number of interest groups for each policy level and issue, each inter-relating with each other to a lesser or greater extent either in opposition or collaboration. To add to the complexity, attitude can also vary with the issue concerned.

6. The Contexts

The final piece of the complex puzzle which makes up the shipping policy and governance model is provided by the contexts within which all these policy initiatives and relationships must operate and which in turn affect their development, potential and success (or otherwise). A number of these can be identified following the work of Ledger and Roe (1996). They include:

1. *Economic:* refers to the impact of economic factors upon the derivation and characteristics of shipping policy for any particular regime (international, supra-national etc.). Thus it might well include the impact of the introduction of the Euro across EU states, the general depressed condition of the world economy in 2008–2009, the specific implications of the state of the scrap market upon the shipping industry and the development of free markets in Eastern Europe. It is a significant but wide ranging context that is difficult to define and understand its full and detailed implications but which is fundamental to shipping policy at all jurisdictions.
2. *Legal:* refers to the legal framework within which the shipping sector has to operate. This will include national laws and regulations as well as those of a supra or international nature – thus shipping operators based within countries within the EU or operating to and from EU ports are required to meet not only the legislation relevant in their home state but also the multitude of EU regulations and directives that are imposed upon the sector. These include, for example, the large number of pieces of legislation referring to safety in the ferry industry, bulk carrier safety, competition rules for liner shipping and rules for cabotage operations. The competition rules for liner shipping are a good example of where different legal regimes

apply to the same industrial sector dependent upon the spatial level that is considered. There are domestic laws in, for example, the United Kingdom, that control numerous shipping activities and impacts relating to the local environment (local government pollution controls), port safety (port regulations), seafarer employment (income tax and social security rules) and taxation (UK tonnage tax). The US legal regime will also become relevant for liner shipping companies active in US trades as it regulates various aspects of liner competition. However, at the supra-national EU level there are further regulations that apply to competition between liner operators, agreements through consortia and conferences and the penalties that can be applied by the European Commission (including the once infamous 4054–4058/86 Regulations which included 4056/86. This provided for the existence of liner conferences despite their clear violation of the Treaty of Rome. By 2009 this had finally been removed but its existence for over 20 years was a persistent anomaly). Meanwhile at an international level, the industry is subject to the rules and recommendations of the IMO in terms of ship safety, seafarer training and environmental protection.

The legal framework is constantly changing at each level as a response to a myriad of social, political and economic pressures and it is within this context that some of the more important failures of co-ordination between jurisdictions are evident.

3. *Managerial:* refers to the relationship of the internal structure of shipping companies with the policy framework that is imposed. Thus the size and complexity of shipping organisations and the changing range of functions that shipping companies have incorporated has an impact in terms of policy-making and its implementation. The latter point is particularly important as shipping companies increasingly integrate vertically, absorbing logistical functions traditionally carried out by separate organisations but now incorporated within one company structure. Thus Maersk's interests in the full range of logistics from shipping to trucking and agency work to air transport has implications for policy-makers and vice versa in that it is no longer shipping policy which is solely important but a range of policies from competition to industrial, transport to regional development. This increase in the range of functions undertaken by traditional shipping companies adds to the complexities and has also increased pressure on the industry to conform to a wider range of policy initiatives. The problems faced by the TACA operators in liner shipping on the North Atlantic in the 1990s is evidence of this in that they fell foul of competition policies of the EU in the area of inland trucking (being accused of being anti-competitive for whole transport journeys and not just shipping links as permitted under Regulation 4056/86 of the EU) rather than any specific shipping offence. It is only whilst the economic and logistical benefits of vertical integration for shipping companies remain greater than the potential complexity that comes with it (and the risks of falling foul of legislation) that this trend will continue.

   A further example of complexity that changes within the managerial context can bring includes conflict within the liner industry again on the North Atlantic between the regimes of the EU and the FMC in the USA with their differing views on the permissible nature of liner conferences and also the option of including inland transport within overall conference legislation.

4. *Organisational:* refers in particular to the structure and characteristics of the shipping

industry as a whole rather than company internal activities and two important trends here stand out in relation to policy-making at all levels – privatisation and globalisation. Following the demise of the Soviet empire (and with it the role of state-owned shipping companies) and combined with the trend of a general divestment of state companies around the world in all sectors, the shipping sector as a whole has seen a considerable move towards private ownership. Thus the significance of state control has lessened as governments become distanced from company decisions, finance and operations. At the same time there has been a consequential increase in supra-national and international policy-making in the sector to control the external effects of the industry as it finds itself released from public sector obligations. This is evidenced in the increased activity in shipping policy-making of the EU, the FMC and the IMO in terms of safety, environment and competition with the objective of protecting public interests in areas where the market has no interest and there is no natural market mechanism to ensure that high levels of safety, low levels of environmental pollution and healthy competition between players in the shipping market are maintained. One problem that emerges here between spatial policy-making levels is that commonly it may be advantageous for competition policy (for example) to be neglected at a national level as this may ensure a strong international presence for a domestic fleet (for example through subsidy in many forms), whilst it is being strictly enforced at a supra-national level – for example at the EU level where subsidies are strictly controlled.

In terms of globalisation, this has changed the characteristics of the shipping industry, which although has always operated at an international level, until recently was much more constrained by nationally The shipping industry is inherently global and able to take advantage of flexibility and mobility in its use of labour, finance and services almost at will. The result is a series of problems for policy-makers as the industry migrates from one national (flag) regime to another, trading off concessions between national regulators. Thus, the UK shipping company P&O was a major bulk, ferry and liner operator worldwide for many years but more recently has found it necessary to enter global strategic alliances and to merge its liner operations with Nedlloyd of the Netherlands. Policy-making in the shipping sector is directly affected by such moves particularly at the national level as national policies in the UK and the Netherlands may conflict (for example in terms of subsidy) causing at best, confusion with in the sector. In addition the increased impact of flags of convenience and international registers confuses the picture further as nationally based companies have to work more and more within an international framework whilst international and national policies towards training, labour and employment for example, may clearly conflict with the requirements of the international regime.

5. *Political:* refers to the political context from which all shipping policies emerge. It is never the case that a single economic, technical or legal framework stimulates and controls shipping policy formulation. In fact, the political acceptability of any particular policy is commonly the most significant context of all. Sizeable political changes (for example those that occurred in Eastern Europe from 1989–1992; the Arab-Israeli conflicts; or the effects of the World Trade Center incident in 2001) are often of less significance than the political

relationships between players within and adjacent to the industry. A fine example, described in some detail by Aspinwall, refers to the political relationship between the European Commission (the executive body of the EU) and the Council of Ministers (the main legislature of the EU) concerning the introduction of Regulation 4056/86. This regulation effectively permitted the existence of liner conferences for shipping operators working into and out of EU ports, something that under the competition rules within the Treaty of Rome should be illegal. The Commission's view was clearly that this should not be permitted but they were ignored by the Council in 1986 who, under pressure from the shipping industry and acting in a political rather than a legal or economic context, legislated to secure their existence. In this example an internal political conflict resulted in policy that conflicts with all other industrial sectors within the EU (none other has such an exemption from competition law) and which has presented a series of difficulties in co-ordinating different policy level initiatives since then. Other political pressures which have been significant at EU level in overtly affecting policy-making include the concessions granted to Greece over the delay in imposing cabotage laws and the continued existence of subsidies for shipping operations against all principles that the EU tries normally to uphold. Such political concessions do nothing to create a consistent and meaningful policy framework for the sector as a whole evidenced in the continuing friction between the European Shippers Council and the European Shipowners Association over shipping conferences and consortia and the maintenance of higher freight rates that the former believe is a consequence.

6. *Social*: refers to a multitude of complex relationships between the shipping industry and the society in which it operates. These issues include the significance of maritime employment and policies which promote or reduce it – a major strand within policy-making at local, regional, national and supranational levels in particular. Much recent debate has focused within the EU upon the introduction of new tax regimes by nation states for shipping, partly at least aimed at encouraging or sustaining employment levels. In addition there have been widespread policy initiatives concentrating upon seafarer training, conditions of service and the environment all with strong social implications. Certainly at all levels, the social implications of a particular policy have to be noted by politicians when they choose policy initiatives as the relationship between the two is close and the impact can be sizeable.
7. *Spatial:* refers to the fact that shipping policy is not only derived at a variety of spatial jurisdictions as we have seen – international, supra-national, national, regional and local – but is also affected by a variety of spatial issues. These might include issues relating to peripherality and cohesion – a major theme within the EU – whereby the disadvantage felt by peripherally located regions and states (for example the accession countries of Eastern Europe; or the economically poor area of southern Italy) can be reduced through policies to promote good transport links including those by ship and through ports. By improving these links, the friction caused by a peripheral location can be reduced. Other spatial influences include promotion of short sea shipping in Europe to reduce dependence upon pollution-generating road transport and various regional policies to improve the lives of island based communities. The latter is evidenced in the EU through the cabotage Regulations which even after the liberalisation of these trades, allow countries to protect some domestic routes for

social reasons. A multitude of other spatially related issues are important to shipping - including regional policies to develop economically backward areas and the consequent industrial and commercial impacts, the effects of the emergence of new countries including those of Russia, Yemen, Bosnia, Croatia, the Ukraine, and the Baltic States of Latvia, Lithuania and Estonia and their relatively important shipping fleets and/or port facilities and the construction of new port facilities including for example those for oil export in the Baltic which recently has seen new developments in Russia, Latvia and Lithuania all affecting the required geographical focus of policy measures to promote or protect various shipping related activities or impacts.

8. *Technical:* refers to the changes in technical facilities and methods which have direct and indirect effects upon the shipping industry. Policies have to take account of these changes and this includes a multitude of new safety and environmental regulations at international, supra-national and national level to accommodate the growth in ship size both in terms of container and bulk vessels. Changes in ferry design and the need for improved technical and safety rules have stimulated further regulation especially within the EU and following the *Herald of Free Enterprise* and *Estonia* disasters. New port facilities and changes in modal choice also have their effect and the continued growth in road transport and the construction of new pipeline facilities have implications for policy-makers in the shipping sector. The EU's continued promotion of intermodalism also has impacted technically upon the shipping policy sector.

These eight major contexts provide the external framework within which all shipping policy – at whatever level – has to be placed; policy-making which ignores their influence has no chance of success. The relative influence of each context will be dependent upon the spatial level and the issue involved as well as a host of other inter-connected issues but undoubtedly in the very large majority of cases, each context has a significant role to play. Some are ever-present and always central – particularly political issues, but also the relevant legal framework and the economic relationships that exist between shipping and its broader setting.

In addition, shipping policy cannot ignore the wider context in which it has to be introduced and implemented. Thus shipping policy at all levels has to accept that there are other policies – including industrial, financial, environmental, competition, infrastructure, energy and so on – with which it must co-ordinate and be aware of. Failure to do so again results in conflict between policy-makers and other players within the shipping sector and therefore ineffective policy-making. In addition, shipping policy makers have to recognise the role of other transport modes and the fact that policies for one mode may conflict with that for another (for example, promotion of road transport through road building and subsidised taxation for trucks has an inevitable impact upon the short sea shipping industry). Clearly and ideally, the separate modal policies would be integrated into one whole, but this is often made difficult as there remains competition between modal interests and structurally these policies commonly emanate from different government ministries. Meanwhile the full range of stakeholders and interest groups need to be accounted for as players in the policy-making game. Finally, shipping policy if it is to be effective, has to be aware of its inheritance in terms of industry structure, ownership, tradition and importance. These in turn will affect its role and potential in terms

of policy. All these issues manifest themselves through the governance framework that is in place for shipping policy-making.

7. Summary and Conclusions

This discussion of shipping policy has focused in particular upon two features – the complexity of the influences that determine both its character and success, and the significance of ensuring that there is compatibility across all spatial levels if policies are to be effective. There is nothing more likely to inhibit the success of shipping policy initiatives than to have conflicting policy ambitions at say, national and supra-national levels – something for example that has characterised the industry in conflicts between Greece and the EU over cabotage trades, and also between the USA's FMC and the EU over liner conferences and their operations on the North Atlantic.

This consistency across levels has to be maintained in the context of policies emerging in other areas as well (for example the environment and economy) or else conflict will again emerge which will effectively prevent the achievement of the objectives that the policies are aimed at. There are many examples of countries promoting both short sea shipping through tax concessions as well as trucking, both operating within the same markets in competition with each other. These conflicts of interest that occur regularly within the shipping policy arena have been made more significant and more difficult to resolve with the increased globalisation of markets and the impact that this has had upon the already highly internationalised shipping industry and its increasing moves towards international joint ventures and strategic alliances. In effect, it is now only at an international level that shipping policy can ever be truly effective. Thus the EU may have ambitions to open up markets and insist upon high environmental and safety standards for shipping but is prevented from achieving these ideals and implementing appropriate policies because to do so would destroy EU shipping fleets within a global context – a consequence that would be politically and socially unacceptable. Thus the EU compromises upon issues such as flags of convenience (which in many ways it should welcome as a consequence of a free market) by allowing member states to subsidise their own fleets through low taxation regimes compared with other industries – thus breaking their own Treaty of Rome competition principles. The very international and mobile nature of shipping makes this inevitable. Similar compromises can be seen in terms of liner shipping, cabotage and manning rules. Meanwhile, Port State Control offers an interesting example of where the EU has achieved much of what it wishes to promote within an international frame work but at supra-national level: – by enforcing high standards upon ships of all nationalities entering EU ports, safety and environmental standards across the EU are maintained even where the ships concerned are operated under a legal regime outside of the EU. Of course this has little impact upon vessels that never enter EU ports.

At the international level (for example the IMO) it would in theory be possible to achieve agreement across all nations for rules that then could be universally applied at all spatial levels, right down to local. As the analysis in this chapter suggests, due to the complex and often conflicting relationships between the different players in shipping and the various spatial levels of shipping policy, such agreements are difficult (if not impossible) to achieve and conflicts between policies imposed at differing levels remain and will do so whilst nations, ship operators, local interests and others see benefits in imposing their own policy initiatives. The globalisation of a complex and highly mobile industry characterised by excessive international interests and heavily entwined with other

sectors – as shipping is – makes policy-making a frustrating and difficult business but one which perhaps more than any other, reflects the complete pattern of commercial interests that exist throughout different areas of the world.

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References

Ademuni-Odeke (1984): *Protectionism and the Future of International Shipping* (Dordrecht, Kluwer).

Aspinwall, M. (1995): *Moveable Feast: Pressure Group Conflict and the European Community Shipping Policy* (Aldershot, Ashgate).

Barla, M.C., Sag, O.K., Roe, M.S. and Gray, R. (eds.) (2001): *Developments in Maritime Transport and Logistics in Turkey* (Aldershot, Ashgate).

Behnam, A. (1994): "The future of the shipping dialogue in UNCTAD", *Maritime Policy and Management*, 21, 1, 15–28.

Bredima-Savopoulou, A. and Tzoannos, J. (1990): *The Common Shipping Policy of the EC* (The Hague, Elsevier)

Brooks, M.R. (2000): *Sea Change in Liner Shipping* (Oxford, Pergamon).

Brooks, M.R. and Button, K. J. (1992): "Shipping within the framework of a Single European Market", *Transport Reviews*, 12, 3, 237–252.

Brownrigg, M., Dawe, G. and Mann, M. (2001): "Developments in UK shipping: the tonnage tax", *Maritime Policy and Management*, 28, 3, 213–224.

Cafruny, A. (1985): "The political economy of international shipping: Europe versus America", *International Organization*, 39, 1, 79–119.

Cafruny, A. (1987): *Ruling the Waves – The Political Economy of International Shipping* (Berkeley CA, University of California Press).

Cafruny, A. (1991): "Towards a maritime policy", in Hurwitz, L. and Lequsne, C. (eds.), *The State of the European Community Policies, Institutions and Debates in the Transition Years* (Boulder CO, Lynne Reinner).

Chrzanowski, I., Krzyzanowski, M. and Luks, K. (1979): *Shipping Economics and Policy: A Socialist View* (London, Fairplay).

Colvin, M. and Marks, J. (1984): *British Shipping: The Right Course*, Policy Study 67 (London, Centre for Policy Studies).

Flynn, M. (1999): "PRC maritime and the Asian financial crisis", *Maritime Policy and Management*, 26, 4, 337–348.

Frankel, E.G. (1989): "Strategic planning applied to shipping and ports", *Maritime Policy and Management*, 16, 2, 123–132.

Frankel, E.G. (1992): "Hierarchical logic in shipping policy and decision-making", *Maritime Policy and Management*, 19, 3, 211–221.

Frankel, E.G. (1999): "The economics of total trans-ocean supply chain management", *International Journal of Maritime Economics*, 1, 1, 61–70.

Gardner, B. (1999): "Investment incentives for British shipping: a further comment", *Maritime Policy and Management*, 26, 2, 195–200.

Gardner, B., Naim, M. and Obando-Rojas, B. (2001): "Maintaining the maritime skills base: does the

government have a realistic strategy?", *Maritime Policy and Management*, 28, 4, 347–360.
Gold, E. (1981): *The Evolution of International Marine Policy and Shipping Law* (Lexington MA, Lexington Books).
Goss, R.O. (ed.) (1982): *Advances in Maritime Economics* (Cambridge, Cambridge University Press).
Goto, S. (1984): *Japan's Shipping Policy*, Research Report 3 (Tokyo, Japan Maritime Research Institute).
Hart, P., Ledger, G., Roe, M.S. and Smith, B. (1993): *Shipping Policy in the European Community* (Aldershot, Ashgate).
Hawkins, J. (2001): "Quality shipping in the Asia-Pacific region", *International Journal of Maritime Economics*, 3, 1, 79–101.
Hawkins, J. and Gray, R. (1999): "Making strategic choices for Asia-Pacific shipping", *International Journal of Maritime Economics*, 1, 2, 57–72.
Hawkins, J. and Gray, R. (2000): *Strategies for Asia-Pacific Shipping* (Aldershot, Ashgate).
Hoyle, B. and Knowles, R. (1998): *Modern Transport Geography* (London, Wiley).
Kiriazidis, T. and Tzanidakis, G. (1995): "Recent aspects of the EU maritime policy", *Maritime Policy and Management*, 22, 2, 179–186.
Kokuryo, H. (1985): *Korean Shipping and Shipping Policy: Shipping Industry Rationalisation Plan*, Research Report 8 (Tokyo, Japan Maritime Research Institute).
Ledger, G.D. and Roe, M.S. (1993): "East European shipping and economic change: a conceptual model", *Maritime Policy and Management*, 20, 3, 229–241.
Ledger, G.D. and Roe, M.S. (1995): "Positional change in the Polish liner shipping market", *Maritime Policy and Management*, 22, 4, 295–318.
Ledger, G.D. and Roe, M.S. (1996): *East European Change and Shipping Policy* (Aldershot, Ashgate).
Lee, T. (1996): *Shipping Developments in Far East Asia* (Aldershot, Ashgate).
Lee, T. (1999): "Restructuring of the economy and its impacts on the Korean maritime industry", *Maritime Policy and Management*, 26, 4, 311–326.
Li, K.X. and Cheng, J. (2007): "The determinants of maritime policy", *Maritime Policy and Management*, 34, 6, 521–534.
Li, K.X. and Wonham, J. (2001): "Maritime legislation: new areas for safety of life at sea", *Maritime Policy and Management*, 28, 3, 225–234.
Lu, C.S. (1999): "Strategic groups in Taiwanese liner shipping", *Maritime Policy and Management*, 26, 1, 1–26.
Managi, M. (2007): "Maritime shipping industry and productivity in Japan", *Maritime Economics and Logistics*, 9, 4, 291–301.
Marlow, P. and Mitroussi, K. (2008): "EU shipping taxation: the comparative position of Greek shipping", *Maritime Economics and Logistics*, 10, 1/2, 185–207.
Mimiran, S.M.R. (1994): *Iran's National Shipping Policy* (Plymouth, University of Plymouth).
Moyer, R.C. (1977): "Maritime subsidies: problems, alternatives and trade-offs", *Journal of Industrial Economics*, 25, 3, 53–68.
Nasiru, I.S. (1994): *The Nigerian National Shipping Policy: Aground or Afloat?* (Plymouth, University of Plymouth).
Omosun, A.Y. (1987): *A Consideration of the Means of Attaining the Nigerian Shipping Policy*

Objectives (Plymouth, University of Plymouth).
Paixao, A. and Marlow, P. (2001): "A review of the European Union shipping policy", *Maritime Policy and Management*, 28, 2, 187–198.
Peeters, C., Verbeke, A., Declerq, E. and Wijnholst, N. (1995): *Analysis of the Comparative Position of Short Sea Shipping: Development of Policy Measures* (Delft, Delft University Press).
Peters, H.J. (2001): "Development in global seatrade and container shipping markets: their effects on the port industry and private sector involvement", *International Journal of Maritime Economics*, 3, 1, 3–26.
Randay, T. (2001): "Internationalisation and foreign direct investment in shipping: a study of Norwegian firms", *International Journal of Maritime Economics*, 3, 3, 298–317.
Roe, M. (2008a): "Safety, security, the environment and shipping – the problem of making effective policies". *WMU Journal of Maritime Affairs*, 7, 1, 263–279.
Roe, M.S. (1998): *Commercialisation in Central and East European Shipping* (Aldershot, Ashgate).
Roe, M.S. (2007a): *Jurisdiction, Shipping Policy and The "New" States of The European Union*, Paper Presented at the International Association of Maritime Economists, Athens, Greece.
Roe, M.S. (2007b): *European Union Maritime Policy. The Role of New Member States and the Need for a Review of Governance*, Paper presented at the International Shipping Management Forum 07, 10–11 May, Athens, Greece.
Roe, M. (2007c): "Shipping policy and multi-level governance", *Maritime Economics and Logistics*, 9, 1, 84–103.
Roe, M.S. (2008b): *State Versus the Stakeholder; The Governance of the Maritime Sector*. Paper presented at the International Association of Maritime Economists Annual Conference, Dalian, China.
Roe, M.S. (2009a): *Policy Failure in Shipping; A Global Disaster of Epic Dimensions*. Paper presented at the 2nd International Symposium on Maritime Safety, Security and Environmental Protection, National Technical University of Athens, Athens, Greece, September 17–18, 2008.
Roe, M.S. (2009b): "Multi-level and Polycentric Governance: Effective Policymaking for Shipping", *Maritime Policy and Management*, 36, 1, 39–56.
Roe, M.S. (2009c): "Maritime governance and policy-making failure in the European Union", *International Journal of Shipping and Transport Logistics*, 1, 1, 1–19.
Ryoo, D.K. and Thanopoulou, H.A. (1999): "Liner alliances in the globalization era: a strategic tool for Asian container carriers", *Maritime Policy and Management*, 26, 4, 349–368.
Schrier, E., Nadel, E. and Rifas, B. (1985): *Outlook for the Liberalization of Maritime Transport* (London, Trade Policy Research Centre).
Selkou, E. and Roe, M.S. (2002): "UK tonnage tax: Subsidy or special case?", *Maritime Policy and Management*, 29, 4, 393–400.
Selkou, E. and Roe, M.S. (2004): "Globalisation, policy and shipping" (Cheltenham, Edward Elgar).
Slack, B., Comtois, C. and McCalla, R. (2002): "Strategic alliances in the container shipping industry: a global perspective", *Maritime Policy and Management*, 29, 1, 65–76.
Sletmo, G.K. (2001): "The end of national shipping policy? A historical perspective on shipping policy in a global economy", *International Journal of Maritime Economics*, 3, 4, 333–350.

Sletmo, G.K. and Williams, E.W. (1981): *Liner Conferences in the Container Age: US Policy* (New York, Macmillan).

Song, D-W., Cullinane, K. and Roe, M.S. (2001): *The Productive Efficiency of Container Terminals* (Aldershot, Ashgate).

Sun, G. and Zhang, S. (1999): "General review of the Chinese shipping policy for the contemporary era", *Maritime Policy and Management*, 26, 1, 93–99.

Sun, G. and Zhang, S. (2000): "Comment. The APEC future maritime policy and its evaluation", *Maritime Policy and Management*, 27, 2, 209–213.

Thanopoulou, H.A., Ryoo, D.K. and Lee, T. (1999): "Korean liner shipping in the era of global alliances", *Maritime Policy and Management*, 26, 3, 209–230.

Tongzon, J. (2007): "Determinants of competitiveness in logistics: implications for the ASEAN region", *Maritime Economics and Logistics*, 9, 1, 67–83.

Urrutia, B. (2006): "The EU regulatory action in the shipping sector: a historical perspective", *Maritime Economics and Logistics*, 8, 2, 202–221.

Van Der Linden, J. (2001): "The economic impact study of maritime policy issues: application to the German case", *Maritime Policy and Management*, 28, 1, 33–54.

Walenciak, A., Constantinou, A. and Roe, M.S. (2001): "Liner shipping between East and West Europe: competitive developments in the Poland-United Kingdom trade", *Maritime Policy and Management*, 28, 4, 323–338.

Wang, S. (1993): *European Community Shipping Competition Policy* (Plymouth, University of Plymouth)

Whitehurst, C.H. (1983): *The US Merchant Marine: In Search of an Enduring Maritime Policy* (Annapolis, Nautical Institute Press).

Wilmsmeier, G. and Hoffmann, J. (2008): "Liner shipping connectivity and port infrastructure as determinants of freight rates in the Caribbean", *Maritime Economics and Logistics*, 10, 1/2, 130–151.

Wrona, A. and Roe, M.S. (2002): "The Polish maritime sector under transition", *Maritime Policy and Management*, 29, 1, 17–43.

Yannopoulos, G.N. (1989): *Shipping Policies for an Open World Economy* (London, Routledge).

Yercan, F. (1999): *Ferry Services in Europe* (Aldershot, Ashgate).

Yercan, F. and Roe, M.S. (1999): *Shipping in Turkey* (Aldershot, Ashgate).

Chapter 19

Government Policies and the Shipbuilding Industry

*Joon Soo Jon**

1. Introduction

The health of the global economy is the most important factor governing the international shipbuilding industry but national economic policies play a crucial role in determining the extent to which a country's shipbuilding industries develop and thrive or, alternatively, decline and possibly disappear. Together, national and international factors can be referred to as the macro economic environment. If the economic climate is unfavourable then industrial organisations, including shipbuilders, will face painful problems and may even have to close their production facilities.

While the macro economic environment sets the conditions that will either allow a shipbuilding industry to thrive, or not, the choices made, decisions taken, by each individual shipbuilding business are crucial to its survival and prosperity. Good decisions at the enterprise level can partially offset an unfavourable macro structural environment.

Government policies in promoting shipbuilding industry are largely implemented through various types of financial assistance such as direct financial aid and or by guaranteeing loans.

Therefore, the main objective of this chapter is to review the historic development of successful shipbuilding countries and provide informative cases for reference in the face of changing national and global circumstances. The structure of this chapter is as follows. The next section focuses on the impact of Government intervention on the shipbuilding industry. Section 3 considers the global shift in the shipbuilding industry and structural changes in this market. Section 4 examines the role of government in developing or supporting the shipbuilding industry. Section 5 explores the impact of recent changes in economic environment on the leading shipbuilding countries such as Japan, South Korea and China. The final section presents the summary and conclusions.

2. The Impact of Government Intervention on the Shipbuilding Industry

2.1 Shipbuilding enterprise

Shipbuilding enterprises can be categorised as falling into two distinct groups: those that engage purely in shipbuilding and those that are diversified enterprises where shipbuilding is only one of a portfolio of interests that may have very little in common. In addition there is also an important distinction to be made between shipbuilders that are private firms and those that are state corporations.

There are strengths and drawbacks associated with being either an independent shipbuilding enterprise or the shipbuilding arm of a conglomerate. Not surprisingly both structures are frequently found within a national shipbuilding industry. Shipbuilders belonging to diversified corporations have the advantage of being able to rely on corporate resources for expansion and support which are independent of the state of the shipbuilding market. Consequently, in periods of shipping recession, the shipbuilding member of the group can call upon reserves acquired in other market areas to

overcome short-term cash flow difficulties. Moreover, this shipbuilder may be able to use group resources to modernise its production facilities at a time when independent shipbuilding firms are being obliged to cut back their overheads and capacity. This enables the shipbuilding member of the group to boost its competitive position compared to other shipbuilders. The flexibility inherent in the within-group transfer of resources to the benefit of shipbuilding operations has been important to the success of Japanese and South Korean shipbuilders.

Access to well organised and funded marketing, and research and development, can be another advantage of being part of a conglomerate. But there is one more, less easily quantifiable, but very important, advantage to being in a big group. Conglomerates have political clout. These diversified, large companies command respect and influence in industrial, financial and political circles. This can mean easier access to capital markets and more sympathetic treatment by politicians, than could be expected by a dedicated shipbuilding company. These factors add up to substantial competitive advantage for conglomerate members.

There is, though, a downside to being part of a conglomerate. Although a shipbuilding subsidiary should theoretically benefit from the resources its parent group devotes to R&D and marketing, the bureaucracy surrounding those functions in a large conglomerate may in practice offset any gains.

Unfortunately, a hierarchical, overly-bureaucratic form of organisation can easily lead to inflexible decision making and rivalry between the managements of member organisations. This can lead to individuals vying for power within the hierarchy of corporate head-office rather than working for the good of the shipbuilding enterprise.

Enterprises solely focused on shipbuilding can, on the other hand, be much more flexible and resilient. As Todd notes:

“They [dedicated shipbuilders] tend to be more loosely organized and more flexible and responsive to changing circumstances in consequence. The independent shipbuilding firm may continue in shipbuilding operations because it simply has no choice – other than closure – whereas the shipbuilding subsidiary may find itself steadily undermined because its corporate parent feels that greater profits can be made by switching assets out of shipbuilding into a more lucrative field. No matter how dedicated the shipbuilding managements of the subsidiary, their subservience to the greater corporate interest takes precedence over their sectoral interests and conceivably, group shipbuilding operations may be phased out not because they are lacking in viability but owing to their low profitability relative to other group interests. It is fair to say that unless the independent shipbuilder can grow to such a position that resources become little or no object, the chances of survival cannot be assured.”[1]

2.2. Impact of government intervention

The state is not necessarily, or even usually, a disinterested observer of the shipbuilding scene. Governments often intervene in their shipbuilding industries. Intervention can range from macro economic management to direct intervention at enterprise level.

This chapter looks at two ways governments can intervene to shape the development of a national shipbuilding industry. One way open to the state is to order the building of warships. Through its allocation of naval contracts, the state often appears to be supporting shipbuilding as a kind of implicit regional policy. Awarding warship orders to particular yards can be a way of protecting employment.

The balance between ordering motivated by such social factors and objective assessment of national defence needs, seems to vary over time.

The other way is formulating policies to promote the shipbuilding industry in direct and indirect ways. Government's role in developing the shipbuilding industry has mainly focused on the financial assistance in various forms.

Governments act as credit guarantors for the construction of ships at their domestic shipyards and often cooperate with shipyards in devising new forms of financial inducement to shipowners to place orders. These can take the form of disguised subsidies to directors. Also a government-sponsored shipbuilding programme with favourable financing (in terms of interest rate and repayment period) provides a great impetus to the development of the domestic shipbuilding industry.

3. The Global Shift of the Shipbuilding Industry

3.1 Structural change in world shipbuilding

In the early 1990s South Korean shipbuilders embarked on an ambitious expansion strategy, despite warnings from the rest of the global shipbuilding industry that the move threatened price stability by creating a large excess of capacity compared to supply. The expansion of the South Korean capacity included new building docks at Hyundai Heavy Industry, modifications at Samsung allowing the building of VLCCs and similarly sized vessels and the construction of the large, modern VLCC capable Halla yard at Mokpo.

Japanese shipbuilders responded by booking large numbers of orders at comparatively lower prices. The price competitiveness of the Japanese shipbuilding industry then deteriorated due to a sharp rise in the yen which rose at one time to as high a level as ¥95 per US dollar. This strengthening of the yen led Japanese yards to buy foreign materials and equipment where possible. Meanwhile the world orderbook increased, mainly due to demand for large-size bulkers and containerships.

Trends of world economy, good or bad, generally begin to produce their effect on shipping with a time lag of around one year, and on shipbuilding one year later than shipping.

3.1.1. Japan

The profitability of the Japanese shipbuilding industry is greatly dependent on exchange rate with the US dollar. Because ship prices are usually denominated in US dollars the sharp appreciation of the yen meant that prices realised by the Japanese yards effectively fell dramatically.

In 1994, the yen rose further to a daunting level of ¥95 per US dollar. Although it then returned to ¥100, these successive surges in the yen caused the shipbuilding industry to become less and less price competitive. However, since the late 1990s the weakening Japanese Yen has once again strengthened the price-competitiveness of Japanese shipbuilders.

3.1.2 South Korea

The OECD shipbuilding working party group considered South Korea's capacity expansion for the first time at a meeting held in January 1995. A representative of the South Korean government said that the government had no legal basis to impose any restraint on expansion by private firms because a matter of this sort was entirely left to the independent judgment of each private enterprise. While the expansion was happening the gap that had existed between Japan and South Korea in the areas of non-price competitiveness, such as technological skills and quality where Japan claimed to lead, was closing.

South Korea succeeded in achieving a level of quality comparable to that of Japan, at least as far as the hull structure is concerned. This was achieved as result of the large amount of experience gained throughout the 1980s, building diverse types of ships and marine structures. But South Korea still lags behind Japan in such areas as marine engines and ship-related equipment.

3.1.3 Western Europe

Germany has finally stabilised its economy following the economically difficult, reunification. The country's shipbuilding industry, which had been not been particularly dynamic in the 1980s gradually revived throughout the 1990s with an expanding order book.

Orders were at a healthy level during most of the decade, with the national industry especially strong in the container ship and passenger vessel sectors. By the beginning of the 2000s, however, Germany was facing major problems. In 2001 deliveries amounted to 55 ships, totalling just over 1m gt. But very few orders were taken during that year with government-related contracts playing an important part in the survival of many yards. A number of yards also started to look more at conversions and refurbishments to compensate for a lack of newbuilding orders.

Germany had become vulnerable because of its specialistion. Korean shipbuilders were increasingly able to beat German owners on price for container ship orders while the sharp downturn in the cruise industry, exacerbated by the 11 September terror attacks, hit passenger ship builders like Meyer Werft very hard.

Denmark is another important EU shipbuilding country. Odense Shipyard is by far the country's largest, and is particularly well known for its high productivity attained through sophisticated computerisation and robotics. A large portion of its order book comes from A P Moller, one of the biggest ship owners in Europe.

3.1.4 Other countries

China has ranked as the third largest shipbuilding country, after Japan and South Korea, since 1992. In 1995, China constructed the New Dalian dockyard, with one building capable of building 250,000 dwt ships.

Poland built VLCCs back in the 1970s but not in recent years. Since the demise of communism, its yards have been successful in attracting newbuilding orders from Greece and Western Europe. Although existing shipbuilding facilities are old, domestic supplies of marine equipment, including main and auxiliary engines makes the Polish shipbuilding industry largely self-sufficient. This insulates them from currency fluctuations and allows them to book orders at lower prices. An upward trend in the volume of ship construction has become apparent since 1992 as a means to earn foreign currency reserves through ship exports.

Brazil is another country with shipbuilding potential. However its shipbuilding programme has suffered from economic turmoil and a shortage of funds. Although Brazil has technological skills comparable with the international standards for building large-size vessels, including DH (double hull) tankers, the real problem lies in its price competitiveness. In an attempt to rectify this Brazil is promoting the rationalisation of its yards. In 1995 the merger of ISIBRAS(Ishikawajima do Brasil) Yard and Verolme was the largest ever in Brazil.

Structural changes are emerging on a global scale in the shipbuilding industry over the second half of the 1990s and 2000s, while at the same time being affected by structural changes in the shipping

industry.

3.2 Demand and ship cycles

Ship costs are strongly affected by the costs of procuring materials and labour in the shipyards. Moreover, shipyard expenses and production costs in general are very sensitive to technological change – a supply factor. Technological change, however, has implications, which extend from supply to demand factors.

Great store was put on the effects of innovation on the competitiveness of industrial organizations.[2] According to this theory, shipbuilders fall into the technological leader category and attract a growing market share as a result of their progressive practices. Those categorised as technological laggards, though, are compelled to react to innovation to retain a share of the market.

Obviously, technological change is having a dramatic impact on demand from both perspectives: the lead firms taking away demand from the laggards and they, in turn, being forced to find compensatory demand largely with government help.

It is important to stress, however, that the level of aggregate merchant ship demand is set independently from the actions of either shipbuilders as a whole, or governments intervening to protect national shipbuilding industries. Aggregate demand is, in fact, the outcome of conditions affecting world trade.

The actions of individual shipbuilding enterprises and individual governments may partially regulate the demand for a small component of world shipbuilding, but they will not greatly affect overall demand conditions. In other words, aggregate demand for shipping is very largely an exogenous factor; something outside of the control of the industry or government institutions.

The approach adopted here is one which sets shipping as the derived demand outcome of world trade conditions. It assumes that, derived broadly, it conforms to two categories: a “traditional” ship cycle manifested through the effects of trade on the production of “typical” ships; and a “modern” ship cycle in which trade effects are expressed in varying ways depending on the type of specialised ship.

Warship production, of course, is influenced by different factors. These vessels not only have their own supply requirements which can be quite different from those pertaining to merchant ships, but they also respond to a peculiar form of derived demand that is very different from the ship cycles affecting merchant ships.

Governments intervene in the market for two main reasons order; to bolster the demand for ships and thereby provide support for an otherwise ailing domestic shipbuilding industry. Governments can also intervene in regional economies, which are suffering from depressed conditions in order to bolster regional development and ameliorate the consequences of locally concentrated unemployment. Ideally, the two objectives complement each other. Ailing shipbuilders receive a boost from government aid, and depressed communities receive a form of employment stabilisation through government support for the job-creation organisations.

Governments are most able to affect demand by ordering warships. Policies using warship procurement as a means of intervention have different effects on shipbuilding than those aimed at stimulating merchant ship demand. This is because demand for commercial vessels is linked to the international trade cycle and is dependent upon the actions of a multitude of mainly private shipping

firms. When it comes to warship building, however, national governments are able to control demand, subject to limits on the overall defence budget. Wherever possible, governments support their national shipbuilding industries by placing orders with local yards.

Warship producers are however highly vulnerable to government whims. Overall economic factors also impact on warship building by putting pressure on the national and defence budgets. In practice warship production is, in its own way, as cyclically unstable as commercial shipbuilding. Warship producers can attempt to secure export orders, but in general they are highly dependent on a single, very powerful customer – their government.

4 The Role of Government and Its Policies to Promote the Shipbuilding Industry

4.1 State subsidies, naval shipbuilding

4.1.1 State subsidies

Shipbuilding subsidies have long been, and remain highly controversial. Ship prices are frequently distorted by the effects of state subsidy. One commentary points to the incompatibility of the “heavy over-tonnaging of virtually all types of ships” on the one hand, and the continual scramble to garner newbuilding orders on the other. The motivation for the imbalance between supply and demand is simple and stems from the belief held by all states that their shipbuilders are too important to be allowed to fail. Consequently, “there is great temptation to support ship production beyond ‘normal’ commercial limits. Whatever form it takes, the end-result is a financial subsidy borne by the stat”.[3]

In actual fact not all states believe that shipbuilders “are too important to be allowed to fail”. Since the late seventies, for example, the UK has generally allowed the decline of its shipbuilding industry to run its course although it did pay subsidies to yards, up to the limit allowed by EU rules.

The conventional subsidy afforded by OECD countries was a credit scheme where 80% of the ship price is funded through a loan repayable over a seven- to eight-year period at a fixed interest rate of 7 or 8% per year. However, some states juggled the terms to secure a more competitive position for their shipbuilders. This was usually accomplished by either the provision of further subsidies, however described, or through a reduction of the interest rate on the loans advanced.

It is abundantly clear that non-OECD countries offer better concessions in as much as their repayment periods are extended beyond the norm, but, even OECD members manipulate the loan terms to serve their own ends. Japan, for example marginally extended the loan period to 8.5 years in the case of a bulker ordered for US principals.

The extent and availability of financial concessions of this kind are ultimately determined by overall economic conditions. In other words, there is a tendency to subsidise during periods of downturn in ship cycles and, correspondingly, a tendency to reduce subsidies when conditions signal an upturn.

This generalisation is discernable from the sample of loan schemes applied to bulker newbuildings since 1975. In that year, financial concessions offered by Japanese shipbuilders were relatively modest, covering as little as 50% of ship costs. Such schemes were permissible at that time because of the massive order backlogs held by Japan, notwithstanding the disruption caused to the industry as a result of the 1973 oil price rises.

By the end of the decade, however, there had been a significant change: loans were being extended to cover up to 90% of ship prices in a variety of countries including Japan. The change was, of course, in response to heightened competition for increasingly scarce orders.

The level of subsidy declined to the standard of 80% over eight years in the early 1980s by virtue of international agreements among OPEC members on the allowable loan scheme. Nevertheless, this was considerably higher than the mid-1970s level and reflected the desperation of many nations to secure newbuilding orders at virtually any price.

This behaviour harms shipping, encouraging owners to buy vessels when they would probably hold back if prices were at levels reflecting the true cost of production. It does, however, clearly demonstrate the serious commitment of governments to support their shipbuilding industries.

Government naval procurement programmes are often designed to serve as countercyclical measures for shipyard employment stabilisation. It is argued that downturns in merchant shipbuilding demand can be countered by building warships. Without naval orders, the decline in merchant shipbuilding experienced by US shipbuilders would have put most of them out of business. There are, however, problems with using warship building in this way. Naval contracts can end up crowding out commercial orders. Thus, the use of warship orders as a counter-cyclical measure can only be effective if such orders are timed to truly use slack resources and not divert resources from other production. In practice, the timing of defence contracts has rarely been truly countercyclical and may have done more harm than good. Moreover, not all yards can build warships or naval auxiliaries efficiently, limiting the scope of warship construction as a regional development tool.

4.1.2 Naval shipbuilding

Since the World War II, the USA has been the example of a nation whose shipbuilding has been heavily dependent on defence contracts. At the present time, something in the order of 75% of new ship construction in the USA is destined for the US Navy.

The residual merchant shipbuilding industry is locked into high cost practices associated with naval construction. According to one official pronouncement, it is owing to generally higher construction costs that the US shipbuilding industry has not, on balance, been an export industry since the days of the clipper ships. As a consequence, merchant shipbuilding as well as naval newbuilding is tied to domestic markets: markets which, in turn, rely on an inordinate amount of government regulation.[4] So while US shipbuilding is influenced by the global shipbuilding market, to some extent, domestic circumstances peculiar to US shipbuilding are much more important. The USA has established a complex framework of federal policy, statute, and regulation with respect to naval shipbuilding, subsidised commercial shipbuilding, and cabotage, including the well-known Jones Act. Indeed, some observers suggest that without subsidies amounting to up to 35% of construction costs, mercantile newbuilding would have been abandoned in the USA.

By its nature, naval shipbuilding is performance-oriented rather than cost-conscious. Navies worry about design details and the fulfilment of target specifications. Ship owners worry about the price of newbuildings, so builders of merchant shipyards are preoccupied with cost efficiency. Consequently shipyards that choose to specialise in warship work largely remove themselves from the discipline of the market. These shipyards may become entirely dependent on a government to the extent of the state being the sole arbiter of demand – a monopolist in fact. In general governments encourage technical

competence in warship suppliers irrespective of production efficiencies.

Warship production when not strictly required to meet defence needs is also justified on strategic grounds. It is argued that defence production capacity must be maintained in a state of readiness for any national emergency. Governments are also seen as being obliged to purchase products from defence suppliers because the latter have committed so much of their resources to the development of these highly specialised products that are tailored to specific government requirements.

4.2 Shipbuilding and national economic development

Economic planners and politicians in Newly Industrialised Countries (NICS) have often seen shipbuilding as having an important role in the modernisation process and in national development. Shipbuilding can appear to be an attractive development tool for three reasons. First, it is a medium technology industry, which suits the factor–cost advantages of NICs. Thus, technology does not act as a barrier to entry while the labour intensive nature of shipbuilding favours countries with large, cheap labour forces. Secondly, the market is an international one and thus shipbuilding can be a net earner of foreign exchange. Customers for ships come from all parts of the world. The existence of flag-of-convenience fleets adds to the emphasis on price competitiveness in the market and allows shipowners to circumvent market protection imposed by national governments. A newly emergent producer, capitalising on low-factor costs, can offer competitively priced ships, which rapidly find customers in such an open market. Finally, shipbuilding has strong links with other industries. It should, therefore, serve to foster other nascent industries in the NICs.

Not surprisingly, shipbuilding has been singled out by a number of countries in recent years as deserving of special treatment. At one extreme, the state has taken the combined role of planner and shipbuilder. This was the case with command economies such as China, Poland, and Yugoslavia and the interventionist economy of India. At the other extreme, the state has encouraged the industry in the name of national development but left the practice of shipbuilding to private enterprise – as is attested by Brazil and South Korea. In between are NICs, such as Spain, which encourage both private and public enterprise in shipbuilding. The case of South Korea is highlighted here – as perhaps the most successful of the NICs engaged in shipbuilding.

4.3 South Korea

The Korean shipbuilding industry in the 1950s had to rely primarily on imported materials, so the cost of building ships domestically exceeded international ship prices. This imposed a heavy burden on cash-strapped Korean shipping companies, and demand for locally built ships declined. The government legislated the Shipbuilding Encouragement Act on 11 March, 1958 in an effort to stimulate development of shipbuilding industry as well as to support the shipping industry. About this time, the shipbuilding industry's sphere of influence shifted dramatically. As labour accounts for between 20% and 30% of the total cost of building a ship, shipbuilding activities declined in the UK and West Germany, where labour was becoming scarce and expensive. Meanwhile, Japan had emerged as the world's foremost shipbuilding nation as early as 1956, and that country's share of the world market continued to increase, eventually reaching almost 50%. Korea also had a large pool of highly skilled, low-cost labour. The government realised the importance of shipbuilding, but it also understood that private sector companies, which lacked capital, could not be expected to build expensive, large-scale shipyards. Thus, the government put forth a battery of industry development

policies and established state-run shipbuilding companies. Korea Shipbuilding & Engineering Corp was founded in January 1950. Capital for the project came from government US dollar reserves as well as the Agency for International Development (AID).

During the 1960s, the Korean government launched two successive five-year plans which rapidly expanded the scale of the national economy. Fishing companies of all kinds cropped up, causing domestic demand for ships to soar.

However, as Korea was in the early stages of economic development, the overall industrial structure was still weak, so the initial focus was put on light manufacturing. Shipbuilding and the rest of the heavy industrial sector did not see significant progress. The Korean government launched its Second Five-year Plan (1967–1971). In 1967, the government enacted the Shipbuilding Industry Promotion Act and designated the period as a time to modernise facilities and raise technology levels in order to improve national competitiveness. At the same time, a foundation was to be laid for Korea to generate her own ship demand as well as to gradually move towards ship exportation. At the same time, world demand trends pointed to ships of ever-increasing size. However, the government's shipbuilding promotion policy was aimed mainly at expanding the tonnage of small ships for Korean end-users. The policy did help expand total industry output volume, but little was done to develop large-sized ships or shipyards. Demand for ships that could not be built domestically was satisfied through imports, and the domestic shipbuilders only supplied 20% of the total new ships bought by Korean shipping companies.

The Long-term Shipbuilding Industry Promotion Plan was announced in March 1973, to promote Korea to be a full-fledged ship exporting nation in the 1980s. Major developments in the Korean shipbuilding industry during the 1970s include the government's establishment of the Planned Shipbuilding Program (PSP) in 1976, which was initiated under a stated goal of "Korean shipyards building Korean ships to carry Korean cargo". Under the aegis of this programme, government-financed projects were provided to Korean shipbuilders, with the end-users being selected by the government. The program was institutionalised with basis in Korean law in 1978. In addition, Korea adopted an export credit system in 1972, a move that would have greatly helped domestic shipbuilders to secure new orders. That is between 80 and 90% of the ships built in Korea from 1973 on were for export, and the number of ships purchased by deferred payment increased with each passing year. However, Korean shipyards, which were just becoming established in the world shipbuilding market, were not able to enjoy the same interest rates or repayment periods as the world's leading shipyards could. In the 1970s, the world shipbuilding market was changing rapidly. Soaring world seaborne trade volumes were spurring demand for new ships, and shipowners were interested in buying ships of ever bigger tonnage, in order to lower both the costs of building new ships and transporting cargo. In the mid-1960s, the largest ships being built were 100,000 deadweight tonnes; the average size was between 30,000 and 50,000 deadweight tons. However, in the early 1970s 200,000 dwt vessels were the norm, and the world's shipyards were scrambling to expand facilities. Another big reason for the trend towards larger ships was the rapid increase in the international movement of oil. In the 1960s, oil tankers made up only 21.5% of all ocean-going merchant ships, but by the end of the decade, 75% of the new ship orders were for oil tankers. The huge increase was brought about by the closure of the Suez Canal, which forced ships to travel much longer distances.

To cope with this change, the Korean government encouraged private sector companies to look for

an overseas joint venture partner who would transfer the technology, and to find buyers for the ships it was to build. With government encouragement, Hyundai which was the leading pioneer in the Korean shipbuilding industry, approached A&P Appledore and Scott Lithgow in the UK and, in September 1971, a contract was made for sales and technical support. Further technical support arrangements were concluded with Kwasaki Heavy Industries in 1972 and at the same time an order of two 230,000 dwt VLCC (Very Large Crude Carrier) was given to Hyundai by the same company. As part of the deal, Kwasaki provided design drawings and trained Hyundai employees.

From the mid-1970s, the principal aspects of the government's policy for advancing the heavy industries: In order to globalise and modernise heavy industrial facilities, the government would provide concentrated support for areas that saved resources, were technology intensive and involved a high degree of local assembly. Korean shipyards continued to increase their output from the early 1970s, but major growth increases began during the fourth five-year plan (1977–1981). During the period, the Korean merchant fleets lacked the tonnage needed to handle the rapidly growing volume of goods being transported to and from Korea. To bolster their fleets, however, Korean shipping companies were mainly buying used ships rather than commissioning the idle domestic shipyards to build new ones. Therefore, steps were urgently needed to help the two industries develop together.

However, a major problem remained: Where would project financing come from? Government provided state-run banks guarantee for those commercial loans secured by private sector companies, from foreign financial institutes.

On the other hand, the government instituted the Planned Shipbuilding Program in 1976. For pre-selected end-users, financial support would be provided for the purchase of domestically-made ships. To help domestic shipyards improve their productivity and design capabilities, it was stipulated that a ship build under PSP have standardised hull forms. At the same time, the programme would provide each shipyard with a stable supply of work. The goal was for Korean-owned ships to end up carrying a greater percentage of Korean-made goods and thereby help to improve the international balance of payments. With the establishment of the Export-Import Bank in 1975, Korea also began offering an export financing programme for the shipowners to build their ships at the Korean shipyards. According to the Korea Shipbuilders' Association, Korean shipbuilding output was just 34 ships, totalling 12,000 gross tonnes in 1973. Five years later, that annual figure had surged to 208 ships, totalling 769,000 gross tonnes. Korean shipbuilding began to take off in response to growing domestic demand, and it continued to develop in step with the growth of other export-driven Korean industries.

The two Oil Shocks of the ‘1970s slowed world economy and the shipping volumes were further cut. Faced with the stagnant shipbuilding market, the Korean shipbuilding industry began looking for ways to change form a business based on quantitative growth to one that was more quality oriented. A cost-cutting campaign and Total Quality Control programme were vigorously pursued. In addition, the Korean shipbuilding industry geared up for greater diversification into such non-shipbuilding sectors as off shore and engineering, industrial plants, engines and machinery, robotics and heavy equipment.

It is a typical phenomenon nowadays that international trade volumes do not increase with the low economic growth rates and rising protectionism. To make things worse, as the Korean shipyards had captured one quarter of the world shipbuilding market and, thus, trade pressure on Korea from the US and EC steadily intensified. In March 1989, the EC nations (now EU) demanded that ship prices be

monitored and that market shares be adjusted. Then in June of that year, the Shipbuilder Council of America claimed that government subsidies and tax breaks granted to shipbuilders in Japan, Korea, Germany and Norway, constituted unfair trade practice. The council then filed a complaint against those four countries based on the Super 301 provisions of the US Omnibus Trade and Competitiveness Act. Negotiations dragged on for several years. No more government intervention is the clear policy of the Korean government at a moment.

5. Structural Changes in Major Shipbuilding Countries

5.1 Japan

The Japanese shipbuilding industry continually increased its output until the late 1980s. Japan's dominant position as the top shipbuilding country has been threatened by the emergence of South Korea. This development led to significant changes in the structure of Japanese shipbuilding, with both its capacity and workforce size cut back considerably.

According to Lloyd's statistics covering ships of 100GT and above, volume of new completions in Japan reached a peak of about 16,991 million GT in 1975, and about 7,206 million GT in the 1990s. In and after 1988, the volume of new completions kept increasing year after year, reaching about 9,263 million GT in 1995, and it went up to about 20,686 GT in 2000. According to the Ministry of Transport (MOT) shipbuilding statistics covering steel ships of 20GT and above, a substantially similar tendency can be observed.

A review of the ratio of domestic ships to export ships in terms of the number of ships built discloses the fact that the domestic ship's share accounted for 70–80% throughout the past 30 years. In terms of GT basis, however, export ships' share is greater than domestic ships' share because export ships are generally larger in size than domestic ships. This ratio of export ships to domestic ships has undergone a significant change due to the multinationalisation of ships, either owned or controlled, following the globalisation of Japanese shipping firms.

Export ships share increased to 80–90% in the 1990s, and it will rise more in the twenty-first century. This structural change is featured by a decrease in the tonnage of domestic ships due to a drastic decline in the volume of the government-sponsored "planned shipbuilding programme".

Such decline is attributable to the changes occurred in the pattern of investments in ships as a result of the multinationalisation of ships. The pattern of ownership has changed from domestic owners to foreign ownership in areas or countries of open registry (flag of convenience). For this reason, among export ships, there are a number of foreign-registry ships, which are substantially owned by Japanese shipping firms.

5.1.1 Changes in the composition of major shipbuilders

Japanese major shipbuilders have implemented many restructuring measures, including conversion of shipyards into offshore and construction facilities. As a result the total capacity of major shipbuilders has declined.

These changes also affected medium-sized shipbuilders because the large ship builders have each been associated with a number of medium-sized yards. Some of Japan's medium- and small-sized shipbuilders have increased newbuilding output greatly over the past 30 years.

A review of the Japan's shipbuilding industry shows that, since the second half of the 1980s when there were drastic cutbacks of shipbuilding capacity and personnel, the volume of newbuilding output

has varied from company to company according to differences in their capacity, and differing management strategies, while market shares of newbuilding output, too, varied depending upon the measures taken by respective companies.

5.2 South Korea

East Asia's financial and currency crises had devastating effects on South Korea, causing drastic structural changes in its economy and industry during the period from the summer of 1997 to middle of 2000. Specifically, the sharp decline in the value of South Korea's currency, the WON, had a severe effect on industries relying on imported commodities whose WON price had soared. The low value of the won did have some positive effects and improved the price competitiveness of its exports. Nevertheless the negative

Table 1: Trends of steel ships built in Japan

	Domestic ships			Export ships			Total		
	Volume of completion		Ship prices	Volume of completion		Ship prices	Volume of completion		Ship prices
Year	No of ships	Million GT	Billion yen	No of ships	Million GT	Billion yen	No of ships	Million GT	Ship prices
1970	2,081	3.95	405.9	222	6.22	392.1	2,303	10.17	797.9
1975	1,010	2.61	432.1	517	12.61	1,403.90	1,527	15.23	1,836.00
1980	1,319	2.78	558.5	273	3.41	643.7	1,592	6.19	1,202.20
1985	817	2.75	486.6	401	6.16	982.4	1,218	8.91	1,469.10
1990	838	1.35	405.9	213	5.12	586.5	1,051	6.48	992.5
1995	593	0.82	293.2	282	7.87	857.2	875	8.68	1,150.40
2000	2,081	3.95	405.9	222	6.22	392.1	2,303	10.17	797.9
2007	247	10.52	–	200	8.3	–	447	18.82	–

Source: Maritime Technology & Safety Bureau. MITI, "Shipbuilding Statistics Summary"[5]

effects of the currency's fall greatly outweighed the positive ones. South Korea's entire economy was forced into a critical situation and there was a desperate attempt to obtain massive amounts of financial assistance from such institutions as IMF.

Because of this situation, South Korea's shipbuilding industry faces a number of tough challenges, such as rationalisation (seen as essential to boosting competitiveness), the rising cost of production, the need to cut out inefficient facilities and to trim the industry's large workforce. A "special retirement programme" is underway and the industry has been compelled to carry out drastic structural reforms. Meanwhile, the need to face up to the overcapacity issue will not go away.

5.2.1 Changes in volume of orders received

In 1991, according to Table 2, South Korea's volume of newbuilding orders stood at about 5,433,970 GT in total. In 1993 expansion of capacity by Halla Engineering and Hanjin Shipbuilding pushed Korea to the top position in world shipbuilding, overtaking Japan. However, the economic crisis that hit South Korea in 1997 forced Korean shipbuilders to seek the improvement of productivity that has resulted from drastic restructuring, which, together with relative weakening of the won against the yen, has allowed South Korea to maintain its competitiveness.

5.2.2 Volume of new completions

South Korea's share of the world total of new completions has grown to such a level that it will affect the distribution structure of the world output among shipbuilding countries. According to the Korean Shipbuilders' Association's statistics covering merchant ships of GT, South Korea's volume of new completions increased from 4,429,952 GT in 1991 to 8,212,848 GT in 1999 (see Table 3).

Completions peaked in 2000 at more than 9 million GT.

Table 2: Volume of newbuilding orders in South Korea

	Domestic ships			Export ships			Total		
	Volume of completion		Ship prices	Volume of completion		Ship prices	Volume of completion		Ship prices
Year	No. of ships	GT	$x1000	No. of ships	GT	$x1000	No. of ships	GT	$x1000
1991	10	116,548	195,377	111	5,317,409	5,365,171	121	5,433,957	5,560,548
1992	10	5,070	107,561	41	1,637,584	1,770,610	51	1,642,654	1,878,171
1993	7	16,290	36,927	177	9,790,581	7,289,974	184	9,506,871	7,326,901
1994	7	4,843	87,441	159	6,366,525	5,794,022	166	6,371,368	5,881,463
1995	2	340	23,438	192	7,132,801	6,768,746	194	7,133,141	6,792,184
1996	2	2,000	29,204	142	6,971,849	7,037,946	144	6,973,849	7,067,150
1997	1	11,800	49,575	200	12,737,616	10,382,531	201	12,749,416	10,432,106
1998	–	–	–	175	9,998,518	7,923,876	175	9,998,518	7,923,876
1999	3	14,800	25,800	224	12,704,309	9,159,620	227	12,719,109	9,185,420
2000	2	23,235	12,647	311	10,378,273	15,146,970	313	10,401,508	15,159,617
2007	3	22,600	–	704	49,967,536	–	707	49,990,136	–

Source : The Korean Shipbuilders' Association[6]

Table 3: Volume of newbuilding completions in South Korea

	Domestic ships			Export ships			Total		
	Volume of completion		Ship prices	Volume of completion		Ship prices	Volume of completion		Ship prices
Year	No. of ships	GT	$x1000	No. of ships	GT	$x1000	No. of ships	GT	$x1000
1991	22	208,778	325,704	87	4,221,174	3,601,592	109	4,429,952	3,927,296
1992	5	103,998	180,258	89	4,463,441	3,778,170	94	4,567,439	3,958,428
1993	15	64,143	181,549	73	3,318,902	3,226,370	88	3,383,045	3,407,919
1994	8	17,423	41,029	107	5,152,735	4,466,004	115	5,170,158	4,507,033
1995	5	9,546	100,507	135	5,653,231	5,048,896	140	5,662,777	5,149,403
1996	–	–	–	170	7,798,235	6,592,552	170	7,798,235	6,592,552
1997	–	–	–	172	7,449,467	6,944,167	171	7,449,467	6,944,167
1998	2	2,000	29,204	161	8,632,593	7,024,020	163	8,634,593	7,053,224
1999	–	–	–	163	9,481,315	8,212,948	163	9,481,315	8,212,848
2000	2	17,760	18,800	178	6,029,189	9,593,137	180	6,046,949	9,611,937
2007	0	–	–	340	18,954,943	–	340	18,954,943	–

Source: The Korean Shipbuilders' Association[7]

A predominant characteristic of South Korea's volume of new completions is that the share of ocean going vessels for export is overwhelmingly greater than that of domestic vessels. This is because the tonnage of the fleet owned by the South Korean shipping industry is still small in world terms.

5.3 China

The two-digit growth rate of economy experienced by China since the early 1990s has grabbed the world's attention. Growth has been so strong that the Chinese government has had to put a brake on its overheated economy.

5.3.1 Changes in China's economy

In the first half of the 1990s, China further promoted the policy of opening up its economy to the outside world in accordance with its Eighth Five-Year Plan (1990–1995). As a result, its economy grew at the high average annual rate of 12.6% between 1992 and 1994.

The growth of industrial production centreing on the steel and heavy machinery industries led to an increase in the production of capital goods and durable consumer goods which are necessary to meet

the domestic demand. And, in the economic zones along the southeastern coast around Guangdong and Hong Kong, the production of consumer goods, such as household electrical appliances, textile and foodstuffs as the light industrial products has dramatically increased. Moreover, the mass movement of farmers from the country side to these coastal regions as an ample source of low wage labour force has significantly contributed to the boosting of China's export industry, thereby allowing it to shift from the exporter of primary goods to that of secondary and finished products.[8]

Thus, China's economy, supported by expanded domestic markets embracing about 1.3 billion population, has structurally changed to assume a more important role in the export and import trades with not only Japan and Southeast Asian countries, but also western countries, including the US, thereby considerably affecting the development of the world economy.

With a huge consumer market supported by enormous domestic demand, China has tremendous potential for growth. So there has been a consistent inflow of foreign capital into China from western as well as Asian countries, including Japan and Korea, aimed at increasing export and import trades. In the medium to long term, this is likely to continue.

5.3.2 Changes in shipbuilding industry of China

It was in 1977 that Lloyd's commenced listing China's tonnage data in its statistics covering merchant ships of 100 GT and above. The volume of newbuilding orders received by Chinese yards has kept increasing since the second half of the 1980s. According to Lloyd's Register, orders totalled 777,000 GT in 1994 and reached 3,011, 000 GT in 1999. Chinese yards then accounted for 10.4% of the total world orders.

China publishes the volume of tonnage built in terms of "composite tonne" which is essentially the mixed unit of deadweight tonne for cargo ships, including non-self-propelling steel ship and displacement tonne for others. According to these statistics, volume of tonnage newly built started from almost 1,079,000 GT in 1994 (see Table 4).

Table 4: Volume of newbuilding completions in China

Year	Number of ships	Thousand GT	Percentage world total
1994	144	1,079	5.5
1995	159	953	4.3
1996	138	1,102	4.3
1997	152	1,479	5.8
1998	154	1,446	5.7
1999	144	1,556	5.6
2000	101	1,484	4.8
2007	661	10,553	18.4

The volume of completions in 1999 reached almost 1,556,000 GT, accounting for 5.6% of the world total.

5.3.3 The role of china state shipbuilding corporation (CSSC)

China State Shipbuilding Corporation is essentially the core of China's shipbuilding industry and it exercises control over large- and medium-sized shipyards capable of building ocean-going vessels and warships, as well as large-size marine structures. Small-size shipyards, engaged in the building medium and small-size steel vessels to be used for inland waterways and for coastal trading, are under the jurisdiction of the Ministry of Communications or regional autonomous bodies.

CSSC is one of the state-owned mammoth enterprises belonging to the Ministry of Machine-

Building Industry. With its headquarters located in Beijing, CSSC exercises general control over major shipyards throughout China through nine regional shipbuilding corporations located in Shanghai, Dalian, Tianjin, Guagzhou, etc. CSSC has control over the Merchant Ship Design & Research Institutes which are located in regional centres such as Shanghai and Wuhan.

As for ship design, basic plans are mainly drawn up in Beijing, while detailed plans are worked out by these regional institutes. Depending upon the type of ships ordered, however, there are cases where basic plans are drawn up by regional institutes.

In the early 1990s, a new modernised large yard was constructed within the Dalian Shipyard. This new yard, together with the old one and factories for the production of ship related products, formed the "Dalian Group". This is a sure indication that the manner of the central control by CSSC has become flexible enough to allow certain autonomy to part of the regional institutes.

The case of Guangzhou Shipbuilding Industry Corporation is a typical example of this flexibility. Its corporate name changed to "Guangzhou Shipyard International" with its stocks listed on the stock exchanges in Shanghai and Hong kong. Although this shipyard is still under the jurisdiction of CSSC, it is essentially the advent of an independent shipyard as a stock company with the same form of business organisation as those commonly seen in the capitalist economy.

China Shipbuilding Trading Corporation (CSTC) became independent of the CSSC in 1987. Since then it has promoted ship exports through collaboration with CSSC.

5.3.4 Change of global shipbuilding leader

The global shipbuilding leader has changed dramatically in the last century. In the nineteenth Century, the US was the dominant position in the shipbuilding industries. Afterwards, Great Britain became the strongest maritime conqueror and monopolised a lions share of the world shipbuilding capacity until World War II. After World War II, it was Western Europe that played the leading role in producing massive new building vessels.

From the 1990s, Europe's competitiveness deteriorated. This was due to the surge in labour costs and taxation. Consequently there was the rapid decrease of their flag tonnages Meanwhile, a large portion of European vessels flagged out to the Flag of Convenience. Subsequently emerging shipbuilding countries such as Japan and Korea took over leadership. Japan enjoyed the dominant position in the world shipbuilding industries and was well armed with competitive edges such as price and technology.

However, as time passed Korea took over Japan's dominant position in the shipbuilding Industries. Korea, home to seven of the top 10 global shipbuilders, has steamed ahead with innovative processes, strengthening reliability among clients due to best quality, on-time delivery at competitive prices. Korea has the highest dock turnover rate in the world. This rate is a reliable way of measuring shipyard's technical capacity and production efficiency. Korean shipbuilders use ground instead of dry docks for shipbuilding, which is an innovative method for shipbuilding and production capacity can be further expanded to meet unexpected surge of shipbuilding demand. Korea built 40% of new tonnages in the world in 2008.

6. Summary and Conclusion

Shipbuilding enterprises come in two distinct groups: those which engage purely in shipbuilding and those which are diversified enterprises where shipbuilding is only one of a portfolio of interests that

may have very little in common.

Shipbuilders belonging to diversified corporations have the advantage of being able to rely on corporate resources for expansion. Consequently, in periods of shipping recession, the shipbuilding member of the group can call upon reserves acquired in other market areas to overcome short-term cash flow difficulties and to modernise its production facilities and to avail itself of research and development initiatives sponsored by the group as well. The flexibility inherent in within-group transfer of resources to the benefit of shipbuilding operations has been important to the success of Japanese and South Korean shipbuilders. Also as a member of a large group called "chaebol"[9] this type of shipbuilder commands respect in industrial, financial and political circles. This respect may be manifested through easier access to capital markets and more sympathetic treatment of the enterprise by policymakers.

The state actively seeks to regulate the activity levels of whatever portion of the industry falls within its jurisdiction. In this way the government can shape the shipbuilding industry.

Aggregate shipbuilding demand is the outcome of conditions affecting world trade. The actions of individual shipbuilding enterprises and individual governments may partially regulate the demand for a small component of world shipbuilding, but they will not greatly affect overall demand conditions. In other words, aggregate demand for shipping is very largely an exogenous factor; something outside the control of the industry or government institutions.

The health of a country's shipbuilding industry has ramifications for the role of governments on the one hand, and the prosperity of communities and regions within countries on the other. In the first instance, governments can intervene in the market in order to bolster demand for ships and thereby provide support for an otherwise ailing domestic shipbuilding industry. In the second instance, governments can intervene in regional economies which are suffering from depressed conditions to bolster regional development and ameliorate the consequences of locally concentrated unemployment.

Ship prices are frequently distorted by the effects of state subsidy. The motivation for the imbalance between supply and demand is simple and stems from the belief held by most states that their shipbuilders are too important to be allowed to fail. Consequently, "there is great temptation to support ship production beyond 'normal' commercial limits". Whatever form it takes, the end result is a financial subsidy borne by the state. The extent and availability of financial concessions of this kind are ultimately dependent on the conditions prevailing in the economic environment.

Government support for shipbuilding is not confined to loan schemes for newbuildings. It can be manifested through direct forms of demand management. One of the means often resorted to by governments is the formulation of naval programmes such that they serve as counter-cyclical measures for shipyard employment stabilisation.

Shipbuilding has been perceived as a key player in modernisation of society and the furthering of national development which follows from industrialisation. Shipbuilding is an enticing tool of development, it is a medium technology industry which appears to suit the factor-cost advantages of NICs. Also shipbuilding has strong links with other industries. It should, therefore, serve to foster other nascent industries in the NICs.

The Japanese shipbuilding industry has had to adapt to an ever-changing environment. Japan's competitive edge was reduced as South Korea emerged as a major shipbuilding country. Worth noting

as the measures that brought about significant changes in the structure and constitution of the Japanese shipbuilding industry were its drastic cutbacks of shipbuilding capacity and mass dismissal of employees through a Special Retirement Programme.

East Asia's financial and economic crises had devastating effects for South Korea, causing far-reaching structural changes in its economy and industry since the summer of 1997. Following the decline of its economy, South Korea's shipbuilding industry has faced a number of major challenges, such as rationalisation to enhance competitiveness, the rising cost of production, cutbacks in capacity and employees, and drastic structural reforms. At the same time South Korea is under pressure to find ways to deal with overcapacity; an issue which is certain to remain controversial in the twenty-first century.

China's economy, supported by expanded domestic markets supporting about 1.3 billion people, has changed structurally with exports and imports becoming more important. The volume of newbuilding orders received by Chinese yards has been kept increasing since the second half of the 1980s. According to Lloyd's Register, orders totalled 777,000 GT in 1994 and reached 3,011,000 GT in 1999. Chinese yards then accounted for 10.4% of the total world orders. China will certainly continue with its ambitious shipbuilding expansion plans.

The shipbuilding industry is simply a player in the commercial market, so any form of subsidy distorts the price and damages free market mechanisms. Government subsidy to shipyards merely undermines the strength of the commercial market for new merchant ships. This has resulted in a situation where the taxpayers of many countries pay substantial sums to support uneconomic national shipbuilding industries.

Artificially low newbuilding prices represent a loss to all in the shipbuilding and shipping markets. In order to improve productivity, it is essential to utilise automated machinery and tools and sophisticated automated systems effectively. Technological competence is equally important. It serves as the basis for the development of design and engineering capabilities. This technological competence coupled with efficient management know-how will determine ultimate productivity. How to achieve the superior productivity will determine the future of a country's shipbuilding industry.

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Endnotes

1. Todd, D. (1985): *The World Shipping Industry* (Croom Helm Ltd).
2. *Ibid*, p. 205.
3. Fairplay, January 1984, p. 9.
4. National Academy of Sciences (1980): Personnel Requirements for an advanced Shipyard Technology, Washington, DC, p. 13.
5. Maritime Technology & Safety Bureau, MITI, Shipbuilding Statistics Summary.
6. The Korean Shipbuilders' Association, 2001, *Shipbuilding Statistics*, p. 15.
7. The Korean Shipbuilders' Association, 2002, *Shipbuilding Statistics*, p. 28.
8. JAMRI, 1995, "Recent Trends of China's Shipping and Shipbuilding", JAMRI Report, No. 53, November, 1995, pp. 4–5.
9. Chaebol are large conglomerate companies in Japan and Korea. They have a great deal of influence on policy making and finance.

10. Hyundai Heavy Industries Co Ltd (1999): Hyundai Shipyard, Yesterday and Today; Traditions of Excellence, KorCom International Inc.
11. Jon, Joon Soo. “Over Capacity: Who is to Blame?”

Part Eight

Aspects of Shipping Management and Operations

Chapter 20

The Impact of Choice of Flag on Ship Management

Kyriaki Mitroussi and *Peter Marlow**

1. Introduction

Ship registration, primarily a requirement under international law, evolved especially after the second half of the twentieth century into an important and at times quite complex commercial decision for ship owners. This change of nature of ship registration from a legal condition to a business choice, largely effected by the absence of universally binding provisions to determine the "genuine link" between the flag state and the ship and by successful and quick industry response to market pressures and opportunities, has had a number of consequences at company, industry, national and international level. Ship owners were presented with an array of flag types and actual flags in which freely to register their vessels; the industry found a means to improve its competitiveness but also ended up with increased and serious safety concerns; some nations came up with a way to earn revenue and gain some political significance, while others were confronted with a national threat along these same lines; at an international level, new sources of supply of labour were developed with transfer of expertise and dynamics changed. The major issue has of course been the proliferation of the open registers regime designed and established to provide mainly a cost reduction service to ship operators in relation to the option of traditional national flags. Today the top 35 maritime countries account for 95.35% of the world deadweight tonnage and 67% of this is under a foreign flag, a figure which drops to 53.7% when the number of vessels is considered (UNCTAD, 2008).

Although other types of ship registration have sprung up, like the second or international registers, the main dichotomy has been between flags of convenience and traditional national flags and the choice between the two has constituted a topical subject for research. Various myths and realities have been widely explored. In the course of research and with the passing of time some have been verified, others have failed to point to safe conclusions and yet for others new scope of thought has been triggered. For example, the significant reductions in crew costs advocated by open registers can be said to be an everyday reality felt by ship owners around the world and manifested clearly in relevant research stipulating that crew cost differences between selected EU flags and lower-cost open registry vessels, for instance, range from +22% to +333% (Anon, 1995). Open registers have conventionally been associated with poorer safety performance than traditional flags and some research results have provided support to this assumption (Li and Wonham, 1999; Alderton and Winchester, 2002). Yet, today some of the most important open registries, like Liberia, Malta, Cyprus, and the Bahamas are on the White List of the Paris MOU together with important traditional flags like Greece, USA and the UK, while the most important open registry, Panama, with 22.6% of the world tonnage registered in it is on the former's Black List (Paris, MOU 2007; UNCTAD, 2008). The unprecedented growth of open registries has alarmed traditional maritime nations which have seen their own flags retrenching with direct and indirect economic, political and national repercussions. A study by Peeters *et al*. (1994), however, exhibited another dimension to the problem concluding that 70% of the value added by the Dutch shipping industry actually came from onshore activities related to shipping, a finding which

was reflected in the new shipping policy introduced in 1996 in the Netherlands. Overall, the examination of the two types of flags has centred on their costs and benefits, their standing in the shipping industry and, in a wider social context, selection criteria, fiscal implications and safety issues.

The two types of flags have been seen to offer two distinct alternatives to ship operators, each with its own advantages and disadvantages and with its own commercial and operational requirements. It is within these realms that the view is taken that flag choice has a bearing also on various management issues in shipping companies. The argument put forward is that opting for a specific type of flag is in fact a strategic business decision with broader consequences for ship management. The aim of this chapter is to address the issue of choice of flag in the context of ship management with the object of assessing its expected impact on management principles and practices. For the purpose of the analysis the traditional, clear-cut distinction between national flags and flags of convenience has been chosen to form the framework of reference. Their noted features and/or requirements are considered in respect of the way they can affect management decisions and the adoption of management approaches. The discussion is based on the case where the flag choice decision is made by the same entity that is both responsible for and also essentially carrying out the management of the vessels. In other words, the analysis relates to the paradigm of the ship owner who is at the same time the ship operator - even if this is concealed by the corporate veil. It does not seek to address the situation where third party ship managers are used and where an association between flag choice and management practice might be differentiated (or not) because of a number of reasons inherent in the characteristics of the service they provide. The subject matter is treated on a theoretical basis developing a rationale founded on critical analysis and appreciating that the influence between the choice of flag and management functions can potentially be twofold and may come from either direction.

Initially, this chapter will set the context of the analysis by looking into the existing literature on ship registration reviewing the different characteristics, conditions, benefits and constraints of the range of ship flags available to ship owners. The authors will then make a case that the choice of flag is a management decision by examining different management dimensions which are related to it. Analytic discussion of the effects of flag preference on managerial aspects will follow; the analysis will focus particularly on the practical impact which the choice between an open register and a national flag is expected to have on management issues relating mainly to strategic management and human resource management. Lastly, an evaluation of the current standing of open and national registries will be presented together with a critical assessment of its effect on contemporary ship management.

2. Literature Review and Background

Since its first significant appearance in the 1950s, flagging out – the change of a vessel’s registry from a national flag to a flag of convenience or open registry – has been a topic of interest in the international shipping industry. This now widespread phenomenon has attracted a great deal of attention for a variety of reasons. First, open registry fleets have expanded at a faster rate than any other fleet in the world. Secondly, it has been felt that the expansion of the open registry has limited the growth of the fleets of other countries and has caused the decline of the fleets of the traditional maritime countries with all the related consequences for their maritime clusters, the balance of

payments, and the supply of skilled labour.

According to Boczek (1962) a FoC can be defined as: “the flag of any country allowing the registration of foreign-owned and foreign controlled vessels under conditions which, for whatever reasons, are convenient and opportune for the persons who are registering the vessels”. However, this definition still does not allow the clear identification of an open registry flag. Even the Rochdale Report (1970) did not give a precise definition of flags of convenience but instead suggested a list of criteria which should lead to the classification of these. It defined the FoCs in terms of six common characteristics:

- the country of registry allows ownership and/or control of its merchant vessels by non nationals;
- access to the registry is easy and transfer from the registry at the owner's option is not restricted;
- taxes on the income from the ships are not levied locally or are low. A registration fee and an annual fee, based on tonnage are normally the only charge made;
- the country of registry is a small power with no national requirement under any foreseeable circumstances for all the shipping registered, but receipts from very small charges on large tonnage may produce a substantial effect on its national income and balance of payments;
- manning of ships by non-nationals is freely permitted; and
- the country of registry has neither the power nor the administrative machinery effectively to impose any government or international regulations, nor has the country the wish or the power to control the companies themselves.

The Report continues that although one or more of the above features may be found in the policies of many maritime countries, it is only when *all* of these features exist that a country is characterised as being an open register.

Metaxas and Doganis (1976) identified as a FoC: “the national flags of those states with whom ship owners register their vessels in order to avoid the fiscal obligations and the conditions and the terms of employment of factors of production, that would have been applicable if their ships were registered in their own countries.” While Bergstrand (1983) adopted the following definition: “A flag of convenience is a flag of a state whose government sees registration not as a procedure necessary in order to impose sovereignty and hence control over its shipping but as a service which can be sold to foreign ship owners wishing to escape the fiscal or other consequences of registration under their own flags.”

The United Nations Convention on the Conditions for Registration of Ships (1986), for the first time defined the principles to be followed when granting nationality to a ship. The existence of a genuine link between a vessel and its country of registry must be verified on the basis of the following characteristics:

- the merchant fleet contributes to the national economy of the country;
- revenues and expenditure of shipping, as well as the purchases and sales of vessels, are treated in the national balance of payments accounts;
- the employment of nationals on vessels;
- the beneficial ownership of the vessel.

This chapter will adopt a definition of “open register” which reflects the matters that most concern the

ship owners, such as: costs, accessibility of the register and standards enforced by the state of registry. Therefore, an open registry should be identified as a flag which allows:

1. Lower crewing costs/manning requirements, since registration under a flag of convenience generally means:
    - unrestricted choice of crew in the international market;
    - not being subject to onerous national wage scales; and
    - more relaxed manning rules.
2. Lower operating costs generated by "lighter" maintenance programmes and less stringent enforcement of safety standards imposed by the register.
3. Less regulatory control and avoidance of bureaucracy.
4. The probable avoidance of corporate tax.
5. Anonymity.
6. Easy accessibility/exit to/from the registry.

Nowadays, even though traditional maritime countries continue to dominate the ownership of world shipping, the extent of flagging out to Open Registries is such that they account for a greater proportion of the total world fleet than the traditional maritime countries themselves. The share of world deadweight tonnage registered in the major Open Registries has risen from about 4% in 1950 to over 54% in 2008 (UNCTAD, Review of Maritime Transport 2008). There exists no clear definition of “open and international registries” but UNCTAD has created such a group by including the 10 largest fleets with more than 90% of foreign-controlled tonnage. These fleets are Panama, Liberia, Bahamas, the Marshall Islands, Malta, Cyprus, the Isle of Man, Antigua and Barbuda, Bermuda, and Saint Vincent and the Grenadines.

The motivation for transferring a ship from one registry to another is no different in principle from the motivation behind any other strategic decision on the part of a profit-maximising firm. The basic principles of the theory of the firm can be applied to the economics of this behaviour. Shipping companies are assumed to be profit maximisers which strive to reach their objective by seeking the production input combination which allows them to minimise costs. However, their choice of factors of production is constrained by their operating environment. Institutional factors and the characteristics of the market in which they operate condition their ability to make independent decisions. The selection of factors, their quantities, their costs and quality appear to be regulated in most of the so-called developed countries.

However, the existence of open registries creates a sort of dualism in the international maritime transport sector splitting the industry into two segments distinguished by operating characteristics peculiar to the two different scenarios and by lower break-even points. The ship owner like any other entrepreneur must chose the optimum amount of inputs to obtain the desired service output and strives to have the freedom to do so. Flagging out is primarily caused by the desire to minimise costs under a relatively lower cost regime but, as we shall see, the decision to flag out might have an impact on several ship management functions.

Flag selection is a high-level decision usually made, on a vessel-by-vessel basis, at the time of vessel acquisition and is generally based on experience. Different companies perceive different factors as being important to their decision on flag (Bergantino and Marlow, 1998). A flag might be chosen

for political reasons, to ensure a supply of skilled labour, for public relations reasons, for historical reasons, because of directives from financial institutions, or for reasons related to the trade routes of the vessel or to its characteristics. In the Bergantino and Marlow study companies which had chosen not to use the national flag gave crew costs as the most common reason for their decision. Other factors which had influenced them were: to escape bureaucratic control, high costs of compliance with standards of the national flag, the unavailability of skilled labour (the need to ensure a supply of same), and fiscal reasons.

In particular, operating costs[1] are identified as the ones where significant savings would be achieved by registering the ship in an Open Register. It is in the manning costs area where flagging out policies allow varying degrees of freedom to be obtained from the constraints of Union agreements and national manning regulations. Hence, according to the vast majority of authors,[2] shipowners, shipowners' associations and trade union representatives, the main reason for flagging out is to reduce manning costs. It has been stated by many authors that the adoption of an open registry flag can lead to savings in the following categories of crew-related costs:

- direct and indirect wages;[3]
- stores;
- maintenance.

The authors share the belief that crew costs can be considered as the main financial reason behind the ship owner's decision to flag out. The cost of manning a ship can be considered the easiest variable to influence when compared to other ship costs which appear to be mostly fixed internationally, especially in the short run. Stores costs are not as relevant as the other two categories and, furthermore, the adoption of an open register flag does not necessarily imply a decrease in this category of cost. As for the maintenance costs it is argued that while some crews can carry out certain tasks within the vessel, thereby eliminating the use of shore labour, others cannot and the lack of such maintenance and the subsequent neglect may lead to major damage claims and therefore higher insurance costs. Operating efficiency could, therefore, depend on the quality of the crew.

Manning costs have two components which are considered of equal importance: the direct and the indirect wage. The basic wage depends on the standard of living in the country of origin of the seaman, on the current exchange rate of the seaman's currency against the US dollar, and on international regulation and ITF policies framed to avoid the exploitation of the FoC crews. Indirect wage costs are those which do not represent immediate payment to the employed and are set independently by single national governments with regard to national seafarers (i.e. national insurance payment, leave entitlement, pensions, training, employment taxes, medical expenses, and so on). Therefore, the indirect wage is the element of the manning costs where different national policies could have a strong impact on the ship owners' decisions regarding flag.

By adopting a flag of convenience the ship owner gains the ability to offer contracts with gross salaries, transferring the responsibility for pension provision, social security costs and coverage of medical expenses to the employee. At the same time employment conditions such as lengths of duty and leave could be re-negotiated on an individual basis. The governments of most of the traditional maritime countries have modified their policies to move them closer to the situation created by the legislation of the Open Registry countries. This has led to the introduction of second or international

registers but these will not feature as the focus of this chapter.

A group of factors that might influence the shipowner's decision, but which have been partly ignored by the existing literature, are the characteristics of the shipping companies and of the ships. It is observed that only some companies of the same nationality decide to flag out, and that the decision to flag out might concern either all or only part of the fleet of the same shipping company. In the next section flag choice as a management decision will be discussed.

3. Flag Choice as a Management Decision

However straightforward the attribution of nationality to a ship may initially sound, the reality described in the previous section clearly shows the variety of alternatives ship owners have at their disposal and the diversity of parameters that have to be taken into account. It is this absence of externally imposed legal conditions, this aspect of informed and educated choice between alternatives that, first of all, makes the preference for a specific type of registry a management decision. Previous research (Bergantino and Marlow, 1998) showed that ship owners are driven in their choice of flag by certain criteria many of which can be seen to be related to management issues, such as marketing considerations or the decision to reduce input costs, i.e. crew costs. However there seems to be another direction in this relationship; the dimensions along which flags differentiate touch upon management issues and therefore flag choice can have an effect on management practices, too. In fact, the direction of such associations can become quite blurred, especially given that the choice of flag tends to be based on different sets of criteria for individual ship owners and individual ships (Bergantino and Marlow, 1998). Within these realms the focus here will be on identifying general management areas which are expected to be influenced by ship owners' choice of registry for their vessels.

Firstly, the choice of a ship's flag is very likely to affect *the location of the management company* itself. Traditionally, the nationality of a vessel has been connected with the nationality of its owner but well-known developments in the international shipping scene have brought about the evolution of the ship registration system and the plethora of registration schemes, procedures and requirements. Although, as already pointed out, there is no international legal instrument that lays down universally accepted registration provisions, the United Nations Convention on the Conditions for the Registration of Ships, 1986 – which is not in force and possibly never will be – provides some useful guidance. Articles 7–10 (UN 1986) call for participation by nationals of the flag state in the ownership, manning and management of the ships; either the ownership or manning criterion has to be satisfied but the management criterion is to be satisfied in all cases. Many nations appear to have indeed taken up – part of – its content at their discretion and to various degrees and today a number of registries require some form of commercial presence in the country. In some cases, such as Liberia, the requirement for a Liberian shipowning company can be easily satisfied by setting it up there only on paper and so it is not thought to have any significant impact on management. In other cases, like the Dutch registry, ships must be managed in that same country, a condition with important management implications. Such implications relate to the general legal framework of company operation prevalent in the country but also to the wider cultural characteristics which should be taken into account. On the assumption that local management companies will be staffed mostly by indigenous expertise, management action should take into account the special features of its human resource as conditioned by cultural differences. Hofstede's work (1980), on how national cultures can be explained by four key factors,

namely, individualism, power distance, uncertainty avoidance and masculinity, has been most influential in this respect. It has shown how nationality affects human behaviour and consequently how it also constrains management practice. For example, he has found that countries which score highly in power distance and uncertainty avoidance are likely to produce forms of organisation that rely heavily on hierarchy and clear orders from superiors, but those which score low in power distance and high in uncertainty avoidance will produce organisations that rely on rules and procedures (Hofstede, 1991). If to the above, the effect of the company's macro environment is added, i.e. the general national economic situation, the existence of infrastructure and telecommunications etc, the expected impact of management location on management practice becomes even more evident.

Clearly, the legal framework that the different registries offer touches upon a number of dimensions in relation to management. *Company laws* and *financial laws* relating to, for instance, the company's organisation, the disclosure of ownership of shares, or the auditing of the accounts, will obviously be expected to have a bearing on management functions. Open registries are generally believed to encompass more flexible and owner-friendly commercial environments but many shipowning nations, such as Greece and the UK, have also attended to the provision of an attractive commercial context for ship operation. A specific trend between registries may perhaps be difficult to observe but although such items may be rather flag-specific, they nevertheless have important implications for ship management.

The way that open registries and traditional ones have dealt with *tax liabilities* has conventionally been one of the most fundamental differences between the two. Open registries have led the way with the early introduction of advantageous taxation schemes for both ship's tax and company tax. Although indeed a significant parameter in ship owners' choice of flag (Gardner *et al*., 1984), differing tax systems may be thought to affect management practice to a small and mostly indirect extent. For example, they may necessitate or not the existence of a separate sub-department in the accounts department or require expertise in the form of outside experts or outsourcing. Indirectly they will influence the company's balance sheets, its cash flow and perhaps ultimately and long-term the investment capability/options of the company. But, unless seen from this perspective, diverse tax schemes cannot be seen to have a considerable impact on management practice. In terms of ship's tax, one more exception may apply; when the tax system, such as a tonnage tax system, is tied to a training obligation, as in the case of the UK and other nations, then, more obvious implications are developed for the human resource management exercised by the company.

The issue of flag has mainly been related to cost differences. In other words the main differentiating factor between traditional flags and open registries is cost, translated into total crew costs, tax and high costs of compliance with safety standards of national flags. Tax does not really have a dramatic effect on management practices. Nevertheless, the degree of preoccupation with cost as a formative parameter of strategy and the repercussions for crew employment choices that occur with the preference for a flag are the two issues with the most impact on management decisions and these will be explored in some detail in the following two sections.

4. The Impact of Choice of Flag on Strategic Decisions

The choice of flag also affects a number of *strategic decisions at corporate level*. In the first place, the flag a vessel flies may influence the actual *market sectors* in which a company engages. Decisions

about the fields and industries in which a corporation's Strategic Business Units (SBUs) will pursue commercial activities are among the most significant decisions corporate executives and top management are expected to make for the success and the viability of every firm. Consider the example of countries, Norway for instance, which offer exclusive employment of vessels flying the national flag in certain protected trades, such as coasting, or when there is a preference for the national fleet for government cargoes, like the case of the USA. Clearly, the flying of a foreign flag automatically prevents the company from involvement in specific market segments. Along the same lines, a firm using reputable and highly recognised flags for its vessels may have built up a respectable and dependable profile and may thus enjoy further business opportunities for involvement in higher risk trades, such as the tanker industry, which it could otherwise perhaps not be provided with. Hand in hand with these strategic choices come also management decisions about the firm's assets or features of the firm's fleet especially in terms of ship types and ship sizes, and so the latter can also be seen to potentially be affected by the ship owners' flag choice. In connection with the above, ship management can also be influenced by the choice of flag *at an operational level*. Preference for certain *trade routes* may be effected by a need, for example, to avoid highly regulated geographic regions, such as the USA especially after the introduction of OPA 90, or the EU, or certain countries or strict Port State Control areas if ships are flying a PSC-targeted flag.

Interestingly, and perhaps unexpectedly, flag choice can be seen to have an impact on yet more strategic management issues. The formulation of a corporate strategy can potentially be affected by a specific flag choice when, for instance, flags give attractive incentives for building new ships. Fleet expansion is of course a management decision primarily driven by market conditions, good freight rates, strong cash flows, and optimistic expectations. But more often than not, history in shipping has shown that ship owners in their decision to invest in new ships are also influenced by favourable building incentives, coming either from the yard or the government, to such an extent that this behaviour has been thought to bring ultimately negative results for the freight market (Strandenes, 2002). In other words, although a rational assumption here, the impact of appealing newbuilding support schemes as part of a flag's regime on a ship owners' decision to adopt a *growth strategy* is in fact a noted reality. Growth and fleet expansion can be achieved also through the acquisition of second hand ships. In this case, too, the flag's effect on the decision to expand can be considerable, especially in situations when the flag provides ship owners with access to loans at better rates of interest within the realms of its industry support plan. On the other hand, the choice of flag does not only have a bearing on whether top management takes up a growth corporate strategy or not but also on the ways in which growth is to take place. A straightforward example relates to the manner in which registries deal with the issue of dual registration. If a flag does not allow dual registration, this affects also the fleet expansion policy as ship owners are restricted with regard to bareboat chartering options under this registry system. On top of that, management decisions on *fleet replacement policy* can at times be impacted by the choice of flag. This is so since many registries, both traditional and open registers, have a maximum ship's age restriction which means that if ship owners, for a number of reasons, wish their ships to fly this flag, they must adjust their replacement policy accordingly.

Associations between the choice of flag and the formulation of *business-level strategies* can also be considered. According to Porter (1980), there are three generic strategies that companies can pursue: a differentiation strategy; a cost leadership strategy; and a focus strategy. The differentiation strategy

seeks to distinguish the company's products or services from those of the competitors' in the industry along some dimensions that are valued by clients. Such dimensions may relate to the quality of the product/service, the development of distinctive product features, etc, and receive higher than average prices. With the cost leadership strategy the company attempts to gain competitive advantage by reducing production costs and selling its product/service at lower prices than competitors. The company will still offer comparable quality at these low prices and make a profit. With the focus strategy the company concentrates on a particular market segment, a group of customers or geographical location, and adopts either a differentiation focus or a cost leadership focus. Bearing in mind that the use of open registries has been instigated particularly by the drive for cost-cutting, it can reasonably be assumed that companies opting for them would follow a cost leadership competitive strategy. On the other hand, ship owners who are willing to take on the additional costs of a national flag and invest further in the image of a traditional, quality operator would, in effect, opt for a differentiation strategy for their business ventures.

The strategic decision of the top management concerning the *employment of third party ship managers* does not appear to be directly affected by the choice of flag. Relevant research indicated that flagging out was ranked low down in importance by ship owners as a potential reason for turning to third party ship managers (Mitroussi, 2004). Other assumptions of indirect associations between flag choice and the use of third party ship management can be attempted but seem to be less able to hold up in a critical rationale, especially when additional dimensions are considered. For example, it has been shown, that when ship owners do not use third party ship management it is very much because they want to keep close overall control over vessels, both in terms of cost as well as maintenance levels (Mitroussi, 2004). National flags, on the other hand, are known to administer and therefore require, on the part of their operators, close control in order to keep safety standards high. On these grounds a logical assumption would be that the choice of national flag might deter the loss of absolute control and therefore the use of third party ship management. Nevertheless, market requirements, with charterers often preferring to do business with a recognised ship manager rather than a small operator, especially in trades of high risk, like the tanker sector, point to the idea that third party ship management and control of safety standards might be on the same side of the road. With ship owners generally retaining the decision on the choice of flag even when third party ship managers are used (Mitroussi, 2004), it seems that although overall the choice of flag can influence ship management practice, it does not have an impact on its outsourcing.

Last but not least, management is concerned with *dealing with the external environment* of a company too, and even more so today, given the upsurge of the concept of corporate social responsibility, with its various stakeholders. Although shipping is indeed a truly international business, choice of flag by definition has an effect on this aspect of management as it dictates the micro external environment of a shipping company through the legal framework it provides, such as the national shipping bodies, government agencies, bureaucratic control and other aspects. In the case of traditional flags usually some important work should be expected on the part of the management of the company to achieve and enhance relationship building with unions, flag officials, other contacts and other shipping related associations. This can be both time-consuming and require specific managerial, social and even negotiation skills but it also allows room for lobbying, and gives

opportunities for recognition within the community and for making the company's voice heard. On the other hand, such aspects of management are usually not required – certainly not to a significant extent – when the ship operation concerns vessels registered in flags of convenience, which are generally accepted to encompass lax governmental controls and a minimum shipping infrastructure. Quite clearly, the choice of flag touches upon management issues in this respect, too.

5. The Impact of Choice of Flag on Human Resource Management

Open registries and the process of changing the flag – the flagging out – have been particularly associated with the issue of ship manning. Applying Vernon's dynamic model of location of production (1966), flagging out is regarded as analogous to the establishment of overseas subsidiaries by large production firms and is considered to be the third wave of maritime transport (Sletmo, 1989). Flagging out is seen as part of the shipping industry's effort to develop least cost systems of ship operation by taking advantage of low cost labour. By definition, therefore, the choice of flag has an axiomatic direct impact on the human resource management of a shipping company. This impact, although primarily related to crews, extends to the overall management practice in a company, not least because crew management is an essential part of it, but also due to the inevitable relationships developed between onboard and shore-based human resource management.

"Human resource management involves all management decisions and practices that directly affect or influence the people, or human resources, who work for the organisation" (Torrington *et al*., 2002). The term has in recent years been more and more used in the place of the term 'personnel management' in order to signify a shift in its importance and in its orientation. Torrington *et al*. (2008) talk about the changing nature of the management of people underlining that personnel management is preoccupied with managing the supply of people to the business, but human resource management with managing the demand for human resources to meet the operational needs of the business. In essence, emphasis on a more strategic approach to people management is given, as human resource management must integrate the firm's goals with the correct approach to managing its human capital (Baron and Kreps, 1999). Effective human resource management has been positively associated with higher employee productivity and better financial results (Delaney and Huselid, 1996; Huselid *et al*., 1997). The role of human capital and its management in sustaining competitive advantage has been stressed in the general management literature (Pfeffer, 1995) but also more recently in shipping-related literature. Lorange (2005), examining contemporary evolutionary forces in relation to shipping company strategies, talks of company cases in which "the assets are the human capital" and underlines "a strong emphasis on being 'a people make the difference' business, without owning any 'steel' at all."

Human resource management is of particular significance in shipping, which although traditionally capital intensive, particularly relies on its people for successful and profitable ship operation. This is so, not just due to their innate characteristics as service-sector organisations, but particularly due to the unique idiosyncrasies of the shipping business itself (Mitroussi and Chang, 2008). The special features of shipping with regard to its people mainly relate to the distinction between shore-based and ship-based personnel in the companies, the inherent complexity of ship operation which places capital intensive assets in the hands of very few (e.g. 15 to 20) people, the multinational aspect and immensely high turnover of the crew and the social aspect of the staff's time on board.

The scope of human resource management activities is quite broad and could perhaps best be described as the effort to attract effective employees, develop them to their potential and maintain them over the long term (Fisher, 1989). These main areas include a number of activities ranging from human resource planning, recruitment and selection, to training, development and appraisal and yet further to managing employee relations and services, such as welfare. The focus in this chapter is primarily on the first two areas, as these are thought to be more directly affected by the choice of flag.

One of the most important aspects of people management in shipping is its *international dimension.* International human resource management is a term which has only recently appeared in shore industries and has emerged as a consequence mostly of the establishment and expansion of overseas subsidiaries and of course the development of globalised firms. Research suggests that the majority of companies in shore industries have yet to deal with and align their human resource policies and practices with globalisation needs (Wellins and Rioux, 2000). International manning is certainly not a new matter for the shipping business, given its inherently international character; however, as already pointed out, the burst of foreign recruitment on board vessels took place with the third wave of shipping – the flagging out process. In other words, if it is assumed that national flags have traditionally required a full – or an overwhelming majority – of national crew complement, then it can safely be deduced that international human resource management should be expected to be more of a concern for companies opting for flagging out. This clearly indicates a considerable impact of the choice of flag on human resource management of companies, as it points to differences in human resource approaches and procedures for companies registering their vessels in different flags. Ship managers involved in dealing with a diverse pool of seafarers coming from around the world are faced with a number of challenges. Cultural and national differences have to be coordinated and accommodated; policies and practices may have to be adjusted to take into account differences in cultures and social norms; effective communication needs to be maintained in different languages and for different backgrounds and frames of reference. As such, the special concerns of ship operators managing a nationally diverse workforce encompass a number of aspects, such as the organisation culture and the education programmes, and primarily should concentrate on building human resource systems which are bias-free in many respects (Cox and Blake, 1991). Special attention must be paid to the significant issue of successful communication not just from the office to the ship but also most importantly among the crew onboard the vessel, not only because these people will be the direct and first handlers of an emergency situation, but also for the good social and working relations and the efficient execution of duties onboard. As language and cultural barriers are bound to be present in the communication of multi-national crews, the proper mix of crew nationalities and knowledge of such potential barriers play a vital role in effective ship management. For example, research has shown that people of different nationalities pay differing degrees of attention to the social context – nonverbal clues, social status, etc – when they communicate verbally (Kennedy and Everest, 1991). The Chinese, for example, come from a high-context culture and tend to derive meaning from context, whereas Scandinavians come from a low-context culture and derive meaning primarily from words. The implications for effective communication within these realms are quite self-evident as well as the implications for the human resource management of shipping companies involved with the manning of multinational crews.

Appropriate planning is the starting point for successful human resource management. *Human resource planning* is the process for identifying an organisation's current and future requirements, developing plans to meet these requirements and monitoring their effectiveness (Beardwell and Claydon, 2007). It is an integral part of broader company planning as it is connected with the organisation's future development and objectives. Its main stages encompass an assessment of current staffing needs, forecasting the future personnel needs, formulating a staffing strategy and finally evaluating and updating the whole process (Kreitner, 2001). Clearly, every shipping company should engage in human resource planning, but circumstances in the shipping business make this a rather challenging task regardless of the flag the ships fly. Items related to the phase of analysing existing needs constitute in fact and, to a great extent, a requirement for shipping companies under international law (i.e. under the International Ship Management (ISM) Code). The reference is for the process of job analysis which is made up of two parts: the job description – the duties of a job, and the job specification – the skills and qualifications needed for the job. Given the widespread adoption and implementation of the SOLAS Convention important differences with regard to this aspect of human resource planning should not be expected to be observed, at least not in relation to staff positions related to the safe management of the vessels. Difficulties in the human resource planning arise for all shipping companies in respect of the forecast of future supply and demand of labour.

Relevant issues which cause complications in human resource planning and are common for all shipping companies, regardless of the flags they use for their vessels, include the unpredictable fluctuations of the freight rate market and the increased flexibility to trade in and out of market sectors primarily through the sale and purchase (S&P) market activities. Of great importance for the forecasting of projected staff needs is the ability to predict revenues and demand for the service. Such predictions, however, are notoriously hard to attain in the shipping business, where forecasting tools generally fail to reflect and encompass the complexity and volatility of macro and micro realities. The S&P market offers shipping companies increased flexibility to trade in and out of varied market sectors within short periods of time and often even at short notice, which can cause further difficulties in the forecast of demand of future labour needs. Forecasting the supply of labour entails basically two tasks: assessing the internal supply – the number and type of employees expected to remain in the firm – and the external sources generally available in the labour market. Given the discussion above about the international character of the human resource process in shipping, the difficulties and complications of trying to anticipate availability of external sources of labour are quite obvious. Within these realms, the companies which use foreign flags are subject to greater complexities in their human resource planning process, but also greater opportunities as the human resource supply area for their ships becomes effectively the whole world. Another difference between firms using open registries and those flying the national flag relates to the estimation of the likely supply of internal candidates to satisfy future staffing needs. Traditionally, shipping offices have been manned by ex-seafarers; this is still the case today, especially in respect of certain office posts, such as the marine superintendent, for which ex-shipmanship can be a requirement (for a detailed account of such posts see Pettit *et al.* 2005). Shipping companies using national flags tend to have an established pool of seafarers who regularly go on their ships. In order for companies to retain the acquired expertise and be able to install more easily commitment and corporate culture, companies often tend to keep

seafarers on their payroll, even for periods of time when they are not serving onboard the company's vessels. This creates a source of internal supply of qualified employees for projected openings in the company's office. Shipowners taking advantage of open registries cannot easily build up this pool of dedicated skilled labour which can potentially be used at the office due to the high turnover and the practicalities of employing staff of different nationalities. Along the same lines, companies using open registries while at the same time relying for their recruitments on an "as needed" basis cannot plan succession schemes for onboard posts either, that is, relating to officers advancing from lower ranks to becoming masters or chief engineers. Exceptions of companies who customarily use open registries but have developed strong ties with foreign crew supply areas – for example, through the establishment of representative crew offices locally, or supporting marine schools there – do exist. However, it is on these conditions of considerable investment on the part of shipping companies in the crew supply areas that the existence of crew succession schemes can be more readily associated with open registers and only really with regard to onboard posts, leaving succession from the ship to the office to still be a major concern. Given this limited potential application of succession plans as well as the fact that such investment in crew supply areas is usually related to a critical company size, not necessarily satisfied by the majority of deep sea tramp operators, some differences can be considered between shipping companies flying the national flag and those using open registries in the application of the human resource planning process.

The next stage for an organisation, after assessing its future human resource needs, is recruitment and selection. This stage is concerned with attracting and choosing suitable people to meet the company's human resource requirements. The importance of effective *recruitment* is quite straightforward as both the quality as well as the number of the candidates is crucial for the selection of ultimately the most suitable employees. There are a number of recruitment methods ranging from internal searches to advertising in the press and on the internet, formal and informal contacts, such as employee referrals or simple "walk-ins", education liaison and recruitment agencies. The choice of a national or foreign flag can have a bearing on the recruitment techniques adopted by shipping companies. For example, companies with ships registered on the national registry and employing nationals onboard their vessels can take advantage of informal contacts, such as word of mouth and speculative applications or even use their own shore or sea staff to recommend candidates for job openings. Traditional ship owners in maritime nations, like Greece, for instance, are famous for historically building their business relying on a pool of expertise which would come from their own village or island and with whom they shared a common background, culture, aspiration and therefore stronger ties. This is important as managers should consider not just the technical competence but also the sociability of candidates, the degree to which they can fit well into the cultural and social context of the company. This subtle aspect of human resource recruitment is generally lost when the search is only for the least expensive crew complement. In addition, ship owners using the national registry may utilise the method of college recruiting, especially as national flags often require the training of cadets onboard registered vessels, as in the case of the Greek flag.

One very important issue for consideration as an option for the recruitment process in a shipping company is the extent of use of and reliance on crew agencies for the manning of its vessels, in other words, the option and degree of *outsourcing*. Outsourcing is increasingly being used on a global scale for different management functions and human resource is one of them, with the jobs outsourced

mainly being administrative ones, like payroll or recruitment. In fact, research shows that human resource is one of the most commonly outsourced business activities today (Lawler, 2004). Crew agencies have been used in shipping to a great extent and for many decades not least at national level, too, but once again the growth of open registers has brought about an increased reliance on crew agencies. Expanding on the aforementioned argument about the impact of flag choice on the internationalisation of the human resource process, the choice of flag is expected to have an effect also on the degree of HR outsourcing in a shipping company. Ship owners who choose open registries to take advantage of lower crew costs by employing seafarers from third countries, should obviously be expected to make considerably more use – both in terms of general crew as well as officers – of outsourcing to crew agencies as a means of access to distant labour supply areas. Management is thus further affected by the potential advantages and disadvantages of outsourcing. In respect of advantages, ship managers opting for some HR outsourcing are presented with: greater flexibility – an especially good thing when a company's needs can fluctuate quickly with the buying in or selling of vessels; access to expertise that could be hard to find otherwise; greater variety and mix of nationalities; reduced costs, which can relate not only to lower crew wages but to the absence of any need for keeping staff on standby and also to the lack of investment in training. However, disadvantages have also been noted. For instance, recent research revealed that UK companies are reluctant to use outsourcing due to fears of loss of control, loss of personal touch and doubts about the quality and commitment of the relevant staff (Hammond, 2002). Especially at the recruitment process the use of crew agencies in shipping may mean that poor candidates can bypass the initial screening process and enter the company's pool with damaging consequences for the business. Additional potential disadvantages include loss of skill and knowledge, reduction in the quality of service, loss of employee morale, short term disruption and discontinuity and damage to long-term competitiveness (Cooke *et al*., 2005).

With regard to the *selection process*, shipowners are also presented with a variety of techniques. The choice of flag is thought to have some effect on this dimension of the human resource management, too. Shipping companies, who make use of international crew agencies for the manning of the vessels they have under foreign flags, in reality give up completely the activities connected with the recruitment stage and some – if not all – of the activities connected with the selection phase. The first step in the process of selection is ordinarily the review of application forms followed by interviews, personality/psychometric/ability tests, work simulations, or participation in assessment centres and medical examinations including drug and alcohol tests. The degree to which such activities are carried out by the agencies rather than the shipping company itself varies but it should be expected that shipping companies using open registries will exhibit a less "hands on" approach in respect of many of them. This is in line with the principle of cost-cutting through outsourcing HR activities and it is not rare that newly recruited, especially lower ranked, crew members never actually set foot in the company's office premises. The shrinkage of direct selection costs, which comes with the shrinkage of the human resource selection activities in which a shipping company gets involved should, however, be weighed against the costs of selection failure, as poor recruitment and selection can have obvious detrimental effects for ship operation.

Along the same lines the *training and development* as well as performance appraisal of the human

resource management in shipping companies can be influenced by their choice of flag. Training refers to teaching employees how to do their present jobs, while development focuses on building the knowledge and skills of employees for future responsibilities and challenges. Given the vital role of staff as a crucial and expensive resource, their contribution to effective and efficient organisational performance and the contemporary movement towards more flexible organisational structures and employee empowerment, training and development clearly constitute a critical HRM function. The main difference that should be expected to be observed between companies using open registries and others using national flags is the degree of investment in training and development especially for their seafarers. Such an investment will relate to the allocation of resources, planning, time, money, equipment and should be considered to be less for shipping firms registering their vessels in open registries and far more for those using national registries. The argument here continues from the reasoning discussed above in connection with the earlier stages of human resource management and concerns the extent to which HR functions are outsourced. Companies relying extensively on crew agencies to take advantage of low-cost distant supply areas cannot easily adopt a systematic approach to the management of training. Such a systematic approach entails several steps, from an assessment of training needs to an embedding of commitment and involvement of staff and from a clearly defined policy to a carefully planned training, review and evaluation programme (Mullins, 1991). A shipping company which mans its vessels on an ad hoc, “as needed” basis from crewing agencies around the world and with a high turnover will find it quite difficult, for example, to engage in any objective assessment of training needs. This requires analysis at three distinct levels, the organisation, the task and the person, and at high turnovers and with minimum knowledge of the employees the chain of the assessment is broken at the third tier of the analysis. In the same way, the review and evaluation of training programmes can hardly be effectively carried out when seafarers do not stay with the same company for more than six to eight months. The choice of flag may also affect the types of training that companies may adopt. To begin with, since companies using open registers may not usually invest in any long-term employment relationship with their seafarers, they should be expected to be less concerned with employee development, such as varied work experiences or formal education. They should also be less concerned with sea staff career development or management. Their training programmes may be more oriented towards induction programmes, on-the-job training or simply the training required by national/international regulations, like the ISM or the ISPS Code. In addition, they would not be expected to adopt apprenticeship training, as open registries do not require any form of cadet training obligation on the part of their vessels, unlike some of the tonnage tax regimes adopted by traditional flags.

The choice of flag is also considered to have an impact on the *performance appraisal* function of the human resource management again due to the diverse crew employment conditions connected with different flag types. Performance appraisal is a review and assessment of the behaviour and performance of staff and its systematic nature involves a scheme of regular and continuous judgement and feedback. It is this systematic approach to appraisal and its various implications for several other managerial functions and decisions that give rise to differentiations in respect of this HRM function between companies using open and national registries. First of all, the appraisal system should be designed in accordance with organisational objectives and to fit its organisational culture and policies, while supervisors should undergo relevant training to avoid the costs of poorly administered

appraisals. However, due to the quick pace with which shipping companies using open registries may change officers onboard their vessels, masters cannot receive appropriate appraisal training nor can they readily align their appraisal practice with the goals and culture of the company. Also, the system needs to be evaluated regularly based on feedback from supervisors, but again the frequent change of crew members onboard foreign flagged vessels does not provide the conditions for effective monitoring of the system and reliable, systematic feedback from the appraisers, the masters/officers. In addition, a successful performance appraisal scheme means that results are fed into other HRM activities, for example, for validation of selection techniques, for assessment of the impact of training programmes, for forecasts of staffing needs or as a basis of a review of financial rewards, promotions, etc. It also means that employees are provided with appropriate feedback to reflect on and improve their individual performance, to identify training/development needs and plan career progression. The usually limited time of crew members onboard ships flying flags of convenience and the ad hoc basis of their employment put severe restrictions on the actual and successful application of performance feedback procedures, while they also have an effect on the frequency with which appraisals can be carried out.

All of the above have an impact on the organisation and structure of the office-based staff too. The more human resource activities are outsourced, the less the responsibilities and activities of the office in respect of them and hence the smaller the relevant department in the office and vice-versa. The operation of the office of a shipping company is also affected in other ways, like in respect of the succession planning, mentioned earlier or the effective communication with the vessel, coordination of duties, the provision of quality service, the attraction of business and other indirect ways. Nevertheless, with regard to the shore staff of shipping companies, it must be underlined that some of the HRM functions discussed above, such as the training and development or the performance appraisal, are not considered to be directly influenced by the choice of flag. Shipping companies, for example, can make considerable investments in training and development of shore staff and take advantage of the wide range of training programmes for their office personnel without being restricted by their choice of flag. In addition, given that ship owners may choose different flag regimes for different vessels of the same fleet – research has suggested that the decision to flag out is taken on a ship-basis and not a fleet-basis (Bergantino and Marlow, 1998) – it is possible that many of the issues discussed above cancel each other out when the overall management approach of a shipping company is considered.

6. Flag Regimes in Convergence

The basis for this comparison of the management approach has been the traditionally clear-cut distinction between open registers and national flags. Contemporary developments, however, in the international ship registration regime have brought the features of national flags and open registries much closer. For example, the overwhelming majority of the ocean-going fleet is suspected to be under some form of tonnage tax system, while nationality restrictions for crew complements become more and more lax for traditional flags. The ways in which flag regimes have recently come towards some convergence as well as the potential impact of these developments on expected management approaches by shipping companies in the light of our discussion, will now be examined.

A growing awareness of the importance of the shipping industry to the international and national

economies and an increased interest in supporting it have resulted in measures being taken by governments to foster the competitiveness of their national shipping industries. Within this context and in order to encourage ships not to flag out, the European Union has attempted to secure a level playing field for the shipping industry by introducing a relevant regulatory framework. The 2004 State Aid Guidelines are in force currently and for a time period of seven years, that is until 2011 (Commission of the European Communities, 2004). The 2004 Guidelines regard shipping tonnage tax as a State Aid, a fiscal incentive which can be endorsed to safeguard quality employment and facilitate the development of community shipping in the global market; they make provisions for reduced rates of contributions for social security and reduced rates of income tax for Community seafarers on board ships registered in a Member State; they propose, *inter alia*, other state aid initiatives, which include the reimbursement of repatriation costs of Community seafarers, tax free reserves for capital gains, specific investment aids, some forms of training initiatives, and financial aid to cover up to 30% of operating costs for a new service that will enable road transport cargoes to be diverted to sea.

Indeed most of the traditional shipping nations in the EU have taken advantage of the aid measures allowed since the 1997 guidelines by introducing, for example, tonnage tax systems and/or schemes to reduce crew costs. Tonnage tax entered into force in the Netherlands and Norway in 1996, Germany in 1999, the UK in 2000, Denmark, Spain, Finland, Ireland, Belgium and France in 2002, and Italy in 2005. The current system of tonnage tax in Greece has existed since 1975. At an international level, too, the trend to come up with ways to support the industry through fiscal and financial incentives is also evident. For instance, Singapore operates the Approved Shipping Logistics Enterprise Scheme which offers a 10% concessionary tax rate for a five-year period (recently changed to ten years, 15/02/07); while the Hong Kong Shipping Register introduced a range of schemes to attract quality tonnage, among them a six month annual tonnage charge reduction scheme every two years provided their ships have not been detained (Grinter, 2007).

A re-examination of the definitions of open register existent in the literature (section 2), suggests that the older the definition provided, the more outdated it appears, given the current status of affairs generally in the political and economic environment and in the international shipping industry. Traditional flags have admittedly been adjusting their registration procedures to make them more attractive, more “convenient” and “opportune” for ship owners:

- foreign-owned or foreign controlled vessels can be allowed to register in traditional flags, e.g the Norwegian Ordinary Ship Register (NOR) accepts EU citizens or companies as equivalent to Norwegian citizens or companies to be registered as owners of vessels flying its flag;
- access to and transfer from national flags is made easy while the cost of registration fees has been brought down, e.g. in the UK flag registration costs are amongst the lowest available in national flags while there are no annual renewal fees;
- taxes on the income of ships are not levied, a tonnage tax system is used instead, e.g. Greece has the longest history in applying a tonnage tax regime that goes back to 1939 (Moraitis, 2003), while the current taxation system applying to the shipping sector was introduced by Law 27 in 1975;
- fiscal obligations can be circumvented usually through the avoidance of corporate tax, e.g. as is the case with the UK and Dutch flag;
- the manning of ships by non nationals is permitted to a smaller or a larger extent, e.g. recently

a softening of Greek flag manning requirements with regard to the complement of Greek nationals has meant that, with the exception of masters, who must remain Greek, shipowners are free to choose whether the Greek contingent (minimum 4-6) consists of officers, lower ranks or a combination of the two.

In the light of these changes to traditional registers, how can our discussion in the previous sections be affected? If the basis of the theoretical rationale we have developed, (i.e. the clear-cut distinction between open registers and traditional flags), is no longer so clear-cut, does this affect, and if so to what extent, the assumptions made about the impact of choice of flag on ship management?

The fundamental distinction between national flags and the flags of convenience has been the absence of a "genuine link" on the part of the latter. This can take the form of a number of attributes and, if the UN relevant instrument on Conditions for Registration of Ships is followed, such attributes can relate mainly to the ownership, the manning and the management criteria as well as the contribution to the national economy and its inclusion in the national balance of payments accounts. With regard then to the actual convergence between flag regimes, the real question is not how close traditional flags have become to the attractive features of open registers but whether, to what extent, and along which dimensions such changes have altered the basic characteristic of national flags, i.e. the genuine link, and so the essence of the nature of national flags.

A detailed reasoning of the potential impact of such developments on ship management choices, in the lines of the discussion in the previous sections, will not of course be attempted at this point, as this would be a valuable exercise in its own right. Rather some basic, underlying principles will be addressed and reviewed in relation to the issue of the recent convergence of traditional and open registers.

The adoption of measures on the part of national flags which relate to the reduction of bureaucracy in registration procedures or the decrease in registration/annual fees is straightforwardly an aspect which should not have an effect on the management behaviour of shipping companies. The much discussed and widely applied tonnage tax scheme, although indeed an important aspect of convergence between the two main flag regimes and with direct consequences to national economies, should not be expected to affect management practice to any significant extent, as argued earlier in this chapter.

Of much greater significance for both the determination of the existence/absence of the genuine link with ships, as well as the management practice is the degree to which national flags nowadays allow for the registration of ships owned by non-nationals. On the one hand the need to enhance competitiveness and, on the other, the political reality of regional unions of sovereign states, like the EU, has meant that traditional flags previously not open to other nationalities, would have to accept foreign shipowners in their register. This development should be expected to affect at a first level the cultural identity of the flag itself and then, as a result of that, to potentially have some impact on a number of elements of ship management for individual shipping companies. Historically, traditional flags have been associated with the maritime nation of their countries, its reputation with regard to ship operation, the way it is thought to conduct business, its know-how and expertise. They have built up a certain image – positive, negative, peculiar, indifferent – based on this. With the participation of foreigners in their registers such identity and consequently image will slowly be infused with elements from the shipping experience and standing of other nations. Initially ships, controlled by

foreign interests, entering a newly opened-to-foreigners traditional flag, should be expected to be drawn to it because they also share some common principles in respect of the business of ship operation. Inevitably, there will be a two-way influence between the two entities affecting the status of the flag itself. The degree to which the traditional flag will sustain its attitude towards the shipping business will largely depend on its desire to treat registration as a procedure necessary to impose sovereignty and hence control over its shipping. In this way, recognising that national flags have the expertise, the infrastructure, the procedures and tools and assuming still also the will, to impose sovereignty then the relaxation of ownership requirements, although bringing them closer to the known attributes of flags of convenience, should not be expected to alter significantly the management choices of the companies who prefer them. However, if a national flag's previous reputation for quality and high safety standards is lost, then this may affect some of the strategic decisions – as discussed in section 4 – of companies registered in it. In respect of the legal framework of company's laws and other laws inherently relevant to every nation, a specific trend between registries may be difficult to observe and such items should be rather flag-specific than flag regime-specific.

The genuine link between registers and their vessels can also be demonstrated by the management criterion, the fact, that is, that nationals must have some presence in the actual management of the vessels. Many traditional flags appear still to adhere to this requirement, despite their opening up to other nationalities or the adoption of favourable tax and registration systems. This issue is of course related to the actual control of and accountability and liability for ship operation but it is also very much connected with the protection of the national maritime cluster and national economy. In recent years the realisation has been that actually 70% of the value added by the shipping industry comes from on-shore activities related to shipping (Peeters *et al*., 1994). It seems, therefore, that maritime nations wishing to keep the primary source of the industry's contribution to their economy and balance of payments – the valued added, the employment generation, the investment generation, the preservation and enhancement of expertise – are willing to "sacrifice" potential corporate tax income to protect the management dimension of their shipping business. Examples of traditional flags which have resorted to the adoption of tonnage tax but have sheltered their shore-based shipping activity by including the management requirement in their registration include the UK and Dutch flag. Others, like Greece, have for many years provided a favourable tax regime for ship management companies established in the country in order to attract more onshore business activity in it.[4] Since the location of ship management has important consequences for management practice, as also discussed in section 3, the decision of traditional flags to retain management functions nationally essentially distances the former from what open registers stand for.

National flags generally go down the path of using open registers as a benchmark in order to increase the competitiveness of their own national shipping industry and extended maritime cluster rather than because they wish to provide a service which can be sold to foreign ship owners wishing to escape the fiscal or other consequences of registration under their own flags. It is in this distinctive philosophy that a main difference between traditional and open flags is still to be observed. Shipping is generally thought to be considered by traditional flags as an important industry for their nation, one in which governments should invest and to which private investment should be attracted. This creates

the environment and further encourages the development of shipping related organisations, trade and shipowning associations, seafarers' and workers' unions and other bodies, all of which should be seen to ensure the sustainability of national shipping through promoting quality, safety, training, expertise, fair working conditions and an appealing commercial environment for conducting the business.

The relaxation of national manning requirements should also be viewed within these parameters, although this development should be expected to have significant repercussions for the adoption of ship management practices by shipping firms. It is in this regard that it can be said not only that the two registry regimes are coming very close in disposition, but also that this alters to a significant extent the assumptions made with regard to the impact of the flag choice on human resource management (section 5). The rationale about the human resource management choices of shipping companies was built basically around the principle that its international dimensions (outsourcing, the 'as needed' strategy and high turnovers) were issues primarily connected with the use of flags of convenience. Given the new development of traditional flags now adopting a more laissez-faire approach to the nationality of seafarers onboard their ships, such issues and their consequences could no longer be regarded as more relevant for companies choosing open registers. The difference between shipping companies with regard to their people and their human resource management should then be expected to stem more from the degree of investment made by them in this key management dimension rather than be implied by their flag choice. The requirement for the training of nationals which is built into some traditional flags is expected to bring some differences in management practices, for instance, in relation to recruitment process. Overall, the preoccupation with cost cutting in order to enhance the competitiveness of flags is most vividly exhibited in the softening of national manning requirements, and changes should be expected in the way the business will be conducted.

7. Conclusion

This chapter has been concerned with the impact of the choice of flag on ship management. The basis of the analysis was the conventional distinction between open registers and traditional, national flags. The subject is treated in a theoretical context and the examination reveals a number of management dimensions in a shipping company which can be thought to be influenced by the choice of flag. General management aspects such as the decision on the actual location of the ship management company can be affected, but most importantly it is the strategic management decisions and the human resource management process that are considered to be particularly influenced by the company's flag choice. With regard to strategic management, both corporate strategies and business-level strategies of a shipping firm can be affected as, for example, the use of open registers corresponds to a cost leadership competitive strategy, while the use of national registers corresponds to the differentiation strategy. Human resource planning, the recruitment and selection process, as well as the training and development and performance appraisal programmes are regarded as management functions on which the choice of flag can have a bearing.

As stated earlier, the basis for comparison of the management approach has been the traditionally clear-cut distinction between open registers and national flags. Contemporary developments, however, in the international ship registration regime have brought the features of national flags and open registries much closer. The overwhelming majority of the ocean-going fleet is suspected to be under some form of tonnage tax system, while nationality restrictions for crew complements become more

and more lax for traditional flags, as in the case of the Greek flag. In the light of such developments a re-evaluation of the different management approaches expected by shipping companies using diverse ship registration regimes would be another valuable exercise. This chapter did not attempt to tackle all the issues in an holistic manner and other considerations, such as cultural diversity and associated crew management practices, could usefully be included in future.

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References

Alderton, T. and Winchester, N., (2002): "Flag states and safety: 1997–1999", *Journal of Maritime Policy and Management*, 29(2), 151–162.

Anon (1995): *Structure and Organisation of Maritime Transport*, July, 1995.

Asteris, M. (1993): "Flagging out UK shipping: causes and consequences", *Transport Management*, Sept/Oct: 19–21.

Baron, J.N. and Kreps, D.M. (1999): "Consistent human resource practices", *California Management Review*, 41(3), 29–53.

Beardwell, J. and Claydon, T. (2007): *Human Resource Management. A Contemporary Approach* (5th edn.) (Harlow, Pearson Education Ltd).

Bergantino, A. and Marlow, P. (1998): "Factors influencing choice of flag: empirical evidence", *Maritime Policy and Management*, 25(2), 157–174.

Bergstrand, S. (1983): *Buy the flag: developments in the open registry debate* (London, Polytechnic of Central London, Transport Study Group, p 4).

Bockzek, B.A. (1962): *Flags of Convenience – An International Legal Study* (Boston MA, Harvard University Press).

Commission of the European Communities (2004): "Community Guidelines on State Aid to Maritime Transport", COM (2004) 43 (Luxembourg, Office for Official Publications of the European Communities).

Committee of Inquiry into Shipping (1970): *The Rochdale Report*, Cmmd 4337 (London, HMSO).

Cooke, F., Shen, J. and McBride, A. (2005): "Outsourcing HR as a competitive strategy? A literature review and an assessment of implications", *Human Resource Management*, 44(4), 413–432.

Cox, T.H. and Blake, S. (1991): "Managing cultural diversity: implications for organizational competitiveness", *Academy of Management Executive*, 5(3), 45–56.

Delaney, J.T. and Huselid, M.A. (1996): "The impact of human resource management practices on perceptions of organizational performance", *Academy of Management Journal*, 39(4), 949–969.

Dorey, J. (1988): "How do the costs with each of the flagging options compare? Which register? Which Flag?", *Lloyd's Register of Shipping Conference* (London, LLP).

Fisher, C.D. (1989): "Current and recurrent challenges in HRM", *Journal of Management*, 15, 157–180.

Gardner, B.M., Goss R.O. and Marlow P.B. (1984): "Ship finance and fiscal policy", *Maritime Policy and Management*, Vol. 11, No. 3, 153–196.

Grinter, Mike (2007): "Awards ceremony celebrates growth of Hong Kong register: Economic secretary announces launch of maritime scholarship", *Lloyd's List*, 16 February.

Hammond, D. (2002): “Firms resist outsourcing”, *People Management*, 8(12) 13 June, 8.
Hofstede, G. (1980): *Culture’s Consequences: International Differences in Work-Related Values* (California, Sage Publications).
Hofstede, G. (1991): *Cultures and Organizations: Software of the Mind* (London, McGraw-Hill).
Huselid, M.A., Jackson, S.E. and Schuler, R.S. (1997): “Technical and strategic human resource management effectiveness as determinants of firm performance”, *Academy of Management Journal*, 40(1), 171–188.
Kennedy, J. and Everest, A. (1991): “Put diversity in context”, *Personnel Journal*, September: 50–54.
Kreitner, K. (2001): *Management* (8th edn) (Boston, Houghton Mifflin Co).
Lawler, E.E. III (2004): “HR on top”, *Strategy + Business*, 35 (Second quarterly), 21–25.
Li, K.X. and Wonham, J. (1999): “Who is safe and who is at risk: a study of 20-year-record on accident total loss on different flags”, *Journal of Maritime Policy and Management*, 26(2), 137–144.
Lorange, P. (2005): *Shipping Company Strategies. Global Management Under Turbulent Conditions* (Oxford, Elsevier).
Metaxas, B.N. (1985): *Flag of Convenience: A Study of Internationalisation* (Aldershot, Gower).
Metaxas, B.N. and Doganis, R. (1976): *The Impact of Flags of Convenience* (London, PCL).
Mitroussi, K. (2004): “The ship owners’ stance on third party ship management: an empirical study”, *Maritime Policy and Management*, 31(1), 31–45.
Mitroussi, K. and Chang, C. (2008): “An Appraisal of Motivation Principles in Shipping Companies”, *Proceeding of the International Forum on Shipping, Ports and Airports 2008*, 25–28 May 2008, Hong Kong, China. CD Rom.
Moraitis, I.G. (2003): “Taxation of shipping and of other conjoint activities”, *Bulletin of International Chamber of Commerce*, Vol. 9, 1183–1192 (in Greek).
Mullins, L.J. (1991): “Successful training – a planned and systematic approach”, *Administrator*, 4–5 July.
Paris MOU on Port State Control (2007): *Port State Control on course for safer shipping, Annual Report 2007.*
Peeters, C., Debisschop, K., Vandendriessche, P. and Wijnolst, N. (1994): *De Toekomst van de Nederlandse Zeervaartsector* (Delft, Delft University Press).
Pettit, S.J., Gardner, B.M., Marlow, P.B., Naim, M.M. and Nair, R. (2005): “Ex-seafarers shore-based employment: the current UK situation”, *Marine Policy*, Vol. 29, 521–531.
Pfeffer, J. (1995): “Producing sustainable competitive advantage through the effective management of people”, *Academy of Management Executive*, 9(1), 55–72.
Policy Research Corporation (1994): *The Future of the Dutch Shipping Sector: Economic Impact Study and Policy Analysis* (Delft, Delft University Press).
Porter, M.E. (1980): *Competitive Strategy* (New York, The Free Press).
Sletmo, G.K. (1989): “Shipping’s fourth wave: ship management and Vernon’s trade cycles”, *Maritime Policy and Management*, 16(4), 293–303.
Strandenes, S.P. (2002): “Economics of the markets for ships”, in Grammenos, C. Th. (ed.) *The Handbook of Maritime Economics and Business* (London, Lloyd’s of London Press).

Tolofari, S.R., Button, K.J. and Pitfield, D.E. (1986): “Shipping costs and the controversy over open registry”, *Journal of Industrial Economics*, Vol. 19, No. 4, June: 409–427.

Torrington, D., Hall, L. and Taylor, S. (2002): *Human Resource Management* (5th edn.) (Harlow, Pearson Education Ltd).

Torrington, D., Hall, L. and Taylor, S. (2008): *Human Resource Management* (7th edn.) (Harlow, Pearson Education Ltd).

United Nations (1986): *United Nations Convention on the Conditions for the Registration of Ships, 1986.*

United Nations Conference on Trade and Development (2008): *Review of Maritime Transport, 2008.*

Vernon, R. (1966): “International investment and international trade in the product cycle”, *Quarterly Journal of Economics*, 80(2), 190–207.

Wellins, R. and Rioux, S. (2000): “The growing pains of globalized HR”, *Training and Development*, May, 79–85.

Endnotes

1. Operating costs comprise all the costs and expenses incurred in the day-to-day operation of the vessel at sea and in port. These costs are associated with manning, maintaining, supplying and insuring a vessel.
2. Metaxas and Doganis (1976), Metaxas (1985), Tolofari, Button and Pitfield (1986), Dorey (1988), Asteris (1993), and Policy Research Corporation (1994) to cite only some.
3. The above category of costs consists of: basic pay, bonuses, leave overtime, pensions, social security, subsistence, uniforms, and so on.
4. The reference is especially to Law 89/1967 on the establishment of offices of ship management and other shipping related activities in Greece.

Chapter 21
Fleet Operations Optimisation and Fleet Deployment — An Update

Anastassios N. Perakis[*]

1. Introduction

Optimising the operation (i.e. minimising operating costs, if revenues are fixed) of a single merchant ship is not difficult to do and can be achieved by a few simple calculations, which can point out the minimum of the operating cost curve as a function of the speed, for example. Texts such as Stopford[1] can provide useful info on the above. Optimising an entire fleet of generally different ships, however, is definitely not as simple, and requires certain levels of computer, probability, optimisation and other mathematical skills, as we will see in the following.

Deployment of merchant shipping fleets covers a wide range of problems, concerned with fleet operations, scheduling, routing, and fleet design. Many use some kind of economic criterion such as profitability, income or costs on which to base decisions. (Benford,[2] Marbury,[3] Fischer and Rosenwein,[4] and Perakis [5]). Others use non-economic criteria such as utilisation or service; these are more common in fleet deployment models used in the liner trades.[6] Reviews of various fleet deployment models and problems are given in.Ronen,[7] Ronen,[8] and Perakis.[9]

An aspect of fleet deployment not covered extensively in the literature until the early 1980s was “slow-steaming” analysis and optimisation. “Slow steaming” is the practice of operating a ship or fleet of ships at a speed less than design or maximum (sustained) operating speed, in order to take advantage of improved fuel economy and reduced operating costs, but, most importantly, to reduce fleet overcapacity (if done by a large number of ship owner).

Managers of merchant ship fleets, especially bulk carriers and tankers, frequently find themselves with excess transport capacity, and hence must decide which ships to use (and at what speeds) and which to keep idle (or perhaps make available to another fleet by sale or charter). Moreover, if fuel prices become relatively high, excess transport capacity offers the potentially profitable strategy of slow steaming some or all of their ships. Such a strategy not only substantially reduces the operating costs of the fleet, but furthermore reduces the supply of tonne-miles of the existing total bulker fleet, thereby improving the depressed freight rates. On the other hand, a sharp drop in fuel prices could make it advisable to “fast-steam” ships built during the expensive fuel era, although this would be limited by their design speed and associated operating margin.

The remainder of this chapter is organised as follows: Section 1 discusses the correct solution of a simple fleet deployment problem, which has been earlier suboptimally solved in the literature. It is shown that its correct solution can save over 15% of the annual fleet operating costs, or $7.93 million per year, for the same 10-ship fleet of the previously published example. In Section 2, more realistic, single-origin, single-destination, and even multi-origin, multi-destination fleet deployment problems for (liquid or dry) bulk shipping are formulated and solved, using both nonlinear and a series of linear programmes. In Section 3, fleet deployment problems for Liner Shipping Fleets are solved, and

specific examples are given from the fleet of a major liner company. Section 4 provides a summary and conclusions, as well as recent developments in this area. An alphabetical list of references is given at the end of this chapter.

2. A Simple fleet Deployment Problem

The ships of a fleet could be assumed to belong to N different groups, each consisting of n(i) sister ships, i = 1, …, N, of equal cargo carrying capacity, speed and fuel consumption (or in general, operating costs). Design speed, cargo capacity and operating costs will in general be different among different ship groups. This is both an efficient and general model, since the case of no two ships in a fleet being identical is obviously covered by setting n(i) = 1, i = 1, …, N. The mission of a fleet is assumed, for our purposes, to be the movement of one commodity between two given ports.

A simple (but realistic) bulker fleet deployment problem was defined in Benford (see endnote 2).Some of the assumptions inherent in the solution approach, such as no-cost lay-up of unneeded vessels, a contract to move a given quantity of a given commodity between one origin and one destination port, availability of more than enough ships (tonnage) suited to the trade, etc., were not unrealistic. However, the method proposed for its solution did not give the optimal answer, primarily because of an artificial constraint that all vessels must be operated at a speed resulting in the same unit cost of operation per ton of cargo delivered, imposed for ease of solution, but not a natural constraint of the problem. Table 1 below presents the approach adopted in Benford (see endnote 2) and its results.

In Perokis (see endnote 5), the problem was correctly solved analytically, without the above equal unit cost constraint, using Lagrange multipliers. The results (see Table 2) showed an improvement of at least 15% over those of Table 1, thus verifying once more that ‘constraints impair performance.’ More realistic and complicated versions of the problem solved in that paper were subsequently formulated and solved.

Comparing Tables 1 and 2, we see an annual cost reduction of $7.93 million, or over 15%. This represents a considerable improvement. The difference in costs could be even greater if lay-up charges are levied against ships I and J in the solution presented in Table 1. On the other hand, this difference could possibly be reduced if ships I and J could be chartered or sold to a third party at a particular price.

Perhaps it is now appropriate to clarify that in the above problem, the annual demanded transport capacity is assumed to be a given output (constant). This is the case for vessels operating under relatively long-term charters, which normally specify, among other

Table 1

Ship group	Annual transport capacity (÷ 10^6 tonnes)	Operating cost per tonne	Annual operating cost (÷ 10^6)
1. A, B, C	4.902	$4.562	$22.36
2. D, E	2.884	$4.546	$13.11
3. F, G, H	3.726	$4.562	$17.00
4. I, J	–	–	–
Total	11.500		$52.47

Table 2

Ship	Annual transport capacity ($\div 10^6$ tonnes)	Operating cost per tonne	Annual operating cost ($\div 10^6$)
1. A, B, C	4.158	$3.531	$14.684
2. D, E	2.450	$3.692	$ 9.046
3. F, G, H	3.241	$4.023	$13.038
4. I, J	1.651	$4.707	$ 7.771
Total	11.500		$44.539

things, the freight rate and the amount of cargo to be carried annually. In a normal market environment, long-term charters are the overwhelming majority of fixtures, whereas vessels operating in the spot market constitute less than 10% of the available capacity.

The conclusion from the above is that, in contrast to past practices where significant effort has been directed toward the optimisation of the design and operation of individual ships, an owner of a fleet of ships (usually non-uniform in terms of age, size and operating speed) should operate each ship in a manner generally quite different from that dictated by single-ship optimisation. Adoption of the results of this and subsequent research should result in significant cost savings in the operations of several shipping companies.

3. More Realistic Bulk Shipping Fleet Deployment Models

Perakis and Papadakis,[10,11] and Papadakis and Perakis,[12] presented far more realistic and complicated fleet deployment problems and their "optimal" solutions. The problem of single-origin, single-destination fleet deployment was first studied. A computer programme was developed to solve the problem and to help the fleet operator to make slow steaming policy decisions. A detailed discussion of the problem solution and a sensitivity analysis are presented in Perakis and Papadakis (see endnote 10). Sensitivity analysis provides the user with an understanding of the influence on the total fleet operating cost of its various components. For small to moderate changes of one or more cost components, the user can get an extremely accurate estimate of his new total operating cost without having to re-run the computer programme. Some interesting conclusions were made on the basis of the sensitivity results.

The fleet deployment problem with time-varying cost components was also formulated and solved. A computer programme was developed to implement the solution of this problem (Perakis, Papadakis and Pogoulates).[13] The relevant algorithms are briefly described there as well. The problem of fleet deployment when the cost coefficients are random variables with known probability density functions was formulated in detail (see endnote 11), where analytical expressions for the basic probabilistic quantities were presented. A shorter description of the above is included in this presentation.

3.1 Objective function and constraints

A fleet, consisting of a given number of ships, is available to move a fixed amount of cargo between two ports, over a given period of time, for a fixed price. Each vessel in the fleet is assumed to have known operating cost characteristics. The problem objective is to determine each vessel's full load and ballast speeds such that the total fleet operating cost is minimised *and* all contracted cargo is transported.

A first constraint imposes upper and lower bounds on the vessel full load and ballast speeds. These speed constraints are necessary to ensure a feasible solution to the problem; which is, that each speed

is less than or equal to its maximum and greater than or equal to its minimum operating limits. In practice, the minimum speed is non-zero and is determined by the lower end of the normal operating region of the vessel's main engine. The minimum speed should also be adequate for purposes of ship safety in maneuverability and control. The equality constraint must be satisfied to insure all contracted cargo is transported.

This formulation is based on the following assumptions, some of which use state-of-the-art empirical formulae taken from published articles, cited in the list of refs of the detailed papers and reports of ours (see endnote 10)[14]:

1. A vessel carries a full load of cargo from load port to unload port.
2. When the vessel is operating in restricted waters, it has a known and constant restricted speed which is usually the maximum allowable speed in the region in question, hence requiring a known, fixed power and fuel rate.
3. The number of days a vessel spends in port per round trip is known and constant.
4. The charges incurred at the load port and unload port per round trip are known and constant.
5. The amount of fuel burned per day in the load port and unload port is known and constant.
6. The annual costs of manning, stores, supplies, equipment, capital, administration, maintenance and repair, and make ready for sail are known and constant.
7. The power of vessel i (in HP) may be expressed by:
   $P_i = a_i \cdot X_i^{b_i}$ for the full load and by:
   $P_{bi} = a_{bi} \cdot Y_i^{b_{bi}}$
   for the ballast condition, where X_i and Y_i are the full load and ballast speeds of ship i respectively and the rest are appropriate constants.
8. The all-purpose fuel rate for a fully loaded vessel i may be expressed by:
   $(R_f)_i = g_i \cdot p_i^2 + s_i \cdot p_i + d_i$ for the full load and by
   $(R_f)_{bi} = g_{bi} \cdot p_{bi}^2 + s_{bi} \cdot p_{bi} + d_{bi}$
   for the ballast condition where p_i and p_{bi} are the normalised (percent) p_i and p_{bi} respectively, and the rest are appropriate constants.
9. The *total* annual cost of laying up vessel i is known for all i = 1, …, z.
10. The number of days per year vessel i is out of service for maintenance and repair is known and constant.
11. This problem formulation and solution is for a single stage, "one-shot" decision.

In the literature, the number of tonnes carried per year is assumed to be a linear function of a ship's full load and ballast speeds. In our research, we have shown that this assumption can be quite unrealistic. This function is quite nonlinear in nature. A derivation of this function may be found in Perakis and Papadakis (see endnote 10).

Operating costs, developed in detail in Perakis and Papadakis (see endnote 14)[15], are considered to fit into one of two categories, those that do not vary with ship speed, or *daily running costs*, and those that vary with ship speed, or *voyage costs*. Typical plots for the total (*not* per tonne) operating costs per year for a particular ship, for various ballast speeds, are given in Perakis and Papadakis (see endnote 10).

A typical plot of $F(X_i, Y_i)$ is also shown in Perakis and Papadakis (see endnote 10), as a function of the full load and ballast speeds. It is seen that F is a smooth convex curve or surface with a single

minimum. There is also a finite speed range in which F is not very different from its minimum value, a property which allows approximate solutions to the problem using very different speeds for individual ships to produce total fleet costs very close to one another and to the optimum cost itself. For X_i and/or Y_i going towards either 0 or 8, F approaches infinity. Figures 1 and 2 are for the same ship and for constant route data.

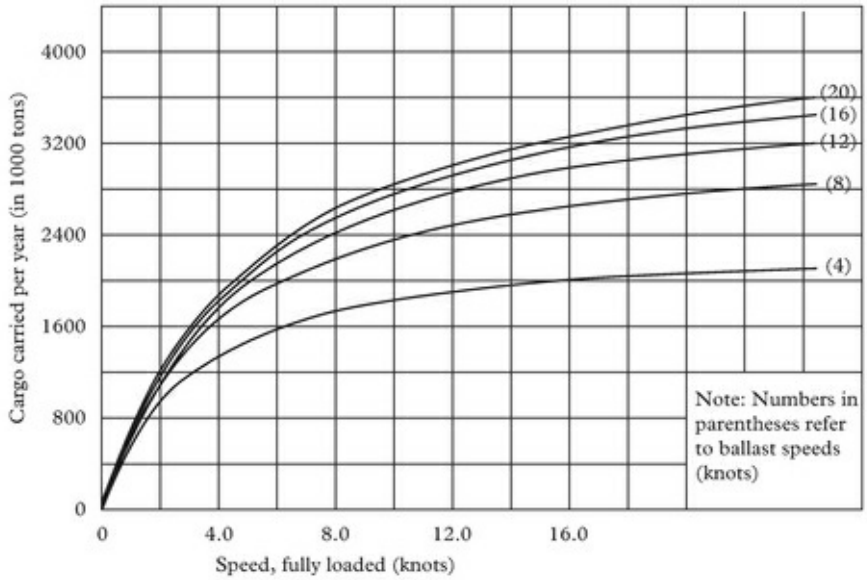

Figure 1: Typical plot of cargo carried per year as a function of ship speeds

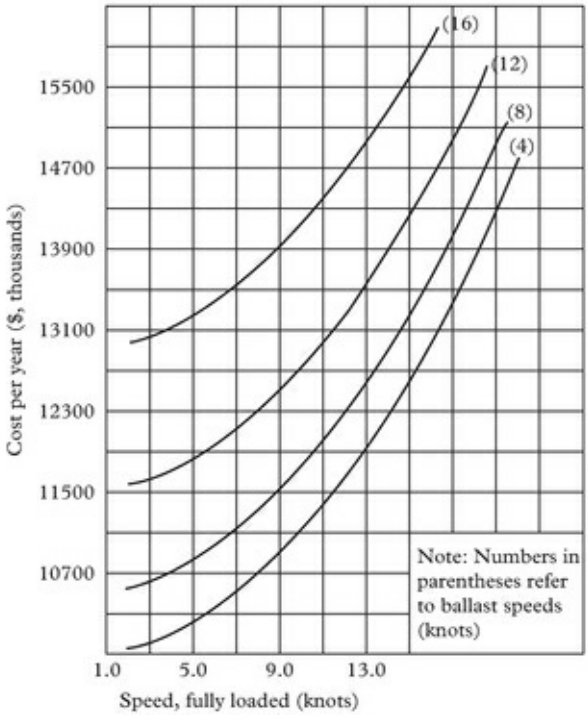

Figure 2: Typical plot for the total operating cost per year as a function of ship full load and ballast speeds

Introducing the linear inequality constraints on the speeds complicates the problem solution considerably. In the first part of this research, an External Penalty Technique (EPT) has been combined with the Nelder and Mead Simplex Search Technique to solve our optimisation problem. The purpose of a penalty function method is to transform a constrained problem into an unconstrained problem which can be solved using the coupled unconstrained technique.

A computer programme has been written to solve this problem using the techniques and the formulation mentioned above. The solution returned consists of the ship speeds, for those vessels

specified for analysis, that will minimise the total mission operating costs and fulfil the cargo transport obligation.

For the lay-up option, it is shown in the technical report that for even moderate numbers of ships in a fleet, it is rather too time-consuming to use an exhaustive enumeration scheme. Instead, a dynamic programming-like sequential optimisation approach is developed, significantly reducing the computational burden. If Z is the number of ships in the fleet, the maximum number of fleets we will have to examine using this approach is $M_{max} = Z(Z + 1)/2 - 1$. The *actual* number of fleets which we will have to consider will be significantly smaller than M_{max}, due to the elimination of several fleets as infeasible and much smaller than the upper limit of total possible cases. The above scheme has been implemented and referred to in the following as the operating cost without re-running the programme. This property holds for a given fleet and not in cases when one or more ships are laid-up or chartered to a third party (on top of the changes in the cost components).

The fleet deployment problem with time-varying cost components was also studied. A time horizon in this formulation is any interval within which cost components are constant but at least one of them is different than its value in another interval. In other words, our cost components are given 'staircase' functions of time. In the case of rapidly changing costs, resulting in rather short intervals where these costs are constant, the problem of non-integer number of round trips per interval could be crucial. A heuristic approach was developed to find the nearest integer solution corresponding to the non-'integer' solution generally provided by the SIMPLEX algorithm.

Further details may be found in Perakis and Papadakis (see endnotes 10, 11, 15), and the associated user's documentation, Perakis, Papadakis and Pogoulatos (see endnote 13), where a more extensive multi-page flow-chart is presented.

The fleet deployment problem for the case when some of the cost components are random variables with known probability density functions was finally considered (Perakis and Papadakis (see endnote 11)). We note that the minimum of the possible mean values of the total annual operating costs, C_{min} and the variance of C_{min} can be found relatively "easily". However, this approach has not yet been implemented on a computer and probably will not prove very useful: The inputs to the problem (i.e. the user-supplied probability density functions) can have any particular theoretical or experimental form, thus discouraging the development of any general computer code for this problem.

3.2 The multi-origin, multi-destination fleet deployment problem

The problem of minimum-cost operation of a fleet of ships which has to carry a specific amount of cargo from several origin ports to several destination ports during a specified time interval was next examined. During the season any vessel can be loaded in any source port (S) and unloaded at any destination port (D) provided that these ports belong to a subset I or J (respectively) of the total set of ports, such that draft and other constraints for the corresponding vessel are satisfied. Under this assumption for each vessel the number of possible routes (number of possible sequences of S–D ports) is quite large. The full load and ballast characteristics of each ship on each route are assumed to be known.

This nonlinear optimisation problem consists of a nonlinear objective function and a set of five linear and two integer constraints. The objective function to be minimised is the total fleet operating cost during the time interval (shipping season) in question. The following constraints have to be

satisfied:

a. for each vessel, the total time spent in loading, travelling from origins to destinations, unloading and travelling from destinations to origins plus the lay-up time has to be equal to the total amount of time available for each ship in the shipping season,
b. the total amount shipped to a particular destination j must be equal to the amount of cargo to be delivered to j during the shipping season (in tonnes),
c. the total amount of cargo loaded from a particular source i must be less or equal to the cargo available at i,
d. for each ship, the number of trips to destination j must be equal to the number of trips out of j,
e. same as (d) for all source ports;
f. the full-load and ballast operating speeds have to be between given upper and lower limits,
g. the numbers of full load and ballast trips for each vessel, origin and destination combination must all be non-negative integers.

The constraints presented above are linear except constraints (a) and (g). The maximum number of unknown variables (if all source and destinations ports are accessible by any ship of the given fleet) is $(4 \cdot I \cdot J+1) \cdot Z$. The number of the associated constraints is $2Z+(1+J)(Z+1)+4 \cdot I \cdot J \cdot Z$. For a case with I=4, J=6 and Z=10 we have 970 variables and 1,090 constraints. Using today's personal computers, it is clear that we cannot use any classical nonlinear optimisation technique, since the expected computation time would be too long.

In the case of the multi-origin, multi-destination fleet deployment problem, it was seen that the linear programming approaches to the literature do not take into account significant nonlinearities of the relevant cost functions and may lead to very suboptimal decisions. The iterative procedure we developed uses a linear programming software in an algorithmic scheme that takes into account these nonlinearities and produces accurate results. This approach is ideally suited for a personal computer due to the reasonable running times of the LP software for almost any practical situation. A second, nonlinear approach to solve the multi-origin, multi-destination problem was also implemented, using the available MINOS nonlinear optimisation package.

In [endnote 12], the fleet deployment problem for a fleet of vessels operating between a set of *several loading and unloading ports* under certain time and cargo constraints was examined. Full load and ballast voyage costs were treated as nonlinear functions of the ship full load and ballast speeds, respectively. An optimisation model, appropriate for bulk carrier fleets, minimising the total operating cost, was formulated. The existence of a coupling between the optimal speed selection and the optimal vessel allocation on the available routes was demonstrated, and conditions leading to the decoupling of these problems were established. Considerations referring to the structure of the optimal solution resulted in a substantial reduction of the dimensionality of the problem. We found that in cases of low-to-moderate fleet utilisation, linear programming may be applied to derive the optimal solution, while in cases of higher fleet utilisation, use of nonlinear optimization may become necessary. The potential benefits of our approach were demonstrated by several examples.

Finally, we would like to note that the algorithms and the computer codes, developed for both the one-origin one-destination and for the multi-origin, multi-destination fleet deployment problem can be easily used to find not only the optimal fleet deployment policy within the given time horizon, but

also to help the fleet operator to make decisions in case unexpected events like strikes or accidents occur. In such a case the programs can be re-run for the remaining time interval and an optimal decision can still be obtained. Other plans, such as renewing or improving a part of the fleet and selling or chartering decisions may also be evaluated.

4. Fleet Deployment Models for Liner Shipping

In Perakis and Jaramillo,[16] we have reviewed the relevant work on liner shipping deployment and described current industry practices. Our objectives and assumptions were then presented. A model for the optimisation of the deployment of a liner fleet composed of both owned and chartered vessels was formulated. The determination of the operating costs of the ships in every one of the routes in which the company operates was carried out by a means of a realistic model, providing the coefficients representing voyage cost and time required for the input of the linear program presented in Jaramillo and Perakis.[17] A method for determining the best speeds and service frequencies was also presented; the fixing of those two groups of variables was required to linearize the deployment problem as formulated there. The overall optimisation method was described in detail, and a real-life case study was presented, based on the co-author's company (FMG, Flota Mercante Grancolombiana) operations, (Jaramillo and Perakis (see endnote 17)).

In Powell and Perakis,[18] we extended and improved on the above. An Integer Programming (IP) model was developed to minimise the operating and lay-up costs for a fleet of liner ships operating on various routes. The IP model determines the optimal deployment of the existing fleet, given route, service, charter, and compatibility constraints. Two case studies were carried out, with the same as above extensive actual data provided by FMG. The optimal deployment was determined for their existing ship and service frequency requirements.

The inputs to the optimisation model (presented in Powell and Perakis (see endnote 18) are based on the existing cost estimation model provided in Perakis and Jaramillo (see endnote 16), including ship daily running costs, voyage costs, costs at sea, costs at port, daily lay-up costs.

The optimisation model in Perakis and Jaramillo (see endnote 16) is given as:

$$\text{Minimise} \left(\sum_{k=1}^{K} \sum_{r=1}^{R} C_{Kr} X_{Kr} + \sum_{k=1}^{K} e_k Y_k \right)$$

where:

C_{kr} = operating cost per voyage for a type k ship on route r

X_{kr} = number of voyages per year of a type k ship on route r

e_k = lay-up cost for a type k ship

Y_k = number of lay-up days per year for a type k ship

In Perakis and Jaramillo (see endnote 16) and Jaramillo and Perakis (see endnote 17), a Linear Programming (LP) approach was used to solve this optimisation problem. Using an LP formulation required the rounding of the number of ships allocated to each route. The rounding led to some variations in targeted service frequencies and to sub-optimal results. An Integer Programming formulation is used in Powell and Perakis (see endnote 18), to eliminate any rounding errors in the previous LP solution.

4.1 Integer programming problem formulation

4.1.1 Decision variables

N_{kr} = the number of a type k ship operating on route r

Y_k = the number of lay-up days per year of a type k ship

for k = 1 to K and r = 1 to R; K is the number of ship types and R is the number of routes.

4.1.2 Objective function

The objective function in the model minimises the sum of the operating costs and the lay-up costs. The objective function in terms of the decision variables is:

$$\text{Minimise} \left(\sum_{k=1}^{K} \sum_{r=1}^{R} C'_{Kr} N_{Kr} + \sum_{k=1}^{K} Y_k e_k \right)$$

where:

$C'_{kr} = C_{kr} X_{kr}$, are the operating costs of a type k ship operating on route r

e_k = daily lay-up cost for a type k ship

4.1.3 Constraints

Ship availability. The maximum number of ships of type k operating cannot be greater than the maximum number of ships of type k available. Therefore:

$$\sum_{r=1}^{R} N_{kr} \leq N_k^{max} \text{, for each type k ship}$$

where:

N_k^{max} = maximum number of type k ships available

Service frequency. Service frequency is the driving force in liner shipping. With all rates being set by conferences, the main product differentiation is on service. To ensure that minimum service frequencies are met, the following constraint is included:

$$\sum_{r=1}^{R} t'_{kr} N_{kr} \geq M_r^{max} \text{ for all r,}$$

where:

t'_{kr} = yearly voyages of a type k ship on route r and:

$t'_{kr} = t_{kr}/T_k$

T_k = shipping season for a type k ship

M_r = number of voyages required per year in route r

By finding the highest load level for any given leg of route r and comparing this with given ship capacity, we find the minimum required number of voyages per year for a specific route.

Ship/route incompatibility. Some ships may be unable to operate on a given route due to cargo constraints, government regulations, and/or environmental constraints. It is necessary to eliminate these ships from the model. Therefore:

$$N_{kr} = 0, \text{ for given (k,r) pairs}$$

Lay-up Time. The lay-up time in our models is equal to the time a ship is not operating during the year. This includes dry-docking and repair time:

$$Y_k = 365 N_k^{max} - T_k \sum_{r=1}^{R} N_{kr}$$

Non-negativity. The decision variables N_{kr} must be non-negative.

4.1.4 Software application

The software package used to run the above example was "A Mathematical Programming Language" (AMPL) (Holmes,[19] and Fourer, Gay and Kerninham.[20]) and OSL, a mathematical programme solver. See Powell and Perakis (see endnote 18) for more details. The output file from AMPL gives the following information:

i. optimal value of objective function;
ii. value of objective function with LP relaxation;
iii. number of iterations to find solution; and
iv. values of variables at the optimal solution.

The values of the N_{kr} variables will show how many type k ships should be allocated to each route r. The Y_k variable will indicate the number of days for which type k ships must be laid-up.

4.1.5 Optimisation examples

The following two examples are for the fleet deployment for FMG. The fleet consists of six types of owned ships and five types of chartered ships (one long-term charter and four short-term charters). The data used to calculate the coefficients for the optimisation model is taken from Jaramillo and Perakis (see endnote 17). The cost and time coefficients used are transformed from per voyage units to per ship values.

Example 1: The first example optimises the FMG fleet deployment for their current shipping conditions. This example uses FMG's existing service frequencies and the number of ships available of each type. The current allocation is shown in Table 3.

Table 3: Current ship allocation

		Route							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**Total**
	1	3			3				6
	2						2		2
(Owned)	**3**				2		1		3
	4							1	1
	5		1						1
	6			1					1
Ship Type									
	7						1		1
	8		1	1					2
(Chartered)	**9**								0
	10								0
	11					2			2
	Total	3	2	2	5	2	4	1	19

Example 1 results: The IP optimal allocation is given in Table 4. The minimum objective function yields a total operating cost of $91,831,000. This is compared with $93,148,000 for the current allocation. This corresponds to a reduction in total operating costs of 1.4% (a savings of $1,317,000 per year). Analysing the resulting allocation shows that all owned ships (k = 1 to 6) and the long-term charter (k = 7) are in use for the entire shipping season. This is due to the high lay-up costs associated with these ship types.

None of ship type 9 are allocated. This ship type has the highest operating cost of any of the short-

term charters.

Example 2: Example 2 uses the frequency constraints of the LP model presented in Jaramillo and Perakis (see endnote 17). The resultant allocation of the LP model is contained in Table 5.This example compares the results and highlights the advantages of the IP model versus the results of the LP model.

Example 2 results: The IP optimal allocation of ships is given in Table 6. The minimum objective function gives a total operating cost of $99,400,000

The resulting allocation of the IP optimisation model maintains all of the target frequencies. Routes 1, 3, and 5 exactly meet the target frequencies while on routes 2, 4, 6, and 7 the frequency is improved. The improvement ranges from 1.3 days to 3.3 days.

For the LP comparison example presented, the optimal objective function of the IP model is $99,400,000. Although the cost produced by the LP model is substantially

Table 4: Resultant ship allocation (Example 1)

		Route							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**Total**
	1	3			3				6
	2			1				1	2
(Owned)	3				1		2		3
	4		1						1
	5		1						1
	6						1		1
Ship Type									
	7			1			1		2
	8								0
(Chartered)	9								0
	10					2			2
	11				1				1
	Total	3	2	2	5	2	4	1	19

Table 5: Linear programming allocation

		Route							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**Total**
	1	1			5				6
	2			1				1	2
(Owned)	**3**						3		3
	4		1						1
	5		1						1
	6						1		1
Ship Type									
	7			1					1
	8								0
(Chartered)	**9**								0
	10					2			2
	11	2							2
	Total	3	2	2	5	2	4	1	19

Table 6: Integer programming allocation (Example 2)

		Route							
		1	2	3	4	5	6	7	Total
	1	1			1		4		6
	2				1			1	2
(Owned)	3				3				3
	4		1						1
	5		1						1
	6	1							1
Ship Type									
	7	1			1				2
	8		1						1
(Chartered)	9								0
	10					2			2
	11			2					2
	Total	3	3	2	6	2	4	1	21

Table 7: Comparison of frequencies

	Route						
	1	2	3	4	5	6	7
Target Frequency	14	14	21	15	30	23	35
IP Model	14	10.7	21	12.9	29.2	20.4	33.7
Difference	0.0	–3.3	0.0	–2.1	0.0	–2.6	–1.3
LP Model	14.7	16.1	18.9	16.1	29.2	19.2	33.7
Difference	0.7	2.1	–2.1	1.1	–0.8	–3.8	–1.3

smaller, it is important to note that the service frequencies are compromised in the 1991 LP solution, which leads to sub-optimal allocation. Table 7 shows the comparison between service frequencies of the IP optimisation model and the LP model.

Since service is a priority in liner shipping, it is necessary to meet the target frequencies. The IP optimisation model ensures that all target frequencies are met. The LP model violates the target frequency for routes 1, 2 and 4. This is an average increase in service time of 1.3 days or 9.1%.

Using Integer Programming to solve integer problems always produces the optimal solution for the given constraints. No manipulation of results is necessary. Using Linear Programming to solve IPs requires manipulation of the results to make the decision variables integer numbers. This leads to sub-optimal solutions and constraints being violated.

Substantial savings may be achieved by applying our IP optimisation model for the fleet deployment of a liner shipping company. The first example in Powell and Perakis (see endnote 18) compares our IP model against the existing fleet deployment of a liner shipping company.

This example shows a reduction in operating costs of 1.5%. The second example compares our IP model with the LP model contained in Perakis and Jaramillo (see endnote 16). The results of the IP model are optimal and meet all service frequency constraints. The LP model violates the service constraints in three routes by an average of 9.1%.

The solution indicates that all owned and long-term charter ship types should be operated for their entire shipping season, due to the high lay-up cost associated with these ship types. Short-term charters should only be used if the owned ships and long-term charters cannot meet the cargo and service frequency constraints.

5. Fleet Deployment and Operations Optimisation: An Update

Recent years have been quite turbulent for the ocean shipping industry, especially considering prices and freight rates. The huge swings in the price of oil in the space of only a few months, from the all-time high of $147 per barrel in summer 2008 to its collapse a few months later, with the help of the world economic crisis, and the possibility of higher fuel prices in the future, when the world economy recovers, and especially when China and other high-growth emerging economies expand their demand for raw materials, and especially fuel, has made the original fleet deployment idea, (i.e. the determination of the optimal speeds of each individual ship in a fleet for a specific mission) reappear back on centre stage. Interestingly, none of the recent fleet optimisation references are in this classic "fleet deployment" form. Regardless, it may be worthwhile to look at some of them and their main results:

Christiansen and Fagerholt,[33] investigate the robustness of ship schedules using time windows. A main objective is to minimise the idle time of ships in port. It has to be ensured that ships arrive at times which are well before port closure, if any (e.g. Friday night). Such arrivals are considered to be "risky" and will be considered using penalties. Depending on the size of the penalty cost, the optimal solution will prefer arrival times at less risky (and hence more robust) times.

Agrawal and Ergun[34] combine the problems of ship scheduling and containerised cargo routing to identify the most profitable routes. The paper develops a model that maximises profit from satisfying a set of demand patterns between sets of origin and destination ports on given days of the week. An important consideration of this model is the capturing of the weekly frequency requirement for liner services. A mixed-integer program is formulated and three solution approaches are provided: a Greedy heuristic algorithm, column generation and Benders decomposition. The solutions are confirmed with application on a set of real data as observed by OOCL and APL in 2005.

Andersen e*t al.*[35] present an optimisation model for the tactical design of scheduled service transportation system networks (in general) and focus on the importance of neighbouring systems in a multimodal transportation system. The main challenge that the paper addresses is how two different transportation modes can be coordinated to minimize fleet costs and throughput time. The resulting model minimises cost and waiting time at nodes subject to cover, count, vehicle balance and node balance constraints such that the demands at the final destination nodes are satisfied. Finally, real data are applied to verify the model.

Christiansen *et al.*[36] give a summary of the developments in ship routing and scheduling within the decade (approximately) before its publication. The reviewed papers are divided in categories: Strategic ship planning (optimal fleets, maritime supply, chain); Tactical/operational ship scheduling (optimal assignment of cargoes to ships and ships to schedules); Liner network design and fleet deployment and a group including all other references such as Navy applications.

In Bronmo *et al.*[37] a ship scheduling model is initially formulated, which requires an input of available combinations of ships and routes–these are then considered through binary variables in an integer LP. A number of initial solutions are generated by a constructive heuristic and then improved by a local search. Finally a computational study is demonstrated to verify the solution methodology.

Fagerholt presents TurboRouter, a decision support system for ship fleet scheduling which is based on interaction with the user rather than analytical methods for optimisation.[38]

Gunnarson *et al.*[39] aim to generate a simultaneous model for terminal location and the ship routing

problem, in intermodal transportation. Using the case of a pulp supplier, they formulate a mixed integer linear programming model minimising total distribution cost, subject to a significant number of network flow constraints, production capabilities and demand from various customers. They also attempt to provide a solution methodology, as their set of columns is very large. A heuristic method, similar to column generation, is used. Fremont, gives a practical (without any operations research applications) approach to the advantages and disadvantages of the hub-and-spoke network contrasted to the direct port-to-port network. The paper uses extensively the example of Maersk's geographical coverage through the hub-and-spoke network.[41]

Bronmo *et al.*,[42] present a Danzig-Wolfe procedure for ship scheduling with flexible cargo sizes. This is a problem similar to the pickup and delivery problem with time windows, but the cargo sizes are defined by intervals instead of by fixed values. The authors found it computationally hard to find exact solutions to the subproblems, hence their method cannot guarantee finding the optimum over all solutions. To be able to show how good the solutions are, the authors generated bounds on differences between the true optimal objectives and the objectives in their solutions.

6. Summary and Conclusions

The optimisation of the operations of a fleet of ships is mathematically far more complicated than the optimisation of the operations of a single ship. However, trying to optimise the various full load and ballast speeds of each different ship in the fleet can be even more complicated than that, and necessitate the use of nonlinear programming algorithms and software, as opposed to the largely linear-integer algorithms in cases when the speeds are fixed and not optimised (slow-steaming).

Due to the very different degree of competition in the bulker and liner markets, and also due to the very dissimilar constraints on their respective operations, optimal fleet deployment is quite different for each one. Over the past several years, we have provided "exact" and "approximate" algorithms for realistic, single or multi-origin and destination problems for bulker fleet deployment, including optimal slow-steaming lay-up decisions, under conditions of certainty or uncertainty for the various cost components. We then also solved problems in optimal strategic planning and ship-route allocation for a major liner company, presenting independent models for fixing both the service frequencies in the different routes and the speeds of the ships, using at first linear and integer programming. Several insights from a review and comparative study of the above were presented here, starting from the proper problem definition (constraints artificially imposed have resulted in 15% higher costs in early literature on this problem) and ending with the benefits of optimal integer solutions to the liner fleet deployment problems we studied.

Length limitations prohibit us from discussing our extensive work in other areas of fleet optimisation, such as the operational, day-to-day decisions for a major oil company fleet, which we modelled and solved in Bremer and Peraklis (see endnote 21) and Perakis and Bremer (see endnote 22), or go into more details on the research modelling and results we did discuss in this paper. Our work with Bremer was an example of an operational (as opposed to long-term or strategic) optimisation.

We will also not discuss the mathematical details of some recent work of ours (Cho and Perakis (see endnote 23)) where we were able to re-formulate a complicated bulk cargo ship scheduling problem formulation Ronen (see endnote 24), from a nonlinear-integer to an equally accurate integer-

linear problem, with far fewer variables, using a generalisation of the "capacitated facility location problem", a classic result of optimisation theory. That problem was referring to a single loading port, several unloading ports, and fixed speeds (no slow-steaming allowed).

A major shortcoming of the classic ship scheduling problem, addressing uncertainty, received more attention after 2002. Shipping networks are prone to a very volatile behaviour. Uncertainty can be considered into two categories: internal and external in regards to the marine transportation network. Internal uncertainty refers to schedule deviation that can occur due to ship operation (within the transportation network), (i.e. bad weather conditions, mechanical faults, speed variation, etc). External uncertainty refers to schedule deviation which occur due to network-related issues, such as the effect of market volatility and inventory variation through supply and demand at origin and destination ports.

In an attempt to attack internal uncertainty, Christiansen and Fagenholt (see endnote 33), introduced the concept of time windows, a technique which has been used in the airline industry. The concept of a time window in general is that departures and arrivals are not considered as a single point in time, but as a time window. In the airline industry this provided with an advantage of allocating flights more efficiently within the network. In maritime operations, time windows account for deviation in arrival times and hence slight delays or early arrivals should not affect the network. In this way robustness is introduced in the model. Time windows also simplify the model as they reduce the number of available time slots. However, a challenge with this technique is to define the "size" of a time window. Too small time windows may not reflect the ship's actual ability to follow the schedule, and the advantage of a time window will be cancelled out. Too large time windows might generate a more realistic but inefficient model as the ship will always be on time, but the terminal's capacity will be inefficiently used.

To address the internal uncertainties, Christiansen and Fagenholt (see endnote 33) use time windows to attack the issue of risky arrivals. In cases where ports have restricted operating hours (e.g. no operation overnight or during weekends), available operating hours can be modelled as time windows. Furthermore, the concept of risky arrivals is introduced, which imply arrivals that are close to weekends and could cause the ship to stay idle for several days. On the basis of how risky an arrival is, each time window is associated with a penalty. Risky arrivals in the network will probably not be eliminated, but will be penalised and therefore reduced. However, it has to be noted that this methodology does not address uncertainty to a sufficient extent. It does not directly tackle the issue of delay propagation in a ship's schedule, but instead it tries to ensure that delays will not be extended due to the port's operating timetable.

External uncertainties have received considerably more attention than internal throughout the literature since 2002, due to the fact that they are usually better defined. An important uncertainty is in the supply and demand on origin and destination ports respectively. It is often the case that the vessel has arrived at its loading port, but has to wait for the cargo to pile up. Christiansen addressed this problem by considering a combination of the ship scheduling problem and the inventory management problem. The objective of the model is to identify the sequence of port calls for each ship with minimum cost while ensuring that inventories at ports are never full or empty (so that ships can always proceed). This is achieved by introducing "alarm levels" on the inventories, defined as *soft inventory constraints*. These include an upper and a lower bound which are tighter than the actual

limits of the inventory. In the case where a ship's arrival would cause the inventory to shift beyond its alarm level, a penalty cost will be introduced. In this way a schedule including such a port call will be avoided. The benefits of this model not only involve the ships, but also the ports as well, since it ensures that they always have sufficient inventories. From a ship scheduling point of view the results from this paper have a considerable effect on robustness by reducing the possibility of port-related delays, which nowadays is the most common source of delays.

Hwang *et al.*(see endnote 40) deal with external uncertainty. Market fluctuations are the most important source of uncertainty in the maritime industry. Unlike other scheduling models, Hwang considered profit variability in the objective function of the problem, by analysing the profit from assigning a cargo to a schedule. The paper assumes that charter rates are linearly related to a single spot rate and therefore a single market random variable can be used to account for freight rate volatility. However, this is not entirely correct, as rates in different shipping sectors may not have such a strong correlation. Furthermore, unlike other models, the shipper had the option of chartering ships in and out of his fleet through time or voyage charters. Assuming that an operator aims for more sustainable profits, the model developed reduces profit variability at the smallest possible cost. The paper makes an important contribution, as there is very little research considering market volatility, which is a driving factor in shipping

For a detailed exposition of liner shipping economics, the textbook by Janson and the late D. S. Schneerson (see endnote 25), is highly recommended. In the recent liner logistics research, Rana and Vickson (see endnotes 26, 27) presented nonlinear programming models, aiming to maximise total profit by finding an optimal sequence of ports of call for each ship. For solution methods, they used Lagrangean relaxation[27] and decomposition methods. Their first paper develops only a one-ship model, while their second is rather complicated by its non-linearities in both objective function and constraints. The model of Perakis and Jaramillo (see endnote 16) and its subsequent more accurate integer solution Powell and Perakis (see endnote 18) is easier to use for a realistic situation, but does not take into account the cargo demand forecasts that arise between pairs of ports in the model.

We have addressed that in Cho and Perakis (see endnote 28), where we have suggested two optimisation models. The first is a linear programming model of profit maximisation, providing an optimal routeing mix for each ship available and optimal service frequencies for each candidate route. The second is a mixed integer programming model with binary variables, providing not only optimal routeing mixes and service frequencies, but also best capital investment alternatives to expand fleet capacity, and is a cost minimisation model. In both models, we have suggested and used the concept of "flow-route incidence matrix", and discuss its usefulness for similar route-ing and scheduling problems (see endnote 28). The most important merit of using the flow-route incidence matrix is that it links various cargo demands to route utilisation in a simple, systematic way. These models can help improve existing network of routes or service frequencies, and their solution can be easily implemented with standard linear or integer programming packages.

Other examples of complicated operational models we have studied in detail are Ship Weather Routing problems, but since we are restricting this chapter to fleet, not individual ship, optimisation, we will not discuss them here. The models described in this chapter are all strategic. However, at the request of the reviewer of this book chapter, we cite a few key recent references in that area (see

endnotes 29–31).

The results of our research in Fleet Deployment have been cited in graduate courses at Michigan, MIT, and elsewhere in the US, but also in universities around the world, such as in the recent textbook used at the Maritime Studies Dept. in Dalian, China (see endnote 32). Further dissemination of these results in this chapter will hopefully result in more students and practitioners being exposed to the significant benefits of proper optimisation and the pitfalls, and their heavy price in higher fleet operating costs, of suboptimal policies.

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Endnotes

1. Stopford, Martin, (2009): *Maritime Economics* (3rd edition) (London, Routeledge).
2. Benford, H. (1981): "A simple approach to fleet deployment", *Maritime Policy and Management*, 8(4), 223–228.
3. Marbury, F. (1982): "The Finer Points of Slow Steaming", *SNAME Ship Cost and Energy Symposium***.**
4. Fischer, M.L. and Rosenwein, M.B. (1985): *An Interactive Optimization System for Bulk Cargo Ship Scheduling*, Dept. of Decision Sciences, Univ. of Pennsylvania, Philadelphia.
5. Perakis, A.N. (1985): "A second look at fleet deployment", *Maritime Policy and Management*, 12(2)**,** 209–214.
6. Appelgren, L.H.. (1971): "Integer programming methods for a vessel scheduling problem", *Transp. Science*, 5, 64–78.
7. Ronen, D. (1982): "Cargo ships routing and scheduling: Survey of models and problems", *European Journal of Operational Research*, 12, 119–126.
8. Ronen, D. (1993): "Ship scheduling: the last decade", *European Journal of Operational Research*, 71**,** 325–333.
9. Perakis, A.N. (1995): "Optimal Fleet Deployment: Insights from a Decade of Research", Paper presented at and included in the *Proceedings, 7th World Conference of Transport Research* , Sydney, Australia.
10. Perakis, A.N. and Papadakis, N. (1987a): "Fleet deployment optimization models, part I", *Maritime Policy and Management*, 14**,** 127–144.
11. Perakis, A.N. and Papadakis, N. (1987b): "Fleet deployment optimization models, part II", *Maritime Policy and Management*, 14**,** 145–155.
12. Papadakis, N.A. and Perakis, A.N. (1989): "A nonlinear approach to the multi-origin,

multidestination fleet deployment problem", *Naval Research Logistics*, 36(5), 515–528.

13. Perakis, A.N., Papadakis, N. and Pagoulatos, P. (1985): *Computer-aided fleet deployment: User documentation, part I*. Report to US Maritime Administration, University Research Program, Contract #DTMA-91-83-C-30032, May.

14. Perakis, A.N. and Papadakis, N. (1985a): *Optimization schemes for rational, computer-aided fleet deployment: Final Report, Vol. II*: Technical Report, prepared for the US Department of Transportation, Maritime Administration University Research Program, Contract #DTMA-91-83-C-30032, August.

15. Perakis, A.N. and Papadakis, N. (1985b): *Computer-aided fleet deployment: User documentation, part II*. Report to US Maritime Administration, University Research Program, Contract #DTMA-91-83-C-30032, October.

16. Perakis, A.N. and Jaramillo, D.I. (1991). "Fleet deployment optimization for liner shipping, part I: Background problem formulation and solution approaches", *Maritime Policy and Management*, 18, 183–200.

17. Jaramillo, D.I. and Perakis, A.N. (1991): "Fleet deployment optimization for liner shipping, part 2: Implementation and results", *Maritime Policy and Management*, 18, 235–262.

18. Powell, B.J. and Perakis, A.N. (1997): "Fleet deployment optimization for liner shipping: An integer programming model", *Maritime Policy and Management*, 24(2), 183–192.

19. Holmes, D. (1992): AMPL (A Mathematical Programming Language) at the University of Michigan Documentation, Version 2.

20. Fourer, R., Gay, D. and Kernighan, B. (1992): *AMPL A Model Language for Mathematical Programming* (San Francisco, Scientific Press).

21. Bremer, W.M. and Perakis, A.N., (1992): "An operational tanker scheduling optimization system: model implementation, results and possible extensions", *Maritime Policy and Management*, 19(3), 189–199.

22. Perakis, A.N. and Bremer, W.M. (1992): "An operational tanker scheduling optimization system: background, current practice and model formulation", *Maritime Policy and Management*, 19(3), 177–187.

23. Cho, S.C. and Perakis, A.N. (2001): "An improved formulation for bulk cargo ship scheduling with a single loading port", *Maritime Policy and Management*, 8 (4), 339–345.

24. Ronen, D. (1986): "Short term scheduling of vessels for shipping bulk or semi-bulk commodities originating in a single area", *Operations Research*, 34, 164–173.

25. Janson, J.O. and Schneerson, D.S. (1987): *Liner Shipping Economics* (London, Chapman & Hall).

26. Rana, K. and Vickson, R.G. (1988): "A model and solution algorithm for optimal routing of a time-chartered containership", *Transportation Science*, 22, 83–95.

27. Rana, K., and Vickson, R.G. (1991): "Routing containerships using Lagrangean relaxation and decomposition". *Transportation Science*, 25, 201–214.

28. Cho, S.C. and Perakis, A.N. (1996): "Optimal liner fleet routeing strategies", *Maritime Policy and Management*, 23(3), 249–259.

29. Perakis, A.N. and Papadakis, N.A. (1988): "New models for minimal time ship weather routing", *Transactions, The Society of Naval Architects and Marine Engineers*, 96, 247–269.

30. Perakis, A.N. and Papadakis, N.A. (1989): "Minmal time vessel routing in a time-dependent

environment", *Transportation Science*, 23(4), 266–277.
31. Papadakis, N.A., and Perakis, A.N. (1990): "On the minimal-time ship weather routing problem", *Operations Research*, 38(3), 426–438.
32. Xie, Xinlian (2000): *Fleet Management and Deployment* (Beijing, Renmin Jiao Tong Press) College Textbook (in Chinese).
33. Christiansen, M. and Fagenholt, K. (2002): "Robust ship scheduling with multiple time windows", *Naval Research Logistics*, 49, 611–625
34. Agarwal, R. and Ergun, O. (2008): "Ship scheduling and network design for cargo routing in liner shipping", *Transportation Science*, 42(2), 175–196
35. Andersen, J., Crainic, T. G . and Christiansen, M. (2007): "Service network design with management and coordination of multiple fleets", *European Journal of Operational Research*, 193 (2009), 377–389.
36. Christiansen, M., Fagerholt, K. and Ronen, D. (2004): "Ship routing and scheduling: status and perspectives", *Transportation Science*, Vol. 38 February 2004, 1–18.
37. Bronmo, G., Christiansen, M., Fagerholt, K. and Nygreen, B. (2007): "A multi-start local search heuristic for ship scheduling – a computational study", *Computers & Operations Research*, 34, 900–917.
38. Fagenholt, K. (2002): "A computer-based decision support system for vessel fleet scheduling – experience and future research", *Decision Support Systems*, 3, 35–47
39. Gunnarsson H., Ronnqvist M. and Carlsson D. (2006): "A combined terminal location and ship routing problem", *Journal of the Operational Research Society*, 57, 928–938.
40. Hwang H.S., Visoldilokpun S. and Rosenberger J.M. (2008): "A branch-and-price-and-cut method for ship scheduling with limited risk", *Transportation Science*, 42, 336–351.
41. Fremont, A. (2007): "Global Maritime networks: The case of Maersk", *Journal of Transport Geography*, 15, 431–442.
42. Bronmo, Geir, Nygreen, Bjorn and Jens, Lysgaard (2009): "Column generation approaches to ship scheduling with flexible cargo sizes", *European Journal of Operational Research*, in press.

Chapter 22

Measuring Business Peformance in Shipping

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1. Introduction

The success or failure of any business depends to a large extent on valid and reliable assessment of performance. Despite the importance of performance measurement, there is a relative gap in the context of the shipping industry. The gap is reflected in the absence of a consistent and coherent stream of research and literature that deal with the issue of how shipping companies measure their performance and what techniques, methods and measures are actually available to improve the process and outcomes of performance measurement. For instance, performance may be related to economic or financial performance and measured using accounting ratios or other financial measures. Performance may also be related to efficiency and the effective utilisation of inputs into a production process, which in this case, includes not only the provision of transportation services but also the process of managing the transportation business and the performance of the business entity. A key issue in the context of the shipping industry is to develop a stream of research that would deal with the different approaches to performance measurement and their application to the major sectors of the shipping industry viz. dry bulk, tanker and container shipping. A stream of research dealing with the measurement of business performance in shipping would also provide useful managerial implications, not least because it will enable managers to assess the performance of their companies and operations and therefore provide a basis for further improvement.

2. Approaches to Performance Measurement: A Literature Review

Performance measurement of organisations has received extensive attention in the literature, since firm performance is the bottom line of a business. Performance reflects the outcome of the implementation of any strategic task and whether such outcome is deemed to be successful or disastrous.

One of the most widely used operational measures for evaluating firm performance is market share, which also serves as a surrogate measure of firm profitability (Tanriverdi and Lee, 2008). Studies that have focused on sectors characterised by network externalities, customer switching costs, and lock-in have used market share as a performance measure. A firm’s market share is measured as the sum over all product markets of the sales-weighted shares of each market (Tanriverdi and Lee, 2008). Other studies, however, have used subjective means to capture market share and proved that subjective measures are as good as the objective ones. Jain and Bhatia (2007), adopting the method of previous studies, have used a "structured non-disguised" questionnaire which requires respondents to state their perceptions on their firm’s market share on a five-point Likert scale.

Nonetheless, most studies in the literature have consistently used accounting-based ratios or measures to assess firm performance. Such measures include Return on Assets (ROA) (Hawawini, Subramanian and Verdin, 2003; Short, *et al.*, 2007; O’Sullivan and Abela, 2007; Morgan, Vorhies and Mason, 2009), Return on Investment (ROI) (Hult, Ketchen and Slater, 2005; Nadkarni and Narayanan, 2007), Return on Capital (ROC) (Capon *et al.*, 1988), Return on Sales (ROS) (Makino, Isobe and

Chan, 2004; Boone and Hendricks, 2009), Return on Equity (ROE) (Luo, Aric and Tse, 2007; Hult, Ketchen and Slater, 2005), Return on Capital Employed (ROCE) (Rajagopalan, 1997), and Return on Invested Capital (ROIC) (Christensen and Montgomery, 1981).

Accounting-based measures have been criticised by researchers as being unsuitable for assessing firm performance. They are historic in nature and do not focus on the firm's future performance or potential. What is more, the differences in accounting policies and in methods of consolidating accounts and the possibility of distortions due to depreciation policies, inventory valuation, and specific treatment of income and expenditure items make their sole use to evaluate firm performance problematic (Chakravarthy, 1986). Hawawini *et al.* (2003) point out that one important aspect of firm performance is the creation of value for the firm's shareholders, in terms of earning returns greater than the cost of capital. However, accounting-based measures do not take into consideration the cost of capital or the replacement value of assets and are thus inadequate to measure the value the firm offers to its shareholders. On top of this, Chakravarthy (1986) suggests that a firm should provide value not only to its shareholders but also to the other stakeholders of the firm, such as customers, employees, and the community, in terms of product or service quality, ability to keep and develop talented people, and responsibility towards the community. Clearly, accounting-based measures do not reflect the value the firm is producing for its stakeholders.

Other studies (e.g. Morgan and Rego, 2009), in an attempt to overcome the disadvantages previously mentioned, have assessed firm performance by using Net Operating Cash Flow (defined as "EBIT + Depreciation – Taxes") and Cash Flow Variability (defined as "the coefficient of variation of the net operating cash flows"). The first reflects current shareholder value and is less dependent on the accounting practices of the firm, while the latter takes into consideration the risk level and captures the stability of a firm's cash flows.

Hawawini *et al.* (2003) measure the economic performance of a firm, instead of the accounting performance. Measures of economic performance are based on the concept of residual income, and take into account capital costs, risk, and the time value of money. Unlike traditional accounting measures, they do reflect shareholder value and are not affected by accounting policies. As measures of performance, Hawawini *et al.* (2003) use Economic Profit (EP) per dollar of Capital Employed (CE) and Total Market Value (TMV) per dollar of Capital Employed (CE), where capital employed is the sum of equity capital and debt capital. The two measures are defined as follows:

$$\frac{EP}{CE} = ROIC - WACC = \frac{NOPAT}{CE} - WACC \qquad (1)$$

where:
ROIC = Return on Invested Capital;
WACC = Weighted Average Cost of Capital;
NOPAT = Net Operating Profit after Taxes;
If ROIC is greater than WACC, economic profit per dollar of capital employed is positive and the firm creates value.

$$\frac{TMV}{CE} \qquad (2)$$

Where:

TMV = Sum of the firm's market capitalisation (market value of equity) and the market value of its debt;

If TMV is greater than CE, the firm is deemed to have increased the value of capital invested in the firm and created value.

Many other studies (Griffith, 2004; Bacidore, *et al.*, 1997; Ryan and Trahan, 2007) use economic profit-related performance measures, such as Economic Value Added (EVA), Refined Economic Value Added (REVA), Shareholder Value Added (SVA) or Cash Flow Return on Investment (CFROI). One of the most important economic performance measures is Economic Value Added (EVA), which was developed by Stern Stewart & Co. EVA is defined as "NOPAT – Cost of Capital* Amount of Capital" and it attempts to relate the firm's accounting data to its stock price. Value-based performance systems are deemed significant in the performance measurement literature, as they drive value creation (Hawawini *et al.*, 2003).

Another important market-based measure, which is widely used to assess firm performance, is Tobin's Q (Short *et al.*, 2007; Chari, Devaraj and David, 2008; Uotila *et al.*, 2009). Tobin's Q is defined as "the sum of the market value of equity, the book value of debt, and deferred taxes divided by the book value of total assets minus intangible assets" (Thomas and Waring, 1999). Tobin's Q compares a firm's market value with the replacement value of its assets; it reflects the investors' views on how the firm will generate value. A value of Tobin's Q greater than 1 implies that the investors assess that the firm will generate greater value from its asset stock than if the assets were deployed outside the firm (McGahan, 1999).

Heiens, Leach and McGrath (2007) use market adjusted holding-period returns (HPR) to assess firm performance. The market adjusted HPR is defined as "the compounded market holding period return minus the compounded stock holding period return". Other studies (e.g. Brammer and Millington, 2009) use risk-adjusted HPR as a performance measure, since it takes into consideration the risk of share ownership. This is defined as:

$$\frac{\frac{(P_t - P_{t-1}) + DIV_t}{P_{t-1}} - RISKFREE_t}{\sigma\left(\frac{(P_t - P_{t-1}) + DIV_t}{P_{t-1}}\right)}$$

where:

P_t= The market price of the firm's share at time t

P_{t-1}= The market rice of the firm's share at time t-1

DIV_t = The dividend paid by the firm at time t

$RISKFREE_t$= The rate of return for a government bond at time t

Nevertheless, many researchers are of the view that there is no single accounting or financial measure that can adequately capture all aspects of firm performance. Therefore, instead of relying on only one measure to determine firm performance, a multi-factor model should be used. Altman's Z is one such multi-factor performance-measurement model. Altman's Z, an established measure of credit default risk, has received increasing consideration in the literature of performance measurement (Short *et al.*, 2007; Craighead, Hult and Ketchen, 2009). Bankruptcy is considered by more and more managers as a

strategic alternative (Short *et al.*, 2007); thus a measure which incorporates this tendency is significant when appraising firm performance in order that the prospects for firm survival are captured (Altman *et al.*, 1981).

Altman's Z is calculated as follows:

$$Z = \frac{1.2*a + 1.4*b + 3.3*c + d}{e} + \frac{0.6*f}{g}$$

where:
a = working capital
b = retained earnings
c = operating income
d = sales
e = total assets
f = net worth
g = total debt

According to Chakravarthy (1986), Altman's Z can be a valuable index of the firm's well-being, since by measuring the distance from bankruptcy, the Z factor can be a surrogate measure of strategic performance. However, Altman's Z is flawed in the sense that a well-managed firm does not devote all of its resources only in the avoidance of bankruptcy. Moreover, the calculation of the Z factor is mostly an empirical result rather than the result of theory.

Hence, an alternative multi-factor measure has been proposed by Chakravarthy (1986). Chakravarthy (1986) deals with the term "firm excellence" and asserts that strategic management is the process through which managers ensure the long-term adaptation of the firm to its environment. In this way, the useful measures of performance are those that help assess the quality of the firm's adaptation to its changing environment. A firm needs to be evaluated on the basis of how well it serves all of its stakeholders (not just its stockholders) and of how well it manages the net surplus of its slack resources. The slack resources will improve the firm's ability to adapt to uncertain or unknown future events. Therefore, the firm should be able to transform itself and adjust to the changing environment around it. Chakravarthy (1986) selects eight slack variables to represent the ability of firm transformation: Cash Flow to Investment ratio, Sales by Total Assets, R&D by Sales ratio, Market to Book Value, Sales per Employee, Debt by Equity ratio, Working Capital by Sales ratio, and Dividend Payout ratio.

Despite the widespread use of the various financial measures mentioned above, there has been increased use of non-financial measures to evaluate firm performance. Proponents of such measures insist that non-financial measures are better predictors of long-term performance than financial measures and help management focus on the long-term effects of their actions (Banker, Potter and Srinivasan, 2000). One of the most important non-financial measures used is customer satisfaction (Ittner and Larcker, 1998; Banker *et al.*, 2000; Jain and Bhatia, 2007). Other measures include productivity (Koka and Prescott, 2008), product quality (Wisner, 2003), and manufacturing-related measures, such as cycle time, lead time, setup times or inventory turnover (Perera *et al.*, 1997; Dehning *et al.*, 2007).

One of the most important performance measurement systems in the literature is the Balanced

Scorecard (Kaplan and Norton, 1992; Hult *et al.*, 2008). Kaplan and Norton (1992) assert that no single performance measure can incorporate all the critical areas of a business; thus, they developed four sets of perspectives that the firm should focus on to evaluate its performance. These perspectives are: customer performance, financial performance, internal process performance, and innovation and learning performance. The measures which will be included in each category will depend on the firm, its goals, and the type of business it is into, but could include lead time, on-time delivery, growth, profitability, cycle time, productivity or ability to launch new products. The Balanced Scorecard's effectiveness lies in the fact that it reduces information overload, as it limits the number of measures used and that it ensures the optimisation of the whole system, instead of the subsystem. Table 1 presents a summary of some key papers in the firm performance measurement literature together with the performance dimensions and indicators used.

3. Performance Measurement of Shipping Companies

To determine the extent to which the performance of the maritime industry has been subjected to systematic examination, a key word search in the electronic databases of the major shipping/transport journals was undertaken. The journals targeted include Maritime Policy and Management (MPM), Transportation Research (Part A and Part E), Journal of Transport Economics and Policy (JTEP), Transport Policy (TP), Transport Reviews (TR), and Maritime Economics and Logistics (MEL, formerly

Table 1: Performance dimensions and indicators

Performance dimension	**Performance indicator**	**Indicative literature**
Competition performance	Sales growth	Tanriverdi and Lee 2008 de Luque *et al.* 2008
	Market share	Jain and Bhatia 2007 Tanriverdi and Lee 2008
Financial performance	ROA	Hawawini *et al.* 2003 Short *et al.* 2007 O'Sullivan and Abela 2007 Morgan, Vorhies and Mason 2009
	ROI	Hult, Ketchen and Slater 2005 Nadkarni and Narayanan 2007
	ROC	Capon *et al.* 1988
	ROIC	Christensen and Montgomery 1981
	ROCRR, defined as ROIC to std dev of ROIC	
	ROCE	Rajagopalan 1997
	ROS	Makino, Isobe and Chan 2004 Boone and Hendricks 2009
	ROE	Luo, Aric and Tse 2007 Hult, Ketchen and Slater 2005
	Return on replacement assets, defined as "EBIT to denominator of Tobin's Q"	McGahan 1999
	P/E ratio	Mehra 1996
	Common stock price change	Fogler and Nutt 1975
	EBITOA, defined as Earnings before interest and taxes, divided by assets	Wan and Hoskisson 2003
	Cash flow	Morgan and Rego 2009
	Cash flow variability	Dechow 1994
	Operating Cash Flow (OCF) to Total Assets	Baliga, Moyer and Rao 1996

Table 1: (Continued)

Performance dimension	Performance indicator	Indicative literature
	OCF to Sales	
	Operating profit	Banker *et al.* 2000
	Net income	Perera *et al.* 1997
	Net Income growth	Nadkarni and Narayanan 2008
	Economic profit to Capital employed	Hawawini *et al.* 2003
	Total market value to Capital employed	
	Var (material purchase price)	Perera *et al.* 1997
	Sales	
	Compound asset growth	Peters and Waterman 1982
	Compound equity growth	
	Market to book value	McDonald *et al.* 2008
	MVA	Griffith 2004
	EVA	Lovata and Costigan 2002
	REVA	Bacidore *et al.* 1997
	SVA	Ryan and Trahan 2007
	CFROI	Madden 1998
	EPS	Gomez-Mejia 1992
	GEPS	Christensen and Montgomery 1981
	Composite index	Bourgeois 1980
	ROVA	Hofer 1983
Non-financial performance	Customer satisfaction	Ittner and Larcker 1998 Banker *et al* 2000 Jain and Bhatia 2007
	Customer loyalty	Morgan and Rego 2009
	Productivity, as sales per employee	Koka and Prescott 2008
	Product quality	Wisner 2003 Jain and Bhatia 2007
	Inventory cost	Gunasekaran *et al.* 2001
	Competitiveness	Jain and Bhatia 2007
	Employees' organisational commitment	

(*Continued*)

Table 1: (Continued)

Performance dimension	**Performance indicator**	**Indicative literature**
	Employees' esprit de corps	
	On time delivery Number of customer complaints Labour utilisation/efficiency Product defects Reduction in set-up times Reports on whether standard product costs are met Rate of new product introduction Number of product returns Cycle time Ability to vary product characteristics Machine utilisation and downtime	Perera *et al.* 1997
Inventory Management Performance	Purchase material turnover	Kaynak 2003
	Total inventory turnover	Dehning *et al.* 2007
Quality Performance	Product/service quality	Crohin and Taylor 1992
	Delivery lead time	Wang *et al.* 2002
Balanced Scorecard	Customer perspective Internal business perspective Innovation and learning perspective Financial perspective	Hult *et al.* 2008
Market-based performance	Tobin's Q (the sum of the market value of equity, the book value of debt, and deferred taxes divided by the book value of total assets minus intangible assets)	Short *et al.* 2007 Chari *et al.* 2008 Uotila *et al.* 2009
	Stock market value	Zott and Amid 2008
	Risk-adjusted measure of market performance, defined as (market performance – risk free)/std dev of market portfolio	Brammer and Millington 2008
	Benchmark-adjusted buy and hold abnormal returns	Sorescu and Spanjol 2008
	Std dev of stock returns	
	Sharpe ratio Treynor's levered and unlevered ratio Jensen's levered and unlevered ratio	Dubofsky and Varadarajan 1987

Table 1: (Continued)

Performance dimension	Performance indicator	Indicative literature
Firm survival	Altman's Z	Short *et al.* 2007 Craighead, Hult and Ketchen 2009
Firm excellence	*Generation of slack* Cash flow to investment Sales per employee Sales by total assets Market to book value Debt by equity ratio *Investment of slack* R&D by Sales ratio Working capital by sales ratio Dividend payout ratio	Chakravarthy 1986
Market efficiency	Data Envelopment Analysis Models Model (inputs: earnings before extraordinary items and discontinued operations, and book value of equity); (outputs: market value – firm's market price * number of shares outstanding)	Tsai *et al.* 1996 Collins *et al.* 1999 Barth *et al.* 1998
Operational efficiency	Data Envelopment Analysis Models Model (inputs: fixed assets (tangible and intangible) – total liabilities); (outputs: revenues – total sales); Model (inputs: profitability as cash flow from operations to total assets and leverage – total liabilities to total assets); (output: asset turnover (revenue to total assets)	

known as the International Journal of Maritime Economics). The majority of the papers identified examine productivity/efficiency issues related to ports or container terminals. As there are already some good reviews on port/terminal productivity (see, for example, Cullinane, 2002; Panayides *et al.*, 2009), we focus here on the performance of shipping companies. Less than a dozen papers have examined this important issue. We make reference to studies outside of shipping firms where appropriate.

The existing studies on the performance of shipping companies may be divided into three main types: the first branch of the literature focuses on firms' financial performance or operational performance/efficiency, the second on the stock market performance (i.e. risk and return) of the listed firms, and the third on other aspects of performance (e.g. third-party rated performance or self-evaluation of performance). The sub-sections below first review the main research findings of the relevant studies, organised in chronological order. This is followed by an evaluation/critique of the research designs and key results of the said studies. Future research directions and opportunities are then discussed.

3.1 Studies of the financial/operating performance of shipping companies

Randoy, Down and Jenssen (2003) examine the effect of corporate governance mechanisms on the financial performance of 32 publicly traded maritime firms from Norway and Sweden during the period 1996–1998. Using Return on Assets (ROA), Return on Equity (ROE) and Return on Sales (ROS) as the measure of firm performance, they find (through regression analysis) that maritime firms with a founding family CEO have better financial performance than maritime firms with a non-founding family CEO; a high level of board independence enhances profitability in maritime firms; but there is no significant relation between the level of board ownership and firm profitability in

maritime firms, although board ownership control is significant in a control sample of manufacturing firms. The authors focus on cross-sectional analysis and provide minimal evidence on the extent to which the sample maritime companies perform, either in absolute terms or relative to a chosen benchmark. The same criticism applies more or less to the other studies reviewed in this sub-section.

Lam, Yap and Cullinane (2007) investigate the structure, conduct and performance of major liner shipping routes during the period 1998–2002. They measure performance using financial performance indicators such as turnover, operating profit and net profit calculated on a per-TEU basis. The results indicate that different companies experienced varying degrees of success or failure in financial performance during the period under examination, but there is no conclusive evidence of any relationship (based on correlation coefficients) between either structure or conduct and performance. The authors note that while industry structure and the conduct of shipping lines can affect performance, the direction of causality may be reversed. For instance, shipping lines that are able to reap significant benefits from the adoption of a particular form of conduct might be persuaded to repeat that strategy, whereas those shipping lines whose conduct failed to generate sufficient returns will be motivated to seek alternative strategies. Similarly, healthy financial gains will enable shipping lines to invest in greater capacity and alter the structure of the market, while poor financial performance can lead to mergers and acquisitions or even exit from the industry altogether (pp. 372–373). In conclusion, Lam, Yap and Cullinane (2007) interpret their results as providing further validation of the assertion that the structure (high levels of concentration) and conduct (e.g. inter-firm collaboration) of shipping lines are the outcomes (as opposed to causes) of low cost strategies for survival in a beleaguered shipping sector.

Lambertides and Louca (2008) examine the relation between ownership structure and operating performance of listed European maritime firms during the period 2002–2004. They adopt multiple measures of operating performance, including cash flow from operations on assets/sales, operating return on assets/sales, capital expenditures on assets, and asset turnover. Judging by these measures, the sample companies seem to be profitable in each of the years under examination, with the average (median) cash flow from operations on assets ranging from 7.3% (8.0%) to 9.4% (10.9%), whereas the average (median) operating return on sales ranges from 1.9% (4.6%) to 8.0% (8.9%). There is also a steady improvement in maritime operating performance through time. By regressing operating performance measures on ownership structure and control variables, Lambertides and Louca (2008) find that firms with more foreign shareholders and greater participation from investment companies have higher operating performance. These and other results lead them to conclude that certain types of ownership structure can result in better investor protection and hence better operating performance. They caution, however, against inferring causality from these results, as both ownership structure and operating performance might be associated with a third, omitted factor (e.g. management quality).

3.2 Studies of the stock market performance of shipping companies

One stream of the literature deals with the risk-return characteristics and behaviour of shipping company stocks and factors associated with stock market performance. Grammenos and Marcoulis (1996a) analyse the determinants of the cross-section of expected stock returns of 19 shipping companies listed in the US, Norway, Stockholm and London. Among the factors examined (company stock market beta, dividend yield, financial leverage and average age of the company’s fleet), they

find that the industry-specific factor (average age of the fleet) and financial leverage are significant in explaining shipping stocks' returns, whereas the stock market beta and the dividend yield are far less significant.

Grammenos and Arkoulis (2002) present evidence, for the first time, about the relations between global macroeconomic sources of risk and shipping stock returns for 36 internationally listed shipping companies during the period 1989–1998. The return on the world equity market portfolio and innovations in the following global macro variables are employed in the analysis: (a) industrial production; (b) inflation; (c) oil prices; (d) fluctuations in exchange rates against the US dollar; and (e) laid up tonnage. Several significant relationships are established between the returns of international shipping stocks and global risk factors. Specifically, oil prices and laid up tonnage are found to be negatively related to shipping stocks, whereas the exchange rate variable displays a positive relationship. In addition, it is found that, in general, the macroeconomic factors exhibit a consistent pattern in the way in which they are linked to the shipping industry, across countries. Kavussanos and Marcoulis (2001, 2005) provide evidence that microeconomic and company-specific factors as well as the market factor are the driving force behind shipping companies' stock returns.

Grammenos and Arkoulis (2001) examine the long-run performance (for the initial 24 months subsequent to public listing) of 27 shipping initial public offerings (IPOs) issued in the stock exchanges of seven different countries during the period 1987–1995. By measuring aftermarket performance respectively against the local stock market indices and against the Morgan Stanley Capital Market (MSCI) index for the shipping equity market, they find that the shipping IPOs underperform the local stock market indices by as much as 36.79% by the end of the second anniversary of public listing, but there is no evidence of underperformance relative to the MSCI shipping index. They further find that the two-year holding period returns of the sample firms are positively related to the initial level of gearing and negatively related to the fleet age of the companies at the time of the offering. In an earlier study, Grammenos and Marcoulis (1996b) find relatively small but statistically significant underpricing for 31 shipping IPOs worldwide during the period 1983–1995. In contrast, Cullinane and Gong (2002) find substantial underpricing for 50 transportation IPOs in stock exchanges in Hong Kong (with an average underpricing of approximately 44%) and the Chinese mainland (with an average underpricing of approximately 126%) during the period 1972–1998. The 23 shipping IPOs on average experienced as much as 126% underpricing, which is statistically higher than that for toll roads, freight forwarders and airlines. They attribute the higher level of underpricing for shipping IPOs to the fact that, relative to other types of transport companies which are typically guaranteed regular incomes through their status as monopolies or franchises, the (usually freight-related) shipping companies are associated with a higher level of *ex ante* uncertainty and thus they need to offer investors a higher level of initial day returns in order to compensate investors for the higher risk involved. With the benefit of hindsight (and based on the results in other related research), it is possible that the investors might have simply overpaid for the IPOs, and that the more speculative investors in the emerging Chinese stock market are just more likely to do so than investors in the more mature stock markets.

3.3 Other studies of performance of shipping companies

Panayides (2003) examines the relationship between competitive strategy and performance in the

context of ship management companies. Recognising performance as a multi-dimensional construct, he measures performance using seven items of self-reported measures constructed from questionnaires that contain instruments found to be valid and reliable by previous research as well as pre-tested with managers and academics. The study finds that companies that apply competitive strategies are more likely to be high performers. The strongest influences on performance seem to be achieving economies of scale, differentiation (in particular through a wider range of services offered), and market-focus and competitor analysis. It is suggested that high performers are more likely to pursue a combination of the generic strategies rather than pursuing one of the generic strategies in isolation.

Jenssen and Randoy (2006) investigate how innovation contributes to company performance in Norwegian shipping. They hypothesise that organisational and inter-organisational variables influence innovation and innovation in turn influences performance in the shipping firms. Performance is said to be measured by financial results, market position and bargaining power, although it is not clear from the paper how these are actually computed and why they are considered appropriate. Using regression analysis based on the results of a survey of 46 Norwegian shipping companies (divided into highly differentiated companies and low differentiated companies) and two measures of innovation (product-process innovation, PPI, and market innovation, MI), they find that PPI is positively associated with performance for the whole sample and for highly differentiated firms, but not for low differentiated firms. No statistically significant relationship is found between MI and performance. Thus, the effect of innovation on performance seems to depend on the companies' degree of differentiation and the type of innovation. The authors suggest that future studies should use more objective information, such as accounting and financial market data, in order to gain more knowledge of the effect of innovation on performance.

3.4 Evaluation and a critique

The key objectives of most of the existing studies on the performance of shipping companies have been to investigate the relations between performance and specific aspects of corporate strategy (e.g. inter-firm collaboration, innovation, mergers and acquisitions) or governance (e.g. ownership structure and control). Few studies take it as their primary objective the determination of objective shipping company performance. It is also difficult to compare the results from the various studies because of the different research designs and the inconsistent definition and measurement of the variables used. Such comparability issues are further complicated by the fact that the sample firms usually come from, and sometimes are spread thinly over different countries, which often adopt different accounting standards and financial reporting practices. It is not clear from the existing studies how well shipping companies have performed, either in absolute terms or against a chosen benchmark. It is also not clear what factors, if any, are associated with differential performance. The inference problem is further made difficult because of potential omitted variable bias, endogeneity bias, and/or other forms of model misspecification.

It is obvious that the ability to draw any reliable inference with respect to shipping companies' performance hinges critically on a proper definition and measurement of performance. As is well-known and as previously noted, performance is a multi-dimensional concept (Walker and Ruekert, 1987; Chakravarthy, 1986) and proves to be rather elusive if not also controversial (Eccles, 1991). The

literature review above suggests a number of possible measures of firm performance, including financial indicators (those based on financial ratios, cash flows, stock market risk-return indicators), operating performance/efficiency indicators (e.g. labour productivity, sales growth, asset turnover, "efficiency scores" based on multiple inputs–outputs), and other performance indicators (e.g. innovation, market share, customer satisfaction, social responsibility "scores").[1] In order to enhance the reliability of the results and strengthen any inference based on the results, it is important to adopt multiple measures of performance and assess the robustness of the results using different indicators of performance. Unfortunately, however, when multiple criteria are adopted in performance measurement/evaluation, one inevitably has to decide how best to aggregate such criteria into a single easy-to-use "score", or to decide on a suitable "weighting scheme".[2] Naturally, certain performance indicators may be more relevant to a given research objective than others, and thus should receive more emphasis over the others. For instance, if the research objective is to examine the effect of corporate strategy and practice on shareholder value, it seems appropriate to place emphasis on measures of financial performance rather than operating performance. In reality, these measures are closely related rather than diametrically opposed because high operational performance/efficiency should eventually lead to high financial performance. Nevertheless, in any single research study the results using different performance measures may be different, and it will be useful to report the findings even when the data do not speak in the same voice. The reader can then weigh the various pieces of empirical evidence before coming to a conclusion about shipping companies' performance.

With respect to studies that focus on the stock market performance of shipping companies, an often-raised concern is their generally small sample size (although in many cases the whole population of firms were examined), the lack of a sufficiently rigorous research design, and tangential contribution to the wider finance literature as a result of the industry focus. Nevertheless, these studies contribute to our knowledge about the risk-return characteristics of the industry and the factors driving shipping stock performance, and in some cases they do offer a unique setting in which to test specific research hypotheses. This may be considered an area of strength and is made possible by the researcher's in-depth knowledge of the industry itself and hence the ability to structure empirical tests and/or to include a concrete set of variables, something that may be difficult to do in large sample studies typical in finance research. For example, Cullinane and Gong (2002) utilise sector affiliation (water transport versus other modes of transport, freight transport versus passenger transport) to proxy for the level of *ex ante* uncertainty and are able to confirm the relationship between this variable and the level of IPO underpricing. Such concrete measures of *ex ante* uncertainty are difficult to find in the general finance literature.

4. Empirical Analysis: Measuring Performance Across Key Shipping Sectors

It is obvious from the above discussion that it is important to illustrate how business performance in shipping may be measured and also to gauge the possible differences in the results when using different performance measures. Therefore, in this section we present an empirical analysis of the performance of a sample of publicly quoted shipping companies spanning the three key shipping sectors, viz. dry bulk, tanker and container shipping.

4.1 The performance measures

On the basis of the discussion in the preceding sections, it is deemed appropriate to assess performance using a number of key performance measures. The chosen measures consist of competition performance measures, financial performance measures, market-based performance measures and an assessment of relative efficiency. The measures are summarised in Table 2.

This study provides extensive findings on the relative productivity-efficiency and market efficiency of maritime firms. The relative productivity efficiency model incorporates inputs and outputs related to operating performance consistent with the prior financial accounting literature (Tsai *et al.*, 2006; Barth *et al.*, 1998; Collins *et al.*, 1999).

As recognised by Graham and Dodd (1962), fundamental analysis is a long-term oriented exercise, where the management factor plays an essential role. Well-managed firms are more likely to keep generating a steady stream of revenues in the future as well. In general, firms aim at (a) maximising revenues given their available resources; and/or (b) minimising cost given their output production. To determine these inputs and outputs we use information from the balance sheet, income and cash flow statement. Specifically, the first model (model 1) uses the following inputs and outputs:

INPUTS:

Total assets

Capex (capital expenditure)

Employee (number of employees)

OUTPUT:

Revenue (Total sales)

EBITDA

EBIT

Table 2: The performance measures

Performance dimension	Performance indicator
Competition performance	Sales growth
Financial performance	Return on Assets (ROA), Return on Investment (ROI), Revenue, EBIT, EBITDA EBITDA margin, Cash flow from operations, Book value of equity, market value of equity, operating profit
Market-based performance	Tobin's Q (the sum of the market value of equity, the book value of debt, and deferred taxes divided by the book value of total assets minus intangible assets
Market efficiency	DEA Model. Input: earnings before extraordinary items and discontinued operations, and book value of equity, Output: market value – firm's market price*number of shares outstanding
Operational efficiency	DEA Model a. Input: fixed assets (tangible and intangible) total liabilities), Output: revenues DEA Model b. Input: profitability as cash flow from operations to total assets and leverage – total liabilities to total assets, Output: asset turnover (revenue to total assets)
Productivity efficiency	DEA Model. Input: Total assets, Capital expenditure, number of employees, Output: Revenue, EBITDA, EBIT

Following Tsai *et al.* (2006), the DEA methodology is employed to capture the entirety of performance with respect to a set of output variables of revenue, EBITDA, and operating profit (EBIT) with input variables of total assets, capex, and employee numbers. Labour is measured as the total number of employees (Karlaftis, 2004). The DEA input-oriented models are chosen for the present study because cost minimisation or reduction is used in this methodology (Tsai *et. al.*, 2006). It is now popular to rely on non-GAAP financial measures such as EBITDA and EBITDA margin (%) to assess

the operating performance of a company against that of its counterparts.

This study sheds light on the degree of relative market efficiency among maritime firms as well. Consistent with the efficient market hypothesis, earnings, cash flows and book value shall contain significant information for the valuation of market equity. Therefore, the second model (model 2) helps in identifying relative *market* efficiency. Following Barth *et al*. (1999), we assume that firm value is a function of earnings, cash flow from operations and book value of equity:

INPUTS:

Earnings (EBIT)

Cash flow from operations

Book value of equity

OUTPUT:

Market Value (firms' market price * number of shares outstanding)

Barth *et al*. (1999) base their analysis on the valuation framework in Ohlson (1999), in which the value relevance of an earnings component depends on its ability to predict future abnormal earnings incremental to abnormal earnings and the persistence of the component. Consistent with their expectations they show that accruals and cash flows provide explanatory power for equity market value incremental to equity book value and abnormal earnings. Our study is consistent with the Barth *et al*. (1999) valuation model.

4.2 Sample

Our sample consists of 18 major (leading) international maritime firms. The data on inputs and outputs were collected from Datastream in 2007. Datastream provides firm accounts and market information and places great emphasis on accuracy, quality and consistency. Since our study deals with markets which have different accounting systems, using Datastream helps to mitigate the problem of inconsistency. Furthermore, to avoid exchange rate variation we denominated all figures to US dollars.

The sample firms are shown in Table 3.

4.3 Empirical results: financial indicators

The results from the analysis of the financial and market indicators are shown in Table 4. We provide summary statistics for the performance measures in Table 5.

The results show that the sample shipping firms have an average of 7% return on assets (ROA), a ratio which indicates how profitable a company is relative to its total assets. The tanker and the dry bulk firms seem to out-perform the container shipping firms in terms of ROA, with a ROA of 8% vs 4% for the container shipping firms.

A similar pattern is observed for the return on investments (ROI) ratio. The average ROI for all shipping firms is 10%. Again, the tanker and dry bulk sectors exhibit a higher ROI than the container sector.

These findings are mainly driven by the fact that container firms are generally much bigger than tanker and dry bulk firms (see TA and ME in Table 5). However, it must be stressed that any conclusions on the basis of single financial ratio analysis need to be corroborated with further evidence from using other indicators and should only be considered as tentative in nature.

Table 3: Sample firms

Tanker	Dry bulk	Container
Stolt-Nielsen	Eagle Bulk Shipping	A.P. Moeller-Maersk 'B'
Teekay	Diana Shipping	Evergreen Marine
Overseas Shiphldg.Gp.	Navios Maritime Hdg.	Nippon Yusen KK
Farstad Shipping	Dryships	Neptune Orient Lines
Euronav	Excel Maritime Carriers	Wan Hai Lines
Frontline	TBS International 'A'	Mitsui OSK Lines

Table 4: Financial performance results

		ROA	ROI	TOBINSQ	SALES_GR	EBITDA margin
ALL	Mean	0.0747	0.1047	1.4389	0.2605	43.74%
	Median	0.0817	0.1089	1.3821	0.1482	44.57%
	Min	0.0141	0.0307	1.0383	–0.0655	6.12%
	Max	0.1502	0.2084	2.0650	1.8844	93.73%
Tanker	Mean	0.0889	0.1172	1.3652	0.0830	53.42%
	Median	0.0914	0.1114	1.3325	0.0237	58.31%
	Min	0.0313	0.0549	1.1459	–0.0655	18.23%
	Max	0.1326	0.2084	1.7288	0.3375	76.20%
Dry Bulk	Mean	0.0887	0.1173	1.5799	0.5589	64.68%
	Median	0.0898	0.1211	1.5606	0.2312	66.17%
	Min	0.0141	0.0454	1.1457	0.0677	37.91%
	Max	0.1502	0.1776	2.0650	1.8844	93.73%
Container	Mean	0.0465	0.0796	1.3715	0.1395	13.13%
	Median	0.0438	0.0641	1.3119	0.1080	12.74%
	Min	0.0162	0.0307	1.0383	0.0296	6.12%
	Max	0.0762	0.1380	1.8615	0.3913	23.11%

This table presents summary statistics for the most used financial performance indicators. ROA: Returns on assets is net income to total assets; ROI: Return on investments is earnings before interest and taxes to total assets; TOBINSQ is market equity and total assets minus book value equity divided by total assets; SALES_GR: Sales growth is net sales change from last year divided by last year net sales; EBITDA margin (%) is calculated as EBITDA divided by net sales.

As far as the Tobin's Q statistic is concerned, the shipping industry has an average value of 1.4, which indicates that the market value of the shipping sector is greater than the value of the firms' recorded assets. This suggests that the market value reflects some unmeasured or unrecorded assets of the shipping firms (i.e. growth opportunities). Although all three sectors have greater-than-unity Tobin's Q, it seems that the dry bulk firms have a slightly higher Tobin's Q (1.5) than the tanker and the container shipping firms (1.3). This may suggest that dry bulk firms have more growth opportunities than other shipping firms, presumably due to their greater flexibility to expand their operations. The results seem to be logical bearing in mind the flexibility that characterises dry bulk shipping operations compared to tanker and container ships. In particular, dry bulk shipping may have higher growth prospects because ships can be deployed more readily in areas and routes that command higher freight rates. In contrast, container ships by definition are deployed on fixed schedules irrespective of the prevailing freight rates, whereas tankers need to operate on specific routes to cater for oil demand and supply. Investors may feel that the flexibility of dry bulk shipping firms provides them with more growth opportunities, and these are accordingly reflected in a higher market value.

Table 5: Summary statistics

		TA	Capex	Employees	Revenue	EBIT	EBITDA	EBITDA margin	BV	ME
ALL	Mean	7,370.0	944.2	10,008.3	5,766.6	793.5	1,160.9	43.74%	2,926.5	4,865.4
	Median	2,417.3	315.0	1,292.0	1,282.1	221.9	320.0	44.57%	966.9	2,019.5
	Min	408.6	0.7	48.0	112.0	46.7	70.6	6.12%	261.5	429.5
	Max	59,242.9	9,305.7	108,530.0	49,407.6	7,348.9	11,419.2	93.73%	26,061.5	28,333.3
Tanker	Mean	4,043.1	381.4	2,483.8	1,252.5	425.6	585.4	53.42%	1,405.5	2,723.9
	Median	3,302.1	328.8	2,065.0	1,282.1	371.6	529.9	58.31%	1,188.3	2,625.3
	Min	1,527.7	187.1	48.0	377.4	187.4	241.1	18.23%	642.4	1,089.7
	Max	9,391.9	682.1	5,600.0	2,218.5	912.7	1,114.9	76.20%	2,805.6	4,176.2
Dry Bulk	Mean	922.3	176.1	268.5	209.9	101.4	138.2	64.68%	449.3	951.4
	Median	732.8	183.1	249.5	188.5	73.0	108.9	66.17%	466.0	870.3
	Min	408.6	0.7	100.0	112.0	46.7	70.6	37.91%	261.5	429.5
	Max	1,619.8	323.3	501.0	350.6	257.2	328.7	93.73%	621.8	1,670.2
Container	Mean	17,144.7	2,275.0	27,272.5	15,837.4	1,853.6	2,759.2	13.13%	6,924.7	10,920.9
	Median	9,296.7	836.0	9,810.5	10,502.2	776.6	1,129.2	12.74%	3,496.1	8,255.1
	Min	2,445.0	131.6	2,083.0	1,651.2	114.8	263.2	6.12%	879.2	1,675.3
	Max	59,242.9	9,305.7	108,530.0	49,407.6	7,348.9	11,419.2	23.11%	26,061.5	28,333.3

This table presents summary statistics for the input and output variables. TA: Total assets; Capex: Capital expenditures; Employees: number of employees; Revenue: Net sales; EBIT: earnings before interest and taxes; EBITDA: operating income plus interest, taxes and depreciation and amortisation; EBITDA margin (%) is calculated as EBITDA divided by net sales; CF; cash flow from operations; BV: book value of equity; ME: market value of equity computed as market price multiplied by shares outstanding; All mean and median values are significant at 1%.

The high growth prospects of the dry bulk sector are confirmed by the growth rate in sales as well. Although the average growth rate of the shipping sector is 26%, the dry bulk sector exhibits a very high growth rate of 55%, which is almost five times higher than the corresponding growth rate of the tanker and the container sectors, which is 8% and 13%, respectively.

Finally, the tanker and the dry bulk firms seem to out-perform the container shipping firms in terms of EBITDA margin, which measures a company's power to generate returns on shareholders' investments. The tanker and dry bulk sectors exhibit an average EBITDA margin of 53% and 64%, respectively, whereas for the container sector it is 13%. These results are in contrast to the DEA analysis of relative efficiency that is carried out in the following section.

A conclusion that emerges from this analysis is the relative high pricing of dry bulk shipping firms. This could be due to one of two things: a) either dry bulk shipping firms have more growth opportunities than other firms and investors price these opportunities (correctly); or b) dry bulk shipping firms are overpriced by investors (hence this becomes an issue of mispricing). Bearing in mind that only six firms from each sector are used, these findings cannot be over-emphasised but instead should only be interpreted as suggestive. One avenue for future research is to first confirm these findings using all firms in the dry bulk sector. Asset pricing tests may then be conducted to explore the growth-based explanation for the dry bulk sector relative to the other sectors.

4.4 Empirical results: relative efficiency indicators

The data envelopment analysis (DEA) approach ranks the performance of each stock relative to the efficient frontier, indicating the (maximal output) production given the optimal (minimal input) cost. For each stock, we determine its location relative to the frontier.

Table 5 reports summary statistics for all inputs and outputs used in our analysis (models 1 and 2).

All variables are expressed in thousand dollars (except the number of employees). The broad range of values for market capitalisation (MV, TA), profitability (EBIT, Revenue), and capital expenditure (Capex) indicates that the sample consists of firms operating on different economic scales. For example, the minimum EBIT of the sample is $46.7K, whereas the maximum is $7,348.9K. In particular, the summary statistics show that the sample includes both small and large maritime companies. The smallest firm in the sample has 408K total assets and 48 employees, whereas the largest firm has 59,242K total assets and 108,530 employees.

The results also reveal a significant difference between the sizes of the three shipping specialties. Dry bulk shipping firms are small relative to the tanker and container firms as far as the total assets, market value and the number of employees are concerned. On the other hand, container shipping firms are by far the largest group. The average total assets, market value and number of employees of the container shipping firms are 17,144K, 10,920K, and 27,273, respectively. These figures are almost four times higher than those of the tanker firms and more than ten times higher than those of the dry bulk shipping firms.

Table 6 shows the Spearman correlation coefficients of the performance inputs and outputs. Consistent with prior studies, market value and revenue exhibit a high correlation with aggregate financial variables such as EBIT, book value of equity, cash flow

Table 6: Correlation coefficients

	Capex	Employees	Revenue	EBIT	EBITDA	CF	BV	ME	EBITDA margin
CAPEX	1	0.488*	0.719**	0.870**	0.860**	0.835**	0.721**	0.858**	-0.181
		0.040	0.001	0.000	0.000	0.000	0.001	0.000	0.473
Employees		1	0.737**	0.477*	0.542*	0.566*	0.795**	0.724**	-0.712**
			0.000	0.045	0.020	0.014	0.000	0.001	0.001
Revenue			1	0.785**	0.849**	0.884**	0.932**	0.909**	-0.697**
				0.000	0.000	0.000	0.000	0.000	0.001
EBIT				1	0.983**	0.911**	0.829**	0.897**	-0.148
					0.000	0.000	0.000	0.000	0.559
EBITDA					1	0.938**	0.872**	0.940**	-0.269
						0.000	0.000	0.000	0.280
CF						1	0.880**	0.940**	-0.399
							0.000	0.000	0.101
BV							1	0.932**	-0.595**
								0.000	0.009
ME								1	-0.459
									0.055
EBITDA margin									1

This table presents Spearman's correlation coefficients between the input and output variables. TA: Total assets; Capex: Capital expenditures; Employees: number of employees; Revenue: Net sales; EBIT: earnings before interest and taxes; EBITDA: operating income plus interest, taxes and depreciation and amortization; EBITDA margin (%) is calculated as EBITDA divided by net sales; CF; cash flow from operations; BV: book value of equity; ME: market value of equity computed as market price multiplied by shares outstanding; Significance presented below the coefficient.
*, ** indicate correlation significance at the 0.05 and 0.01 level (2-tailed), respectively.

Table 7: Productivity efficiency – DEA Ratings

Company	Efficiency score	EBITDA margin (%)
TBS International 'A'	100%	37.91%
Excel Maritime Carriers	100%	69.31%
Evergreen Marine	100%	6.12%
Frontline	100%	76.20%
Neptune Orient Lines	100%	6.71%
Mitsui Osk Lines	100%	17.32%
AP Moller-Maersk 'B'	94.70%	23.11%
Dryships	87.08%	93.73%
Euronav	84.12%	74.08%
Farstad Shipping	74.90%	63.88%
Nippon Yusen KK	72.38%	9.55%
Overseas Shiphldg.GP.	71.42%	52.74%
Stolt-Nielsen	70.90%	18.23%
Wan Hai lines	65.04%	15.94%
Diana Shipping	60.19%	72.84%
Navios Maritime HDG.	56.19%	51.24%
Teekay	47.60%	35.41%
Eagle Bulk Shipping	37.70%	63.04%
	Average	
All	79.01%	43.74%
Tanker	74.82%	53.42%
Dry Bulk	73.53%	64.68%
Container	86.42%	14.53%

This table presents DEA efficiency ratings using model 1 for relative productivity efficiency. EBITDA margin (%) is also presented for each company. EBITDA margin (%) is calculated as EBITDA divided by net sales.

and total assets (Barth *et al.*, 1998; Collins *et al.*, 1999). Moreover, all input and output variables have a positive and significant correlation between them. This is a necessary and basic assumption of the DEA approach known as "isotonicity". It guarantees that the increasing of an input will not cause the decreasing output of another item. This result corroborates the selection of our models.

Table 7 shows results on relative *productivity* efficiency using model 1. The average productivity efficiency of the maritime firms is 79.01%. Table 7 shows that six maritime firms exhibit 100% productivity efficiency using model 1. Two firms have less than

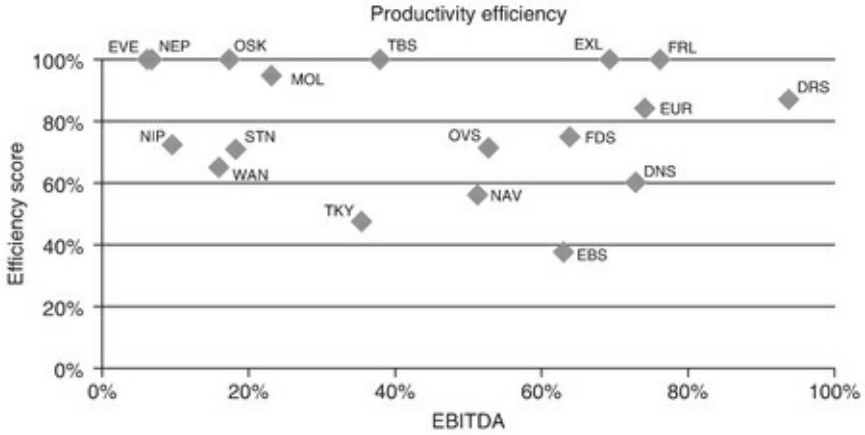

Figure 1. Productivity efficiency plot (EBITDA)

This figure describes the DEA efficiency ratings using model 1 for relative productivity efficiency. Y axis is % efficiency score and X axis is EBITDA.

50% productivity efficiency. The six 100% productivity efficient firms (of our sample) are TBS

International, Excel Maritime Carriers, Evergreen marine, Frontline, Neptune Orient Lines, and Mitsui OSK Lines. Eagle Bulk Shipping is the firm with the worst productivity efficiency rate relative to its competitors (Figure 1).

Table 7 also shows the EBITDA margins (%) of each firm. A higher EBITDA margin means that a company has free cash flows to make investments and generate returns on shareholders' investments. Our sample firms exhibit a mean of 43.74% EBITDA margin. This low level of financial performance is in sharp contrast with our findings on productivity efficiency using the DEA approach. Only the EBITDA margin of Dryships (93.73%) is consistent with its high DEA productivity efficiency score (87.08%). It is worth noting that Eagle Bulk Shipping has a high EBITDA margin (63.04%) relative to its corresponding low DEA efficiency score.

As far as the average efficiency scores of the three shipping sectors are concerned, Table 7 shows that the container firms are more productivity efficient than the tanker and the dry bulk shipping firms. The container shipping firms have a mean efficiency score of 86.4%, whereas the tankers and the dry bulk shipping firms have a mean of 74.8% and 73.5%, respectively. On the other hand, the average EBITDA margin of these groups shows the opposite results. Particularly, the container shipping firms have a very low EBITDA margin (14.5%) relative to the tankers and the dry bulk shipping firms, which have an average EBITDA margin of 74.8% and 73.5%, respectively. These differences between the two measures of performance are consistent with the argument that it is not proper to draw conclusions based on only two financial variables. The advantage of the DEA approach is the ability to consider various input and output variables simultaneously.

Table 8 shows market efficiency rates using model 2. Model 2 calculates market efficiency rates by maximising the market capitalisation (output) given the corresponding

Table 8: Market efficiency – DEA Ratings

Company	Efficiency score	ME improvement %
Eagle Bulk Shipping	100%	0.00%
Dryships	100%	0.00%
Frontline	100%	0.00%
Nippon Yusen KK	100%	0.00%
Mitsui Osk Lines	100%	0.00%
Neptune Orient Lines	97.47%	2.60%
Evergreen Marine	97.20%	2.90%
Diana Shipping	95.51%	4.70%
Wan Hai lines	73.93%	35.30%
Stolt-Nielsen	71.85%	39.20%
Overseas Shiphldg.GP.	60.39%	65.60%
Euronav	60.09%	66.40%
Excel Maritime Carriers	59.69%	67.50%
Teekay	59.59%	67.80%
Farstad Shipping	58.84%	69.90%
Navios Maritime HDG.	58.44%	71.10%
TBS International 'A'	54.12%	84.80%
A P Moller-Maersk 'B'	39.72%	151.80%
	Average	
All	77.05%	
Tanker	68.46%	
Dry Bulk	77.96%	

This table presents DEA ratings using model 2 for relative market efficiency.

earnings, cash flow and book value of equity (inputs), the three primary summary measures of the income and cash flow statements and balance sheet. Moreover, Table 8 provides the percentage market value improvement required by each firm in order to achieve 100% relative market efficiency. This is the optimal market value (given the corresponding earnings, cash flow and book value of equity) that would set (shift) the firm on the efficient frontier.

According to Table 8, the maritime firms exhibit an average market efficiency of 77.05% (Figure 2). Five (5) of the maritime firms are 100% efficient, whereas only one (1) firm exhibits less than 50% market efficiency. The firms with the highest relative market efficiency score (100%) are Eagle Bulk Shipping, Dryships, Frontline, Nippon Yusen KK, and Mitsui OSK Lines. A.P. Moller-Maersk is the firm with the

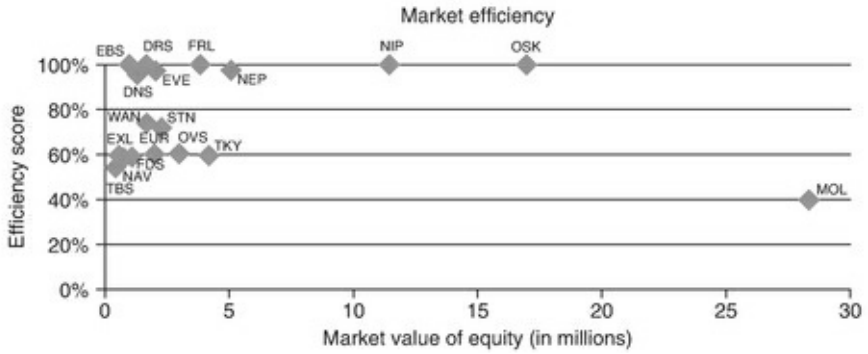

Figure 2. Market efficiency plot (ME)
This figure describes the DEA efficiency ratings using model 2 for relative market efficiency. Y axis is % efficiency score and X axis is market value of equity (ME).

smallest market efficiency score (39.7%). Therefore, two firms (Frontline and Mitsui) are consistently

rated as productivity and market efficient; as far as the DEA efficiency scores are concerned (Mitsui OSK has a very low EBITDA margin). It is noted that although Eagle Bulk Shipping is not productivity efficient, it is 100% market efficient. Conversely, A.P. Moller–Maersk is 94.7% productivity efficient, but it is not market efficient.

In terms of the market efficiency of the three shipping sectors, Table 8 shows that the container shipping firms are more market efficient (84.72%) than the dry bulk shipping firms (77.96%), and the dry bulk sector is more market efficient than the tanker firms (68.46%). Therefore, container firms seem to be both productivity and market efficient. Although tanker and dry bulk shipping firms exhibit similar productivity efficiency, dry bulk firms appear more market efficient than tanker firms, though the difference is relatively small.

In summary, conclusions on the productivity and market efficiency of the maritime firms seem to depend on the specific performance measure used. It seems that the container shipping sector is the most robust sector, being both productivity and market efficient, whereas the tanker and dry bulk sectors exhibit mixed evidence.

5. Discussion and Implications

The discussions above suggest several avenues for future research. First, there is a need to more systematically and rigorously evaluate the performance of shipping companies using multiple measures of operating and financial performance as well as in the use of inputs and outputs for relative efficiency measurement.

Performance should be measured both in absolute terms and relative to a chosen benchmark, such as the industry average (in the case of using accounting ratios or operating efficiency measures) or risk-adjusted metrics (as in stock performance evaluation). Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis have been extensively used in studies of container terminal or port/airport performance but there is room to apply these and other performance measurement methods (e.g. Balanced Scorecard) to shipping companies. One advantage of these performance measurement methods (especially when the right inputs and outputs are used) is that they may overcome difficulties in making international comparisons which may result from inconsistencies/differences in accounting and taxation rules in different countries (Schefczyk, 1993). By capturing the multi-dimensional nature of business performance, they may also mitigate inference problems arising from the use of only a small number of performance measures (variables).

In this chapter for instance we used data envelopment analysis (DEA) to estimate the so-called “efficient frontier” of international maritime firms in the dry bulk, tanker and container sectors in order to analyse deviations from such frontier corresponding to loss of efficiency. Consistent with Barth, Beaver and Landsman (1998), we build on the seminal work of Ohlson (1995) and Feltham and Ohlson (1995) concerning accounting-based valuation models. The use of this approach is innovative in the shipping industry context.

The second future research opportunity is to investigate the possible determinants of differential performance levels among shipping companies. Both within-country studies and cross-countries studies can be undertaken. Taken together, these studies have the potential to shed light on institutional, firm-specific as well as market-specific factors that are associated with differential performance. Knowledge of such factors is important for making informed decisions in resource

deployment and allocation. In this regard, the finance, economics and management literature offers much useful guidance on the possible factors that determine firm performance. A comprehensive review of this literature, supplemented by implications for the shipping industry, is currently lacking but is warranted. This chapter makes an initial attempt at this important task.

On the managerial and policy front, it will be useful to conduct more research on the long-term performance of shipping companies conditional on the adoption of a certain corporate strategy or change in industry policy. For example, it will be of interest to know how shipping companies' risk or cost of capital is affected by regulatory changes such as implementation of the International Safety Management (ISM) Code or the Tanker Management and Self Assessment approach (TMSA). It is also of interest to assess the change (if any) in the competitive positioning of a shipping company subsequent to the formation of alliances, privatisation or restructuring. There are only a limited number of studies that look into these interesting topics, and the majority of the existing studies tend to focus on short-term (as opposed to long-term) stock market reactions. Gong (2009) reviews some of the related studies in the transport industry and presents a detailed discussion of the event study methodology that is well suited for this type of research.

Given the distinct possibility that different performance measures (e.g. financial, operating, and market-based measures) may lead to different conclusions on business performance, it is important to conduct a robustness check by applying multiple performance measures before drawing any concrete conclusion. Only after such thorough analyses can reliable conclusions be drawn on the profitability and performance of the shipping industry as a whole, or of specific companies that have adopted specific strategies. Well-supported evidence of this type, which is currently missing, will be useful to all of (existing as well as prospective) investors in shipping, industry analysts, corporate managers, and policy makers alike.

Appendix

Acronyms

Name	Acronvm	Specialty
Stolt-Nielsen	STN	Tanker
Teekay	TKY	Tanker
Overseas Shiphldg.GP.	OVS	Tanker
Farstad Shipping	FDS	Tanker
Euronav	EUR	Tanker
Frontline	FRL	Tanker
Eagle Bulk Shipping	EBS	Dry bulk
Diana Shipping	DNS	Dry bulk
Navios Maritime HDG.	NAV	Dry bulk
Dryships	DRS	Dry bulk
Excel Maritime Carriers	EXL	Dry bulk
TBS International 'A'	TBS	Dry bulk
A P Moller-Maersk 'B'	MOL	Container
Evergreen Marine	EVE	Container
Mitsui Osk Lines	OSK	Container
Nippon Yusen KK	NIP	Container
Wan Hai Lines	WAN	Container
Neptune Orient Lines	NEP	Container

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Endnotes

1. In the shipping market context, Lagoudis, Lalwani and Naim (2006) use 24 factors in 4 categories (quality, service, cost and cycle time) to measure the performance (in terms of creating value) of ocean transportation companies. They find that the companies surveyed place the strongest emphasis on quality but the least emphasis on time as a value contributor. Also see Chou and Liang (2001) for the use of multiple criteria in assessing shipping company performance.
2. Jensen (2001) argues for a single corporate objective function, i.e. maximising a firm's long-term total market value, in contrast with the view of traditional stakeholder theory which argues for taking into account the interests of all stakeholders in a firm including not only financial claimants but also employees, customers, communities and even the environment. He proposes a variant of value maximisation, known as Enlightened Value Maximization, and argues it is identical to enlightened stakeholder theory (and Balanced Scorecard, the managerial equivalent of stakeholder theory).

References

Ashar, A. (1995): "Factor analysis and benchmarking ports' performance", *Maritime Policy & Management*, 22(4), 389–390.

Bacidore, J.M., Boquist, J.A., Milbourn, T.T. and Thakor, A.V. (1997): "The Search for the Best Financial Performance Measure", *Financial Analysts Journal*, 53(3), 11–20.

Banker, R.D., Potter, G. and Srinivasan, D. (2000): "An empirical investigation of an incentive plan that includes nonfinancial performance measures", *Accounting Review*, 75(1), 65–92.

Barth, M., Beaver, W., Hand, J. and Landsman, W. (1999): "Accruals, Cash Flows and Equity Values", *Review of Accounting Studies*, Vol. 4, 205–229.

Barth, M., Beaver, W. and Landsman, W. (1998): "Relative valuation roles of equity book value and net income as a function of financial health", *Journal of Accounting and Economics*, 25, 1–34.

Bichou, K. and Gray, R. (2004): "A logistics and supply chain management approach to port performance measurement", *Maritime Policy & Management*, 31(1), 2004, 47–67.

Boone, C. and Hendriks, W. (2009): "Top management team diversity and firm performance: moderators of functional-background and locus-of-control diversity", *Management Science*, 55(2), 165–180.

Brammer, S. and Millington, A. (2008): "Does it pay to be different? An analysis of the relationship between corporate social and financial performance", *Strategic Management Journal*, 29(12), 1325–1343.

Brooks, M.R. and Pallis, A. (2008): "Assessing port governance models: process and performance components", *Maritime Policy & Management*, 35(4), 411–432.

Baliga, B.R., Moyer, R.C. and Rao, R.S. (1996): "CEO duality and firm performance: what's the fuss?", *Strategic Management Journal*, 17(1), 41–53.

Barth, M.E., Beaver, W.H. and Landsman, W.R. (1998): "Relative valuation roles of equity book value

and net income as a function of financial health", *Journal of Accounting and Economics*, 25(1), 1–34.

Bourgeois III, L.J. (1980): "Performance and consensus", *Strategic Management Journal*, 1(3), 227–248.

Buxton, L.L. and Akgul, B.U. (1989): "The comparison of general cargo ship economic performance by simulation", *Maritime Policy & Management*, 16(1), 27–44.

Capon, N., Hulbert, J.M., Farley, J.U. and Martin, L.E. (1988): "Corporate diversity and economic performance: the impact of market specialization", *Strategic Management Journal*, 9(1), 61–74.

Chakravarthy, B.S. (1986): "Measuring strategic performance", *Strategic Management Journal*, 7(5), 437–458.

Chari, M.D.R., Devaraj, S. and David, P. (2008): "The impact of information technology investments and diversification strategies on firm performance", *Management Science*, 54(1), 224–234.

Christensen, H.K. and Montgomery, C.A. (1981): "Corporate economic performance: diversification strategy versus market structure", *Strategic Management Journal*, 2(4), 327–343.

Chou, T-Y. and Liang, G-S. (2002): "Application of a fuzzy multi-criteria decision-making model for shipping company performance evaluation", *Maritime Policy & Management*, 28(4), 375–392

Collins, D., Pincus, M. and Xie, H. (1999): "Equity valuation and negative earnings: the role of book value of equity", *The Accounting Review* 74, pp. 29–61.

Craighead, C.W., Hult, G.T.M. and Ketchen Jr, DJ (2009): "The effects of innovation– cost strategy, knowledge, and action in the supply chain on firm performance", *Journal of Operations Management*, 27, 405–421.

Crohin, J.J. and Taylor, S.A. (1992): "Measuring service quality: a reexamination of extension". *Journal of Marketing* vol. 56, 3, 55–68.

De P. and Ghosh, B. (2003): "Causality between performance and traffic: an investigation with Indian ports", *Maritime Policy & Management*, 30(1), 5–27.

De Langen P. W. (2002): "Clustering and performance: the case of maritime clustering in the Netherlands", *Maritime Policy & Management*, 29(3), 209–221.

de Luque, M.S., Washburn, N.T., Waldman, D.A. and House, R.J. (2008): "Unrequited profit: how stakeholder and economic values relate to subordinates' perceptions of leadership and firm performance", *Administrative Science Quarterly*, 53(4), 626–654.

Dechow, P.M. (1994): "Accounting earnings and cash flows as measures of firm performance: The role of accounting accruals", *Journal of Accounting and Economics* Vol. 18, No.1, pp. 3–42.

Dehning, B., Richardson, V.J. and Zmud, R.W. (2007): "The financial performance effects of it-based supply chain management systems in manufacturing firms", *Journal of Operations Management*, 25(4), 806–824.

Dragovic´, B., Park, N.K. and Radmilovic´, Z. (2006): "Ship-berth link performance evaluation: Simulation and analytical approaches", *Maritime Policy & Management*", 33(3), 281–299.

Dubofsky, P. and Varadarahan, P. (1987): "Diversification and measures of performance: additional empirical evidence", *Academy of Management Journal*, 30(3), 597–608.

Eccles, R.G. (1991): "The performance measurement manifesto", *Harvard Business Review*, January/February, 131–137.

Feltham, G. and Ohlson, J. (1995): "Valuation and clean surplus accounting for operating and

financial activities", *Contemporary Accounting Research*, 11, 689–731.
Fogler, H.R. and Nutt, F. (1975): "A note on social responsibility and stock valuation", *Academy of Management Journal*, 18(1), 155–160.
Griffith, J.M. (2004): "The true value of EVA®", *Journal of Applied Finance*, 14(2), 25–29.
Gomez-Mejia, L. (1992): "Structure and process of diversification, compensation strategy and firm performance", *Strategic Management Journal*, 13(5), 381–397.
Gong, S.X.H. (2009): "Event study in transport research: Methodology and applications", *Transport Reviews*, 29(2), 207–222.
Grammenos, C.Th. and Arkoulis, A.G. (1999): "The long run performance of shipping initial public offerings", *Maritime Economics & Logistics*, 1, 71–93.
Grammenos, C.Th. and Arkoulis, A.G. (2002): "Macroeconomic factors and international shipping stock returns", *Maritime Economics & Logistics*, 4, 81–99.
Grammenos, C.Th. and Marcoulis, S.N. (1996a): "A cross-section analysis of stock returns: The case of shipping firms", *Maritime Policy & Management*, 23(1), 67–80.
Grammenos, C.Th. and Marcoulis, S.N. (1996b): "Shipping initial public offerings – a cross-country analysis", in: M. Levis (ed.) *Empirical Issues in Raising Equity Capital* (North-Holland), pp. 380–400.
Gunasekaran, A., Patel, C. and Tirtiroglu, E. (2001): "Performance measures and metrics in a Supply Chain Environment", *International Journal of Operations and Productivity Management*, 21(1/2), 71–87.
Hawawini, G., Subramanian, V. and Verdin, P. (2003): "Is performance driven by industry – or firm-specific factors? A new look at the evidence", *Strategic Management Journal*, 24(1), 1.
Hult, G.T., Ketchen Jr., D.J., Adams, G.L. and Mena, J.A. (2008): "Supply chain orientation and balanced scorecard performance", *Journal of Managerial Issues*, 20(4), 526–544.
Hult, G.T., Ketchen, J., David J. and Slater, S.F. (2005): "Market orientation and performance: an integration of disparate approaches", *Strategic Management Journal*, 26(12), 1173–1181.
Ittner, C.D. and Larcker, D.F. (1998): "Are nonfinancial measures leading indicators of financial performance? An analysis of customer satisfaction", *Journal of Accounting Research*, 36(3), 1–35.
Jain, S.K. and Bhatia, M. (2007): "Market orientation and business performance: The case of indian manufacturing firms", *Vision*, 11(1), 15–33.
Jensen, M.C. (2001): "Value maximization, stakeholder theory, and the corporate objective function", *European Financial Management*, 7(3), 297–317.
Jenssen, J.I. and Randøy, T. (2006): "The performance effect of innovation in shipping companies", *Maritime Policy & Management*, 33(4), 327–343.
Karlaftis, M.G. (2004): "A DEA approach for evaluating the efficiency and effectiveness of urban transit systems", *European Journal of Operational Research*, 152 (2), 354–364.
Kaynak, H. (2003): "The relationship between Total Quality Management practices and their effects on firm performance", *Journal of Operations Management*, 21(4), 405–435.
Koka, B.R. and Prescott, J.E. (2008): "Designing alliance networks: the influence of network position, environmental change, and strategy on firm performance", *Strategic Management Journal*, 29(6), 639–661.

Lagoudis, I.N., Lalwani, C.S. and Naim, M.M. (2006): "Ranking of factors contributing to higher performance in the ocean transportation industry: A multi-attribute utility theory approach", *Maritime Policy & Management*, 33(4), 345–369.

Lambertides, N. and Louca C. (2008): "Ownership structure and operating performance: Evidence from the European maritime industry", *Maritime Policy & Management*, 35(4), 395–409.

Lathrop, D.S. (1979): "Ship productivity as a measure of maritime performance", *Maritime Policy & Management*, 6(3), 183–186

Lovata, L.M. and Costigan, M.L. (2002): "Empirical analysis of adopters of economic value added", *Management Accounting Research*, Vol 13, 2, pp. 215–228.

Luo, X., Rindfleisch, A. and Tse, D.K. (2007): "Working with rivals: The impact of competitor alliances on financial performance", *Journal of Marketing Research*, Vol. 44(1), 73–83.

Kaplan, R.S. and Norton, D.P. (1992): "The Balanced Scorecard: The measures that drive performance", *Harvard Business Review*, January–February, 71–79.

Lam, J.S., Yap W.Y. and Cullinane, K. (2007): "Structure, conduct and performance on the major liner shipping routes", *Maritime Policy & Management*, 34(4), 359–381.

Lin, L.C. and Tseng, C.C. (2007): "Operational performance evaluation of major container ports in the Asia-Pacific region", *Maritime Policy & Management*, 34(6), 535–551.

Madden, B.S. (1998): "The CFROI valuation model", *The Journal of Investing*, vol. 7, 1, pp. 31–44.

McDonald, M.L., Khanna, P. and Westphal, J.D. (2008): "Getting them to think outside the circle: Corporate governance, CEOs' external advice networks, and firm performance", *Academy of Management Journal*, 51(3), 453–475.

Mehra, A. (1996): "Resource and market based determinants of performance in the US banking industry", *Strategic Management Journal*, 17(4), 307–322.

Makino, S., Isobe, T. and Chan, C.M. (2004): "Does country matter?", *Strategic Management Journal*, 25(10), 1027–1043.

McGahan, A.M. (1999): "The performance of US corporations: 1981–1994", *The Journal of Industrial Economics*, 47(4), 373–398.

Morgan, N.A. and Rego, L.L. (2009): "Brand portfolio strategy and firm performance", *Journal of Marketing*, 73(1), 59–74.

Morgan, N.A., Vorhies, D.W. and Mason, C.H. (2009): "Marketing orientation, marketing capabilities, and firm performance", *Strategic Management Journal*, 30(8), 909–920.

Nadkarni, S. and Narayanan, V.K. (2007): "Strategic schemas, strategic flexibility, and firm performance: the moderating role of industry clockspeed", *Strategic Management Journal*, 28(3), 243–270.

Ohlson J. (1995): "Earnings, book values and dividends in security valuation", *Contemporary Accounting Research*, 11, 661–687.

Panayides. Ph. M. (2003): "Competitive strategies and organizational performance in ship management", *Maritime Policy & Management*, 30(2), 123–140

Perera, S., Harrison, G. and Poole, M. (1997): "Customer-focused manufacturing strategy and the use of operations-based non-financial performance measures: a research note", *Accounting, Organizations & Society*, 22(6), 557–572.

Peters, T.J. and Waterman, R.H. (1982): *In Search of Excellence: Lessons From America's Best Run Companies*, (New York, Harper & Row).

Rajagopalan, N. (1997): "Strategic orientations, incentive plan adoptions, and firm performance: Evidence from electric utility firms", *Strategic Management Journal*, 18(10), 761–785.

Randoy, T., Down, J. and Jenssen, J.I. (2003): "Corporate governance and board effectiveness in maritime firms", *Maritime Economics & Logistics*, 5, 40–54.

Ryan, H.E. and Trahan, E.A. (2007): "Corporate financial control mechanisms and firm performance: The Case of Value-Based Management Systems", *Journal of Business Finance & Accounting*, 34(1), 111–138.

Saundry, R. and Turnbull, P. (1997): "Private profit, public loss: The financial and economic performance of UK ports", *Maritime Policy & Management*, 24(4), 319–334.

Roll, Y. and Hayuth, Y. (1993): "Port performance comparison applying data envelopment analysis (DEA)", *Maritime Policy & Management*, 20(2), 153–161.

Schefczyk, M. (1993): "Operational performance of airlines: An extension of traditional measurement paradigms", *Strategic Management Journal*, 14, 301–317.

Short, J.C., Ketchen Jr., D.J., Palmer, T.B. and Hult, G.T. (2007): "Firm, strategic group, and industry influences on performance", *Strategic Management Journal*, 28(2), 147–167.

Sohn, J-R. and Jung. C-M. (2009): "The size effect of a port on the container handling efficiency level and market share in international transshipment flows", *Maritime Policy & Management*, 36(2), 117–129.

Sorescu, A.B. and Spanjol, J. (2008): "Innovation's effect on firm value and risk: Insights from consumer packaged goods", *Journal of Marketing*, 72(2), 114–132.

Tabernacle, J.B. (1995): "A study of the changes in performance of quayside container cranes", *Maritime Policy & Management*, 22(2), 115–124.

Talley, W.K. (1988): "Optimum throughput and performance evaluation of marine terminals", *Maritime Policy & Management*, 15(4), 327–331.

Tanriverdi, H. and Chi-Hyon, L.E.E. (2008): "Within-industry diversification and firm performance in the presence of network externalities: Evidence from the software industry", *Academy of Management Journal*, 51(2), 381–397.

Thomas III, L.G. and Waring, G. (1999): "Competing capitalisms: capital investment in American, German, and Japanese firms", *Strategic Management Journal*, 20(8), 729–748.

Tsai H-C., Chen C-M. and Tzend G-H., (2006): "The comparative productivity efficiency for global telecoms", *Int. J. Production Economics*, 103: 509–526.

Turner, H.S. (2000): "Evaluating seaport policy alternatives: A simulation study of terminal leasing policy and system performance", *Maritime Policy & Management*, 27(3), 283–301.

Uotila, J., Maula, M., Keil, T. and Zahra, S.A. (2009): "Exploration, exploitation, and financial performance: Analysis of S&P 500 corporations", *Strategic Management Journal*, 30(2), 221–231.

Veenstra, A.W. and Ludema, M.W. (2006): "The relationship between design and economic performance of ships", *Maritime Policy & Management*, 33(2), 159–171.

Wan, W.P. and Hoskisson, R.E. (2003): "Home country environments, corporate diversification strategies, and firm performance", *Academy of Management Journal*, 46(1), 27–45.

Wang, Y., Cohen, M.A. and Zheng, Y-S. (2002): “Differentiating customer service on the basis of delivery lead times”, *IIE Transactions* vol. 34, 11, 979–989.

Wisner, J.D. (2003): “A structural equation model of supply chain management strategies and firm performance”, *Journal of Business Logistics*, 24(1), 1–26.

Walker, O.C. and Ruekert, R.W. (1987): “Marketing’s role in the implementation of business strategies: A critical review and conceptual framework”, *Journal of Marketing*, 45, 15–33.

Zott, C. and Amit, R. (2008): “The fit between product market strategy and business model: Implications for firm performance”, *Strategic Management Journal*, 29(1), 1–26.

Part Nine

Shipping Investment, Finance and Strategy

Chapter 23

Investing in Twenty-First Century Shipping: An Essay on Perennial Constraints, Risks and *Great Expectations*

Helen Thanopoulou[*]

1. Introduction. Investing In Ships Revisited

The extraordinary twists and turns of the world economy since the start of the twenty-first century could not be more revealing or instructive of the inner workings of shipping investment. Shipping economics exist as a separate branch of economics for two reasons: the one is the cyclicality of the shipping markets; the other is the idiosyncratic nature of shipping investment. The two are inextricably linked: Investing in ships could be classified as an astute, a brave or an irrational decision depending on the state and the prospects of the shipping markets which rarely – if ever – fulfil the promises they seem to give. Yet the first decade of the current century unfolded as if this latter element of uncertainty had been removed as investors proceeded euphorically into taking the world fleet well over the one billion dwt mark.[1] However, by the end of 2008 any doubts whether the "endemic tendency to over-invest", as astutely described by the late B.N. Metaxas,[2] stills holds in shipping had dissolved as freight rate lows - not seen since the dry-bulk crisis of the 1980s – succeeded the records the market had kept breaking since 2003. Late 2008 developments were not, however, the result of investors' *great expectations*. As the first decade of the new century is drawing to a close pending massive future deliveries have yet to hit the market in order to be measured against future demand which remains an unknown quantity, literally. Nevertheless, the prospect of supply developments coinciding with an eventually protracted world trade recession have revived investors' worst basic fears while painfully inviting a return to well-known basics of shipping economics.

Less than a year from September 2008 – and about a quarter of a century later from the early 1980s – a familiar picture has formed: dearth of orders, death of shipyards, creation of equity funds to target distress sales of second-hand vessels as companies winding-down leave wound-up creditors with few options than to foreclose. Looking at this last cycle of shipping investment there are few better expressions to describe the way events have been unfolding than "*Plus ça change plus c'est la même chose*".[3] Despite main mechanisms and results remaining the same, the picture in shipping investment has changed also: firstly in the way physical and paper assets intertwine in what can be considered anymore as commonly managed shipping-based portfolios; second, in the way changes in the transactional setting in shipping resulted in aggravating risks or even adding new to the "standard" one of market cyclicality. All types of risk were highlighted most powerfully in the light of the manifestation of the "credit crunch" as a full-blown "credit crash" in late 2008, upsetting markets along with theoretical dogmas considered until then not only academically definitive but also final.[4]

This chapter focuses on traditional investment in physical shipping assets. The main text begins with familiarising the reader with the idiosyncrasies of shipping investment in the second section. Section 3 analyses the operational constraints that bulk and liner companies face when deciding to

invest in either new or second hand-vessels. Section 4 discusses the difficult balancing act of weighing anticipated vessel endurance, cost differences and delivery lags in the investment decision; section 5 focuses on asset play on the basis of the experience from the last major shipping crisis with references to the period before and after the September 2008 financial crisis. The penultimate section 6 of the chapter reviews the setting for shipping investment in the twenty-first century while the summary in section 7 concludes by pointing to research themes that this decade's developments bring to the fore.

2. Market Cyclicality and Investment in Commercial Vessels

Market cycles are common in competitive markets; fully competitive markets are, however, rather uncommon in the modern economy. As discussed earlier in this volume, while price fluctuations of fixed assets can be assessed in other markets, there is little comparison with the volatility asset prices in shipping have shown.[5] The parallel effect of recessional factors on the shipping, shipbuilding and – usually – scrapping markets[6] create an absolute impasse for investors who often found themselves with very substantial amounts of tied-up capital and practically little or no alternative use for assets often valued at no more than an insignificant fraction of their acquisition price. Equally, as developments related to cancellations following the 2008 financial crisis reminded, precipitated adjustments of previous investment decisions are achievable, often at a price that cash-poor market conditions may justify as entirely necessary, but can hardly qualify as totally ideal.

2.1 Investing in the different shipping segments

While volatility of asset prices can vary between individual shipping markets,[7] due to differences in the market structure of traditional and specialised bulk shipping markets,[8] it remains a common feature of all bulk shipping segments which make-up the majority of the world tonnage. Liner shipping is not exempt from asset price volatility either; while liner shipping idiosyncrasies may dictate a different approach with regard to investment, recent policy and market developments have increased risk for investors in container vessels as well.

As far as the bulk markets are concerned, volatility of both the freight markets and of asset prices should be considered as the key factors which should – or at least common sense would require so – weigh heavily on all decisions regarding investment in merchant vessels. In practice, an ex post analysis of investment decisions reveals that despite volumes of literature and a series of investment disasters there is still little practical understanding of the nature of the bulk shipping markets and of their idiosyncrasies. In this sense, the repetitive nature of shipping over-investment remains a conundrum especially when considering industry returns,[9] pointing to either *lack* of *investment memory* or simply to the competitive nature of most shipping markets, or to a combination of both. The history of world shipping is fraught with examples of crises that can be blamed on excessive ordering more than they can be blamed on any other factor.[10] When the competitive behaviour of investors is taken into account in the context of the competitive nature of most of the industry, the textbook ignorance of individual investors regarding the impact of their own investment decisions is put in context. What is, however, definitely intriguing is that patterns of over-ordering can be easily traced in this century even in markets where "speculative" investment (i.e. investment with no guaranteed demand) was previously unknown. This has been the case of Liquefied Natural Gas (LNG) carriers,[11] since around the millennium, as the segment was evolving from a "hybrid"[12] *quasi-market* to its current – *more or less* competitive than other shipping markets[13] – structure. Regardless,

however, of how different in nature the different bulk shipping segments can be, the inherent risks investors face are more or less common; they only differ in terms of the particular weight they can potentially hold in each individual market. Although the risks discussed below apply mostly to bulk shipping, it should be noted that the liner sector – shielded to a degree from excessively violent fluctuations until lately – remained exposed throughout its modern existence to the potential risks of large sunk costs and of technological obsolescence. In one of these synchronicities that abound in shipping, the manifestation of the financial crisis coincided with the end of the exemption of shipping conferences from European competition regulation; this was about a decade after US trades had seen the power of conferences weakened through the practical implications[14] of OSRA 1998. Both regulatory changes increased the exposure of liner shipping to trade volatility; shortly after September 2008, the latter led to rate levels associated usually with bulk segments, smoothing in its wake differences between bulk and liner shipping investment risks.

2.2 Different markets – common risks

2.2.1 Uncertainty taken to the extreme

The first and foremost risk investors face when committing their money to bulk shipping comes from market volatility. Most markets tend to present fluctuations more in terms of volume of sales than in terms of price levels. Bulk fleets which constitute the bulk of the world's tonnage[15] as well, are as a rule affected by both vessel unemployment and rapidly declining prices at times of ever-returning shipping recessions which can appear with or without any – mostly unheeded by investors – warning. Liner owners have been finding increasingly that their predicament is not dissimilar. The quick reversal of shipping market conditions in the second half of 2008 has been in itself a "crash" course in what S. Kaplan and B.J. Garrick defined in 1981 as the "set of triplets" related to risk:[16] the specific "*scenario"* was in the minds of very few at the time the bulk of – bulk and liner – orders had been placed; it was considered of low "*likelihood"* in the context of ever-growing confidence in infallible markets, but eventually the sheer force of the painfully felt "*consequence"* finally showed the range of magnitude that should have been attributed to the risk taken. While common investment appraisal techniques had traditionally not served shipping, even more modern approaches could well prove of limited use in investment planning in such extraordinary circumstances.

2.2.2 Problematic fitting of common investment appraisal techniques

The risk of reduced sales or asset inactivity can be deemed common for shipping and all other markets. However, the prospect of freight levels continuously fluctuating not only adds to the real risk of investment, it also renders attempts for calculating this risk accurately rather ineffective. Indeed, most common investment appraisal techniques require some degree of assumed stability of prices or a predictable path of price changes and a reasonable chance of assets being fully employed when the investment starts yielding. In the case of bulk ships, common investment appraisal techniques can prove highly misleading and their role should be limited to that of a guide about what the investment would cost and what would be the expected return.[17] More sophisticated approaches need to take into account long-term factors which are not always visible to outsiders to the industry. Unless investors and lenders alike are well versed in shipping market volatility incorporating it into any effort to appraise returns,[18] only chance can reconcile predictions to results.

2.2.3 Large sunk costs

High volatility of freight rates and asset price volatility combine to create the perfect nightmare for the potential investor especially when resale values and alternative uses of the vessel themselves are considered. As already underlined, the scrap market usually shifts in parallel with the markets for shipping services and the markets for ships; this has been most evident over the crisis of the 1970s and the 1980s. That results in a barrier to exit which is difficult to surmount by a resale of the vessel for storage or other uses.[19] It is perhaps better that too many investors go ahead with their plans ignoring the worst-case scenario or shipping would have become a market suffering from chronic under-investment: taking into account how few alternative uses and potential resale opportunities there are in a crisis should normally make the bravest of investors fret when considering the potential market depreciation of their assets. While there are few sunk costs of another nature for bulk shipping companies, liner companies face an additional sunk cost as they tend to invest heavily in offices, agency networks and, eventually, terminals as well. The relative stability of liner shipping business compared to the degree of volatility of bulk shipping markets and the nature of liner competition in the past moderated the exposure to sunk costs by limiting not their potential magnitude in absolute terms but the likelihood of the related scenario. However, adverse trade developments following the recent downturn, coupled by the impressive growth of the container fleet and the termination of the EU conference exemption, have changed the picture so drastically as to allow what has been recorded as “zero”[20] rates to be observed in main routes.

2.2.4 Technological obsolescence

Ships not only become obsolete by wear and tear; they can also become obsolete through the introduction of a new type of vessel which would be deemed superior in terms of quality of service or indeed in terms of cost for providing shipping services. The product life cycle, as introduced by Dean many decades ago,[21] finds application both in terms of types of tonnage as well as in terms of type of service.[22] Although rarely taken into account[23], technological obsolescence can reverse estimates of investment returns and shorten the economic life of a vessel dramatically. Developments in recent years in both specialised bulk shipping markets, such as reefers, and in liner shipping, which had provided in the 1960s the prominent example of the replacement of conventional general cargo ships by cellular ones, require that the impact of what could be termed broadly technological obsolescence – incorporating the aspect of size – and ensuing commercial obsolescence are taken into account. In bulk shipping, the fading-out of an entire segment of specialised bulk tonnage[24] proved inevitable as technology and economies of scale combined to allow the cost-competitive carriage of cargo under controlled temperatures in suitable containers by liner operators. In the liner sector, unless smaller markets develop at a pace sufficient to absorb lower-capacity vessels removed from the main routes as carriers take advantage of economies of scale (or ironically unless trade declines to take vessel-capacity requirements to past levels), previous container vessel generations are extremely vulnerable[25] as new larger ones add to competitors’ fleets. These examples from both liner and bulk shipping show a degree of commonality in terms of the risks investors are faced with in both markets; however, it is not necessarily so in terms of constraints under which investment decisions are taken in bulk and liner shipping although in the latter case the distinction between investor-operator and investor in tonnage alone becomes critical.

3. Operational Constraints of Bulk and Liner Acquisitions

Examining investment attitudes automatically leads to discussing the particular constraints operating companies face when proceeding to vessel acquisitions. The question of company motives for investing seems *prima facie* naive; a blanket statement on profit maximisation would seem to provide the rule. However, as business goals[26] can deviate from this axiom so can investment motives. In the case of shipping this will be largely dependant on the nature of the shipping company. Although a small minority today, state enterprises had been a force to be reckoned with[27] in the not too distant past and for some, at the time, the potential source of threats to free competition in shipping which has yet to materialise. State companies, however, are likely to have different motives than the typical shipping company of private ownership when considering investment. By the same token, the profit maximisation rule is unlikely to apply to integrated shipping divisions of non-shipping companies; the most known example of companies of the latter type historically is that of shipping divisions or subsidiaries[28] of large oil companies.[29] In the case of state companies the motive for an investment decision might be the balance of payments, national security, including securing supply chains, or eventually that of national prestige;[30] all result equally in particular constraints under which investment decisions have to be taken. If investment would for instance be decided to align to the growth of national trades, new investment could be a multiple of what competitive advantage and ship values would dictate, assuming that cash-flow and capital availability do not come into play in the case of state companies. Table 1 summarises the different positions of each main type of shipping company *vis-á-vis* the potential special constraints under which they consider new investment in tonnage in addition to habitual business ones associated with investment decisions.

Table 1: Investment/divestment constraints in shipping[31]

Company type	**Constraints**
Bulk	insignifi cant in most cases
Liner	frequency constraints, cooperation constraints, route constraints
Non-commercial: state-owned or integrated	share of own transport as defi ned/desired by parent company or state policy

3.1 Investing in bulk shipping: no holds barred

The most significant differences in terms of investment constraints exist between liner and bulk shipping companies (assuming both are under private ownership). Bulk shipping companies, unlike liner companies, are usually exempt of limitations when programming investment or divestment in ships and hence determining company size. In most cases a bulk shipping company will invest (or divest) in whatever type or size of bulk vessel it considers profitable on the basis of the state and the prospects of the freight and ship markets. A bulk shipping company mainly active in the dry bulk sector may invest in tanker vessels also or even completely shift from the dry to the liquid bulk market if the prospects of the tanker market look more promising or vice-versa.[32] By the same token, a bulk company can choose to diversify by investing into more than one bulk shipping segment including specialised shipping markets. Investment/ divestment flexibility may be affected mainly due to governance or regulation issues pertaining to specific company structures such as listed companies. However, when it comes to the specialised bulk shipping segments absolute investment freedom might in reality prove a little more relative: specialised vessel types, such as Liquefied Petroleum Gas carriers (LPGs), Liquefied Natural Gas carriers (LNGs) or chemical carriers, still

require a significant degree of know-how and experience to consider entry into these markets as automatic or barrier free. The role of bulk shipping pools[33] in the specialised shipping markets and of other companies open to manage outside tonnage alongside their own or eventually act as managers only,[34] has nevertheless preserved the right of shipowners to enter with minimum investment even in specialised shipping segments; shipping pools had been found, however, to be a constraint for owners when it comes to divestment affecting asset-play opportunities.[35]

3.2 Investing in liner tonnage: operational and cooperation constraints

Liner shipping companies are without doubt under more constraints when considering their investment policy not only by comparison to bulk shipping companies but also by comparison to a large number of industries. These constraints relate not only to the specific characteristics of the routes these companies serve, but also to the cooperation agreements liner companies usually have; very few, usually among the top two or three largest, have historically survived successfully without resorting to what has been described as strategic or operational alliances of various forms.[36] Pools and consortia – the latter evolving over the last 15 years into global alliances – have dominated the supply of liner shipping services;[37] these forms of cooperation between container carriers allowed to combine capacity to serve trade routes which became increasingly demanding in terms of capacity and frequency. Operational cooperation normally requires that operational capacity adjustments – and hence investment decisions – are planned from a common perspective otherwise under-utilisation of capacity and problems in network planning, or equipment incompatibity lurk. It is possible that a combination of these constraints together with the eagerness of outside investors[38] to invest in the container market has led to an – increasing over recent years – part of tonnage being drawn from the container charter market.[39] The nature of the liner business itself, which is the provision of regular advertised and – increasingly over the globalisation era – frequent sailings of containerships, precludes drastic capacity reductions or service withdrawals through massive asset-play motivated divestment due to loss of goodwill,[40] cyclical downturns notwithstanding. In this regard the combination of co-operation agreements together with the existence of a pool of container tonnage available in the container charter market has added to the flexibility of liner shipping companies which would otherwise remain much more restricted than their bulk counterparts in terms of freedom in investment and divestment decisions.

4. Newbuilding Vs Second-Hand Vessels: Balancing Delivery Lags With Vessel Endurance

Both bulk and liner companies, are faced with a number of alternative choices when they decide to proceed with new investment. Although often a fraction of such levels, deep-sea going vessel values, especially of newbuildings, have been on average in the order of tens of millions of dollars in the past decades. The globalisation of the shipbuilding industry and the expansion of capacity have resulted in multiplying choices for placing orders but equally in dividing prices by a factor analogous to the observed successive waves of shipbuilding capacity coming into the market.[41]

Despite, however, the relatively easy access to shipping investment through the enlargement of the circle of shipbuilding competitors, aggressive competition[42] and abundant finance in the post-war period, the role of fixed cost remains critical for shipping competitiveness. In this regard, the choice

between investing in a newbuilding or in a second-hand vessel must take into account *market prospects for both the freight and* – the closely related – *ship markets, current price levels* as well as *price differences* between new and old tonnage.

4.1 Know thy market: New-orders vs second-hand acquisitions

Acquiring vessels is perhaps the major pillar of company strategy in an industry environment that is characterised by cyclicality of both income and asset values especially when the exit barriers already discussed are taken into account. The realisation by many firms of the importance of investment decisions in this context is perhaps at the origin of the popularity of second-hand acquisitions of vessels. Otherwise, taking into account the existence of abundant finance and – for most of the post-war period – of attractive prices, grants or of a combination of all of the above, it would seem surprising that second-hand vessels would be an investment option at all. Investing in secondhand tonnage implies not only a shorter economic life of the vessel but also assuming the risk of hidden defaults that can eventually still remain undetectable despite strict checks before the purchase of the vessel.

The reasons for the popularity of second-hand acquisitions are in essence two-fold: (a) when investing in a second-hand ship the shipping company faces a much lower capital cost[43] compared to the alternative of a newbuilding; and (b) the waiting time for the actual delivery of the ship is minimal compared to the "normal" 1.5 to two years in the case of new orders. Normality is, however, the exception in a competitive market entirely open and extremely vulnerable to the influence of a multitude of exogenous factors. The quick reversal of market conditions due to the oil shock of 1973 is in that sense a classic example which shows how investment in newbuildings can prove riskier than investment in second-hand vessels. During the first half of the 1970s the expected delivery lag for orders placed at the time was often much longer than the 18–24 month usual range.[44] As the case of the 1970s proved, lags can be catastrophic if vessels are to be delivered so late that they cannot catch even a glimpse of the short booms which characterise shipping;[45] investors placing orders in the final years of the latest peak were painfully reminded so. Delays guarantee that delivery will come after – or sometimes long after – the relatively brief period of prosperity has degenerated into a lengthy recession if not into a full-blown depression as the case was for many segments in the crisis of the 1970s and the 1980s.

In view of these remarks, it could seem that opting for readily available second-hand vessels while freight rates are still climbing is more effective. At least the market seems to share such a view as price differentials between new-buildings and second-hand vessels tend to narrow – or even reverse – as shipbuilding availability tightens;[46] the repeat of this phenomenon in the twenty-first century has a long history in modern shipping as data for the first post-World War II years suggest. [47] Yet, as the most important disadvantage of a second-hand acquisition is the – normally – much shorter economic life of the ship, narrowing price differentials between new and second-hand tonnage during market booms are a strong indication that shipping investors obey to laws particular to this industry and often to this industry alone: while the short duration of shipping booms is perhaps the only certainty one can have about bulk shipping markets, even cash-tight companies risk their liquidity betting on excessively priced second-hand vessels at the peak of the market. The multitude of arrests and foreclosures at the downturn of markets serve as ex-post evidence that rationality of expectations or

just plain rationality[48] has found its way into the academic books but not in investment behaviour in shipping.

5. Investment Strategies, Risk and Asset Play: a Twenty-First Century Perspective

The frequent and very ample fluctuations of second-hand ship prices which follow in general the fluctuations in the freight rates – albeit not necessarily so in the very short-run – create the *opportunity (not the certainty)* of large profits from speculation on ships, a strategy/activity called *asset play.* Asset play has indeed compensated for lacklustre margin profits in shipping. It has, however, overshadowed the advantages of astutely timed investment in ships without – necessarily – the *ex-ante* intention to further sell them but simply the acquisition of additional tonnage or fleet renewal at low(er) prices. While investment strategies are associated often with asset play, if not with asset play alone, there is scope for a company to formulate a general strategy of acquisitions regardless of whether the intention is to use ships for trade or trade them *per se* as sheer commodities.

5.1 Limiting risk: a shipping averse investment strategy

Risk aversion and shipping investment are not necessarily antonyms but they would hardly be classified as synonyms either.[49] However, had most market participants been following a strategy with a view to avoiding risk entirely, supply of shipping services would have been considerably tighter[50] as the only real guarantee from cash-flow pressures and company vulnerability in cyclical markets would be to finance purchases entirely by equity. Although not necessarily a net profit maximisation strategy, as traditional loan finance may be more advantageous especially at times of high inflation, it is definitely the most conservative approach. The use of some debt finance need not necessarily put companies at bankruptcy risk as long as their cash-flow situation is healthy and projections and decisions are balanced and guided respectively by the knowledge of market cyclicality. Excesses in all directions – including expectations[51] – seem, however, to characterise all aspects of shipping investment increasing risk but also creating market opportunities as prices falter.

Acquisition prices do not have to be ridiculously low to allow for a competitive fixed-cost, although this has been recorded in the past as well. To be competitive in terms of capital cost companies have essentially to acquire vessels at significantly lower prices than the prices competitors had to pay for their own tonnage often just by waiting or speeding up investment decisions by only a few months. The investment strategy of a firm becomes thus a relative one and a continuous effort to take advantage of significant asset price shifts over time periods which may represent only a tiny fraction of the entire life expectancy of the vessel. As operating costs for similar vessels are easily adjustable – variations which cannot be effectively hedged stemming essentially from manning costs – market survival and success can easily be shown to depend to a very large extent on fixed cost (i.e. essentially capital cost in bulk shipping and hence on investment strategies).

5.2 Fixed cost and investment strategy: still the essence of competitiveness

Shipping competitiveness is a complex issue related to market structures. However, in both liner and bulk shipping markets capital cost is, as a rule, the single most important element of total cost, while investment strategies can make or break companies as the impact of investment related paid-out costs determines the resilience of companies in times of crises.[52] Fixed cost influences company

competitiveness through (a) differences in acquisition prices of either new buildings or second-hand vessels; (b) differences in the way capital is raised; and (c) differences in the terms of finance of vessel acquisitions.[53] Minimising fixed cost provides a significant advance on competitors in the main bulk markets where cost leadership is still the main viable option, without taking into account the idiosyncrasies of some very specialised shipping segments or those of liner shipping where quality of service and product differentiation may have a role to play in company strategy.

Shipping has always been perceived as capital intensive and automation and the downsizing of manning requirements have contributed little in changing this; on the contrary, the labour to capital ratio seems to have declined in the post-war period.[54] However, past progress towards automation combined with quality concerns have removed the focus from the prospect of the ever-more automated ship. Hence, as there are few margins for minimising the cost of main inputs such as bunkers or stores,[55] the efforts for achieving an overall low cost cannot but concentrate on what constitutes on average half of the total cost of shipping services[56] (i.e. capital cost).

Minimising acquisition costs should not be mistaken as pointing necessarily to the purchase of second-hand tonnage. As Figures 1 and 2 show there can occasionally be

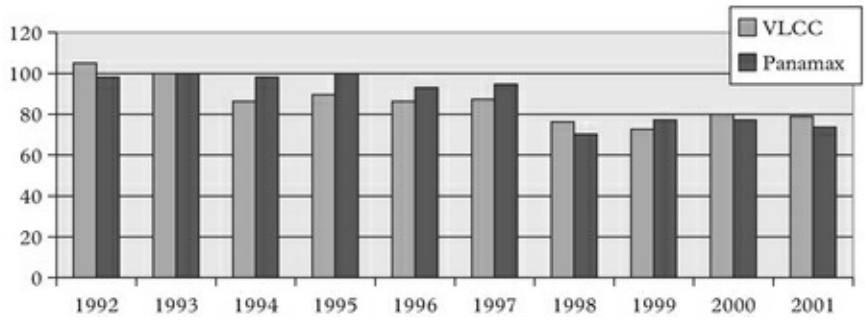

Figure 1: Indicative development of shipbuilding prices, 1993–2001 *Index: 1993=100*

Note: 2001 = Mid-year prices. The graph is based on a 1993=100 index calculated from data in Clarkson Research, *World Shipyard Monitor*, and Clarkson Research, *Shipping Review and Outlook*, various dates.

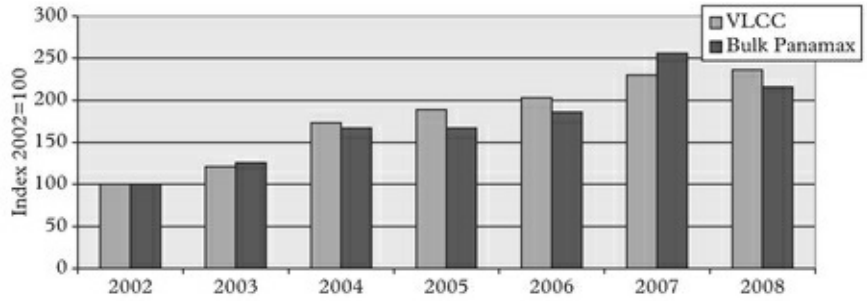

Figure 2: Index of shipbuilding prices, 2002–2008

Note: The 2002 based index is calculated from data in Clarkson Research, *World Shipyard Monitor*, and *Shipping Intelligence Weekly*, various dates.

significant differences in new vessel prices over relatively short periods of time which can be translated into the difference between a low, but positive, profit margin and a limited, yet definitely negative, loss if the total cost is considered.

Tankers ordered at the very high 1992 price levels for example (cf. Figure 1) reached the market in the morose tanker markets of the mid-1990s, while orders placed at the low prices of 1998 took advantage of the millennium boom in tankers. As many twenty-first century shipping investors in bulk carriers found out ex-post and at their expense, for instance, a shorter than 12-month delay would have

resulted in millions saved between 2007 and 2008 (cf. Figure 2); in the latter case of course a timely cancellation might had proved a few months later the only corrective action for cash-poor companies.

Timing of all types of shipping investment decisions is indeed of essence; while investors' expectations may well prove quite elastic in the sense of Zannetos, [57] budgets may not. Distress sales – which are the ones to give rise to substantial asset play opportunities along the evolution of the shipping cycle as analytically discussed by Stopford[58] – can be considered as a function of a number of variables such as – or similar to – the ones discussed by Grammenos, Nomikos and Papapostolou for high-yield bond defaults.[59] In the context of sales, the larger the variance in liquidity positions of individual investors as defined mainly by outstanding acquisition costs to be paid out, gearing levels and cash reserves, which depend in turn mainly on actual vs predicted rates/revenue differentials, the larger the potential asset-play gains for the liquid ones.

5.3 Asset play: still "the bulk" of bulk shipping profits?

Asset play is often put forward as the only justification for investors having kept investing in markets with such low and precarious profitability.[60] The expectation of profits

Table 2: Indicative returns of sale and purchase

Ship Type	Transactional Vessel Age	Bought	Sold	Annualised Return
VLCC	9 (10)	11/85	3/86	330%
VLCC	10 (10)	7/86	10/86	164%
SUEZMAX	10 (10)	7/85	10/85	105%
SUEZMAX	15 (15)	9/87	11/87	187%
HANDYSIZE BC	15 (18)	12/86	9/89	102%
HANDYSIZE BC	10 (12)	10/86	10/88	122%
HANDYSIZE BC	15 (18)	9/86	11/89	132%

Notes: VLCC=Very Large Crude carrier, SUEZMAX=Tanker ship 100,000–200,000 dwt BC=Bulk carrier. HANDYSIZE denotes here vessels between 20,000 and 35,000 dwt. Figures in brackets indicate approximate age at time of sale.
Source: Adapted from the 2002 edition to include only high returns in tankers and bulk carriers. On the basis of data and calculations in Theotokas, J. (1997): "Greek-Owned Shipping Companies of Piraeus: Organisational and Managerial Methods, 1970–1990", PhD thesis, University of Piraeus, Table 6.4, p. 328.

as high as the ones in Table 2 had constituted an evidently strong enough incentive for betting on a future market reversal. Indeed, before the "dot.com" bubble at the turn of the century there were few legal possibilities for such rates of return especially when trading non-innovative assets.

Exceptional returns from asset play (or the achievement of a significantly lower fixed cost in relation to competitors) have been based on investing against the tide or what has been called "anticyclical investment strategy"[61] especially during major crises[62] both before[63] and after World War II,[64] as was the case in the early 1980s. Even less turbulent markets provide opportunities to minimise fixed-cost or achieve substantial capital gains: price differences for a 10-year-old Panamax between their lowest 1994 levels and the autumn of 1995 highs could be of the order of 25% easily providing for a total cost differential of over 10% and allowing non-negligible asset-play profits. Shipping companies *with the necessary liquidity* – possibly as a result of similar successful moves in the past or as a result of refraining from investment during market booms – or *able to secure funds under terms that enable them to wait for the revival of the markets*, have often exercised *anticyclical investment strategies*. In a sense, successful investment strategies are self-sustained as astute moves in the past allow the build-up of sufficient cash reserves to be invested in when the next opportunity

arises; conversely, unsuccessful asset players, along with all types of shipping investors overextending during booms, carry the disadvantage of both reduced liquidity and ability to raise credit at times of crises. Banks have been traditionally reluctant not only to lend in such cases but some refuse to even get involved in shipping when the market is depressed, thus narrowing the circle of potential sources for raising capital. Banks tend to return to the shipping business along with profits and prosperity,[65] but by then, the real opportunities for large profits through the Sale and Purchase of vessels have lapsed; the experience of late 2008 has hardly helped in inducing any changes in this regard. Stock markets are equally rather unlikely candidates for providing the necessary funds for such investment in periods of crises and of high uncertainty so, unless astute entrepreneurs manage to convince investors to contribute equity capital,[66] asset play remains largely a self-financed and indeed historically self-sustained activity.

5.4 Asset play: risks and attitudes

Such bold Sale and Purchase (S&P) strategies as described in the previous sub-section and illustrated by Table 2 are of a high risk as there is no time pattern for defining the point at which the market situation will turn, thus providing opportunities for materialising S&P profits. “Intuition”, often provided as a basis for such moves in S&P, is a rather poor basis for decisions of this type. The level of ship prices compared to the level of scrap prices[67] seems a “safer” market signal for triggering purchases provided, of course, there is sufficient liquidity. Still, there are no guarantees about the relative success of such a move as the time horizon of the – always much awaited – revival of the markets remains uncertain under the influence of a multitude of factors often exogenous to the shipping markets.

The term asset play is also used by researchers to describe activities related to buying and selling of newbuilding contracts or even of newbuilding options; returns from such activities seem to have been quite impressive in the past with purchase and sale of such contracts taking place within relatively short periods of time.[68] The market path which can generate profits following the placement of a contract is one of a weak market reversing or of an accelerated freight rate hike generating expectations and additional demand for prompt deliveries, both scenarios resulting in significantly higher newbuilding prices. Due to the necessary lags between orders and vessel delivery, this type of asset play could *eventually* prove less risky if the order has been placed in poor markets: if the market has hit low levels the reversal is likely to occur some time in the mid-term future when the order should normally have been transformed into a delivery or an imminent one. Conversely, distress sales of tonnage on order by financially frustrated owners or yards during recessions may be targeted by liquid buyers – with the caveats discussed above – especially if their strategy is one of tonnage renewal at lower prices more than an asset-play one.

However, whatever form asset play activity takes, the most significant danger associated with it is the absence of any guarantees on the time or path for market reversals; as the 1980s proved, market lows can be one more trough further down into a deepening depression. Liquidity and equity finance prove in this way the only guarantees, regardless of whether the vessel is intended for further operation or for further trading as an asset, while patience and flexibility emerge as the major attributes of the ideal asset-player player whether this would be an individual investor or a fund; in both cases, eventual lay-up costs until the market reverses have to be taken into account in the

investment decision.

Although speculation on ships bought during periods of low vessel prices is an extremely risky investment move, it should be reminded that the risk when investing – in either new buildings or second-hand tonnage – in a booming market can definitely be – and usually proves – higher;[69] such timing requires that freight rates are further sustained for a lengthy period of time at high levels. The far right column of Figure 3 shows clearly the investment spike which – with hindsight – a number of recent investors in new tonnage would have liked to have avoided especially if they had been financing deals through banks (many of the latter having experienced in the meantime similar difficulties to their clientele's) or through any type of debt non-convertible to equity. The absence of any time path for market turns[70] and the short duration in principle of shipping booms often condemn a large proportion of vessels acquired in similar periods

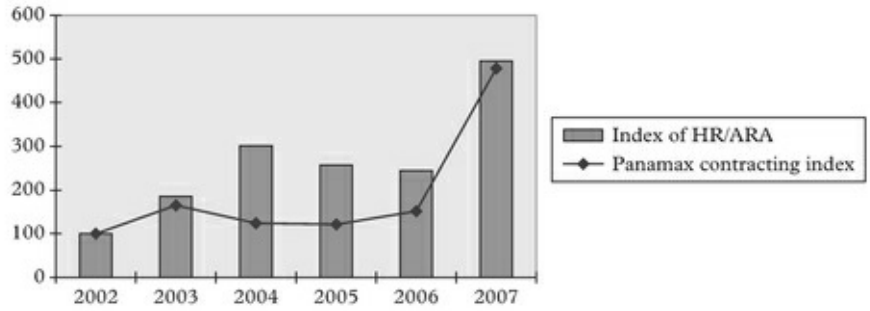

Figure 3: Freight rate development and new contracting 2002–2007 in Panamax bulk carriers
Note: On the basis of an index 2002=100 of HRds/ARA coal freight rates in $ per tonne and yearly new contracting. Calculated from data in Clarkson Research, *World Shipyard Monitor*, December 2008 and *Shipping Review and Outlook*, Spring 2008.

to a chronic financial underperformance or even to an early death through emergency scrapping under the pressure of cash-flow problems. Despite the extraordinary relative length of the 2003 to 2008 euphoric phase, recent developments reminded that the risk of moving into a booming market is perhaps the only obvious one and should be much better assessed as a move of this type requires long periods of prosperity. Through the market's own "endemic tendency to over-invest" or through an exogenous shock (or any unfortunate combination) prosperity is bound to be cut short in shipping. The Reksten case in the early 1970s[71] constitutes a typical example in this regard; the recent downturn has yet to provide its full range of victims for exemplary ones to emerge.

5.5 Asset play: a " game" with winners and losers

The review of S&P activity over the period of the crisis of the 1970s and the 1980s in shipping has proved that there are significant differences in investment attitudes. This dilutes efforts to make blanket assumptions on the nature of investors' expectations. Research in the previous decade[72] has pointed out that there had been marked differences in both investment attitudes and in exposure to asset play between leading traditional shipping communities during the last major crisis but also among members of the same shipowning community. Although associated with the increased resilience of many Greek companies, the econometric investigation of the observed anticyclical investment pattern – within limitations due to the nature of the available data – resulted in showing that although there was a trend among this shipping community to invest against the tide, the trend was not uniform and definitely not a national exclusivity either. Some of the most astute moves in the S&P market such as the purchases of VLCCs at below their scrap price were made by Norwegian

owners[73] pointing that although investment behaviour can be cultivated, propagated or exemplified within a shipping community, talent in shipping investment knows no boundaries and is not a geographically defined exclusive privilege. Most attitudes, including varying investment patterns, are dictated by objective constraints. Norwegian owners traditionally invested in new buildings while Greek owners, had built a reputation in the past for successfully managing older fleets. At a time when depression settled fast in the markets following the first oil shock in 1973, the former found themselves with young – and expensively acquired – vessels with high demands in cash flow for their repayment. As fleet age data indicate or rather reveal,[74] Greek owners could afford to be more resilient as their older tonnage was by comparison far less burdened with fixed-cost obligations since it was either bought second-hand or had been largely depreciated already, or both.

However, as the face of shipping has undergone major changes in the past few years, so has the age structure of major fleets especially as tankers went into a phase of "compulsory renewal".[75] Similarly, the latest boom seems to have been unprecedented in uprooting in its wake successful investment strategies which had apparently survived at least well into the third year of the last boom among close-knit communities of shipping investors.[76] However, while the change in fleet fundamentals may have diluted discernable investment patterns, it has not diminished the importance of investment timing. On the contrary, as average tonnage age for most main competitors declined – and with the extension of the economic life of vessels not being a viable option anymore,[77] at least for tankers – the fate of national fleets and individual companies may depend henceforth (even more than in the past) on small differences in investment timing.

Table 3: Indicative potential differences in acquisition costs in dollars of max. five year-old vessels Mid 2008–Early 2009

Ship type	Absolute difference	% change
VLCC	48 million	32%
PANAMAX BC	58 million	68%

Note:

Figures rounded to the closest million. Source: Calculated on vessel price data of weekly published Baltic Sale & Purchase assessments as reported in Clarkson Research, *Shipping Intelligence Weekly*, 30 May, 2008 and 16 January, 2009 issues.

In second-hand transactions, differences of the order of tens of millions of dollars (or even impressively more)[78] for vessels of similar type, size and age over just a few months continue to point to the all-important potential fixed-cost differences and the analogous importance of the timing of investment in all types of physical shipping assets. While the more limited acceleration of orders before 2007, (cf. Figure 3 supra.), seemed to have had relatively staved off the "endemic tendency to over-invest", developments since then only confirmed it; otherwise, the level of price differentials in Table 3 would not be justified. Assessing how new investment soared well into the boom period and how it subsequently shrank a few months later to a single digit share of 2008 levels[79] pessimists would despair in repetition. Optimists would continue to monitor transactions, be these of new or second-hand vessels, and especially distress sales with a view to including them one day into examples of successful anticyclical investment; *or not*.

6. Investing in an Environment of Increased Uncertainty

Despite the survival of main mechanisms related to market and investment/divestment cyclicality, world shipping is not what it used to be anymore. Changes involve commercial, regulatory and technical aspects, often intertwined in pairs; these have hardly removed uncertainty; on the contrary. In a number of markets, the product cycle of tonnage categories and designs has accelerated, increasing the risk of future technological obsolescence. This was brought about either through competition increasing from *outside* the segment – such as in the case of the successful container threat to bulk reefer shipping – or from within, as in the case of the now fully fledged and less "esoteric" nowadays LNG market where on-board liquefaction of the boil-off gas and, more importantly, regasification of the cargo, as in LNG RVs, are making inroads.

Potential regulatory changes are now a factor to be discounted in every investment decision be that at varying rates, while the related focus on quality is increasing. Although attention has shifted away from ship registration, as flags of convenience have become now the most significant part of the world fleet,[80] other elements of competitiveness related to quality, such as the length of exploitation of vessels, have come to the fore. In today's shipping, the age of tonnage has become significant even for dry bulk carrier charterers, exceptions due to the "prompt ship" effect in extreme markets notwithstanding.[81] The age issue is directly related to investment strategies and especially asset play. Successful asset play requires a total length of the economic life of the vessel which should not only cover this of the shipping cycle but also allow to the ultimate buyer the chance, or at least the hope, for a further profitable exploitation of an asset acquired – by definition– at high prices. Investing in older vessels is now practically constrained by regulatory requirements as in the case of tankers; older tonnage has been equally subject to enhanced surveys and to structural modifications.[82] Although, the scope for minimising fixed-cost or even for asset-play has not disappeared, the continuing decline of the average age of the world fleet and new tonnage specifications coupled by the precipitated – since the millennium,[83] – banning of older designs in tankers have by definition limited asset-play possibilities to a smaller range of tonnage age. Past experience prevents assigning a probability of the direction of future regulatory developments and their impact on investment as the ones in this century have extended from changes in the operations management of ships – as those brought about shortly after 2001 by the ISPS 2002 – to the acceleration of the single-hull tankers' withdrawal. Regulatory goalposts impacting on trading opportunities have kept moving adding to the uncertainty of investment in a – *par excellence* – volatile environment.[84]

While shipping investment is regarded now, especially for larger investors, as the act of managing a portfolio of real and paper assets, (cf. Table 4), risk can be managed eventually better, but it cannot be eliminated. Whereas the only risk-free position is at the very left corner point of the lower left quadrant – the latter significantly denoted by zero (0) – including low exposures to either the paper or physical shipping markets of atypical/diversified[85] investors from outside the segment, there is no intended suggestion or compulsory assumption that risk increases as investors move clockwise into quadrants I to III in terms of commitment in physical and paper shipping markets. However, these two categories of shipping-related investment do not necessarily create perfect hedges[86] unless intentionally and skilfully designed for. Equally, the risk tolerance of typical shipping players will tend to insert some element of speculation into Quadrant II.[87] Offsetting returns from financial instruments notwithstanding, short to medium term strategies for investors in Quadrants I and II in an

environment of

Table 4:
A quadrant typology of shipping investment portfolio structures

Commitment in physical shipping assets

High

Traditional shipping investor **I**	**Modern type of shipping investor** **II**
Atypical/Diversified **0**	**Financial-type investors** **III**

Low High

Commitment in shipping – paper market

less than full fleet employment, remain focused on improving operating costs. Lack of employment is, however, among the usual "risks of the trade"; some others which have emerged or re-emerged in this decade, are not.[88]

Following the market collapse in September 2008, complex chains of sub-chartering activities, previously fuelled by spiralling rates and ever-growing *great expectations* for future gains equally collapsed. In chain-like sub-letting activities, failures of a middle or initial link can unleash domino effects. This was one more uncertainty added to phenomena whose extent had been hitherto marginal for post-war shipping business:

1. the significant disruption of "shipping as usual" in the first months of the financial crisis due to the letters of credit problem,[89] threatening supply chains;
2. the equally significant collapse of trust to chartering counterparties as some of the latter were collapsing themselves. The extraordinary circumstances rallied to increase charter default risks which research by Adland and Jia had already found to be dependent on the state of the freight market;[90]
3. the significant number of successful (and unsuccessful) piracy attacks. Although piracy is an insurable risk, unlike the investment one, the stress on the company's operations management – often over a prolonged period – is comparable to dealing with a major accident; diversion from financial management in turbulent times creates risks in itself.

As the resurgence of such an old phenomenon as piracy reminded even to the most optimistic investor, shipping is a most idiosyncratic industry, capable of leaping back and forth "in time"[91] and market phase as easily as it traverses meridians.

7. Summary and Conclusions

Investment strategies have been a core factor, if not the most critical one, for succeeding in shipping, especially in the volatile bulk shipping markets. Market cyclicality increases the risks for investors. The competitive nature, however, of most of bulk shipping means that there are few constraints in terms of investment and divestment. While the fundamental characteristics of shipping investment in terms of risks and attitudes in general have survived, uncertainty has further increased due to often interrelated changes in technical, commercial and regulatory aspects; this is not only in the bulk segments. Increasingly, volatility concerns investors in liner tonnage more than in the past; this is both through new, more competitive liner market regulation but also through the increased number of

outside investors targeting employment opportunities of container tonnage by carriers. Asset play, which is an extremely risky investment strategy but with potentially high payoffs, remains as an investment opportunity across shipping in volatile markets but with added caveats: these include sudden changes in specification requirements through regulation and potentially accelerating technological obsolescence; the latter is further supported by increased competition in liner and specialist segments. Recent experiences might prove enlightening in terms of research into triggers of distress sales and of the – eventually varying through market phases – attitudes and expectations of investors whose investment learning curves remain to be assessed. The largely underused, in shipping, tool of surveying expectations[92] can serve equally in that direction as experts have suggested in the past in the context of macroeconomics[93] from where researchers have often drawn hypotheses for testing in the, nevertheless still idiosyncratic, shipping markets.[94]

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Endnotes

1. By the beginning of 2007 the world fleet of vessels of 100gt and over was more than 1.04 billion dwt, according to UNCTAD (2008): *Review of Maritime Transport 2008*, Table 6, p. 33.
2. In his classic 1971 book *Economics of Tramp Shipping* (London, The Athlone Press).
3. Translated usually as "The more it changes the more it stays the same".
4. The reader can benefit from a related article by Lord Skideslky in the *Financial Times* of 4 August, 2009.
5. For example a five year-old tanker in 1983 was worth approximately 15% of its 1980 price and less than 10% of the respective price in 1990. Calculated on the basis of VLCC price data in Clarkson Research Limited, various publications. For more on ship prices cf. S. Strandenes, earlier in this volume. While, the effect of recent market developments has not yet manifested itself until the summer of 2009 fully – or to that extent – ship prices have fallen quite substantially from their 2008 levels, see *infra.* in the main text. There have been reports of three figure differences (in million dollars) between prices paid for similar vessels said to have changed hands over a period of some months. Cf. article by Lillestolen, T. in *Tradewinds*, of January 9 2009, p. 3.
6. See Chapter 8 on Shipping Market Cycles by M. Stopford. The interesting volatility pattern of scrap prices in the months since late 2008 will only be confirmed by their evolution in the medium term.
7. Rates of newbuilding and second-hand price changes can well vary among vessel types.
8. See Thanopoulou H. (2009): "Bulk reefer economics in a product cycle perspective", Paper presented at the *IAME 2009 Conference*, Copenhagen, 24–26 June.
9. See Stopford, M. (2008): *Maritime Economics* (3rd edn) (London, Routledge), p. 320 for a synopsis of the state of shipping returns over time before 2003.
10. See Thanopoulou, H. (1995): "The growth of fleets registered in the newlyemerging maritime countries and maritime crises", *Maritime Policy and Management*, Vol. 22, No. 1, pp. 51–62,

for the role individual factors – and in particular the tendency to over-invest – played in the crisis of the 1970s and the 1980s.

11. Essentially, speculative investment in this segment did not become significant until the US-related energy transport boom around the millennium. For evolving investment patterns in this segment, see Drewry Shipping Consultants (1990): *Prospects for LNG and LPG Shipping in the 1990s* (London, Drewry), Drewry Shipping Consultants (1992): *Trading in LNG and Natural Gas* (London, Drewry) and Drewry (2001): *Annual LNG Market Review & Forecast* (London, Drewry).

12. The term is used here to denote the embryonic state and lack until recently of main market properties. It should not be considered as the simple application of a most common term in transaction cost economics (TCE). However, short-term spot market transactions and vertical integration are considered as two extremes, *cf.* Boerner, C. and Macher, J., "Transaction Cost Economics: An assessment of Empirical Research in the Social Sciences", accessed as HMTL June 2002. "Hybrids" include joint ventures such as the ones existing in the LNG industry between plant and shipping partners and thus the use of the term could be accommodated even in the strict TCE terminology sense. However, long-term contracting would describe better a large part of the market.

13. Product differentiation as in the case of reefers cf. Thanopoulou, H. (2009): *op.cit*. is also becoming significant here as the market has evolved recently with new types of tonnage emerging.

14. Cf. Gardner, B., Nair, R. and Thanopoulou, H. (1999): "From deregulation to concentration? Prospects for the liner shipping industry". Paper presented at the IAME Conference, Halifax, Canada, September 1999.

15. Despite the rise of containerships in recent years. Gross tonnage calculations on the basis of end 2000 data in Lloyd's Register (2001), World Fleet Statistics. By the start of 2008 the bulk and tanker capacity alone accounted for more than 70% of the world dwt. On the basis of market shares in UNCTAD, *Review of Maritime Transport 2008* (UNCTAD, Geneva).

16. For an enlightening in depth discussion of risk in general see Kaplan, S. and Garrick, B.J. (1981): "On the quantitative definition of risk", *Risk Analysis*, Vol.1, 11–27 and Kaplan, S. (1997): "The words of risk analysis", *Risk Analysis*, Vol. 17, 407–417.

17. See other chapters in this part of the volume for related shipping finance problems.

18. For an instructive approach incorporating this element *cf.* Stopford, M. (2008), *op.cit*. Chapter 8.

19. There have been examples, however, of successful conversion of vessels into special oil production units (FPSOs) and other uses.

20. Setting historic lows and incorporating essentially only – if at all – currency and bunker adjustments. *Cf*. Pritchard-Evans A. (2009): "Shipping rates hit zero as trade sinks", *Daily Telegraph*, January 14, p. B4 and Porter, J. (2009): "Box carriers in crisis as rates continue in freefall", *Lloyd's List*, 15 January, p. 1.

21. For a review of the concept see Day, G. (1981): "The product life cycle: analysis and application issues", *Journal of Marketing*, Vol. 45, 60–67.

22. *Cf*. Thanopoulou, H. (2009) *op.cit*.

23. *Cf*. Metaxas, B. (1988): *Principles of Maritime Economics* (Athens, Papazissis) (in Greek) and

Metaxas B. (1992): *Principles of Maritime Economics (*Athens, Papazissis) (in Greek).

24. See Thanopoulou, H. (2009) *op.cit*. For a detailed discussion of the container invasion into the bulk reefer market see Mehta, S. (2000): "The Reefer Market and Changing Trends", MSc Dissertation, Cardiff and various Drewry Shipping Consultants and Wild. P. Ltd. reports.

25. See Gardner, B. (1997): "EU competition policy and liner shipping conferences", *Journal of Transport Economics and Policy*, Volume XXX, No. 3, 317–324.

26. For a quick overview of business objectives see Reekie, W.D., Allen, D.E. and Crook, J.N. *The Economics of Modern Business* (2nd edn) (Oxford, Blackwell). With relation to the focus on market value as an alternative for shipping companies, *cf*. Syriopoulos, T. (2007) "Financing Greek shipping: Modern instruments, methods and markets", Chapter 6 in Pallis. A . (ed.) *Maritime Transport: The Greek Paradigm*, (Oxford, Elsevier), pp. 171–219, p. 172.

27. In the heydays of the socialist bloc, the state companies of this group of countries still amounted to less than 10%. See the various OECD statistics as included in the annual review *Maritime Transport*. There have been equaly, however, very large state companies in more recent years as well such as COSCO.

28. There is really no essential difference between fleets directly integrated in shipping divisions of oil companies and those belonging to controlled subsidiaries. In both case the ultimate owner and the decision centre is the same (i.e. the oil company). More sophisticated structures created in recent years through alliances and joint ventures should not be confused with regard to the centre of investment decisions.

29. Despite the significant reduction of the fleet owned by the major oil companies, if state oil companies are included, integrated tonnage still accounts for a non-negligible part of the world tanker tonnage. Independent fleets, however, represented in the period 2007–2009 a share as high as 84% and 82% of the tanker and combination fleet over 10,000dwt. Percentages in INTERTANKO, Tanker facts, annual.

30. For the influence of non-economic motives such as the national prestige see Haralambides H.E (1993): *A New Future for European Shipping* (Rotterdam, Erasmus University).

31. Developed on the basis of Figure 1 in Thanopoulou H. (1995): *Lecture notes in Special Subjects in Maritime Economics* (University of Piraeus, mimeo).

32. Freedom in shifting or diversifying is paid, of course, dearly when the policy proves to have poorly estimated market prospects.

33. See Theotokas, J. (with the cooperation and introductory assistance of Thanopoulou, H.) (1994): *Pools in Greek-owned bulk shipping* (University of Piraeus, mimeo).

34. Equally, cases of outsourcing technical management, previously undertaken in-house, can be observed, as for instance in LNGs.

35. See Thanopoulou, H. and Theotokas, J. (1997): *Pools in a Greek bulk shipping perspective: asset play vs. synergy benefits*. Occasional Paper No. 46, Cardiff University, mimeo.

36. The term operational alliance allows to distinguish them clearly from buyer-supplier strategic alliances.

37. See Thanopoulou, H., Ryoo, D.K. and Lee, T.W., (1999): "Korean liner shipping in the era of global alliances", *Maritime Policy and Management*, Vol. 26, No. 3, 209–229.

38. In the form also of investment vehicles such as KGs. For more, see Stopford, M. (2008), *op.cit.* p. 307. The increased reliance of carriers on chartered-in tonnage was obviously a key factor for the turn of investment communities traditionally committed to bulk markets towards container capacity as well, *cf.* Thanopoulou, H. (2007): "A fleet for the 21st Century", Chapter 2 in Pallis. A. (ed.) *Maritime Transport: The Greek Paradigm* (Oxford, Elsevier), pp. 23–6, p. 47. See also next footnote.

39. An earlier comment, included in the 2002 version of the chapter, has been validated by developments: "Company-owned tonnage is equally offered for hire when capacity adjustments or vessel replacements prompt so. Establishing a trend in this regard requires comparing chartered to owned tonnage over a period of years at least for the leading container companies. A *prima facie* look at current data seems to establish such a trend, however, very little can be supported by randomly examined data. For more see Min Jung Kee (2001): "Cooperation and competition in deep-sea liner shipping", MSc Dissertation, Cardiff, 2001." The trend is confirmed by now as a majority one. Stopford, M. (2008), *op.cit.*, refers to the chartered tonnage's share of 15% trebling between 1991 and 2004 while for the top 50 carriers the figure has risen over 50%, cf. *The Journal of Commerce*, 8 December, 2008.

40. The reader will benefit from reading Pearson, R. (1987): "Some doubts on the contestability of liner shipping markets", *Maritime Policy and Management*, Vol. 14, No. 1, 71–78, especially 77.

41. Japan's leading role in the post-war period was later challenged by South Korea. whose share in the industry rose from 0% in 1970 to almost 30% in the late 1980s. See Thanopoulou, H. (1994): *Greek and World Shipping* (Athens, Papazissis) (in Greek), p. 200. Data: *Lloyd's Register Annual Summary of Merchant Ships Completed* in ISL, *Shipping Statistics Yearbook 1989*, Bremen. China's more recent ascent was equally, if not more, spectacular, its share rising to 33% in 2008, cf. BRS (2009): *Annual Review 2009* (Paris, Barry Rogliano Salles), p. 15.

42. State subsidies were much more common and important in the past as were investment incentives to owners. For a review of the role of these factors on British shipping see Gardner, B., Pettit, S. and Thanopoulou, H. (1996): "Shifting challenges for British Maritime Policy", *Marine Policy*, Vol. 20, No. 6, 517–524.

43. S. Strandenes pointed out that "whereas the investment is smaller when acquiring a second-hand vessel, the interest rate on the loan may exceed that offered for yard financing". I am grateful to S. Strandenes for this and other comments on the 2002 version of the chapter.

44. Even in 1974, after the oil crisis, a 1977 delivery date was most common. See the review of Greek orders placed worldwide in *Naftica Chronika*, 15 January, 1975, pp. 92–93. In late spring 2008 a number of delivery dates were going well into 2012, cf. Clarkson Research, *World Shipyard Monitor Database*, May 2008.

45. See Chapter 8 by M. Stopford on Shipping Market Cycles earlier in this volume.

46. See Chapter 7 by S. Strandenes earlier in this volume.

47. See Metaxas, B. (1972): *The economics of tramp shipping* (London, The Athlone Press).

48. Adopting its interpretation along the lines of what Gkonis, K. and Psaraftis, H. astutely

commented in 2007: “the rationality of players can be interpreted as the degree of their understanding of the market dynamics”, in their paper “Investment rules and competition patterns in LNG Shipping: A Game Theory approach”, presented at the 2007 IAME conference, Athens, June 4–6. For research in investment decisions and their timing see also Alizadeh, A. and Nomikos, N. (2006): “Investment timing and trading strategies in the sale and purchase market for ships”, *Transportation Research Part B,* Vol. 41, 126–143 and Alizadeh, A. and Nomikos, N. (2006): “Trading strategies in the market for tankers”, *Maritime Policy and Management*, Vol. 33, 119–140.

49. As astutely put by Veenstra, A. and Ludema, M., in their 2006 article, “The relationship between design and economic performance of ships”, *Maritime Policy and Management*, Vol. 33, 159–171, 159: “To be successful in the shipping industry depends on entrepreneurship, market insight, and, some say, a certain lack of risk aversion.”

50. Martin Stopford has made a similar remark of the post-World War II role of shipping finance in expanding shipping supply beyond what equity accumulation would have allowed. See Stopford, M. (1997): *Maritime Economics* (2nd edn) (London, Routledge), Chapter 6.

51. Cf. Zannetos, Z. (1966): *The Theory of Oil Tankship Rates* (Cambridge, Mass, MIT Press).

52. In 1988, Martin Stopford encapsulated in a classic manner the importance of this factor entitling the relevant paragraph of his book: “Cash flow and the art of survival”, cf. Stopford, M. (1988): *Maritime Economics* (1st edn) (London, Routledge), p. 93.

53. For a related discussion of the fundamentals of competitiveness in the traditional bulk markets see Thanopoulou, H. (1998): “What price the flag? The terms of competitiveness in shipping”, *Marine Policy,* Vol. 22, No. 4–5, 359–374.

54. In the 1970s and 1980s the successive influences of increased vessel size and automation and then of cutbacks in manning scales resulted in the ratio declining for a number of fleets. For an econometric model of the trend towards lower demand for sea-going personnel due to economies of scale see Haralambides, H. (1991): “An econometric analysis of the sea-going labour market", *Logistics and Transportation Review,* Vol. 27, No. 1, 15–31.

55. Efficient management can definitely contribute in minimising these costs through adequate planning of operations and knowledge of ship technical requirements and of input markets. Yet, as technical management solutions are readily available differences between companies will tend to be lower. Fuel cost hedging may also play a role for operators exposed to fuel risks.

56. Capital cost has been below 50% of total cost at times of high bunker prices. For the early 1980s see Moreby, D. (1985): “Crew Costs”, *Maritime Policy and Management,* Vol. 12, No. 1, 50–60. For the middle of the first decade of the present century *cf.* Stopford, M. (2008), *op.cit.*, p. 225.

57. *Cf*. Zannetos, Z. (1966), *op.cit*, p. 1.

58. *Cf*. Stopford, M. (2008), *op.cit.*

59. *Cf*. Grammenos, C. Th., Nomikos, N. and Papapostolou N. (2008): “Estimating the probability of default for shipping high yield bond issues”, *Transportation Research Part E: Logistics and Transportation Review*, Vol. 44, 1123–1138. Distress sales can be considered as one critical phase further down the distress cycle. For the full account of the role of market cycles in

distress sales see the third edition of Martin Stopford's *Maritime Economics*, *op.cit.*

60. In the words of a shipowner "Independent tankers owners are not remunerated properly for the important service they provide – they should not have to rely on asset plays [s&p] to ensure their survival", *Lloyd's List*, December 1995.

61. This term is attributed by some to this author. Although investigation of the subject has indeed been undertaken by H. Thanopoulou in various publications, a very similar term (countercyclical) must have been mentioned once by the late B. Metaxas in one of his teaching manuals in Greek.

62. See Thanopoulou, H.A. (1997): "What price the flag? The terms of shipping competitiveness ...", *op.cit.* For a comprehensive description of the process of the relation between ship values and cash flow pressures see the recent 2008 edition of Martin Stopford's, *Maritime Economics* (3rd edn) (London, Routledge) and previous editions of his book.

63. For a brief reference to Onassis' asset play in the 1930s, see Goss, R. (1987): "Editorial. How to make money in shipping", *Maritime Policy and Management*, Vol. 14, No. 1, 1–3.

64. In the crisis of the 1970s and the 1980s tanker vessels could be bought at below scrap price levels. See Thanopoulou, H. (1995): Lecture Notes in Special Shipping Issues, University of Piraeus, mimeo, pp. 247–248. See further in the text for details. Voyage costs for the last voyage to scrap also play a role in pushing eventually the accepted price below that of scrap.

65. For example, at the start of the 1980s there were 200–250 banks active in shipping finance; by the middle of the decade this number was less than 30, with banks returning massively to shipping a few years later as markets recovered. There were about 60 involved in shipping finance by the end of the 1980s; by 1997 their number had increased back to about 200. *Cf.* Thanopoulou, H. (1994): *op.cit*. p. 190, and *Seatrade*, various dates. It is difficult however, to compare the above figures with more recent numbers due to the wave of mergers that has swept the banking sector in the past few years. On this last point see Starbuck, S. (2001): "The shrinking world", *The Baltic*, February 2001, 17–18. Developments due to the latest financial crisis and M & A activity in banking, have turned "provided funds" into better activity indicators than "number of banks involved", cf. also Syriopoulos, T. (2007) *op. cit.*, p. 176.

66. Only months after the financial crisis of 2008 and the market collapse, a number of equity funds are reported to have been forming to take advantage of market opportunities. In the 1980s undervalued assets had been targeted for later resale in a similar way. See Thanopoulou, H. (1995): *Lecture Notes in Special Shipping Issues*, Piraeus, mimeo, p. 252.

67. See below in the text for such incidents in the early 1980s.

68. Cf. Theotokas, I. *Lecture Notes in Shipping Management*, University of the Aegean, mimeo. The author is grateful to John. Theotokas for drawing her attention on this sub-category of asset play, earlier in this decade.

69. The Reksten case in the early 1970s is a typical example, *cf* Thanopoulou, H. (1995): *Lecture Notes on Special Shipping Issues, op.cit*., p. 251, in this category as the shipowner was quick to pick up the tanker fleet of Erling Dekke Naess – who had felt uneasy with the prolonged market prosperity – just before the first oil shock. The Reksten bankruptcy had been recorded as the largest in Norwegian shipping history. See Isachsen, F. (1992): *Crude Oil Shipping*

(Bergen, SNF), pp. 18–20.

70. The term here means at the same time the absence of knowledge of the time path pattern and the absence of a specific pattern, both concepts being intertwined. For the concept of time-path in the modelling of expectations see Chapter 7 by S. Strandenes earlier in this volume.

71. See Stokes, P. (1992): *Ship Finance: Credit Expansion and the Boom-bust Cycle* (London, Lloyd's of London Press), p. 35.

72. See Thanopoulou, H. (1996): "Anticyclical investment strategies in *Shipping*: *The Greek Case*", in D. Hensher and J. King (eds.) *World Transport Research* (Oxford, Elsevier), Vol. 4, pp. 209–220.

73. See Lambert Brothers, *World Trade Review and Outlook*, 1983 issues.

74. See Thanopoulou, H. (1994): Greek and World Shipping, *op.cit*.

75. After a period of deterioration, the age of the world fleet decreased within ten years from 14.8 years at the end of 1997 to 11.8 years at the start of 2008, cf. UNCTAD, *Review of Maritime Transport 1998* (Geneva, UNCTAD) Table 8, p. 19, *Review of Maritime Transport 2007* (Geneva, UNCTAD), p. 28 and *Review of Maritime Transport 2008* (Geneva, UNCTAD) Table 10, p. 37.

76. Cf. Thanopoulou, H. (2007): *op.cit*.

77. For the role played by older tonnage in main patterns of competitiveness in previous periods *cf*. also Thanopoulou, H. (1994): *Greek and World Shipping*, *op.cit.*, and Thanopoulou, H. (1998): "What price...", *op.cit*.

78. There were reported differences of the order of three figures (in million dollars) between prices paid for similar vessels said to have changed hands over a period of some months. *Cf*. Article by Lillestolen, T. (2009): *Tradewinds*, 9 January, p. 3.

79. By the first quarter of 2009. Cf. www.theseanation.gr/news/shipping/ship-finance.htm, accessed 29 May, 2009.

80. As the twenty-first century dawned flags of convenience were close to becoming the absolute majority in the world fleet having risen to 48.5% of the total tonnage. See UNCTAD (2001): *Review of Maritime Transport 2001*. By the time the financial crisis broke out in 2008 their share had already exceeded substantially half of the world's capacity even when only the most important ten registries were taken into account. See UNCTAD (2008): *Review of Maritime Transport 2008*, Table 14, p. 47.

81. For more on this subject see Tamvakis, M. and Thanopoulou, H. (2000): "Does quality pay? The case of the dry bulk market", *Transportation Research Part E: Logistics and Transportation Review*, Vol. 36, pp. 297–307. Tentative and sporadic differentiation found then in main bulk markets has evolved over this century. *Cf*. Köhn, S. and Thanopoulou, H. (2009): "A GAM evaluation of 21st century quality rewards: Dry bulk freight rates 2003–2007", paper presented at the *IAME 2009 Conference*, Copenhagen, 24–26 June.

82. As the ones imposed on dry bulk carriers through the addition of Chapter XII to the SOLAS convention.

83. Following the *Erika* and the *Prestige* accidents, in 1999 and 2002 respectively, the phasing-out of single-hull tankers was accelerated, among other measures. On the subject, and the *Prestige* trigger for developments, *cf*. www.imo.org/About/mainframe.asp?topic_id=758&doc_id=2916,

accessed August 2009. For a summary evaluation of the regulatory impact on competitive strategies see, Thanopoulou, H. (2007), *op.cit.*, pp. 41–44.

84. *Ibid.*

85. At the time of the final editing, a discussion with J. Theotokas was instrumental in the author providing a title for this quadrant as well.

86. For a review of their potential uses see Kavussanos, M. and Visvikis, I. (2006): "Shipping freight derivatives: A survey of recent evidence", *Maritime Policy and Management*, Vol. 33, 233–255 and related chapters in this volume.

87. Cf. Syriopoulos, T. (2007): *op.cit.*, p. 211, for a summary of recent research results on the speculative/or hedging, or combination use of freight derivatives by shipping companies.

88. For a comprehensive list of risks see Stopford, M. (2008), *op.cit.* Chapter 7: Analysing Risk in Ship Finance, p. 313.

89. Problems persisted into early 2009, *cf.* Porter, J. (2009): "Letters of credit crisis continues to halt cargo", *Lloyd's List*, 9 January.

90. See Adland, R. and Jia, H. (2006): "Charter market default risk: A conceptual approach", *Transportation Research Part E: Logistics and Transportation Review*, Vol. 44, 152–163.

91. The idiosyncratic character of shipping – even in these Late Modern Times – was underlined once more, at the time of the final writing of the chapter, as a three-week hunt to – finally – locate the whereabouts of the *Arctic Sea* ended.

92. Used for instance in the past by Peter Lorange and Victor D. Norman in 1973 in the context of their article "Risk preference in Scandinavian shipping", *Applied Economics*, Vol. 5, 49–59.

93. See Klein, L.R. (1988): "Carrying forward the Tinbergen initiative in macroeconomics", *Review of Social Economy*, Vol. 46, 231–251.

94. Through systematic "sample surveys of the people who actually formulate expectations", as noted by Klein in the context of similar efforts in macroeconomics, *ibid.*, p. 247.

Chapter 24

Valuing Maritime Investments with Real Options: The Right Course to Chart

Helen Bendall[*]

1. Introduction

Real option analysis (ROA), an extension of discounted cash flow (DCF), has at its core the calculation of shareholder value and thus is a very powerful metric to value maritime investments. The basic principles underlying real options are intuitively appealing and readily understood by management, having been used for millennia. The first recorded real options deal being that of the philosopher and mathematician, Thales of Miletus (circa 624BC–536 BC) who made a fortune by taking an option on renting olive presses in Miletus and Chios in Asia Minor at a set price and the crop turned out to be bountiful.[1] Their intuitive appeal led Copeland and Antikarov (2001), to predict that by the end of the first decade of the second millennium AD that real option analysis, ROA, would become the standard valuation metric. It is indeed true that most mainstream academic finance texts now include real option analysis as a tool for investment evaluation but perhaps we are still a little distance off from the analysis achieving "standard" investment evaluation status. Others (Triantis and Borison, 2001 amongst many) suggest that it is the process and discipline of framing an investment decision in real options terms that provides the greatest benefit. If used as a conceptual tool, it allows management to characterise rather than calculate and communicate the strategic value of an investment project. Real options helps managers formulate their strategic options (Amram and Kulatilaka, 2000) enabling investment strategy to be crafted as a series of options that are continually being exercised to achieve both short and long term returns on investment (Yeo and Qui, 2003). The real option method enables decision-makers to leverage uncertainty and limit downside risk. In this current period of heightened business uncertainty ROA offers managers a very useful and an appropriate approach to evaluate investments and formulate strategy.

A discussion of the key issues of valuing investment in an uncertain world follows in Section 2 with real options analysis, ROA, offered as an alternate paradigm as it allows managers the ability to alter/adapt the project in light of new information. Various applications of real options in the maritime industry are used to illustrate the scope and applicability of an option approach. Real options are embedded in most projects but there has been a certain hesitation by management to forego their traditional DCF "comfort zone". This is somewhat surprising as ROA should not be viewed as a revolutionary approach but evolutionary as it extends traditional DCF analysis. Section 3 reviews the reasons for this view and outlines and discusses several ROA methodologies. Section 4 demonstrates ROA by illustrating the power of the technique in specific maritime case studies involving new technology. Section 5 concludes the chapter.

2. Valuing Investments

2.1 Limitations of traditional DCF

Conventional DCF analysis for project evaluation is taught extensively in business schools and is used

by a majority of firms.[2] It appears that many academics and executives, by implementing investment decisions based solely on traditional capital budgeting techniques or by focusing on narrowly defined problems may have failed to take into account uncertainty and the flexibility to alter or adapt projects once begun. Often there is a lack of understanding as to how to include strategic issues in an analysis. This is not to say that mangers have not recognised that the failure to do so can lead to costly errors, but the difficulty of such planning leads many to ignore the potential costs and hope that serious problems do not arise (Teisberg, 1995). Managers must be able to include uncertain future outcomes and potential strategic responses in a prospective analysis of a capital investment project.

Because of its inflexibility and the failure to take into account strategic or competitive issues, DCF criteria may undervalue investment opportunities, leading to lack of investment and loss of competitive position. Dissatisfaction with traditional DCF led some to propose that the problem was simply a misuse or misapplication of the underlying theory (Hodder and Riggs, 1985) or move strongly that DCF was an inappropriate valuation method. Hertz (1964). Magee (1964) suggested instead the use of simulation and decision trees, or Decision Tree Analysis (DTA) as a means to capture the value of future operating flexibility associated with many projects. Other academics and company executives wanting to refine DCF have turned their attention to technical questions related to the selection of the risk-adjusted process without considering adequately the appropriateness of DCF for valuation of particular projects which have strategic implications. The traditional DCF approach cannot fully accommodate the interdependencies between current and uncertain or contingent future decisions which make the risk-adjusted discount rate non-deterministic.

Traditional DCF is based on value maximisation under *passive* or static conditions and on implicit assumptions concerning a predetermined operating strategy in which the project would be initiated immediately and operate continuously at base case until the end of a pre-specified useful life. Ansoff (1965) and Myers (1987) point out that traditional capital budgeting techniques are unable to forecast the value of projects not yet in hand and that they are difficult to use in situations involving multiple objectives or substantial project interdependencies e.g. synergies or other unique qualitative attributes (Lai and Trigeorgis, 1995). The standard NPV although perfectly suitable for projects that once undertaken require no further decisions or actions by the firm, is of little assistance in the valuation of projects which offer managerial flexibility in dealing with future contingencies. In summary, DCF may be appropriate when applied to narrowly defined problems but is inadequate when uncertainty and strategic considerations are paramount (Pinches, 1982, Myers, 1987 amongst many). These observations point to the existence of an extra parameter which managers implicitly or explicitly factor into their investment decisions.

Well before the development of Real Options Analysis, ROA, managers and strategists intuitively adjusted their investment strategies to include other factors such as future growth considerations, realising that traditional DCF criteria undervalued many investment opportunities. Kester (1984) developed Myers' (1977) concept of thinking of discretionary investment opportunities as "growth options". These embody both strategic and competitive elements. For example, shipping lines may enter a new market or trade not so much because the immediate investment generates a positive NPV, indeed it may be the opposite, but in order to keep a competitor out of the trade or to put the line in an advantageous position for valuable follow up opportunities. An investment such as this is an example

of a multistage decision that involves "real" options. The decision to enter the trade has the ability to create future assets (cash flow) as a by-product of the initial investment decision. The shipping line, by undertaking the initial investment, has the option in future to expand the number of ships in the trade, or exit the trade depending on market circumstances in the future.

2.2 Real options

Real options capture the value of managerial flexibility to adapt decisions in response to unexpected market developments, giving the manager the right to defer, to expand, to contract or abandon the project once more information becomes available. Companies create shareholder value by identifying, managing and exercising real options associated with their investment. The concept is similar to financial options.[3] An option gives the right but not the obligation to undertake an action i.e. a business decision, at a predetermined cost (the exercise price), for a predetermined period of time (the life of the option). A *call* option is the right to buy the underlying asset at the predetermined (exercise) price. As there is no obligation on the part of the holder of the option to exercise the call, the option can lapse. However if the option is exercised then the profit on the option is the difference between the value of the underlying asset and its exercise price. A *put* option is the right to sell the underlying asset to receive the exercise price and thus is the opposite of a call. A *European* option can only be exercised on its maturity date where as an *American* option can be exercised at any time during its life and thus is more applicable to investment in real assets. An option is *in the money*, i.e. profitable to exercise if the price of the underlying asset is above the exercise price with a call option and below the exercise price with a put option. If not profitable to exercise it is *out of the money*.

Although examples of real options have been recorded throughout history, the first to coin the term "real options" was Myers (1977), who applied financial option pricing theory to the valuation of a non-financial or "real" investment in a multi-stage manufacturing plant expansion. Other academic papers followed but it was not until the last 10 years that interest in ROA began to attract considerable attention from corporates as a potentially important tool for valuation and strategy (Borison, 2005). ROA has been adopted by a number of organisations in the transport, energy, infocom and mining industries as well as large consumer and industrial companies, particularly those engaged in R&D and involving a multi-stage production process (Triantis and Borison, 2001).

Real options are often classified by their flexibility. If management wants to scale up production then management needs to value an option to expand. They would need to value an American call which gives them the right but not the obligation to add additional capacity to their current project by further investment at a later date. In contrast to scale down an operation or to close an operation are examples of American put options where management has the right to sell, but not the obligation, should the operating environment worsen. An option to *contract* allows management to sell a fraction of the operation while an option to *abandon* at a fixed price leads to closure for a predetermined salvage value. Being allowed to defer the decision to invest is an option to *defer* while *switching* options are portfolios of American puts and calls which allow the flexibility to switch inputs or outputs. *Compound* options are options on options and point to the need for sequential investment decisions while *rainbow* options reflect multiple sources of uncertainty.[4]

2.3 A taxonomy of maritime real options[5]

2.3.1 Option to expand

Perhaps one of the easiest real options to identify is the option to accelerate the rate or expand the scale of operation by investing an additional outlay. Once established in a trade, for example a shipping line can increase the number of vessels in a trade, should market conditions warrant. This ability to make a discretionary investment is similar to an American call option on the increased scale of the project and with the exercise price, the additional outlay. The project then can be seen as the base scale project, or static NPV, plus a call option on the future investment, which is the value of flexibility. The option becomes profitable to exercise, if future demand turns out to be higher than expected. A major source of value from infrastructure investments arises from the ability to enhance the upside of a project during good market conditions by making follow-on investments (Myers, 1977). Ports with surplus land can build extra terminals and terminal operators can increase the number of gantry cranes on a berth. This option, which will be exercised only if future market developments turn out favourably, can make seemingly unprofitable investments (based on static NPV base-case) worth undertaking. Infrastructure investments consist of both tangible and intangible core assets on which individual operating flexibility options are based. Flexible computer-based manufacturing systems, such as CAD-CAM manufacturing in the ship building industry, are evidential. Investment in training has intangible option benefits for ship and port operators if for example the management has a multi-skilled workforce to utilise.

2.3.2 Growth options, strategic options, competitive options

Growth options are similar to expansion options but with more emphasis on strategic or competitive positioning. They set the path for future opportunities. Growth options are possible because of the firm's ownership of intangible assets such as patents, proprietary technologies, ownership of valuable resources, managerial capital, reputation or brand name, scale and market power which allow companies to grow through future profitable investments and to more effectively respond to unexpected adversity or opportunities in a changing technological competitive or general business environment (Trigeorgis, 2000). The ownership of growth options enhances management's flexibility for future action and gives the firm a sustainable competitive advantage.

Technological superiority and know-how permit further sequential (or parallel) developments ensuring competitive edge is maintained. In this way growth options such as in this example are called complex or compound options as growth comes from exercising a series of options (i.e. an option on an option). For the shipbuilding and related industries, R&D investment is essential in a competitive environment with rapid technological developments. Australian shipbuilders became world leaders in aluminium welding techniques and design of high-speed craft which ensured that they remained ahead of other competitors by continual design development. Thus the development of first generation product can create a proprietary growth option acting as a springboard for developing in the future lower cost and improved design or indeed new applications. Investment in Information Technology (IT) can be viewed at a growth option as it provides a link in the chain to interrelated projects and growth opportunities.

Similarly development of a new market/trade with an initial negative NPV can open up or generate opportunities in other markets at a later stage or can pre-empt the entrance of a competitor. This investment may be viewed as a strategic investment. Strategic acquisitions such as purchase of a terminal by a shipping company gives the shipping line control over competitor access and timing to

the facilities conferring on the company a competitive edge via the proprietorial real option.

Once investment opportunities are properly seen as collections or a portfolio of real options, strategic planning can be more readily viewed as involving the explicit recognition, creation and management of current and future investment opportunities (Lai and Trigeorgis, 1995). Examples taken from Bendall and Stent (2005, 2007a) are used below in Section 4 to demonstrate how real options can be used to value complex maritime investment applications involving both mutually exclusive and non-mutually exclusive investment strategies.

2.3.3 Option to contact, option to abandon

Investors may also have embedded options to contract or abandon if a project fails to achieve the required rate of return envisaged, due to less favourable market conditions. If market conditions are weaker than originally anticipated management can operate below capacity or even reduce the scale of operations and thus save part of planned investment outlays as well as reducing operating costs. This flexibility to lessen the loss is analogous to a put option on part of the base scale project with the exercise price being equal to the potential cost savings. The option to contract is particularly valuable in the case of entering into a new market (trade) or in choosing among technologies with different construction to maintenance cost mix. To illustrate this point, management may chose initially a lower cost asset with higher maintenance expenditures in order to acquire the flexibility to contract operations by cutting down on maintenance if market conditions worsen.

If the project suffers severe losses through a systemic market decline or for some other reason such that the firm can no longer sustain its fixed costs then the project should be shut down. The more general purpose the capital asset (i.e. lower asset specificity, the higher will be the value of the abandonment option). For example a container ship or bulk ship would be considered to have low asset specificity while a gas carrier would have high asset specificity. This real option is equivalent in this case to an American put option. The underlying asset is the current value of the vessel where the salvage value is the exercise price.

In contrast infrastructure companies' abandonment options may be less valuable than that of shipping lines because of the sunk cost nature of the assets. This means that their exercise price is low. Once constructed a port or terminal cannot be moved to another location or may not be profitably used for another purpose, although port land can be turned over to recreational use. With low exercise prices, the options and the business that own them would be worth less than they would otherwise.

2.3.4 Option to switch (output or input), location options

Product or input flexibility is a valuable option for management. With an option to switch, management can change the output mix (product flexibility) if prices or demand change or alternately, the same output can be produced using different types of inputs (input flexibility). For instance, Kulatilaka (1993) found that the value of the flexibility provided by an industrial dual-fired steam boiler that can switch between alternative energy inputs (natural gas and oil), as relative prices fluctuate, far exceeded the incremental cost of a single-fuel alternative. In fact, because of the existence of the switch option, the firm should be willing to pay a positive premium for flexible technology over a rigid alternative that confers no or less choice.

In the maritime industry there are many examples where management has opted for technology which allowed flexibility in output (product switch option) or choice of inputs (input switch option).

In the 1970s a cement carrier was introduced into service on the Australian coast which could switch between diesel and compressed natural gas. In a greener world, the ability to use renewable resources to power vessels has been welcomed. The Solar Sailor can switch between wind, solar and diesel-electric power sources or can use a combination of all three, depending on weather conditions. New vessel designs are incorporating sail features allowing operators the option to save fuel by supplementing wind power Many ports/terminals opt for more expensive technology which allows flexibility in output (output switch) e.g. cranes with flexibility to service both panamax and post-panamax vessels. These investments may appear expensive at the time of purchase but the true valuation has included a (product or input) switch option.

Closely linked to switch options are location options. Multinational manufacturing firms are sensitive to changes in exchange rates and switch production inputs to choose, ex-post, the lowest input mix (input switch option) (Kogut and Kulatilka, 1994). Companies, such as Nike have moved production sites from one country to another to reduce costs and maximise profits as exchange rates, labour costs and investment incentives change. Shipping is a service industry sensitive to exchange rates and exchange rates may affect export competitiveness. The changing pattern of trade changes the demand for shipping services. However vessels can be re-routed or positioned in a new trade. Ships, in contrast to other capital intensive investments, usually have low asset specificity (Bendall and Manger, 1991) and can be switched (output switch) easily to a new trade. A vessel owner has thus acquired a valuable switch option which is nested in the initial cost of the ship.

2.3.5 Option to defer or waiting to invest or timing options

An option to defer is an example of an American call option with its exercise price the money to be invested at a later date. It can be found in most projects where one has the right to delay the start of the project. If a shipbuilder holds a patent for new technology, the builder can delay marketing the new design until market conditions prove more favourable or has sold existing vessels with older technology currently under construction. A deferral option is often at the heart of real option flexibility value because it can be linked to other options. Being able to postpone a business decision to expand, to contract, to change inputs or outputs, to abandon etc until more information is available is extremely valuable to management. A project with a negative NPV may become profitable if it can be deferred over a certain time period. If a ship operator acquires a controlling interest in a port/terminal in a different trade he can chose if and when his ships will use the facilities, safe in the knowledge that he will take priority at the berth over competitors in the future and thus the opportunity to enter and control that trade. If the firm chooses to invest “now” rather than invest “later” the NPV must be raised to offset the loss of the timing option (Dixit and Pindyck, 1994). This is in contrast to the expansion or growth opportunities where the option to expand makes up any shortfall in the static NPV.

A lease enables management to defer investment. If the fast ship/ferry operator had been able to obtain a time charter (an operating lease) or an option to buy (or an option on a financial lease) from the shipbuilder and was able to defer a commitment to purchase until there was more certainty regarding oil prices, or other market conditions then the ferry/ship operator would have acquired a valuable real option (to defer). Similarly a terminal may lease equipment before committing to buy, awaiting the necessary growth in throughput to make the investment profitable.

Time charters with purchase options, T/C-POPs, investment strategies offer the owner of the (call) option valuable flexibility. They are options to defer the decision to buy, but can be combined with a number of embedded options. In a European style T/C-POP the charter is given the opportunity to purchase the vessel at the end of the charter period at a pre-determined price while in an American T/C-POP the owner can opt to purchase the vessel at any time up before the expiry date.[6] The value comes from the flexibility to choose if and when to buy the vessel (exercise the option) as uncertainty unfolds. T/C-Pops can be structured to give the holder a number of strategy choices. The T/C-POP holder may purchase of the vessel (exercising an expansion option) if buying is more advantageous to the ship operator than opting to continuing chartering or take on a new T/C-POP (i.e. deferring for another period) or indeed to abandon the trade altogether (an abandonment option).

2.4 The grantor of the real option

To encourage investment in infrastructure projects governments often grant real options to compensate for the sunk nature of the investment. This can be in the form of a revenue guarantee or clauses guaranteeing buy-backs at given prices. Shipbuilders may offer as a safety net or security to new investors/financial institutions an option to buy-back the vessel should the profitability of the venture fail. The buy-back is pre-set generally on a sliding scale at rates commensurate with depreciation and the time value of money. This is a great deal for the shipowner as the holder of the real option posses a valuable asset, but as grantor of the option the shipbuilder is bearing the risk as he takes on a contingent liability until the option lapses. Bendall and Stent (2007b) demonstrated how to value such “sweeteners” from the shipbuilder’s point of view.

3. Valuing Real Options

“Whether advocated in its strong form as a core valuation tool or its more moderate forms as a ranking tool, a heuristic or a metaphor, the appeal of real options lies in its promise of structuring decision making under uncertainty” (Adner, 2007).

While the argument that the advantage of ROA lies in its framing and structuring of the investment decision in real option terms has great allure, Damodaram (2005) advocates the importance of the strong form. He argues that if used only in a qualitative way that there is danger that the approach could be used to justify poor investments. Managers who argue for taking on a project with poor returns or pay a premium for acquisitions on the basis of embedded real options should be required to value these real options and demonstrate that in fact the economic benefits do indeed exceed the costs.

3.1 Real options analysis

As described in Section 2, the conceptional principles are similar to that of financial market options. The opportunity to put an additional ship in the trade is similar to an American call option and is the right but not the obligation to acquire a claim to the cash flow value. Similarly the right, but not the obligation, to reduce the scale of operation, say moving from two ships to one in a trade or exiting the trade altogether, is an example of a put option. ROA thus can correctly value managerial flexibility by explicitly considering appropriate action at future dates on which information about the project’s profitability is revealed. The project’s true valuation may look more attractive when the value of this flexibility is incorporated.[7] This means that a project may have a static NPV that is negative and therefore would be rejected using traditional NPV rules but may be accepted if the value of flexibility is added.

Value of project with flexibility = Value of project without flexibility + Value of flexibility

Thus the value of the project is equal to the traditional static NPV or base case plus a value for active management. An option's approach views capital investment as an on going process requiring active managerial involvement and ROA provides the means to value this flexibility at the ouset.

The quantitative origins of real options' pricing derives from the financial markets with the seminal work of Black and Scholes (1973) and Merton (1973) in pricing financial options. The model was perceived to be complex and off-putting to many practitioners (Trigeorgis, 2000). Cox, Ross and Rubinstein's (1979) binomial approach presented a more simplified methodology by evaluating financial options in discrete time.

Although the Black Scholes' model is mathematically challenging and the assumptions necessary too restrictive for pricing of real options, the principles are useful in developing an understanding of real option valuation. The basic variables in their "closed form" financial option pricing model are the value of the underlying asset; the exercise price; the time to expiration of the option; the volatility (standard deviation) of the underlying risky asset and the risk free rate of interest over the life of the option.

In the case of a real option the underlying risky asset is the value of the investment or project. If the value of the project rises, so too would the value of the option. The exercise price is the amount needed to exercise the option i.e. the additional investment costs in a multistage project. Note that in the case of a call options, as the value of the exercise price increases, the value of the option decreases but increases the value of the option in the case of a put. As the time to expiration (maturity of the option) increases so too does the value of the option. This makes intuitive sense in situations where there is a great deal of uncertainty. Obviously the longer the time there is to delay the investment decision the more information is likely to become available. The value of the option is therefore sensitive to the degree of uncertainty or riskiness (volatility) of the underlying asset. Again this makes sense if we understand that the payoff of the call option depends on the value of the underlying asset exceeding its exercise price. This is more likely to occur if volatility increases. Lastly the value of the option increases if the risk free rate rises as it increases the time value of money advantage in deferring the investment cost until more information is known.

Cox and Ross (1976) recognised that an option could be replicated (to create a "synthetic" option) from an equivalent portfolio of traded securities. The replicating portfolio approach is based on the Law of One Price which simply states that to prevent arbitrage (riskless) profits, two assets with the same payoffs ("twin security"[8] or "twin asset"[9]) in every state of nature are perfect substitutes (i.e. perfectly correlated) with the underlying risky asset and therefore have the same price (value). The risk-neutral probability approach is mathematically equivalent. A hedge portfolio is created, composed of one share in the underlying risky asset and a short position in "*m*" shares of the option being priced. The hedge ratio *m* is riskless as loss on the underlying asset is offset by the gain on the option (and vice versa) – hence risk free.

3.2 Risk neutral valuation example

The example, although simple, illustrates ROA valuation principles. It demonstrates how static NPV can underestimate the value of the project simply by not taking into account the embedded real option.

Assume that a firm is considering an initial investment costing $12 million. The value of the project

in one year's time is dependent on the (currently unknown) demand for the product or service. If demand turns out to be high, the project will be worth $15 million; if demand turns out to be low, the project's value including the original investment would be only $10 million.[10] These high and low outcomes are equally likely, i.e. each occurs with a 50% probability (a 50–50 chance). The present value, PV, was determined by multiplying the value of the high and low outcomes by the respective probability and discounting by the risk adjusted discount rate of 12%. See Figure 1. The risk free rate is 5%. The parameters are summarised in Table 1.

If the standard NPV analysis is applied by discounting the expected cash flows by the risk adjusted discount rate the base project's present value is $11,161,000.

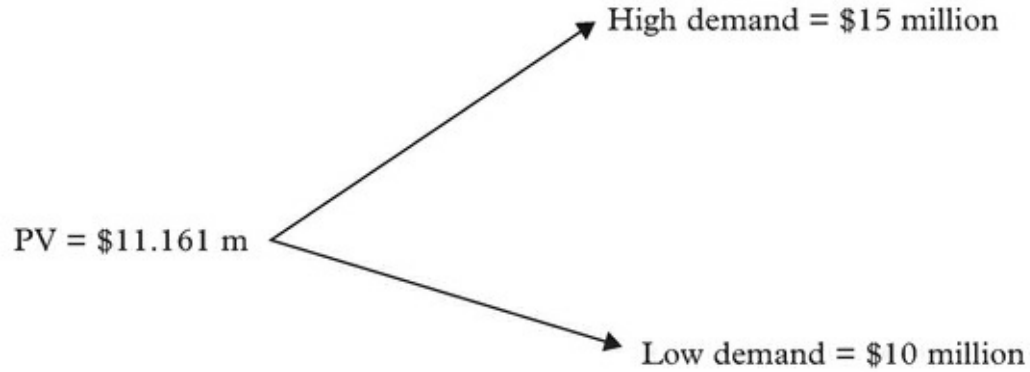

Figure 1: Project's present value

Table 1: Parameters for expansion option example

Parameter	Value
Cost of base project	$12 million
Value of base project in one year's time if demand is high	$15 million
Value of base project in one year's time if demand is low	$10 million
Probability of demand being high	50%
Cost (in one year) of expansion	$1 million
Proportional increase in base project value if expansion occurs	20%
Risk free rate of interest	5%
Risk-adjusted discount rate for base project	12%

$$PV = 0.5 \star \left(\frac{15}{1.12}\right) + 0.5 \star \left(\frac{\$10}{1.12}\right) = \$11.161\text{m}$$

NPV = Present Value − Initial investment

= $11.161m − $12m

= – $839,000 → negative. Do not invest.

The NPV of – $839,000 is obtained by subtracting the initial capital cost of $12 million. In the absence of managerial flexibility (real options), the DCF analysis rule leads to a rejection of the project as acceptance would destroy value in the firm. This decision ignores the ability of management to alter the investment in response to new information. Traditional NPV is unable to capture the value of any embedded real option. Should demand conditions be more favourable than expected one year later, management would like the flexibility to expand (an expansion option). The traditional NPV analysis deals with this by implicitly assuming that management commits to a particular course of action (expand or not expand) at the time the project is launched, regardless of the conditions that subsequently prevail. This severely underestimates the value of the investment by ignoring the ability of management to respond to new information. ROA allows management to

incorporate this flexibity into the investment valuation.

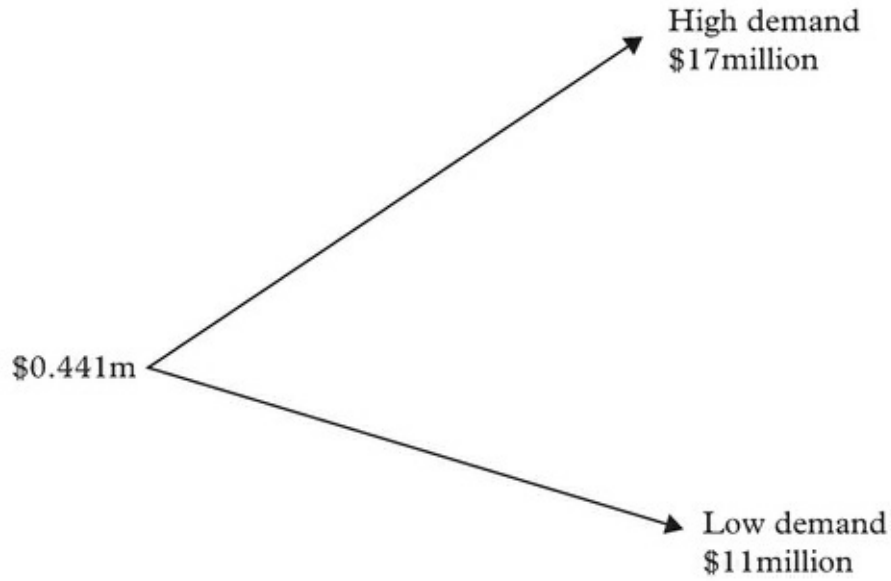

Figure 2: ROA project value

Having determined the base case NPV, the event (decision) tree is utilised to calculate the additional payoffs under both demand states should an additional investment be made in the next period. From Table 1, an additional investment of $1million would increase the scale of operation by 20%. In high state demand the project's pay-off lifts to $18million ($15m*1.20), a net gain of $2 million. However if low demand occurred the payoff would rise by the 20% to $12 million ($10m*1.20), a net gain of $1million. See Figure 2.

The next step in the ROA analyis is to identify a portfolio that exactly mimics high and low demand state-contingent payoffs. The ability to construct a "synthetic claim" or an equivalent replicating portfolio enables a solution for the present value to be independent of the actual probabilites, in this case (0.5) or the investor's risk attitudes (risk adjusted discount rate = 12%). In effect mangement can replicate the pay-off by contructing a portfolio using *m* units of the base case NPV and *b* units of the riskless bond (equivalent to financing the purchase by borrowing at the riskfree rate of 5%).

Therefore the replicating portfolio's pay-off equals

$m^*15 + b^*1.05$ in the high-demand state and

$m^*10 + b^*1.05$ in the low-demand state.

If this portfolio is to replicate the option, *m* and *b* must satisfy the two equations

$$15\,m + 1.05\,b = \$2\text{million}$$
$$10\,m + 1.05\,b = \$1\text{million}$$

The first equation says that the portfolio has the same payoff as the expansion option in the high-demand state; the second equation says that it has the same payoff as the expansion option in the low-demand state. Solving the two linear equations with two unknown variable (*m* and *b*) gives $m = 0.2000$ and $b = -\$952{,}380$. That is, owning a portfolio consisting of 0.2 units of the base case project and riskless borrowing of $952,380 is equivalent to holding the option to expand.

The ROA approach states that, since both have the same future payoffs, the present value of the expansion option is the same as the present value of the portfolio. Thus the ROA option value = (0.2*$11,161,000) − $952,380 = $1,279,820 and a project value of $440,820 (−839,000 + $1,279,820), found by adding the real option value to the base case NPV.[11] As the value of the NPV is positive the

project should be accepted. The base case NPV (value of the project without flexibility) undervalued the project by not including in the valuation the value of flexibility created by the expansion option.

Value of project with flexibility = Value of project without flexibility + Value of flexibility

The example used assumes that there are only two points in time and only two possible future states, and ignores various real-world complications. The tree only considers an expansion option.[12] However the valuation principle can be extended to more complex and realistic situations. Although the analysis becomes more complicated, it relies on the same fundamental method; the principle that assets with the same future payoffs must have the same present value.

3.3 ROA methodologies: which one to use?

Despite the extensive literature[13] and practitioner interest in real options, Copeland and Antikarov's prediction that ROA would be the accepted metric for investment valuation by 2010 seems unlikely at this stage, although in recent years software making it easier for practitioner is more freely available. NPV took at least 25 years to gain the status it now enjoys as the principal tool for investment evaluation. A real option approach is appealing for high risk projects and for industries such as the maritime industry operating with a highly uncertain market environment as it allows managers to structure decision making and incorporate the value of flexibility. Although some applications are relatively simple and straightforward and suitable for commercially available generic real option software, many real world applications involve sequential projects (compound options) and/or multiple uncertainties (rainbow options) requiring more complex modelling, thus perhaps inhibiting a more general acceptance.

To be more widely accepted as an investment decision tool, managers should appreciate that ROA is not a replacement for DCF analysis. It extends NPV by being able to incorporate and value a firm's ability to adapt to changing information at the outset. While some firms put more emphasis on using real options for strategic management formulation rather than modelling in a quantitative way, firms such as Boeing[14] have become committed to ROA and now apply an option's approach to most of their investment and strategic decision making (Matthews and Datar, 2007). However other firms appear hesitant and, although managers may understand the basic concepts do not yet have the confidence to use or use as a standalone technique. There are a number of possible reasons for this. Some concern stems from not fully understanding when and in what circumstances it is more appropriate to use a real option framework. Not all investment decisions contain an embedded real option or, if present, can be simply accommodated into the standard NPV valuation. The NPV value may be so convincing in some analyses that although also containing embedded real options, further identifying and valuing the real option component has little point.

Real options really come into their own in the "grey area" where NPV is close to zero. It is at this point where uncertainty is greatest and management needs to make tough decisions. Having the means to quantify flexibility is extremely helpful. Copeland and Antikarov (2001) argue that if the NPV is very negative then no amount of optionality is likely to rescue the project. Similarly when the NPV is high, additional options have a low probability of being exercised. Adner and Levinthal (2004) caution that an option approach may be misleading in some instances by providing examples where an option framework is unsuitable for some strategy applications involving sequential decisions and abandonment, particularly where resolution of technical and market uncertainty is largely

unconstrained. They argue strongly that knowing the boundaries of ROA only serves to make ROA a more powerful and precise valuation tool.

Perhaps the strongest factor limiting wider application in practice may be the variety of methodologies that have been proposed under ROA, causing concern that if the "*wrong*" method should be applied then perhaps an incorrect investment decision could result. This apprehension too is understandable. However all ROA approaches have at their core the calculation of value. Reviewing the literature and applications it appears that it may be simply a case of "*if the cap fits*" i.e. the appropriate real option methodology depends on the specific problem, the market, the nature of the uncertainty, the type of the option being valued and to a certain extent the disciplinary background strengths of the researcher.

ROA methodologies encompass both finance and operations research/management science disciplines. In some circumstances the data are freely available in the market and the appropriate methodology would be similar to financial market option models. However for some projects market data are not available and may need to be replaced by subjective inputs and calculated by drawing on other decision making techniques. The following illustrate different approaches applicable for different data sets.

3.3.1 Using market data and replicating portfolio approach

If the investment can be effectively hedged through a traded tracking portfolio, the data used to value the investment can be taken from a traded portfolio or twin security i.e. market data, and the option value calculated is thus the no-arbitrage value of the investment. The assumption is that markets are complete with respect to all corporate investments and can be tracked with a traded portfolio. Thus, the cash flows from the project are replicated by a self-financing portfolio of riskless securities and futures contracts (Brennan and Schwatz, 1985).[15] The twin security has the same risk characteristics and thus can be viewed as being, if not perfectly correlated, closely correlated with the project under consideration. As more shipping companies become listed then shipping stocks or indices could be used as the replicating portfolio to evaluate an investment in shipping. Having identified the replicating portfolio or twin security and calculated price and volatility factors, the investment then is "sized" in relation to the twin security. The traded replicating portfolio from the financial market assumes that asset price movements follow geometric Brownian motion, GBM, so standard financial tools such as Black Scholes may be appropriately applied.

3.3.2 Subjective assessment approach

For staged or sequential investments, Luerhram (1997) and Howell *et al*. (2001) follow a similar approach of no-arbitrage replicating portfolios but because of inadequate or non-availability of market data, use subjective assessments. The authors argue that if the option to be valued is a compound option, early stages (investments) may or may not provide a direct cash flow but simply provide the right to further investments. As the risks of the option can be hedged away with a replicating portfolio and uncertainty is assumed to follow geometric Brownian motion then standard financial option pricing tools may be still used. The difference in this approach to that above is that subjective assessments need to be made, as opposed to data from traded markets, for value calculations. As it is no longer possible to "size" the investment relative to an equivalent traded investment, DCF may then be used to determine the value of the underlying asset.

3.3.3 Dynamic programming and DTA

In some cases, the assumptions underlying the standard financial market option approach may be too restrictive so real options analysis, based on a financial option approach, is thus inappropriate. Where market data are not available i.e. markets are not complete and it is not possible to find an asset which is perfectly correlated, Dixit and Pindyck, (1994)[16] and Amram and Kulatilaka, (2000) apply management science techniques such as dynamic programming and decision analysis to value real options. In place of standard option pricing, a decision tree representing alternative strategies is constructed with probabilities and values assigned to the company specific risk based on subjective assessment. A spreadsheet is used at each tree endpoint to calculate the NPV,[17] with an appropriate WACC. The tree is then rolled back to determine the optimum strategy.

3.3.4 Public v private risk approach

Smith and Nau (1995) and Smith and McCardle (1998) analyses also recognised that for many investment decisions the assumption that markets are complete is inappropriate. They point out that markets are generally only partially complete. They were the first to separate the two types of risk, public (market) and private (company specific risks) and incorporate both into the decision-making process. For example, in the case of a LNG ship investment the risk associated with the international gas prices could be classed as a public risk (market risk) and freight demand for a particular shipping company as a private risk (company-specific risk). The valuation method of each differs depending on the type of risk. Rather than forcing real option valuation into an either/or approach (standard financial option pricing versus decision analysis), they incorporated both into their methodology. Traditional option pricing methods should be used where risks can be hedged by trading securities and that proportion of the asset driven by private risks, by assigned probabilities in a decision analysis framework. A risk adjusted decision tree would then be built based on investment alternatives and tree branches representing public risks resolved by identifying the replicating portfolio and applying standard finance no-arbitrage option techniques such as Black Scholes or binomial lattice (Leunberger, 1998), and private risks branches using subjective probabilities, before folding back in the usual way.

3.3.5 The MAD approach

The Market Asset Disclaimer (MAD) approach does not rely at all on the existence of a traded replicating portfolio. Copeland and Antikarov (2001) point out the difficulties of finding a market based “twin asset,” or “twin security” that is perfectly correlated with the underlying asset. Instead of searching for a perfectly correlated asset in the market, or even a close substitute, they propose that the present value of the project itself be used as the value of the underlying asset. “What is better correlated with the project than the project itself?” The present value of the project without flexibility becomes the best unbiased estimate of the market value of the project, were it a traded asset. The MAD real option approach built on previous studies by Kasanen and Trigeorgis (1993), Trigeorgis (1999), Brealey and Myers (2000) amongst others. The underlying asset is itself not traded. The initial NPV is an estimate of the value of the future behaviour that the asset would have if it was traded. The authors point out that the real options are still able to be valued even though not traded, because the process of capital budgeting determines the value of the project’s cash flows in the market.[18]

By using the MAD approach we are no longer restricted to resolving projects in complete markets.

Private versus public risk is dealt with directly with the NPV calculation. Samuelson's proof that properly anticipated prices fluctuate randomly ensures that even an irregular stochastic pattern of future cash flows will follow a random walk through time with constant volatility. A binomial lattice can thus be used. Monte Carlo simulation generates a distribution which is used to build a risk-neutral binomial lattice and option value. There is now no need to assume a specific discount rate or weighted average cost of capital, WACC. The underlying asset value is determined using a spreadsheet. The MAD approach is intuitively appealing for practitioners as it extends NPV analysis and has a much wider application to a number of real options investment valuation problems.

3.3.6 Probabilistic v possibilistic distribution approaches

Two recent real option valuation methods also appear promising and arousing a lot of interest. DM and Fuzzy ROV may be solved using commercially available software and require minimum modelling. Thus they appear intuitively appealing to practitioners with minimum modelling skills. It can be used for strategy discussion before the analytical valuation calculation, providing an opportunity for direct input by managers in the firm at the formulation of the model stage. As with MAD, information available from traditional project analysis using NPV also forms the basis of Mathews and Datar (2004, 2007) and Matthews and Salmon, (2007) DM methodology. The DM option approach was initially developed to evaluate staged projects for new product developments at Boeing involving R&D (compound options) and thus would be applicable to similar maritime applications, particularly in shipbuilding and marine engineering fields. Because of the uncertainty regarding operating profit forecast each year, to value the option Monte Carlo simulation is used to generate a probability distribution of project's value,[19] rather than a single expected value in other ROA methodologies. In this method a variety of discount rates can be applied to reflect the risk of different aspects of the project's cash flow. For example, projected profit cash flows could be discounted by an appropriate risk adjusted discount rate while the discretionary investment level (the exercise price of the call option on the new venture), by the risk free rate. The risk free rate here is appropriate as the risk is low.[20] Only positive outcomes are selected for the next stage as the project would be terminated if a loss is forecast. Net profit, equal to the difference between operating profit and exercise price, of the positive outcomes is used to build a further payoff distribution. The real option value is the weighted mean or average value of this positive probability distribution.

Their approach, the authors argue, simplifies and helps manage complex strategic investment problems and is algebraically equivalent to the Black Scholes when the same constraints are used.[21] It uses the language and framework of standard DCF. Because it can be modelled on a spreadsheet using off-the-shelf simulation software to incorporate uncertainty and timing decisions, the authors argue that is easily more understood by management and so not only provides a valuation method that is transparent, but can give structure to early scenario based strategic discussion at all levels in the company providing further modelling refinement from input of experts.

Collan (2008) proposes using fuzzy numbers to calculate the value of a compound real option. Here, the treatment of risk is different from the DM approach. Uncertainty means that it may be difficult, or managers may not have the confidence, to give absolutely correct (crisp) values. Fuzzy sets[22] allow for graduation or qualitative estimates. In place of a probabilistic distribution of the DM approach, the fuzzy pay-off method uses a possibilistic distribution based on triangular or trapezoidal fuzzy

numbers.[23] Simulation is not a necessary step and can be solved using spreadsheet software. Although the fuzzy set approach is a late addition to the stable of real option methodologies, it is as yet to be tested empirically and/or taken up by corporates. However, one advantage of this method over other methods the author states, is that it will be perceived as more realistic by management as it allows direct input of non-crisp subjective values.

3.3.7 So which course should maritime companies chart?

Although each method has merit when applied to a specific set of variables or application, the Market Asset Disclosure, MAD, approach has been shown to be far less restrictive. Instead of having to separate public from private risks or search for a perfectly correlated asset in the market, the present value of the project itself can be used as the best unbiased estimate of the project were it to be traded, and thus can be applied to a wider set of real option valuation problems. The approach is intuitively appealing as it is not a "black box". It does not rely on using a correct weighted cost of capital, WACC. It extends NPV analysis, a valuation technique well understood by management, by valuing at the outset management's flexibility to alter a project when more information becomes available and uncertainty resolved.

4. Valuing Complex Maritime Investment Decisions

Companies operating in a changing and turbulent market environment must be flexible. The maritime industry is no exception and operates in an environment characterised by many volatile and uncertain factors. It is an industry whose cash flows are exposed to daily changes in international financial markets, to multi-currency risk, to multi-country sovereign risk, to pirates, to movements in oil prices, to other competitors and, above all, the trade cycle. So the decision to proceed with the acquisition of new ship technology or a new portainer crane can be regarded as a large scale capital evaluation problem within the context of a great number of volatile parameters. Optimisation of the firm's value is dependent on correct investment choices by management. Management thus needs sound and reliable tools to minimise the risk of poor investment decisions.

The following maritime examples of ROA are based on the MAD approach and illustrate the advantage of a ROA approach over traditional static NPV. In each case, the value of flexibility, the real option, is calculated and added to the present value of the original strategy to derive the present value of the flexible strategy. The examples chosen[24] demonstrate how to value alternate strategies in the face of high uncertainty and how to correctly choose from a portfolio of investment strategies which are not mutually exclusive.

4.1 Maritime Example 1

The first maritime example is that of an investment in a high speed hub and spoke feeder service based on Singapore to Penang and Klang.[25] Three alternate investment strategies were proposed involving the employment of one or two ships with port visits to each or both.

Demand and base freight rates were modelled as triangular probability distributions and a simulation performed[26] to calculate the NPV of the three strategies. See Table 2. A period of one year elapses (the time to build the ship) between the decision to commit to a particular strategy and commencement of the cash flow. Consequently the present values of the cash flows need to be discounted a further year at the cost of capital at 10% and the cost of the vessel at the risk free rate of 5% to obtain the NPVs. These values became the base case (static) NPV for the ROA.

The flexible strategys are summarised in Figure 3. An option on the maximum of three risky assets (the three strategys), is determined like a financial option using no-arbitrage and added to the value to the base NPV case to obtain a value for a flexible NPV.

Table 2: NPVs of Three Strategies (USD)

	Service	PV	Ship Cost	NPV$m[1]
Strategy 1	Both ports, 1 ship	61.06	60	–1.63
Strategy 2	Both ports, 2 ships	121.00	120	–4.29
Strategy 3	Klang only, 1 ship	67.56	60	4.27

[1] *PV/(1+k) – Ship cost/(1+r)*

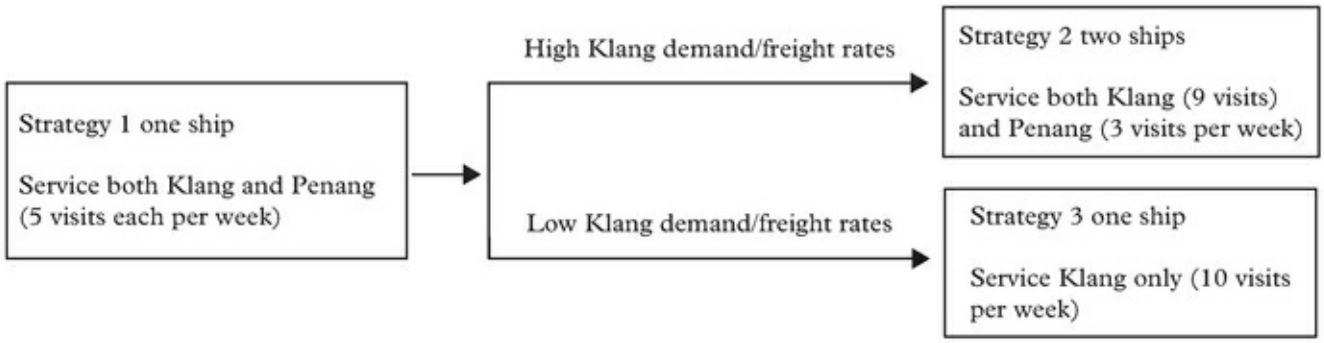

Figure 3: The flexible strategy

Table 3: Arguments in Equation 1

Argument		Implied action
1	0	Stay with strategy 1
2	$M_{2T}/(1 + k) - S_T/(1 + r) - M_{1T}$	Change to strategy 2
3	$M_{3T} - M_{1T}$	Change to strategy 3

Strategies 1 to 3 are risky assets. The flexible strategy is to proceed with original Strategy 1 (NPV = −$1.63m) with an option to change to original strategies 2 or 3 as uncertainty is resolved. If the combined value of the NPV of strategy 1 plus the option value exceeds the NPV of strategy 3 (NPV = $4.27m) then the flexible strategy is preferred. The option is an American style since the decision to exercise is not restricted to a single fixed point in time. An efficient multinomial lattice algorithm with risk neutral probabilities developed by Kamad and Ritchken (1991) was used to calculate the option value by valuing each path of the multinomial tree and then folding back, checking for early exercise at decision points.

The formula used at the end of each path (time denoted by T) is

$$\max(0, M_{2T}/(1+k) - s_T/(1+r) - M_{1T}, M_{3T} - M_1 T \qquad (1)$$

where M_{iT} is, for each original strategy i = 1,2,3, the market value generated along the path, and *max* is the function which assigns the maximum value of the three arguments. If the end of a path is reached then there has not been earlier exercise and strategy 1 is still in operation. The formula assigns the extra value that would result by making the best decision at this time and is summarised in Table 3.

Since the value of the second strategy is subject to the one-year time to build the second ship, its value is discounted one year and the discounted cost of the second ship, S_T, as calculated above deducted. r is the risk-free rate. Folding back from the end of the tree to the single starting node is performed in the usual manner using the risk-neutral probabilities and the risk-free rate of interest. At a decision step, every six-months folding back, the option value is the maximum of the folded-back

value (wait) and the early exercise value calculated as in Equation 1 with T now denoting the particular point in time.

Value of project with flexibility = Value of project without flexibility + Value of flexibility

The value of the option to expand the service (value of flexibility) was calculated to be $13.43 million. To allow for the time elapse between the decision and delivery of the vessel, the value of the real option also needs to be discounted an extra year (to $12.21m) and added to the NPV of Strategy 1 (−$1.63m), the inflexible NPV. As the value of the flexible strategy at $10.57m exceeds the value of original Strategy 3 of $4.27m, then the flexible strategy is preferred. The flexible strategy in this case was revealed to be more valuable than the three inflexible strategies.

These results demonstrate that rather than purchasing one ship and servicing Klang as indicated by traditional NPV analysis in Bendall and Stent (2001), ROA has shown that a better strategy would be that as set out in Figure 3. The ship would initially be used to service both ports, Klang and Penang. As uncertainty is resolved either a second ship should be ordered to expand the frequency of service being offered to each port (expansion option) or the service to Penang should be abandoned (abandonment option) and the one ship used to provide a more frequent service to Klang only. To determine which branch to follow, the shipowner would need to re-work the exercise at regular intervals. The recalculation ensures that parameters and stochastic variables can be updated in the light of actual experience.

4.2 Maritime Example 2

Possessing options expands the company's opportunity set and attributes value to management's ability to react to changing circumstances. The more options, the more valuable is the investment. In this second example ROA is used to value more than one embedded real option, a European put associated with a replacement investment and an option on the maximum of two operating strategies; trading if buoyant demand, or chartering out the vessel, should the trade prove not to be economically viable.

The case involved a decision to invest in a new fifth vessel by an established shipping line in the Trans-Tasman trade. Because of the long lead time from the time of placing an order to the vessel entering the trade the shipping line was faced with a number of uncertainties regarding future operating conditions such as demand, freight rates, risk of entry of competitors etc. Traditional inflexible DCF analysis indicated that the project should not go ahead as an NPV of − $1.346m[27] was negative and would thus be rejected. The present value is of course an average of the simulated scenario cash flows. As an alternate, a second strategy was proposed to buy the ship but then charter it out which yielded a small positive NPV of $0.515m. Here cash flows from chartering, c, were discounted by the cost of capital, k, to yield the present value, Q_0, of $2.88m[28] using the following formula. The initial discounting term $1/(1+k)^{1.25}$ covered the 15 months required to build the ship.

$$Q_0 = \frac{1}{(1+k)^{1.25}} \sum_{t=1}^{15} \frac{c}{(1+k)} \qquad (2)$$

However in both these traditional static NPV strategies some scenarios being averaged could favour a decision to build or charter out, though others will not. With a static analysis management does not have the flexibility to adapt to particular scenarios as they unfold and thus ROA is a more appropriate methodology to value the flexibility to respond as more information becomes available.

Three flexible strategies were investigated. The first combined the two static strategies by building a ship initially for the trade but with an option to charter out if the trade turns out not viable to support a fifth vessel with the better of the two strategies selected after gaining more information. It was modelled as an American style call. The second flexible strategy was modelled as a European put on the fifth ship and allowed the shipowner to use the ship as a replacement for the oldest in the fleet, scheduled in four years time, if the trade was unable to support a fifth ship. The strike price is the savings in costs from delaying the replacement of the fourth ship which would now not occur for a further 11 years.[29] The decision to exercise the put would occur in 2.75 years after allowing for time to build the vessel. However the two flexible strategies are not mutually exclusive and can be combined to form the third flexible strategy to allow the shipowner the flexibility to build a ship for trade, charter out or retire oldest vessel.

Table 4: Valuation of three flexible strategies

Strategy	NPV $m	Option value $m	ROA $m
Flexible strategy 1	-1.346	2.608	1.262
Flexible strategy 2	-1.346	1.888	0.542
Flexible strategy 3	-1.346	2.661	1.315

The flexible strategies were valued. The value of the flexible strategy, ROA, was found by adding the value of the option to the static NPV valuation and are set out in Table 4.

In each case the valuing the flexibility, ROA, increased the value of the strategy compared to the static NPV, by the value of the real option. The more alternate strategies present the more value will be added. With strategy three, the combined case, the value was greater than either flexible strategy one or two alone. However the component values are not cumulative. In the study, a sensitivity analysis showed that the more correlated are the underlying projects (the strategies), the less net value will be added. A sensitivity analysis also showed that the greater the volatility of the underlying base project, the greater the value of the embedded real options and thus the ROA.

5. Conclusion

Real options are persuasive and valuable and are an essential tool to value investments under uncertainty for decision makers in highly capital intensive industries, such as the maritime industry. The standard capital budgeting techniqes cannot capture the value of management flexibility to respond to changes in market conditions, forcing mangers to rely heavily on qualitative “strategic” judgment (managerial experience) when valuing investment opportunities. Even without a calculated financial value of the option ROA can be used as a powerful conceptual tool to discuss future investment projects within the firm. The approach can highlight and define concepts (underlying asset value, exercise price, maturity etc), particularly of staged investments, in place of vague concepts of flexibility. However care must be taken to avoid poor investments if only a qualitative approach is used. A ROA quantitative approach will not only identify and value the embedded real options but can demonstrate if the benefits of flexibility outweigh the costs.

The chapter described a number of maritime real otion applications before outlining various real option approaches. ROA draws on both finance and operations research/management science disciplines and in most cases the appropriate methodolgy will depend on the actual application and the data available. The MAD approach was seen to be theoretically sound and most applicable for the

maritime applications chosen to illustrate ROA in practice. The ROA examples selected demonstrated that traditional NPV analysis fails to capture managerial flexibility. If an ROA approach valuing flexibility is not undertaken then project value may be underestimated and if rejected on that basis, lead to under-investment and opportunity loss. Thus ROA should become a standard tool for investment decision making and an appropriate course to chart for the maritime industry.

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Endnotes

1. If the harvest had failed, he had the flexibility to walk away from any deal as the option gave him the right (but not the obligation) to rent the olive presses. Aristotle reported that the harvest was excellent. Thales exercised the options and paid the owners of the olive presses the agreed rent. Because of the bumper harvest the presses were in high demand and Thales' fortune was made by charging others a much higher market price for their use. Thales of Miletus was the first known Greek philosopher and mathematician. He was an astronomer and is credited with five theorems of elementary geometry. His business acumen regarding the oil presses was related by Aristotle and recorded by Plutarch (*Plut.Vit.Sol.II.4*) but Thales' purpose was to prove that philosophers could indeed become rich if they so choose to do so. His successful foray into the commercial world was only in response to taunts as to the uselessness of philosophy (Lewis, 2009).
2. Surveys of international corporate practice indicate over 90% of firms use the NPV rule and that for most firms this is the primary method of project evaluation. (See Kester *et al.*, 1999.)
3. An option is a financial derivative traded on exchanges or in the over the counter market (OTC). It enables the holder to benefit from upside gain while limiting downside losses to the price paid for the option, its premium.
4. Phillippe (2005) groups real option further to classify as investment options (defer, contract), operating options (abandon, shut/restart, switching inputs or output) and strategic options (expand/growth, inter-related options i.e. compound etc)
5. The taxonomy simply describes the real option's purpose however there is variation in the naming of the real options by analysts.
6. A variation is a Bermudian option (halfway between Europe and the US) setting a number of pre-determined exercise dates.
7. However although the value of flexibility is always positive, the price (premium) paid for the real option may exceed the additional value added to the basic NPV. In this case the NPV would be negative and the investment would not go ahead. For example a dual fired engine system may offer the ability to switch fuel inputs but the cost of the sophisticated technology may exceed the benefit of this flexibility.
8. Stock price of a similar (perfectly correlated) non-levered company with the same risk characteristics.
9. For example, the demand for oil may be used as a "twin product" when valuing options associated with tankers, if volatilities are similar.
10. The values of the project's payoffs in year 1 are assumed for illustration purposes.

11. The risk neutral probability approach yielded the same project value of $1.28million. The PV of the hedge portfolio is multiplied by the risk-free rate and set equal to the payout for the high (up) and low (down) demand state. The PV of the option is calculated using risk neutral probabilities, (pu = 0.3438, pd= 0.6563). Note these risk-neutral probabilities are not the same as the objective probabilities in Table 1. The Present Value of the option is equal to the expected payoffs multiplied by (risk neutral) probabilities to adjust them for their risk.
12. An option to abandon or an option to switch may be appropriate but are abstracted from this example.
13. Real options are now widely found in corporate finance literature, academic journals, financial texts and financial press (Graham and Harvey, 2001, Phillippe, 2005).
14. The Datar Matthews, DM method for solving real options has been patented by the Boeing company (US patent 6862579). See below.
15. See for example Amram and Kulatilaka (1999). Building on the work of Brennan and Schwatz (1985) they evaluate a new mill using listed textile mill shares as the replicating portfolio.
16. Dixit and Pindyck (1994) refer to real option pricing as contingent claims analysis and applied their approach to a shipping example. Freight rates they argue are stochastic and follow a GBM with no drift. Their real options approach demonstrated if/when tankers should be mothballed or scrapped (abandonment option) when facing market condition uncertainty. Their entry–exit-scrapping model is further developed in Sodal (2001). He points out the problems of assuming Dixit and Pindyck's GBM and suggests that mean reversion of freight rates is more likely. Sodal (2003) uses a similar real options methodology to ascertain the appropriateness of investment in fuel cell technology vessels (switching options).
17. Assuming a log-normal distribution.
18. The certainty equivalent (risk neutral) value of a real option is likewise an estimate of the option's market value if it were traded (Brealey and Myers, 2000).
19. Datar Matthews (2007) use Monte Carlo software to create a triangular distribution for each year of the operating profit forecast. The authors point out that other distributions can be applied.
20. Risk is low as management controls the funds. The new project would only be launched if there a good prospects for a successful outcome. Datar and Matthews (2007) used Boeing's corporate bond rate which was close to the risk-free rate as it was easier for management to understand. The degree of risk aversion reflected in the option value is a function of the differential of the discount rates used. A risk-neutral valuation would exist if the discount rates used were the same.
21. Black Scholes would only be an appropriate benchmark only if the distribution is log-normal. However the DM methodology has been found to be reliable using the Binomial process for in-the-money calls and for out-of-the money calls with longer maturities Datar and Matthews (2004).
22. Zadeh (1965) developed the algebra for fuzzy sets. For fuzzy logic applied to ROA see Carlsson and Fuller (2003), (Colan, Carlsson and Majlender (2003), Carlsson and Majlender (2005).
23. Scenario analysis can be used to generate the fuzzy NPV or fuzzy numbers from the outset. Collan (2008).

24. Examples are taken from Bendall and Stent (2005) and Bendall and Stent (2007a).
25. The hub and spoke strategies were based on an earlier study (Bendall and Stent, 2001) where an optimising model determined the most profitable routes to maximise returns.
26. The simulation over 15 years was based on 15,000 iterations.
27. For parameters and full analysis see Bendall and Stent (2007a).
28. This value was arrived at by using a seven-year daily charter rate supplied by industry, less daily operational costs and a further allowance for off-hire and overhaul.
29. Economic ship life was assumed to be 15 years.

References

Adner, R. (2007): "Real options and resource reallocation processes", in Jeffrey J. Ruer and Tony Tong (eds.) *Real Option Theory. Advances in Strategic Managment*, Vol 24 (Emerald) pp. 463–472.

Adner, R. and Levinthal, D.A. (2004): "What is not a real option: considering boundaries for the application of real options to business strategy", *Academy of Management Review*, Vol. 29, No. 1, January. 74–85

Amram, M. and Kulatilaka, N. (1999): *Real Options. Managing Strategic Investments in an Uncertain World* (Boston MA, Harvard Business School Press).

Amram, M. and Kulatilaka, N. (2000): Strategy and shareholder value creation: the real options frontier", *Journal of Applied Corporate Finance*, Vol. 13, No. 2, Summer, 15–28.

Ansoff, H.I. (1965): *Corporate Strategy* (New York, Freeman Press).

Bendall, H. B. and Manger, G. (1991): "Corporate investment decisions: What are the relevant criteria?", *Corporate Management*, 43: 3, May–June 64–69.

Bendall, H. B. and Stent, A.F. (2001): "A scheduling model for high speed container service: a hub and spoke short sea application", *International Journal of Maritime Economics*, 3 September, 262–277.

Bendall, H.B. and Stent, A.F. (2002): "Investment decision stategies in an uncertain world: A real options approach to investments in the maritime industry", *ICHCA 2002*, 26th Bienniel Conference. Yokohama, Japan, 13–15 April, 197–218.

Bendall, H.B. and Stent, A.F. (2005): "Ship investment under uncertainty: valuing a real option on the maximum of several strategies", *Maritime Economics and Logistics*, Vol. 7, No. 1, March, 19–35.

Bendall, H.B. and Stent, A.F. (2007a): "Maritime invesment straegies with a portfolio of real options", *Maritime Policy and Management*, Vol. 34, No. 5, 441–452.

Bendall, H.B. and Stent, A.F. (2007b): "Valuing Shipbuilders' Sales Incentives: An Option Approach", *IAME 2007*. Proceedings. International Association of Maritime Economists Conference, Athens, 4–6 July.

Black, F. and Scholes, M. (1973): "The pricing of options and corporate liabilities", *Journal of Political Economy*, 81 May–June, 637–659.

Borison, A. (2005): "Real option analysis: where are the emperor's new clothes?", *Journal of Applied Corporate Finance*, Vol. 17, Issue 2, June, 17–31.

Boyle, G. and Irwin, T. (2001): "A Child's Guide to Real Options", Discussion Paper, Otago University, New Zealand. January.

Brealey, R.A. and Myers, S.C. (2000): *Principles of Corporate Finance* (6th edn) (New York, McGraw Hill).

Brennan, M.J. and Schwartz, E.S. (1985): "Evaluating Natural Resource Investments", *Journal of Business*, Vol. 58, No. 2, 135–157.

Carlsson, C. and Fuller, R. (2003): "A fuzzy real option valuation", *Fuzzy Sets and Systems*, 139, 297–312.

Carlsson, C. and Majlender, P. (2005): "On Fuzzy Real Option Valuation" Proceedings, *9th Annual Real Option Conference on Real Options*, Paris.

Collan, M. (2008): "A new method for real option valuation using fuzzy numbers", *Insitute for Advanced Managment Systems Research, Research Report 7.*

Collan, M., Carlsson, C. and Majlender, P. (2003): "A fuzzy Black and Scholes real option pricing", *Journal of Decision Systems*, Vol. 12, Nos. 3–4, 391–416.

Copeland T. and Antikarov, V. (2001): *Real Options*, (New York, Texere).

Cox, J. and Ross, S. (1976): "The valuation of options for alternative stochastic processes", *Journal of Financial Economics*, 3:1, 145–166.

Cox, J., Ross, S. and Rubenstein, M. (1979): "Option pricing: a simplified approach", *Journal of Financial Economics*, 53(1), 220–263.

Damadoram, A. (2005): "The Promise and Peril of Real Options", *New Y ork University, Working Paper No. S-DRP-05-02*. July.

Datar, V. and Matthews, S. (2004): "European real options: An intuitive algorithm for the balck scholes formula", *Journal of Applied Finance*, Vol. 14, No. 1, Spring, 43–51.

Dixit, A. and Pindyck, R. (1994): *Investment Under Uncertainty* (Princeton, Princeton University Press).

Dixit, A. and Pindyck, R. (1995): "The options approach to capital investment", *Harvard Business Review*, May–June, 105–115.

Graham, J.R. and Harvey, C.R. (2001): "The theory and practice of corporate finance: evidence from the field", *Journal of Financial Economics*, Vol. 60, Issues 2–3, May–June, 187–243.

Hertz, D. (1964): "Risk analysis in capital investment", *Harvard Business Review*, 42:1, 95–106.3

Hodder, J. and Riggs (1985): "Pitfalls in evaluating risky projects", *Harvard Business Review*, January–February, 128–135.

Howell, S., Stark, A., Newton, D., Paxson, D., Cavus, M., Pereira, J. and Patel, K. (2001): *Real Options: Evaluating Corporate Investment Opportunities in a Dynamic World* (Harlow, Financial Times/Prentice Hall).

Kamad, B. and Ritchken, P. (1991): "Multinomial approximating models for options and k state variables", *Managment Science*, 37, 1640–1652.

Kasanen, E. and Trigeorgis, L. (1993): "A market utility approach to investment evaluation", *European Journal of Operations Research*, Special Issue on Financial Modelling, 74:2 April, 294–309.

Kester, G.W., Chang, R., Echanis, E., Haikal, S., Isa, M., Skully, M., Tsui, K. and Wang, C. (1999): "Capital budgeting practices in the Asia-Pacific region", *Financial Practice and Education*, 9, 25–33.

Kester, W.C. (1984): “Today’s options for tomorrow’s growth”, *Harvard Business Review*, March–April, 153–160.

Kogut, B. and Kulatilaka, N. (1993): “Operating flexibility, global manufacturing and the option value of a multinational network”, *Management Science*, Fall, Vol. 40, No. 1, 123–139.

Kogut, B. and Kulatilaka, N. (1994). “Option thinking and platform investments: investing in opportunity”, *California Management Review*, Winter, 52–71.

Kulatilaka, N. (1993): “The value of flexibility: the case of a dual-fuel industrial steam boiler”, *Financial Management*, 22:3, 271–279.

Lai, V.S. and Trigeorgis, L. (1995): “The strategic capital budgeting process: A review of theories and practice”, in Trigeorgis, L. (ed.) *The Capital Budgeting Process Real Options in Capital Investment: Models, Strategies and Applications* (London, Praeger) pp. 69–96.

LeRoy, S. and Werner, J. (2001): *Principles of Financial Economics* (Cambridge, Cambridge University Press).

Luehrman, T. A. (1997): “Investment opportunities as real options. Getting started on the numbers,” *Harvard Business Review*, July–August, Vol. 75, No. 3, 132–142.

Luenberger, D.G. (1998): *Investment Science* (New York, Oxford University Press).

Lewis, Bethan (2009): “Real History. Thales and the Olive Presses” www.jamboree.freedom-in-education.co.uk/real history/thales.htm. Accessed 23 April 2009.

Magee, J. (1964): “How to use decision trees in capital investmemts”, *Harvard Business Review*, September–October.

McDonald, R. and Siegel, D. (1985): “Investment and the valuation of firms when there is an option to shut down”, *International Economic Review*, 26:2, 331–349.

Matthews, S. and Datar, V. (2004): “European real options: an intuitive algorithm for the Black Scholes formula” *Journal of Applied Finance*, Spring, 14.1, 45–51.

Matthews, S. and Datar, V. (2007): “A practical guide for valuing real options: the boeing approach”, *Journal of Applied Corporate Finance*, Vol. 19, No. 2, 95–104.

Mathews, S. and Salmon, J. (2007): “Business Engineering: A Practical Guide to Valuing High Risk, High Returns Projects Using Real Options”, *Tutorials in Operations Research*, Informs Conference, Seattle.

Merton, R.C. (1973): “Theory or rational option pricing”, *Bell Journal of Economics and Management Science*, 4, 141–183

Myers, S.C. (1977): “Determinants of corporate borrowing”, *Jounal of Financial Economics*, 5:2, November, 147–176.

Myers, S.C. (1987): “Finance Theory and Financial Strategy”, *Midland Corporate Finance Journal*, 5:1, 6–13.

Phillippe, H. (2005): “Real Options: Still Looking for Evidence”, Procedings *9th Annual International Conference Real Options*, Paris, 22–25 June.

Pinches, G.E. (1982): “Myopia, capital budgeting and decision making”, *Financial Management*, 11:3, Autumn, 6–19.

Plutarch, Plut “De Is et Os., De Iside at Ostrids; De Pyth. Or., De Pythiae oraculis; Conv. Sept, sap., Convivium sept sapientium [The Dinner of the Seven Wise Men]” Vit.sol., Vitae Parallelae, Solon.

Sick, G. (1995): “Real Options”, in Jarrow, R., Maksimovic, V. and Ziemba, W.T. (eds.), *Handbooks in Operations Research and Management Science* (Amsterdam, North-Holland), p. 9.

Sodal, S. (2001): “Entry and Exit Conditions Based on a Discount Factor Approach”, Working Paper 2, Agder University College, Department of Economics and Business Administration, Norway.

Sodal, S. (2003): “Fuel Cells in Shipping: Higher Capital Costs and Reduced Flexibility”, *Real Options Conference*, Washington DC, USA, 10–12 July.

Smith, J. E. and Nau, R.F. (1995): “Valuing risky projects: option pricing theory and decision analysis”, *Management Science*, Vol. 41, No. 5, May, 795–815.

Smith, J.E. and McCardle, K.F. (1998): “Valuing oil properties integrating option pricing and decision analysis approaches”, *Operations Research*, Vol. 46, No. 2, March–April, 198–217.

Triantis, M. and Borison, A. (2001): “Real options: state and practice”, *Journal of Applied Corporate Finance*, Vol. 14, No. 2, Summer, 8–24.

Teisberg, E.O. (1995): “Methods for evaluating capital investment decsions under uncertainty”, in Trigeorgis, L. (ed.) *Real Options in Capital Investment. Models, Strategies and Applications* (London, Praeger).

Trigeorgis, L. (1996): *Real Options. Managerial Flexibility and Strategy in Resource Allocation* (Cambridge, MA, The MIT Press).

Trigeorigis, L. (1999): “Real options: a primer”, in James Allerman and Eli Noam (eds.) *The New Investment Theory of Real Options and its Implications for Telecommunications Economics* (Boston, Kluwer Academic Publishers) pp. 3–33.

Trigeorgis, L. (2000): “Real options and financial decision-making”, *Contemporary Finance Digest*, 3, 5–42.

Trigeorgis, L. (ed.) (1995): *Real Options in Capital Investment. Models, Strategies and Applications* (London, Praeger).

Yeo, K.T. and Qiu, Fasheng (2003): “The value of management flexibility – a real option approach to investment evaluation”, *International Journal of Project Management*, Vol 21, Issue 4, May, 243–250.

Zadeh, L.A. (1965): “Fuzzy sets”, *Information and Control*, 8, 338–353.

Chapter 25

Business Risk Measurement and Management in the Cargo Carrying Sector of the Shipping Industry — An Update

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1. Introduction

Risk management in an industry which is riddled with cyclicalities in its rates and prices and which has made and destroyed millionaires over the years is extremely important. The issue has been discussed in Gray,[1,2] comparing traditional methods of hedging, as he calls the choice of contract during ship operation,[3] with the "new" instruments that appeared in the market at the time. The latter were the futures contracts, which were launched by the Baltic Exchange in London and the International Futures Exchange in Bermuda, trading BIFFEX (Baltic International Freight Futures Exchange) and INTEX contracts for the dry bulk and tanker sectors, respectively.

In the meantime a number of developments have occurred, including the restructuring, renaming and the eventual abandonment of the Baltic Freight Index (BFI) in 2002 – the underlying commodity upon which BIFFEX contracts have been trading. The development of Over the Counter (OTC) Freight Forward Agreements (FFA) since 1992, the introduction of clearing of these OTC contracts and the appearance of options and swaps can be added to these developments, all of which have major implications for the way risk is managed in the industry today. A comprehensive description of these developments is provided in Kavussanos and Visvikis.[4,5]

At the same time research has been published which has established formally a number of relationships not fully worked out previously empirically, and has uncovered new results on a number of important issues in the topic of risk measurement and management in the shipping industry. For instance, Kavussanos,[6–10] measures for the first time the (time varying) volatility of ship prices and freight rates by sector and type of contract, thus allowing for a formal comparison of risk levels between sectors and freight contracts at each point in time. The later work by Kavussanos and Nomikos[11–15] on the now-abandoned BIFFEX, of Kavussanos *et al.*[16,17] and Kavussanos and Visvikiss (see endnotes 4–5)[18,19] on FFAs and of Kavussanos and Dimitrakopoulos[20] on Value at Risk (VaR) and extreme value methods has looked at significant issues underlying the freight derivative instruments and their use for risk management purposes. This chapter aims to provide a review of the issues in order to help the reader see where we currently stand.

Broadly speaking, the owner of the assets, ships, is faced with a number of commercial decisions. They include decisions on:

1. Whether to enter the shipping industry by buying or leasing ships?
2. What kind of ships to purchase?
3. When to buy the ships and when to sell them?
4. How to finance the purchase of the assets – debt, equity, shareholding, etc.

5. Once owning the vessels, where to operate them and what kind of contract to seek for them?
6. Whether to use financial instruments, such as futures and forward contracts, to manage the risk in such markets as the freight, bunker, foreign exchange and interest rate market?

These are all real decisions that the shipowner is faced with in everyday decision making. They all amount to viewing ships as investments – as assets in portfolios, which generate a stream of cash flows by operating the ships and a possible capital gain if selling the assets at prices higher than they are bought for. Given that commercial investments have risks attached, one can immediately see that the above issues are highly relevant for decision making. See Kavussanos and Visvikis (see endnote 4) for a detailed discussion of these.

The issues raised become more evident when examining the shipowner's balance sheet, in Table 1. The shipowner's cash flow problem is outlined in the table, where:

Cash Flow = Operating Revenue – Operating Costs (Fixed) – Voyage Costs (Variable) – Capital Costs (Fixed or Variable) + Capital Gain

Table 1: Shipowner's cash flow in spot (voyage) and T/C markets

Spot(voyage) market	**Time-charter market**
Voyage Hire (in US$)	T/C Hire (in US$)
Less: Operating costs (in domestic currency, e.g. euro)	Less: operating costs (in domestic currency, e.g. euro)
Less: Voyage Costs	
=Operating Earnings	**=Operating Earnings**
Less: Capital costs (from loans)	Less: Capital costs (from loans)
Plus: Capital gain/loss from buying and selling the vessel	**Plus: Capital gain/loss** from buying and selling the vessel
=Overall Cash Flow	**=Overall Cash Flow**

Notes:
(1) Operating costs include manning, repairs and maintenance, stores and lubes, insurance, administration.
(2) *Voyage costs* include broking commission, fuel costs, port charges, tugs, canal dues, etc. Fuel costs form the largest part of these, and are subject to the highest fluctuations.
(3) *Capital costs* refer to debt servicing through capital repayment.

Fluctuations in revenue or costs can cause fluctuations in operating earnings. This may be due to changes in revenue, which is affected by changes in demand for freight services and by changes in freight rates, or because of changes in voyage or operating costs (e.g. changes in bunker prices, wage rates, exchange rates, etc). Operating costs include manning, repairs and maintenance, stores and lubes, insurance, administration, and are thought to be relatively constant, rising in line with inflation. In contrast to time charter markets, operations in the spot market involve voyage cost payments by the shipowner. Thus, apart from fluctuations in the freight market, owners are exposed to fluctuations in voyage costs, the main part of which are bunker prices. This is one of the reasons why spot markets are deemed riskier than time charter markets. The others relate to the nature of the relationship of spot and time charter rates, which leads us to expect that spot rates trade at a premium to time charters to compensate for the higher risk involved when operating the ships spot. The relationship is that, say, one-year time charter rates must be the sum of a series of expected (monthly) spot rates plus a risk premium. This is discussed fully in Kavussanos and Alizadeh.[21]

The volatility in freight rates, examined later in the chapter, and in Kavussanos (see endnotes 6–10), could be a source of risk. From the above table though it is apparent that voyage costs – in particular bunker prices – are the source of a certain volatility apparent when operating in the spot market, which does not affect the owner when operating in the time charter market. Alizadeh, Kavussanos and

Menachof[22] examine ways of mitigating bunker price risks through derivatives trading. They are discussed later in the chapter. Gray (see endnote 1) and Kavussanos and Visvikis (see endnote 4) discuss how selection of contract type can reduce freight risks, and Kavussanos (see endnotes 6–10) examines the same and other issues at the empirical level. The use of freight futures contracts (BIFFEX) for freight risk management has been examined in the past by Cullinane,[23] Haralambides[24,25] and Kavussanos and Nomikos (see endnotes 11–15). Finally, with the decline of interest in BIFFEX, Freight Forward Agreements (FFAs) and other financial instruments have provided the alternative for freight risk management. The issue is examined in Kavussanos and Visvikis (see endnotes 4,18) and in Kavussanos *et al*. (see endnotes 16,17). These are discussed later in the chapter.

The other source of risk for the owner apparent in the table is the interest rate risk. This relates to the capital charges, associated with debt finance. They fluctuate with interest rates. The higher the debt-equity ratio in the financing of a ship, the greater the financial leverage, and the more the residual cash flow is at risk. Thus, financial leverage compounds the risks created by operating leverage.

A further source of risk comes from the fluctuation in the value of the asset – the ship. Often, owners are involved in asset play, see Stopford[26]. They see ships as assets whose prices fluctuate, and offer the possibility of a capital gain or loss. This is shown in the last part of Table 1. Fluctuations in ship prices then influence the risk level involved in the investment. A major part of this chapter is concerned with this issue, which has been analysed in papers such as Kavussanos (see endnotes 6–10).

Credit risk, or counterparty risk, is yet another source of risk that shipowners face and it refers to the possibility that the counterparty in a private contract does not fulfil its obligations. This risk is more prevalent under bad market conditions and when the other party is losing money from the agreement. Such risk is prevalent, amongst others, in freight (voyage or time charter) contracts, in FFAs in bond issues, in interest swaps, etc.

In all the above, one has to add exchange rate risk, which is present in such an international industry. It affects the owner's cash flow through a number of routes, including freight rates, voyage expenses, purchasing of the asset, etc. Interest rate and exchange rate risks fall outside the scope of this chapter. Sophisticated derivative instruments exist in the finance profession, which enable interested parties to deal with these risks – see Kavussanos and Visvikis (see endnote 4) for a description.

2. Risk/Return Trade-Offs in Shipping

In making commercial decisions the owner has in mind that greater rewards are usually achieved by undertaking higher risks. Usually such risks are measured by the volatility of the variable a decision has to be made for. For example, because freight rates fluctuate widely, say from month to month, taking a position in the market in a particular month can produce substantial gains or losses depending on what happens in subsequent months. Fluctuations in freight rates around their average values over a period of time may be used typically as measures of freight risk; technically, by their variance or by its square root, the standard deviation. High (low) standard deviations reflect high (low) volatility in rates and of the risks involved.[27]

Considering shipowners as asset holders, who wish to maximise return and minimise risk on their

portfolio of shipping assets. Can they do anything to mitigate the risk involved in their shipping investments and in operations resulting from freight rate fluctuations? Say the shipowner is a specialist in the tanker sector. He is faced with two important decisions which can affect the risk/return position of his portfolio; (1) what size ships to invest-on? and (2) For a given investment, whether to operate the vessels in the spot or in the period (time charter) market? The issue of what size ships to invest-on, if approached from the pure asset-play point of view, may be answered by considering the risk-return profiles of different size vessels.

Vessel size considerations are important as the markets for each size are distinct in terms of the rewards and risks they carry, and so is positioning in the spot or time-charter market. From a different point of view, Glen[28] has shown that the industry is divided into sub-markets. Kavussanos (see endnotes 6–10), shows that these markets are distinct in terms of their risk return profiles. As a result, investments in different size vessels can be thought of as having the same portfolio diversifying effects as different stocks included in an investor's portfolio. To see that consider the possible disaggregation of the cargo carrying shipping industry discussed next.

3. Market Segmentation of the Shipping Industry

3.1 General cargo and bulk cargo movements

The *parcel size distribution* (PSD) of each commodity determines the shipping consignment of the cargo, see Stopford (see endnote 26). Some commodities are typically moved in larger sizes than others. For example, iron ore and grain consignments are much larger than phosphate rock or bauxite and alumna. Furthermore, the consignment size or PSD of each commodity changes over time and may be different on different routes. The PSD depends on: (1) Commodity demand and shipping supply economics (e.g. low value goods move in large consignments); (2) Transport distances (consignment is directly proportional to distance) and transport system restrictions (e.g. limited draft in ports, regulations); (3) Vessel availability. Consignments of over 2,000–3,000 tonnes can fill a whole ship (or hold) rather than part of a ship, and are typically transported in bulk. Smaller consignments, which fill only part of the ship (or hold), move as general cargo.

Bulk cargoes refer mainly to raw materials and are transported on a one -ship, one-cargo basis. They are further sub-divided into liquid cargo and dry cargo. Liquid cargo includes crude oil, oil products, chemicals (e.g. caustic soda), vegetable oils and wine. Dry Cargo is broadly divided in three categories: (a) Majors (i.e. iron ore, coal, grain, bauxite and phosphates), (b) Minors (i.e. steel, steel products, cement, sugar, gypsum, non ferrous metal ores, salt, sulphur, forest products, wood chips and chemicals; (c)Specialist bulk cargoes requiring specific handling or storage requirements such as heavy lift, cars, timber and refrigerated cargo. The ships involved in bulk cargo transportation are tankers, bulk carriers, combined carriers (they carry either dry or liquid bulk) and specialist bulk vessels. Bulk cargoes constitute two thirds of seaborne trade movements, and are carried mainly by tramp ships, which constitute three quarters of the world's merchant fleet. These are vessels which move around the world seeking employment in any place/route of the globe. Bulk ships usually carry one cargo in one ship at rates negotiated individually for the service provided.

General cargo, is also dry cargo, but is not transported in bulk. A large part of general cargo is transported in containers, multipurpose and other specialised ships (Ro-Ro, car carriers, etc.). General cargo (one third of seaborne trade) is transported in either tramp ships or liners; the latter provide a

regular, scheduled service, transporting small cargo consignments at fixed tariff levels between areas of the world.

The economics of each type of transport service are different. For example, oligopolistic conditions prevail in liner markets, while conditions of perfect competition guide tramp markets.

3.2 Bulk-cargo segmentation

For analysis, dry and liquid bulk cargoes may be further subdivided according to the PSD functions of the products carried. The PSD function depends on the maximum size delivery an industry is able or willing to accept at any one time. In some industries stockpiles are around 10–15K tonnes, so a delivery of 50K tonnes is too large. Physical limitations on ship size draw a line between groups. For instance, Suezmax, Panamax, etc. This is because size determines the type of trade the ship will be involved in, in terms of type of cargo and route; this is a result of the different PSD's of commodities and the port and seaway restrictions for certain size ships. Design features are important. For example, cargo handling gear (cranes), pumping capacity and segregation of cargo tanks in tankers; certain ports in developing countries cannot be used (e.g. ships which do not have cargo handling gear). Also, coating of tanks and ballast spaces are distinguishing factors. Tables 2 and 3 present the submarkets that are distinguished for dry and liquid bulk.

Very Large Ore Carriers (VROC) vessels (200,000+ dead-weight tonnes (dwt)) transport only iron ore from Brazil to West Europe (Rotterdam). They are VLCCs converted into dry-bulk carriers. Capesize vessels (100,000–199,999dwt) transport iron ore mainly from South America and Australia and coal from North America and Australia. Panamax vessels (around 60,000–99,999dwt) are used primarily to carry grains and

Table 2: Dry bulk market segmentation by vessel size

Vessel type/market	Vessel size	Cargo type
VROC	200,000+ dwt	Iron ore
Capesize	100,000–199,999dwt	Iron ore, coal
Panamax	60,000–99,999dwt	Coal, grain, bauxite and larger minor bulk parcels
Supramax	54,000–59,999dwt	Minor bulks and smaller parcels of major bulks such as grains, coal and bauxite.
Handymax	34,000–53,999dwt	>>
Handysize	10,000–33,999dwt	>>

Minor bulks: Steel, steel products, cement, sugar, gypsum, non ferrous metal ores, salt, sugar, sulphur, forest products, wood chips and chemicals.

Table 3: Liquid bulk market segmentation by vessel size

Vessel type/market	Vessel size	Cargo type
Ultra-large crude carriers (ULCCs)	320,000 + dwt	Crude oil
Very-large crude carriers (VLCCs)	200,000–319,999dwt	Crude oil
Suezmax	120,000–199,999dwt	Crude oil
Aframax tankers	75,000–119,999dwt	Crude oil
Large product tankers	50,000–74,999dwt	Oil products, sometimes crude oil
Small product tankers (coasters)	10,000–49,999dwt	Oil products, sometimes crude oil

coal from North America and Australia. Handy vessels (around 10,000–59,999dwt) transport grains, mainly from North America, Argentina and Australia, and minor bulk products – such as sugar,

fertilisers, steel and scrap, forest products, non-ferrous metals and salt – virtually from all over the world. Over time, in the category of Handy vessels, Handysize (10,000–33,999dwt) vessels have gradually become Handymax (34,000–53,999dwt), while Supramax (54,000–59,999dwt) vessels have appeared over the last years, as a consequence of vessel sizes becoming larger to satisfy the demand for larger PSDs for dry bulk commodities.

Smaller vessels such as Handy and Handymax in the dry bulk sector are, in general, geared so that they can load and unload cargo in ports without sophisticated handling facilities. They can avail of more ports compared to larger vessels. As ports

Table 4: Container market segmentation by vessel size

Vessel type/market	Ship size, TEU	Speed in knots
Feeder	0–499	16.5
Feedermax	500–999	19.0
Handy	1,000–1,999	20.3
Sub-Panamax	2,000–2,999	21.0
Panamax	3,000–4,999	24.3
Post-Panamax	>5,000	25.9

of the world have been developed the new generation of Handymax and Supramax vessels are carrying more and more of the trade the Handys carry. The same is also true in the liquid bulk sector; the very large vessels trade in only four-fifths of routes as the draught restrictions in ports and the storage facilities required ashore are very large to accommodate them and their cargoes. The smaller vessels are more flexible in terms of the routes and trades they are involved in. See Kavussanos and Visvikis (see endnote 4) for more details.

3.3 General (dry) cargo segmentation

When general dry cargo is not moved by dry-bulk ships it is transported by liners. The following distinctions are common. Container ships, Ro-Ro, Multi Purpose MPP (Single-deck, multi-deck, Semi-containers), Barge Carrying vessels (BCV). Other specialised vessels include Refrigerated (Reefers), Car-carriers, Cement carriers, Heavy lift, Ore carriers, Vehicle carriers, LPG tankers, etc. Within the liner trades there is a move towards containerisation at the expense of non-unitised cargo which used to be transported in MPP ships. Containerships themselves have sub-markets according to size. These are shown in Table 4.

Just as with dry-bulk, each of these sub-markets has its own economic characteristics, and the risks and rewards involved for the shipowner and the charterers are different.

4. Comparison of Volatilities of Second Hand Ship Prices

Since smaller vessels can approach more ports (due to their smaller size and the existence of cargo handling gear on board) and can switch between different trades/routes they are more flexible for employment. As a consequence, they are less risky than the larger vessels. This is established in the market by the volatilities of both their prices and of their freight rates being lower than those of the larger vessels. This was first shown formally in Kavussanos (see endnotes 6–10), who compares freight rate and ship price volatilities between different vessel sizes. This is discussed next.

Having obtained data for freight rates and second-hand Handysize, Panamax and Capesize vessel prices, monthly returns and volatilities are calculated. These volatilities are compared between vessel sizes. Investments in vessels with higher volatilities are

Table 5: F-statistics for equality of unconditional variances in dry bulk ship prices

	Cape vs Panamax	Cape vs Handy	Panamax vs Handy
F-statistic	1.635	1.842	1.127

Notes:

(1) These statistics, which are defined as $F=SD_1^2/SD_2^2 \sim F(n-l, m-1)$, where SD_1^2 and SD_2^2 are the sample variances and follow the F distribution with (n-1, m-1) degrees of freedom; in this case (195,195) degrees of freedom.

(2) Critical values of the statistics at the 5% and 1% levels are 1.26 and 1.36 respectively.

(3) Sample period 1979: 5-1995:8.

Source: Kavussanos (see endnote 8)

Table 6: F-statistics for equality of unconditional variances in tanker ship prices

	VLCC vs Suezmax	VLCC vs Aframax	Suezmax vs Aframax
F-statistic	1.84	2.71	1.47

Notes:

(1) F distribution degrees of freedom (166,166), with critical values at the 5% and 1% levels 1.29 and 1.44, respectively.

(2) Sample period 1980: 2-1993:12.4.

Source: Kavussanos (see endnote 7)

deemed riskier compared to those with lower ones. Tables 5 and 6 show the results for the dry bulk and the tanker sectors, respectively.

Broadly speaking, for asset players who choose to have ships in their portfolio of assets they can reduce risk by investing in smaller vessels, compared to larger ones. Moreover, the results make sense as explained earlier. The smaller vessels are more flexible as assets. They have a lower risk of unemployment in adverse market conditions, as they can be switched more easily between routes and trades to secure employment. In addition, the cargo sizes that larger vessels carry makes them less useful for charterers requiring transportation of smaller quantities. This makes the demand for these vessels less flexible, and vessels cannot switch between sea-lanes and charterers as easily as their smaller counterparts. For instance, if anything happens (e.g. a political or economic change) in one of the routes the VLCC's operate in this will have a significant impact in rates in the market, which is translated into high volatility in rates. As a consequence, the income stream from operations of smaller vessels, and their prices, as present values of the expected future income, are subject to less fluctuations in comparison to the larger vessels.

4.1 Dynamically adjusting volatilities

The studies by Kavussanos, (see endnotes 6, 7) mentioned above, have gone a step further in the analysis of ship price volatilities. They introduce, for the first time in shipping, the class of Generalised Autoregressive Conditional Heteroskedasticity (GARCH) models of Engle[29] and Bolerslev,[30] to estimate time varying volatilities of ship prices. Thus, price volatilities are explained in terms of their past values, values of squared shocks to long-run equilibrium in each market, and allow for the possibly of introducing a set of exogenous factors. The general form of the augmented GARCH-X(p,q) model of Bollerslev (see endnote 30) can be represented by the following equations:

$$\Delta \ln P_t = \mu_{t-1} + \varepsilon_t ; \varepsilon_t \sim IN(0, h_t)$$

$$ht = \alpha_0 + \sum_{i=1}^{p} \alpha_i \varepsilon^2_{t-i} + \sum_{j=1}^{q} \beta_j h_{t-j} + \delta Z_t \qquad (1)$$

$$LL = -(T/2)\ln h_t - (1/2h_t)\sum_{i=1}^{p} \alpha_i \varepsilon^2_{t-1}$$

where, μ_{t-1} is the specification of the conditional mean, that is, of the change in the log of ship prices, $\Delta 1nP_t$, ε_t is a white noise error term with the usual classical properties and a time-varying variance h_t, which may include a set of exogenous factors, Z_t, and *LL is* the corresponding log-likelihood function after omitting the irrelevant constant. The parameters of interest are those included in μ_{t-1}, say $\varphi(L)$, and the GARCH parameters $\alpha_0, \alpha_i, \beta_j$ and δ and can be estimated by maximum likelihood methods.

The estimated time varying volatilities allow the measurement and comparison of volatilities at each point in time, rather than relying on the averages over the period examined in Tables 5 and 6. Considering average volatilities(standard deviations) of ship prices (or freight rates) over a period of time as indicators of risk levels provides a partial picture of the risk/return situation. This is because uncertainty in prices, is not constant over time. The patterns and relative levels of volatilities, at each point in time (market situation) can now be measured, and compared between different ship sizes. Such estimates of time varying variances are also deemed important in the financial literature, as they may be used in the construction of dynamic portfolios of assets. These time varying volatilities of ship prices for the tanker and dry bulk sub-sectors are shown in Figures 1 and 2, respectively.

This method of analysing volatilities and examining them graphically has allowed further inferences for the dry bulk sector, such as that: Volatilities, and thus risks, vary over time and across sizes; in particular, volatilities are high during and just after periods of large imbalances and shocks to the industry. These include the period of the oil crisis of the early 1980s, the recovery period of 1986–1989 and the Gulf crisis of the early 1990s. Panamax volatilities are driven by old “news”, while new shocks

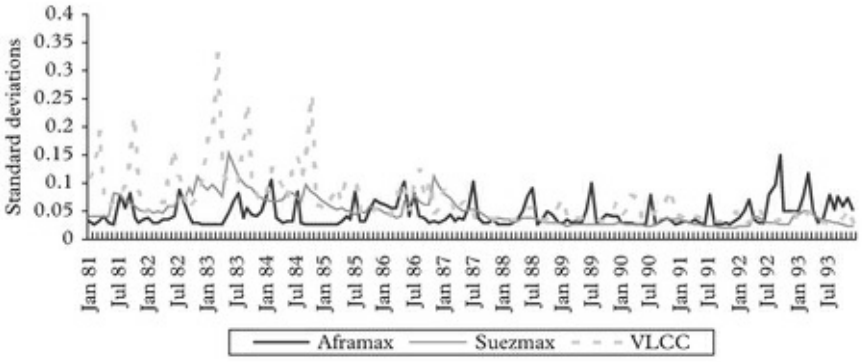

Figure 1: Vessel price volatilites in segments of the tanker sector

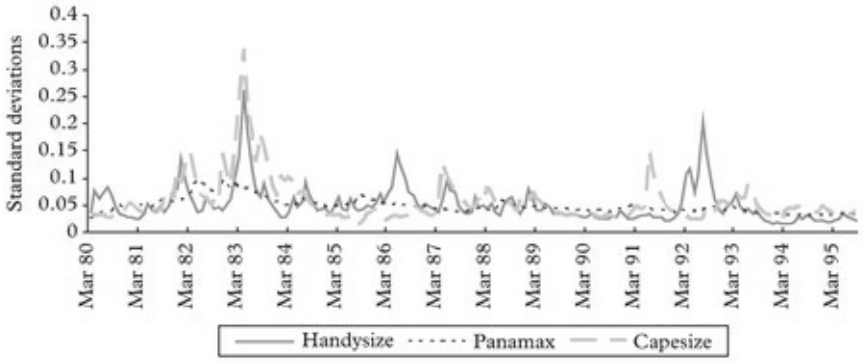

Figure 2: Vessel price volatilities in segments of the duty bulk sector

are more important in the Handy and Capesize markets. Also, conditional volatilities of Handysize and Panamax vessel prices are positively related to interest rates and Capesize volatilities to time-charter rates.

The three markets tend to respond together to external shocks, and yet quite differently, implying market segregation between different size ships. (i.e. there are some common driving forces of volatilities in different size markets, and yet there are idiosyncratic factors to each market that make each size-ship volatility move in its own way). These idiosyncratic factors relate to the type of trade each size ship is engaged in. Thus, volatility for Handysize and Capesize vessels has several hikes, while that for Panamax is smoother. This differing nature of volatil ities over ship sizes is manifested in the GARCH alpha(news) coefficients being higher than the beta (persistence) coefficients for Capesize and Handysize vessels, while the opposite is true for Panamax.[31]

Regarding volatility levels, Capesize volatility generally lies above the volatilities of the other two sizes, except for two–three years in the mid-1980s. Similarly, the Panamax volatility is, in general, at a level above Handysize, which, however, is exceeded at times by the hikes in the Handy volatility.

Similar results are reached by considering the time varying volatilities for the tanker sector. In addition, volatilities in the tanker sector and thus risks levels seem to be positively related to oil prices. The downward trends in volatilities observed in the dry bulk and tanker industry sub-sectors seem to indicate that risks in the shipping industry have decreased over time. It should also be mentioned that the availability of time varying volatility estimates for vessel prices, as with other assets in the financial literature, may be used as inputs in pricing derivative instruments such as options prices, etc.

5. Comparison of Volatilities of Spot and Time Charter Rates

Theoretically, ship prices are the present value of the expected stream of cash flows (profits) from their operation. The relationship has been investigated formally in

Table 7: Pairwise sample variances of time-charter (upper triangle) and spot (lower triangle) rates in tanker sub-markets

	Handymax (H)	**Aframax (A)**	**Suezmax (S)**	**VLCC (V)**
Handymax (H)		8.23*(H<A)	1.14 (H<S)	8.68*(H<V)
Aframax (A)	1.30*(H<A)		7.24*(A>S)	1.06(A<V)
Suezmax (S)	1.27*(H<S)	1.03(A>S)		7.64*(S<V)
VLCC (V)	2.68*(H<V)	2.05*(A<V)	2.11*(S<V)	

Notes:
(1) 5% and 10% critical values for F(166,166) are 1.29 and 1.22, respectively.
(2) *Indicate significance at the 10% level.
(3) The symbol < indicates less than, while the symbol > indicates greater than.
Source: Kavussanos (see endnote 10)

Kavussanos and Alizadeh.[32] As a result of this theoretical relationship, comparison of freight rate volatilities by vessel size should reveal a similar relationship to that uncovered by examining the second hand prices. This is indeed the case; Kavussanos (see endnotes 6, 9) shows that volatilities of spot rates and of time charter rates are smaller for smaller size vessels, compared to those of larger ones. Table 7 compares these volatilities in the tanker sector.

In both the spot and time charter markets the VLCC sector exhibits the highest volatility compared to smaller sizes over the period examined. The Handymax volatilities are the lowest in both markets compared to other sizes. The Aframax and the Suezmax sectors show significantly larger volatilities in comparison to the Handymax sector and smaller ones compared to the VLCC in both the spot and the time-charter markets. However, the volatilities between the Aframax and Suezmax sectors are not statistically different between them. Overall, within the dry bulk and tanker sectors, risk levels, as expressed by freight rate volatilities, are different between vessel sizes. Coupled with the different levels of return each vessel size yields, different size vessels can be viewed as distinct asset classes in a portfolio of ships. This has implications for investors.

The above findings then, of the possible diversification effects that may be achieved by holding different size ships in a portfolio of assets have not been discussed in the literature previously. The studies by Kavussanos (see endnotes 4,7–11), have provided a formal justification of pursuing such strategies. In addition, these studies have also investigated, for the first time, empirically some well-known propositions regarding the possibility of operational risk reduction by choice of contract. Gray (see endnote 1) discusses the gradual risk reduction effects that are achieved by shipowners selecting to employ their vessels in markets such as voyage charter(spot), trip time charter, period time charter and in contracts of affreightment,[33] consecutively.

Table 8 compares, statistically, pair-wise volatilities between the spot and the time-charter market for each size ship in the tanker sector. In all vessel sizes, but the Aframax, the spot rates are significantly more volatile compared to time-charters. In the Aframax size there is no significant difference between spot and time-charter volatilities. Once again the evidence seems to be consistent with *a priori* expectations, in that the spot rates are much more exposed to the day-to-day market conditions in determining rates compared to time-charter rates. The latter, being theoretically the discounted stream of

Table 8: Pairwise comparison of volatilities in Spot(FR) vs Time-Charter(TC) rates of the tanker industry

Size	Handymax	Aframax	Suezmax	VLCC
Result	FR > TC*	FR < TC	FR > TC*	FR > TC*

Notes: (1). * indicates statistical significance.
(2). Also, see notes in Table 7 for definitions.
Source: Kavussanos (see endnote 10)

12-months expected spot rates, are smoother, and this is reflected in the smaller volatilities in comparison to the one-month spot rates, see Kavussanos and Alizadeh (see endnote 33) for an empirical formulation of this relationship.

It seems that the risk involved in operating tankers in the spot markets is greater than in the time-charter markets and this seems to hold irrespective of size.

5.1 Comparison of time varying freight volatilities over vessel sizes

Risks in the spot and time-charter tanker markets are a combination of industry-market risk and "idiosyncratic" risk (e.g. relating to individual vessel size). As long as one is faced with more than one

option over choices, then idiosyncratic risk may be diversified. The shipowner, for instance, may choose to use the spot instead of the time-charter market, or may decide to invest in alternative size ships. Decisions about this process take place on a continual basis. This is not possible by considering the averages of volatilities over a 10–15 year period. Monthly estimates of these volatilities though, resolves the problem. The results in Kavussanos (see endnotes 6–10) enable this.

Consider first how the industry has been affected across markets by examining time-varying risks in the spot and time charter tanker and dry bulk sectors, as observed in Figures 3–6. A tendency for volatility clustering is observed. Volatility is high during and just after periods of large shocks and imbalances in the industry; such as during the 1980–1981 oil crises and the decline in demand for shipping services as the world economy slowed down following the second oil shock; the supply of oil restrictions imposed by the OPEC production ceiling in 1982–1983, the targeting of ships in the Gulf in 1984, the sharp decline in oil prices in 1986 and the 1990–1991 period of the Gulf-war are particularly visible.

The above incidents affected all markets and are manifested in patterns of risk, which are specific to vessel sizes. In tanker markets for instance, the VLCC sector seems to have the highest volatility and fluctuations are a lot sharper than in any of the other sizes. The sector involves vessels trading in four routes, all lifting oil from the Gulf, which were severely disrupted in periods of crises. The Handymax volatility is the lowest in both the spot and time charter markets reflecting the steady trades this type of ship is involved in. The Suezmax and Aframax volatilities fluctuate between those of the Handymax and the VLCC. In the spot market, the levels of volatilities are interchanged with neither being significantly above the other.

Figures 5 and 6 compare time varying volatilities of spot and of time charter freight rates between Handysize, Panamax and Capesize vessels in the dry bulk sector. Once more, risk, as manifested by volatility estimates, is in general higher in larger vessels. The reasons for the lower volatility levels in Handysize vessels as compared to the other

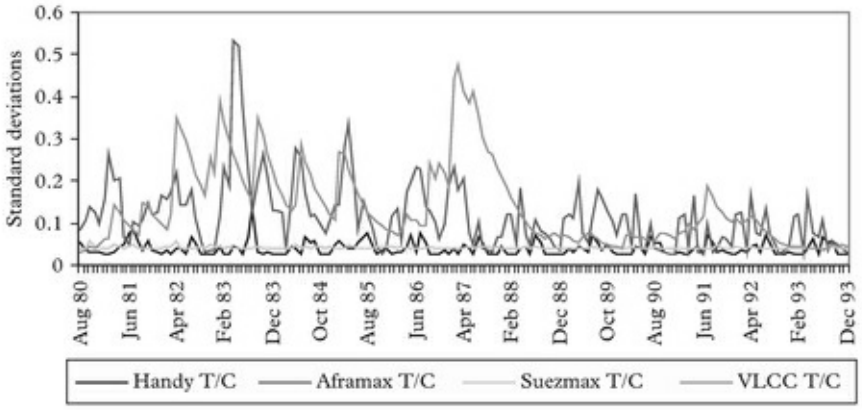

Figure 3: Time charter volatilities by vessel size

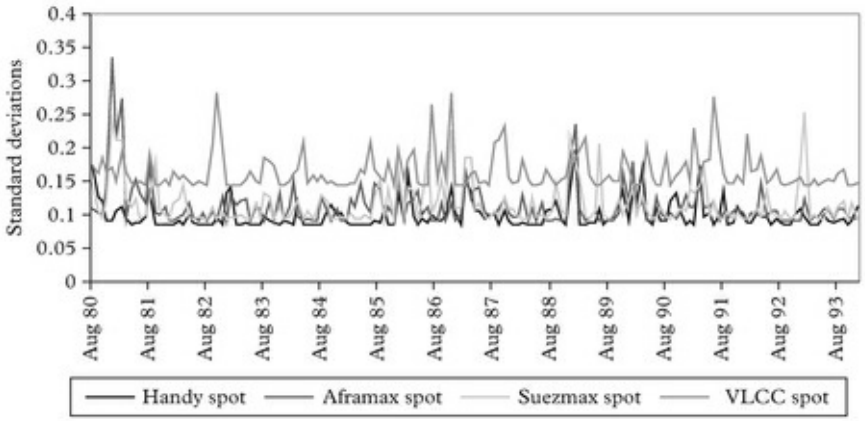

Figure 4: Spot freight rate volatilities by vessel size

sizes and of Panamax in comparison to Capesize have been explained before. Smaller ships serve many more different trades than larger ones, with less draft restrictions on certain ports because of size, and are not therefore subject to so many ups and downs in the market. On the contrary, larger size vessels may be thought of as operating in narrower markets, serving only a few major commodities and being restricted to approaching specific ports only. This has its toll on volatility levels.

Overall, it may be said that the shipping markets tend to respond together to external shocks, and yet quite differently implying market segregation between different size ships. That is, there are some common driving forces of volatilities in different size vessels, and yet there are idiosyncratic factors to each market that make each size-ship

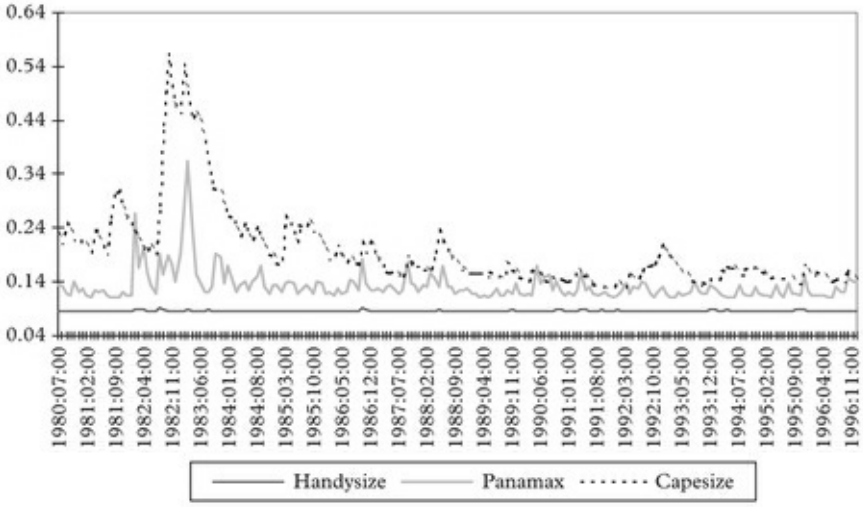

Figure 5: Spot freight rate volatilities by vessel size; dry-bulk sector

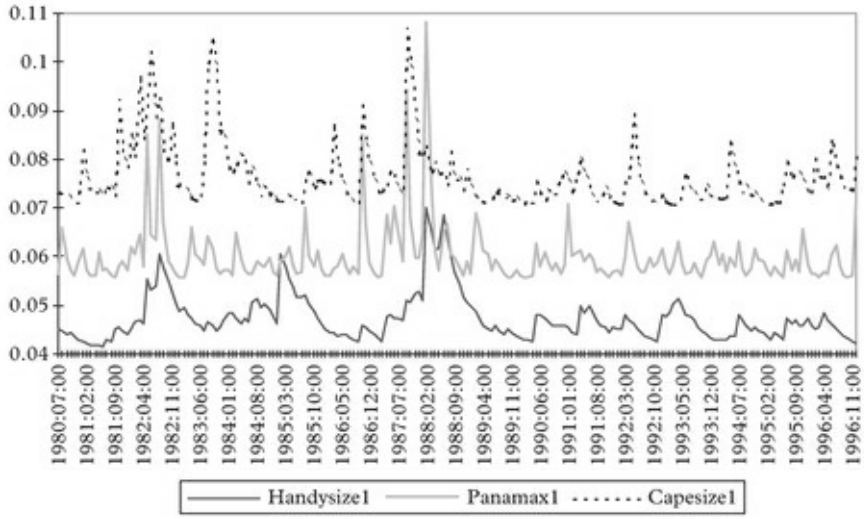

Figure 6: Time charter rate volatilities by vessel size; dry-bulk sector

volatility move at its own level and in its own way. These idiosyncratic factors relate to the type and number of routes each size ship is engaged in.

The results suggest that operational risks in the larger sub-sectors of the tanker and dry bulk sectors of the shipping industry may be mitigated by holding smaller vessels. Hence, risk averse investors in shipping can diversify risks in their portfolios by heavier weighting towards smaller size vessels.

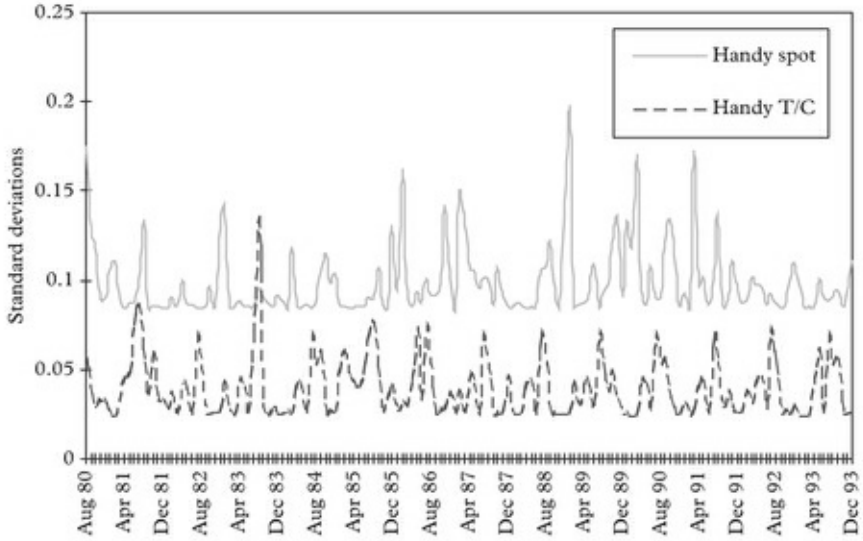

Figure 7: Spot vs time charter volatilities: Handymax sector

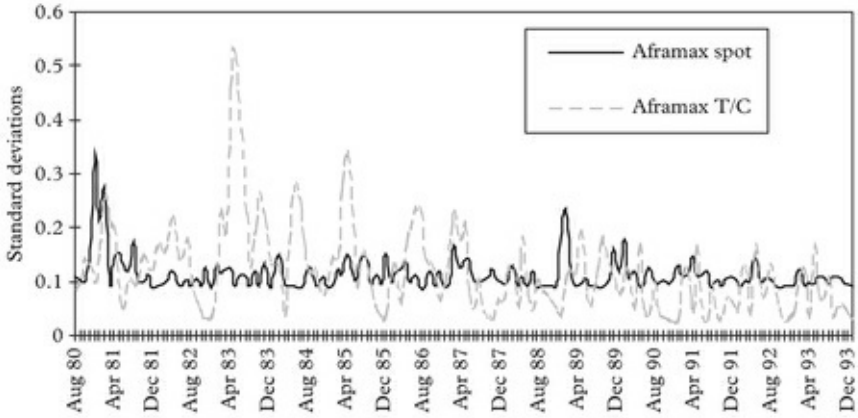

Figure 8: Spot vs time-charter volatilities: Aframax sector

5.2 Comparison of time varying freight volatilities over type of contract, spot vs time-charter

With respect to the choice between spot and time-charter markets, volatilities are compared in Figures 7–10, between time-charter and spot freight rates for each size vessel in the tanker sector. See Kavussanos (see endnote 10) for full details of this exercise. Figures 7 and 9 reveal that the volatility of spot-freight rates in the Handymax and

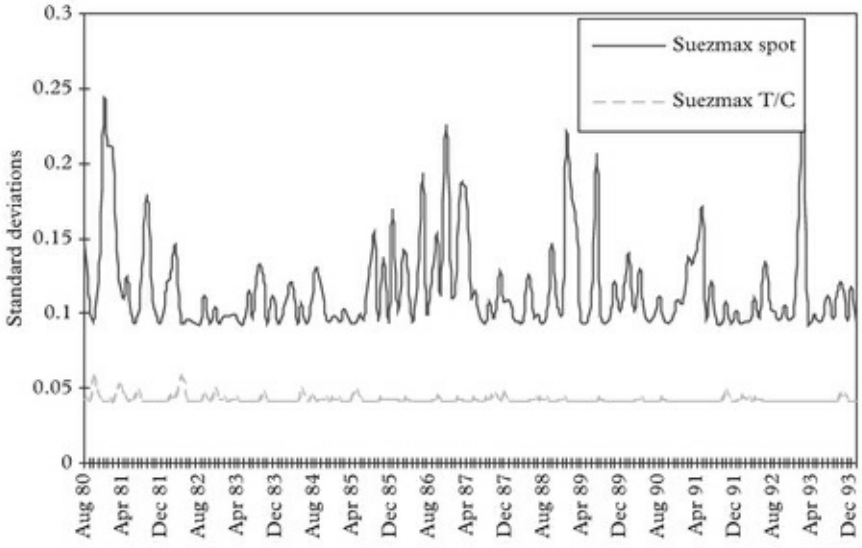

Figure 9: Spot vs time-charter volatilities: Suezmax sector

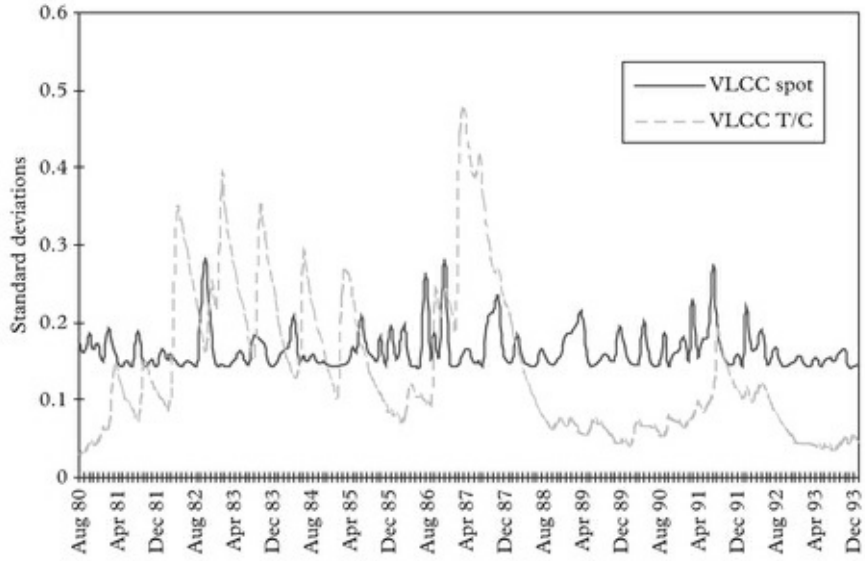

Figure 10: Spot vs time-charter volatilities: VLCC sector

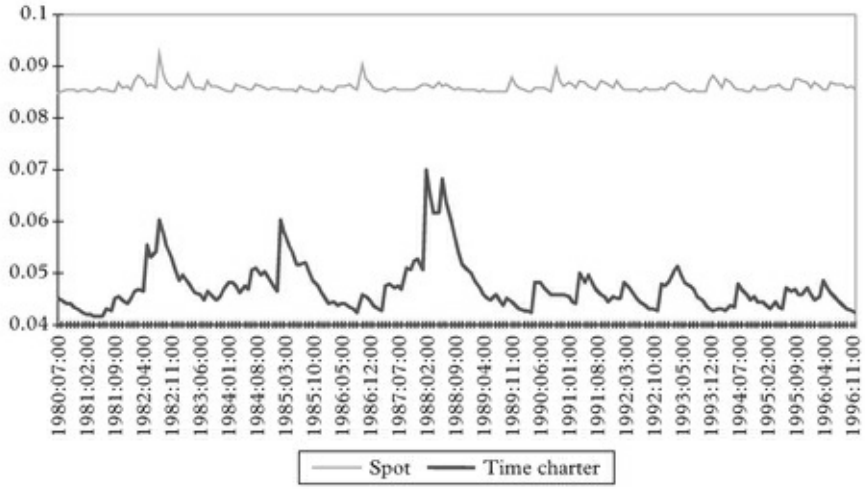

Figure 11: Handysize sector: Spot vs time charter rate volatilities (SD's)

Suezmax sectors are clearly above the corresponding time charter rates over the whole period. The results are not so neat for the Aframax and VLCC markets. Figure 8 shows that before 1987, the Aframax time charter volatility was mostly at a higher level than the spot one, with the reverse occurring once the market recovered. The fluctuations in the volatility of time charter rates in the early period are sharp and in wider bands as compared to the post-1987 period, forcing the average in

Table 8 to be, though insignificantly so, above the spot rate. The story is similar in the VLCC sector. The downward trend in time charter risk, lying constantly below the spot rate level of risk from 1988 onwards, is particularly noticeable.

Kavussanos (see endnote 6) compares aggregated (over vessel sizes) spot with time-charter volatilities for the dry-bulk sector. The results there are somewhat in line with the findings in the Aframax and VLCC sectors discussed above. That is, when the market is low, time-charters are more volatile than spot rates, probably because time-charter rates reflect expectations of future events, which makes them more sensitive to changing perceptions of the future market. When the market is at the bottom and there is a feeling for a market upturn, charterers rush to fix vessels on time charter. This results in time-charter rates moving more steeply upwards than spot rates. The opposite happens when the market is at its peak, where charterers fix in the spot market and the lack of demand for time charters results in an abrupt drop in their values.

As the data used in this last comparison of spot-with time-charter rates on the dry bulk sector were at the aggregate level, and did not refer to time charter rates of individual vessels, it was felt that more information could be obtained if the results were refined by vessel size. Thus, time varying volatilities of spot and of time charter rates in dry bulk have been estimated and presented for the first time in this chapter for each vessel size using GARCH models. Their plots are shown in Figures 11–13. Spot volatilities seem to be above the one-year time charter ones for each vessel size. This takes us back to the traditional belief that spot rates are more volatile and hence riskier than time charters.

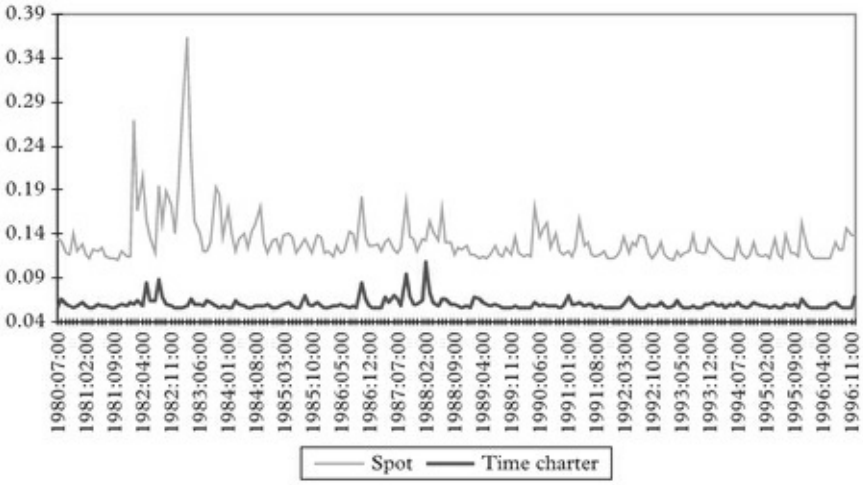

Figure 12: Panamax sector: Spot vs time charter rate volatilities (SD's)

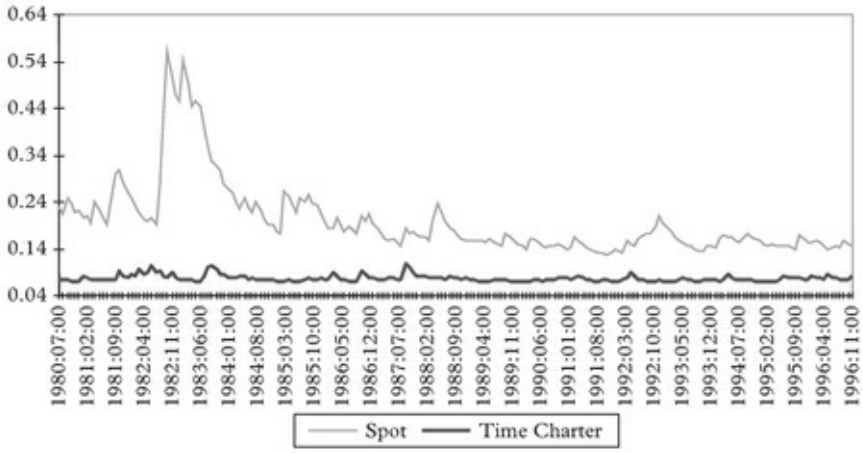

Figure 13: Capesize sector: Spot vs time charter rate volatilities (SDs)

The result is justified in Kavussanos and Alizadeh (see endnote 21), and identify four types of risk

which the owner is faced with when employing the vessel in the spot as opposed to the time-charter market. In a time charter the vessel is fixed, say, over a year. Expenses are being paid by the charterer, making income from operations quite predictable. The alternative to the one-year time charter would be, say, 12-monthly spot fixtures, with expenses on the owner's side. The owner would thus be faced with the risk of not finding employment every month on the vessel; even if employment is secured, the risk of having to relocate the vessel to a nearby port, thereby increasing his costs; the risk of the freight market decreasing by the time the next voyage contract is secured, thereby decreasing his revenues; bunker prices may move adversely for him, thereby increasing his costs. Of course, seasonal factors may also be contributing to such risks. See for example, Kavussanos and Alizadeh[34,35] for their measurement and comparison in the dry bulk and tanker sectors under different market conditions. Moreover, it can be argued that, administratively, a time charter contract is simpler to implement over the course of 12 months, in comparison to a series of voyage contracts, and is hence a cheaper option for the shipping company. Finally, it is well known that a long period time charter contract on a ship is viewed favourably by banks seeking collateral to finance the vessel, thereby making it a "safer" option for the shipping company in comparison to a series of voyage contracts.

On balance, one could say that policy implications for risk averse shipowners with a choice of employing ships between the spot and time charter markets, point to preferring the lower risk time charter market over the spot market, in general. However, in prolonged "bad" periods for the industry, time charter risk in some sectors, such as in the Aframax and VLCC sectors, may rise above the corresponding spot market risk.

5.3 Correlation coefficients amongst shipping and other asset classes

To reinforce the case made above about different size vessels being distinct asset classes, which if included in the same portfolio can have significant diversification effects, correlation coefficients amongst segments of shipping markets and some other potential investments – such as shares and commodities – are considered next. In finance portfolio theory it is well known that pairs of assets with low or negative correlation coefficients of returns provide substantial risk reductions, if combined in the same portfolio of investments. In that spirit, Table 9 displays correlation coefficients of daily logarithmic returns of freight rates in dry bulk Capesize, Panamax and Supramax sectors, and tanker dirty and clean sectors of shipping, as well as share price (S&P500) and commodity prices (wheat, corn and Brent crude oil) to represent alternative classes of investments that the international investor – the shipowner – might consider to include in his portfolio of assets.

Consider first the three correlation coefficients between the three subsectors of the dry bulk shipping industry. Their values range from a low of 0.384 to a high of 0.517. Given their relatively low values, around 50% and lower, there is scope for diversification between subsectors of dry bulk shipping by investing in different size ships. The correlation coefficients between freight rates in the dry bulk and the tanker subsectors are even lower and very close to zero, the reason being that the drybulk and tanker shipping cycles, particularly in the short run are distinct. The S&P500, wheat and corn can provide good alternative investment assets for shipowners, for diversification purposes, as seen by the very low – almost zero – correlation coefficients that they display with freight rates. As expected, Brent crude oil prices has some positive but low correlations with the dirty and clean tanker freight indices, again making a case of a potential diversifying asset.

The contribution of the analysis so far, is to point to real possibilities of risk reduction by choice of sub-sector within the dry bulk and tanker sectors of the shipping industry. In addition, the use of GARCH models to estimate time-varying volatilities points to a strategy of dynamic revisions of assets to include in a portfolio of vessels. No empirical analysis has yet been carried in the literature for the container sector, but one

Table 9: Correlation coefficients of sectoral freight rate indices, S&P500 share price index and commodity prices of Wheat, Corn and Brent crude oil

	BCI	BPI	BSI	BDTI	BCTI	S&p 500	WHEAT	CORN	BRENT
BCI	1								
BPI	0.517	1							
BSI	0.384	0.513	1						
BDTI	−0.032	−0.004	0.123	1					
BCTI	0.058	0.127	0.195	0.488	1				
S&P 500	0.102	0.143	0.086	0.066	0.091	1			
WHEAT	0.023	0.022	0.062	−0.063	−0.046	−0.122	1		
CORN	0.026	0.032	0.074	−0.037	−0.024	−0.047	0.586	1	
BRENT	0.017	0.068	0.147	0.213	0.308	0.297	−0.086	−0.115	1

Notes: BCI, BPI, BSI, BDTI and BCTI refer to the Baltic Capesize, Panamax, Supramax, Dirty Tanker and Clean Tanker Indices, respectively. S&P500 is the stock exchange index covering large publicly held companies that trade on either NYSE Euronext or NASDAQ OMX. Wheat, Corn and Brent refer to prices of these commodities. Variables are in logarithmic first differences. Sample period September 2006–January 2009.

would expect similar conclusions regarding volatilities in rates of different vessel sizes. Once the investments (ships) have been acquired, shipowners have to make similar decisions on how to maximise their return from operations, subject to the operational business risks that they face. The second contribution of the analysis so far is to point to the possibility of using period contracts as ways of reducing risks in a portfolio of "long" positions on tonnage. Caution needs to be exercised though, say in a dynamic portfolio setting, to ensure that the relationship holds true in adverse market conditions, as time charter volatility may rise above the spot one.

The strategies that the above possibilities point to are useful, but may prove to be expensive, non-existent or inflexible, if not planned properly. For example, it costs to buy and sell ships and to go in or out of freight contracts. This reduces their flexibility. Long-term charters may be hard for owners to find when the market is in decline. The opposite is true when the market is improving. In addition, when the conditions turn too much against one of the parties (owner or charterer) it may be that they decide to abandon the agreement. The introduction of derivatives contracts, such as freight futures, in 1985, and of Over the Counter (OTC) freight-forward contracts, options and swaps, since 1992 has helped to alleviate these problems with respect to operational risk management. They have made operational risk management cheaper, more flexible and readily available to parties exposed to adverse movements in freight rates.

6. The use of Derivatives for Operational Risk Management in Shipping

Many other industries have used derivative contracts to manage risks. To see for instance how futures/forward contracts work, consider a "party" which is "long" in a "commodity". For the shipowner this would be the freight service, for the charterer it would be the cargo he wants to transport. If freight rates are expected to decrease by the time the owner secures the next contract with

a charterer, he may want to avoid taking the risk of reducing his revenue. Apart from the traditional methods of managing this risk, discussed earlier, such as entering a time charter contract, he may decide to use, amongst others, freight futures, forwards, options or swap contracts to hedge these risks.

For these to function, a market price of the underlying physical commodity is needed. For instance, if a "party" is long in coffee, a spot market price for coffee is needed – which is available in the market – and based on that, futures contracts could be issued, say one month ahead. The party that owns coffee and expects its price to be lower next month will sell futures contracts to buy them back in a month's time at the lower price prevailing in the market(provided his expectations materialise). He will thus, make a profit from the selling and buying of the futures contracts at different periods, which will offset the loss which will occur in the physical market because of the reduction in the price of the commodity.

In a forward agreement, the two parties (owner of coffee and potential buyer of coffee) will come "directly" together. They will agree on a forward price for coffee and the producer will deliver that quantity at the agreed price. This is a practice which has been used as a hedging mechanism for years in a number of industries. Gray (see endnote 2) claims that the problem with this is inflexibility and unreliability; if either party wanted to change any part of the contract (e.g. quantity delivered or price), they will not be able to do so without renegotiating the whole contract. If there is a futures market operating for the commodity both parties are flexible in terms of being allowed to change the details of the original contract. Thus, delivery date, quantity, price and other characteristics may be altered at will.

7. The Baltic Freight Index

The shipping industry did not have an underlying "commodity", which could be used to trade futures contracts. In 1985 the Baltic Freight Index (BFI) produced by the Baltic Exchange in London and the International Futures Exchange in Bermuda was established. The latter was abandoned early. Until 2002 the BFI was used as the underlying "commodity" for futures BIFFEX (Baltic International Freight Futures Exchange) contracts trading for the dry bulk sector of shipping. Unlike physical goods, such as coffee, which could be delivered physically at the expiry of the futures contract, the trade of freight services amounted to delivering the cash value of the commodity. This cash settlement procedure has enabled the introduction of BIFFEX contracts, based on the BFI (Gray (see endnotes 1, 2)). The underlying asset, which is delivered at the settlement date, is the cash value of a freight rate index, the BFI. This makes the whole process a paper transaction with no ship or cargoes being involved.

The BFI–previously called the BDI (Baltic Dry Index) – is a weighted average index of dry cargo freight rates (see e.g. Kavussanos and Visvikis) (see endnote 4).The index is revised every year from a panel of brokers appointed by the Baltic exchange, namely the panellists. The revisions are such so as to take into account the changing conditions in the industry and keep the index up to date. For instance, separate indices have been introduced for the Capesize, Panamax and Handy sectors in recognition of the distinctiveness of the sectors, while the weightings of the constituent routes of each of these indices (and of the BDI) have changed over time, to reflect the relative importance of seaborne trades in these routes.

8. The Price Discovery Role of Freight Derivative Contracts

In the theory of futures and forward markets it is claimed that there are two main economic benefits that these markets provide to market agents. These are price discovery (of future spot prices) and risk management through hedging (see e.g. Garbade and Silber[36]) . Price discovery is the process of revealing information about current and expected spot prices through the futures or forward markets.

Kavussanos and Nomikos (see endnote 11), using BIFFEX contracts of one and two months to maturity show that these contracts are unbiased predictors of the spot price, (i.e. of the BFI). The evidence on the three-months contract is marginal. Kavussanos *et al*. (see endnote 16) show that FFA prices one and two months prior to maturity are unbiased predictors of the realised spot prices in routes 1, 1A, 2 and 2A. However, the efficiency of the FFA prices three months prior to maturity provide mixed evidence, with routes 2 and 2A being unbiased estimators, while routes 1 and 1A being seemingly biased estimators of the realised spot prices. Thus, it seems that "unbiasedness" depends on the market and type of contract under investigation.

The evidence uncovered by these studies is important for market agents in that they can rely on the free information provided by the futures/forward markets as to the level the spot market will be, say two months ahead. Therefore, through the FFA contracts, market agents can get an indication of the expected level of freight rates in the future. Moreover, Kavussanos and Nomikos (see endnote 11) show that, BIFFEX prices provide more accurate forecasts of the realised spot prices than forecasts generated from forecasting models, such as the random walk, ARIMA and the Holt-Winters exponential smoothing models.

In addition to providing a mechanism for market agents to form expectations regarding spot prices that will prevail in the future, trading in futures/forward markets also provides information regarding current spot prices. Kavussanos and Nomikos (see endnote 15) show that futures prices tend to discover new information more rapidly than spot prices. Subperiod results, corresponding to revisions in the composition of the underlying index, show that the price discovery role of futures prices has strengthened as a result of the more homogeneous composition of the index in recent years. Moreover, futures prices, when formulated as a VECM, are found to produce more accurate forecasts of spot prices than VAR, ARIMA and random-walk models, over several steps ahead.

Kavussanos and Visvikis (see endnote 19) investigate the lead-lag relationships between forward and spot markets, both in terms of returns and volatility. Causality tests and impulse response analysis indicate that there is a bi-directional causal relationship between spot and futures returns in all routes. The latter imply that FFA prices can be equally important as a source of information as spot prices are. A closer examination of the results suggests that causality from FFA to spot returns runs stronger than the other way in all routes. These results are in line with those for futures contracts presented in Kavussanos and Nomikos (see endnote 11).

Volatility spillovers between the spot and FFA markets are also investigated in the Kavussanos and Visvikis study (see endnote 19). Results from a bivariate VECM-GARCH-X model, indicate that the FFA volatility spills over to the spot market volatility in route 1. In route 1A the results indicate no volatility spillover in either market. In routes 2 and 2A there is a bi-directional relationship, as each market transmits volatility to the other.

Thus, FFA prices seem to contain useful information about subsequent spot prices, beyond that already embedded in the current spot price, and therefore can be used as price discovery vehicles.

Furthermore, the FFA contracts in routes 1, 2, and 2A contribute in the volatility of the relevant spot rate, and therefore, further support the notion of price discovery. In the absence of futures contracts, following the de-listing of BIFFEX in April 2002, FFAs seem to do an equally important job as vehicles of price discovery of spot prices.

Even if market agents are not aware of the valuable information that FFA contracts incorporate for them as a source of information regarding the likely developments of the spot market, they would be keen to know how successful the use of these contracts are in mitigating their risks in freight markets. This is important as it relates to direct monetary benefits from the use of the contracts. If these are perceived important and the service offered by the existence of FFA contracts is used enough by the industry it will survive to serve the players in the industry.

9. The Hedging Effectiveness of Freight Derivative Contracts

Risk management refers to hedgers using futures contracts to control their spot price risk. The issue of the effectiveness of BIFFEX contracts in hedging freight risk has been investigated in Thuong and Vischer,[37] in Haralambides (see endnotes 24, 25), and in Kavussanos and Nomikos (see endnotes 12–14). Kavussanos *et al.*(see endnote 17) and Kavussanos and Visvikis (see endnote 19) investigate the risk management function of the FFA markets. As explained earlier, hedging involves taking a position in the futures market that is opposite to the position that one already has in the spot market. The shipowner is “long” on tonnage and sells BIFFEX/FFA contracts to protect him against a decline in freight rates. The charterer is ‘short’ on tonnage, thus buying BIFFEX/FFA contracts to protect him against a rise in freight rates. Of course, for a trade to occur the views of these two “parties” to the trade must be opposite. Futures/forward markets simply transfer risks from one willing party to another.

In hedging, the “party” interested in mitigating risks has to determine a hedge ratio, which will make the hedge as “effective” as possible (i.e. he has to decide on the number of futures/forward contracts to buy or sell for each unit of spot commodity on which he bears price risk). Johnson,[38] Stein,[39] and Ederington,[40] apply the principles of portfolio theory to solve the problem. They show that the hedge ratio, which minimises the spot market risk equals the covariance between spot and futures/forward price changes over the variance of futures/forward price changes.

The effectiveness of the hedge is determined by the degree of variance reduction it achieves in the hedged portfolio. Alternatively, effectiveness is determined by the proportion of risk in the spot market that is eliminated through the futures/forward position (hedging). Alternative strategies in calculating hedge ratios involve a naïve one-to-one hedge, under which for each $ exposition in the spot market a $ position is opened in the futures market. This may be sub-optimal. Other strategies involve using constant or time varying optimal hedge ratios. The latter would be justified if the distributions of the covariance and/or the variance entering the calculation of the optimal hedge ratio are time varying. In this case, at each point in time, a different hedge ratio would be appropriate. To make this point evident, Figure 15 plots the estimated constant and time varying hedge ratios for spot and FFA contracts for route 1 of the BDI. It is obvious that using the constant hedge ratio, instead of the time varying one, in observation 30 on the graph would have provided estimates, which are way off the most efficient hedge.

The “technology” to calculate time varying hedge ratios for BIFFEX contracts has been introduced

by Kavussanos and Nomikos (see endnotes 12–14) to individual routes of the BFI and in FFA contracts by Kavussanos *et al*. (see endnote 17) and Kavussanos and Visvikis (see endnote 19). These time varying hedge ratios, have been calculated by extracting time varying variances and covariances of spot and futures prices from the estimation of multivariate GARCH models, with a VECM specification of the mean of the variables. Alternative hedging strategies are evaluated by comparing the portfolio variance reduction from the use of a particular hedge ratio (strategy) to a benchmark portfolio – that of the unhedged position. The larger the reduction in the unhedged variance, the higher the degree of hedging effectiveness. Whether time varying or constant ratios for BIFFEX or FFA contracts are appropriate for each individual route cannot be determined *a priori*. It is a matter of empirical evidence.

Kavussanos and Nomikos (see endnotes 12–14) examined the issue of hedging effectiveness for BIFFEX contracts. Two cases are distinguished: in-sample and the more pragmatic out-of-sample hedge ratios. In the former case time-varying hedge ratios are superior in routes 1, 1A, 3A, 7 and 10. Out-of-sample results indicate that time-varying hedge ratios perform better in routes 1, 1A, 3A and 8. In route 3, the constant hedge ratio seems superior. The naive hedge is the worst hedging strategy in all in sample results. For out of sample, in routes 7 and 10, hedging increases the portfolio variance compared to the unhedged position, suggesting that market participants should leave their positions unhedged. Also the naive hedge in route 9 seems superior. Overall, the average variance reduction for the Panamax routes is higher than that for the capesize routes across all the estimated models. This is not surprising as the Panamax routes represent 70% of the total BFI composition. Ultimately, the user of the futures contracts is interested in the variance reduction that may be achieved with the best method of hedging available. The above study shows that the highest variance reduction possible is in route 1A (23.25%) and the lowest is in route 7 (–14.86%). It seems then that for all routes a large proportion of the variability of the unhedged portfolio is not eliminated. It explains the decreasing interest in the use of BIFFEX by market participants, which lead to its eventual abandonment.

During its history, the composition of the BFI has been restructured several times (see Figure 14) to make it more representative of the industry, and to improve the hedging performance of BIFFEX contracts. Kavussanos and Nomikos (see endnotes 11,15) show that the restructuring of the BFI has helped improve the price discovery function of the futures market. Kavussanos and Nomikos (see endnote 13) also investigate whether the other function of futures markets, that of hedging performance, has changed as a result of changes in the composition of the BFI. There seems to be no evidence of statistical change in the hedging performance of BIFFEX on any route, following the inclusion of time-charter routes in the BFI. However, performance improves in route 1 following the exclusion of the handysize routes. The exclusion of the capesize routes from the index, in November 1999, making the index more homogeneous increases the

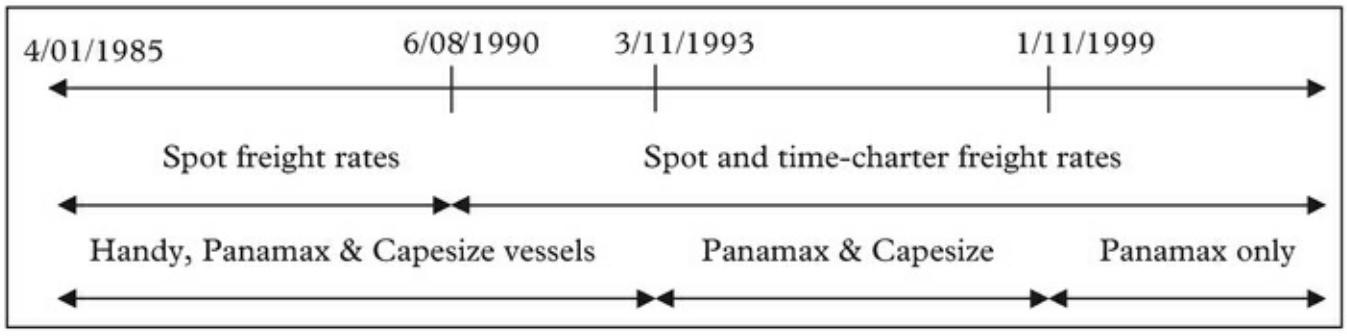

Figure 14: Major revisions of the BFI
Source: Kavussanos and Nomikos (2000b)

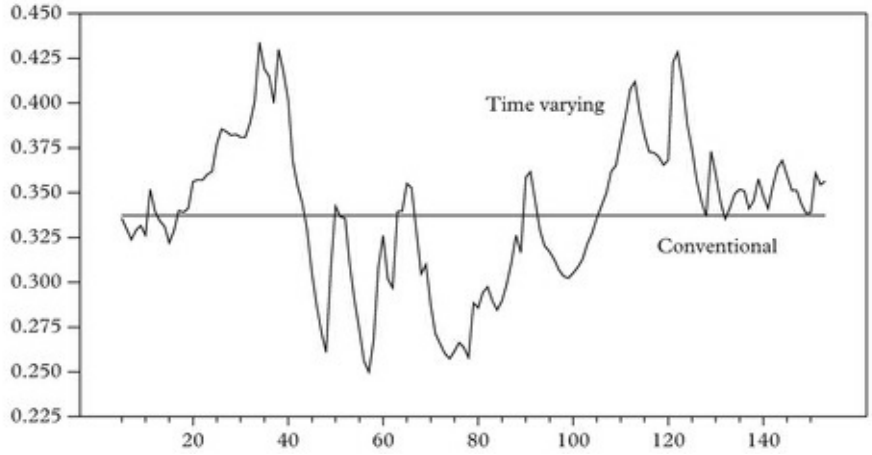

Figure 15: Constant vs. time-varying hedge ratios for spot and FFA in route 1
Source: Batchelor, Kavussanos and Visvikis (2002b)

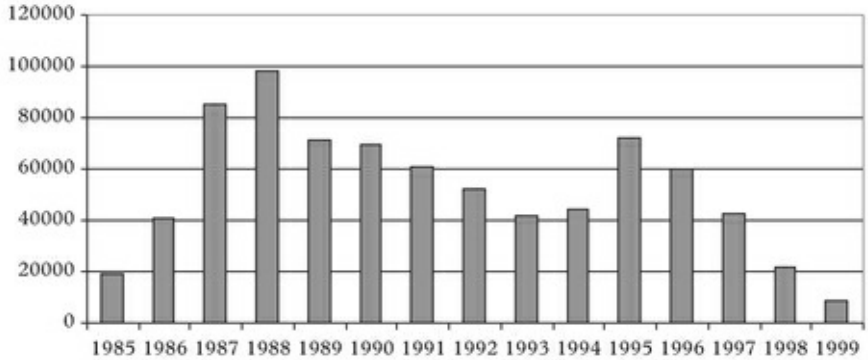

Figure 16: Yearly Volumes of the BIFFEX Contract (May 1985–June 1999)
Source: LIFFE, 1999

in-sample hedging effectiveness for every route (except route 1) in comparison to the pre-November 1999 period. This improved variance reduction is as high as 23.03% in route 3A, with an overall average improvement (over routes) of 14.36%. For the BPI then the highest hedging effectiveness achieved through the use of BIFFEX was in route 3A, reaching a figure of 39.95%.

It seems that the increased homogeneity of the index has had a positive impact on hedging effectiveness, despite leaving the variance reduction achieved well below that evidenced in other markets in the literature. At the time of writing, Kavussanos and Nomikos (see endnote 13) argued that: “the magnitude of the observed increases in hedging effectiveness is still small, and may not be sufficient to induce market agents in actively using the market for hedging purposes. This also seems to be in line with the trading preferences of participants in the shipping markets who are now increasingly using over-the-counter (OTC) forward contracts which are cash settled against the underlying shipping routes of the BPI. Because these contracts are traded against specific routes,

rather than a general index, they also avoid the problem of basis risk, which is evidenced in the BIFFEX market."

Unfortunately trading volumes, seen in Figure 16, have not turned around sufficiently to justify the BIFFEX contract's existence for LIFFE. Over the period September 1992 to October 1997 the average daily trading volume has been 210 contracts per day, the equivalent of the average freight cost of transporting 220,000 tons of grain from the US Gulf to Rotterdam (i.e. four voyages in Route 1 of the BFI). This had become minimal for the later years of the history of BIFFEX. As a consequence, LIFFE stopped trading BIFFEX in April 2002.

Currently, in order to hedge freight rate risk, one has to turn to OTC financial products. Their performance is examined in a series of seminal papers by Kavussanos *et al*. (see endnotes 16,17) and Kavussanos and Visvikis (see endnotes 18,19). Kavussanos and Visvikis (see endnote 18) investigate the risk-management function in the FFA markets. In sample, the time-varying hedge ratios perform better, in increasing hedging effectiveness, in capsize route C4 (59.96%) and in the panamax PTC (62.69%), capesize CTC (64.02%) and supramax STC (42.18%) time-charter baskets. In contrast, in route P2A, the simple conventional model (63.96%) outperforms other specifications. Out-of-sample, specifically, for the period March to October 2008 investigated in routes P2A and C4, and in the PTC, CTC and STC time-charter baskets for June to October 2008, results show that-in routes P2A (76.59%) and C4 (85.69%) and in the CTC basket (65.73%), naïve (one-to-one) hedge ratios produce the highest variance reductions. In contrast, in the STC basket, the constant hedge ratio produced by the VECM model provides the greatest variance reduction (52.17%). In the PTC basket, the time-varying VECM-GARCH-X model seems to outperform the alternative hedging strategies (75.76%). The hedging performance results in this paper, with the greatest variance reduction of 86%, compares favourably with results, achieved through the use of futures contracts, in other markets – (57.06% for the Canadian Interest rate futures (Gagnon and Lypny[41]), 69.61% and 85.69% for the corn and soybean futures (Bera *et al*.[42]) and 97.91% and 77.47% for the SP500 and the Canadian Stock Index futures contract, respectively (Park and Switzer[43]).

Finally, Kavussanos and Dimitrakopoulos (see endnote 20), consider appropriate Value at Risk (VaR) and extreme value methods of determining the maximum loss that may be sustained from long positions on freight, and which can drive decisions on whether to hedge freight exposures through the use of freight derivatives – see also Kavussanos and Visvikis (see endnote 4).

10. Forward Freight Agreements (FFAS)

As mentioned earlier, FFAs are principal-to-principal contracts, between a seller and a buyer to settle a freight or hire rate, for a specified quantity of cargo or type of vessel, for usually one, or a combination of the major trade routes of the dry-bulk and tanker industries. Settlement is made on the difference between the contracted price and the average price for the route selected in an index over the last seven working days. The indices published by the Baltic exchange on routes of the tanker and dry bulk industry are used as the "underlying commodity" on which to base the FFAs.

In OTC derivative agreements there is credit risk involved. For the agreement to go ahead, the parties have to approve each other–i.e. each party accepts the credit risk from the other party. Over the past years, clearing houses, such as those of the London Clearing House (LCH Clearnet) in 2005, the Norwegian Options and Futures Clearing House (NOS) in 2002 and Singapore Asia Clear in 2006,

have provided the facility of clearing FFAs for a fee, if one counterparty was not prepared to accept the credit risk of the other counterparty in an FFA agreement – see Kavussanos and Visvikis (see endnote 4) for full details of this issue.

Institutions, which facilitate FFA markets are major shipbrokers, investment banks, and other financial intermediates in the fund management industry. The International Maritime Exchange (IMAREX) has also been established in Oslo and since 2002 trades and clears (through the NOS) FFAs, in what resembles futures contracts on freight. The New York Merchantile Exchange (NYMEX) made a similar move and has provided futures contracts for the tanker industry since 2005.

The primary advantage of an OTC market is that the terms and conditions are tailored to the specific needs of the two parties. It is a private market in which the general public does not know that the transaction was done. It is considered to be flexible in the sense that the "parties" can introduce their own contract specifications to cover their specific needs, saves money by not normally requiring initial, maintenance, and variation margins (common in the futures organised exchanges), and allows the market to quickly respond to changing needs and circumstances by developing new variations of old contracts.

In the dry-bulk sector, FFAs are available to match the Capesize, Panamax, Supramax and Handymax routes. For those wishing to hedge long-term freight risk, time-charter based FFAs, typically "baskets" of routes of the indices are tradeable with settlement based on the difference between the contract price and the daily average of the spot "basket". It is customary to divide the period into monthly settlements to establish cash-flow. These routes are regularly reviewed to ensure their relevance to the underlying physical market. The combination of time-charter routes can create the equivalent of a period time-charter trade (Clarkson Securities[44]).

Figure 17 shows the tremendous growth in FFA contracts, which, according to Clarkson's, have grown to an estimated 17,000 contracts in 2007. In value terms, they have surpassed the value of the physical trading of freight. Figures 18–21 present the near-month FFA prices against the spot prices (underlying asset) in Panamax routes 1 (US Gulf/Antwerp-Rotterdam-Amsterdam), 1A (Transatlantic round to Skaw-Gibraltar range), 2 (US Gulf/Japan) and 2A (Skaw Passero–Gibraltar/Taiwan–Japan), respectively. In every route the FFA and spot prices move closely together. This is verified by the values of the correlation coefficients of logarithmic differences of FFA prices with spot prices in routes 1, 1A, 2 and 2A. They are, respectively, 0.965, 0.972, 0.986, and 0.985.

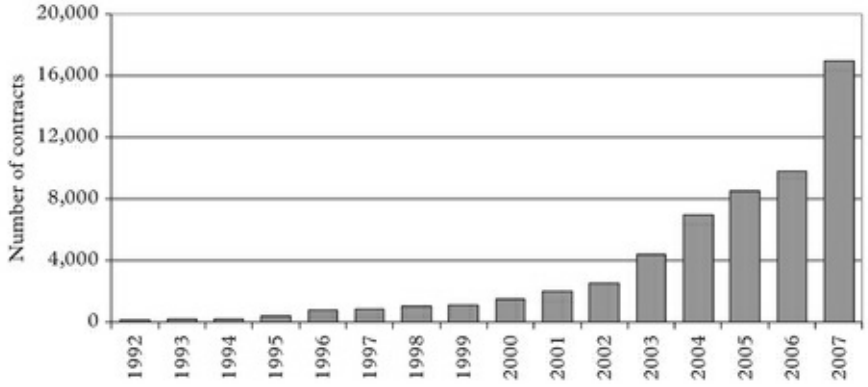

Figure 17: Yearly volumes of dry bulk FFA contracts (Jan 1992–Dec 2007)
Source: Clarksons Securities

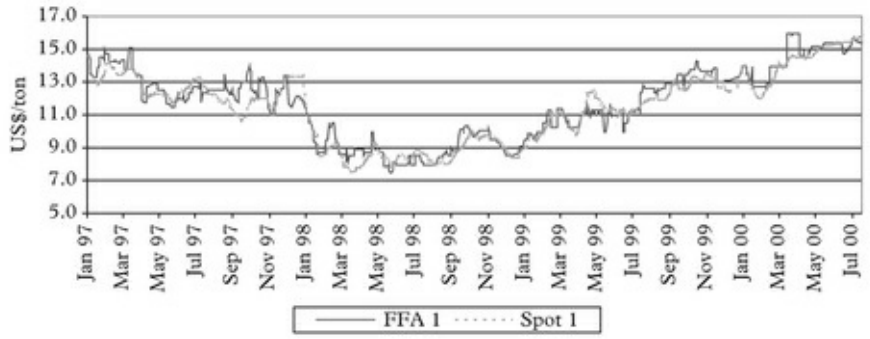

Figure 18: FFA and spot prices in route 1; Daily data (16/01/97–31/07/00)

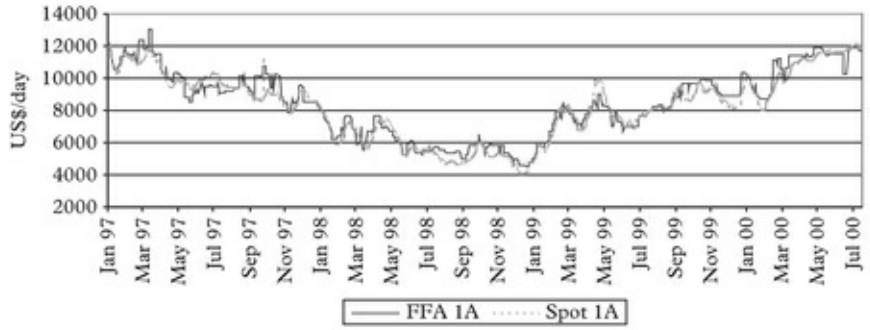

Figure 19: FFA and spot prices in route 1A; Daily data (16/01/97–31/07/00)

Figure 20: FFA and spot prices in route 2; Daily data (16/01/97–10/08/01)

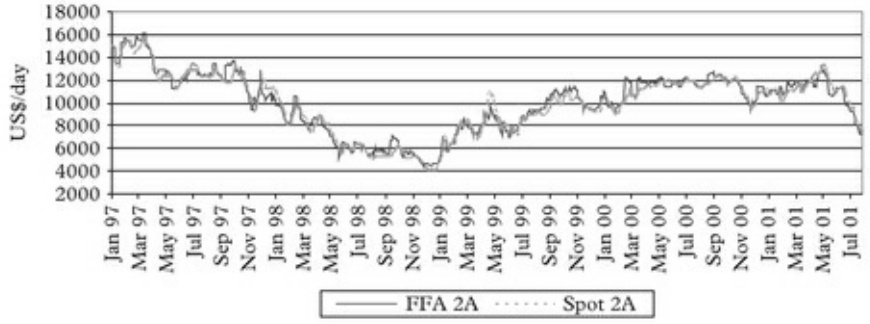

Figure 21: FFA and spot prices in route 2A; Daily data (16/01/97–10/08/01)

11. The Effect of FFA Trading on Spot Price Volatility

It is often claimed that the advent of futures or forward prices can have an adverse impact on spot price volatility. Kavussanos *et al.* (see endnote 17) investigate the issue in the FFA market. The results suggest that the onset of FFA trading has had (i) a stabilising impact on the spot price volatility in routes 1 and 2; (ii) an impact on the asymmetry of volatility (market dynamics) in routes 2 and 2A; and (iii) substantially improved the quality and speed of information flow in routes 1, 1A and 2. Overall, the results indicate that the introduction of FFA contracts has not had a detrimental effect on the underlying spot market. On the contrary, it appears that there has been an improvement in the way that news is transmitted into prices following the onset of FFA trading. By attracting more, and possibly better informed, participants into the market, FFA trading has assisted in the incorporation of

information into spot prices more quickly. Thus, even those market agents that do not directly use the FFA market have benefited from the introduction of FFA trading.

12. Stabilising Voyage Costs: Hedging Bunker Price Risk

Returning to the cash flow position of shipowners, as mentioned in section 1 and shown schematically i n Table 1, the major and most volatile part of their voyage costs comes from bunker price fluctuations (amounting to 50% of voyage costs, according to Stopford (see endnote 26)). Yet, with the exception of some financial institutions,[45] offering tailor-made OTC derivatives products such as forwards, swaps and options, there were no tradable futures contract for the bunker fuel[46] until a few years ago. In the absence of bunker futures contracts, hedging against bunker price fluctuations using other similar futures contracts, such as energy futures, involves a cross-hedge. In order to offer market participants the possibility to eliminate credit risk involved in OTC bunker fuel contracts, in 2006 SGX AsiaClear introduced clearing of bunker forward contracts, with cash settlement against a monthly average of the Platts daily quotations. Since December 2005, IMAREX introduced bunker fuel futures contracts for the most popular bunker fuel grades, and for contract durations up to two calendar years ahead. The settlement prices used are those of Platts and Bunkerworld and the settlement period is the average of the month.

Although marine bunkers are bought and sold in almost every port in the world, the world bunker market can be broadly divided into three major regional markets in which the bulk of physical bunkering activities takes place. These are: Singapore, Rotterdam and Houston. Singapore has long flourished as a transhipment centre due to its strategic geographical location. The Singapore bunker market is by far the largest marine fuels market in the world, and is duly considered to be a prime benchmark for the industry. Singapore's turnover in marine fuel oil in 2000 was 18.7 million tonnes. In Europe, the Amsterdam–Rotterdam–Antwerp (ARA) region sells as much as 16 million tonnes of bunker fuel annually. The heart of the ARA region is Rotterdam, which sells about 8 to 9 million tonnes of bunker oil and lubes annually, helped by a hub of oil refining and storage facilities sited in its Europort complex, which handles around 100 million tonnes of crude annually. Bunkering on the US Gulf coast is dominated by Houston, recording an annual sales volume of 3 million tonnes in 2000.

Before the introduction of bunker futures contracts, Alizadeh, Kavussanos, and Menachof (see endnote 22), explored the possibility of using a number of traded petroleum futures contracts as instruments for risk reduction in relation to this major operating expense for the shipowner. They examined the effectiveness of hedging marine bunker price fluctuations in Rotterdam, Singapore and Houston using different crude oil and petroleum future contracts traded at the New York Mercantile Exchange (NYMEX) and the International Petroleum Exchange (IPE) – now Intercontinetal exchange – in London.

Using both constant and dynamic hedge ratios, it is found that in and out-of-sample hedging effectiveness is different across regional bunker markets. The most effective futures instruments for out-of-sample hedging of spot bunker prices in Rotterdam and Singapore are the IPE crude oil futures, while for Houston it is the gas oil futures. However, they achieve only up to 43% variance reduction when using IPE crude oil to hedge bunker prices in Rotterdam. Hedging effectiveness varies from one bunker market to the other. For agents determined to use futures contracts to hedge bunker price risk, policy action points to using IPE crude oil contracts to hedge bunker price fluctuations when loading

in Rotterdam, NYMEX gas oil contracts when loading in Singapore, and IPE gas oil futures contracts when using Houston for refuelling vessels. The maximum hedging effectiveness are 43%, 15.9% and 14% in each case. This compares unfavourably with other futures contracts. However, as discussed earlier, the availability of bunker fuel futures contracts at IMAREX, and the existence of an active OTC bunker fuels market in association with the market clearing of these products serves the market in a much better way – see Kavussanos and Visvikis (see endnote 4) for further discussion of these issues.

13. Summary—Conclusion

Shipowners are faced with substantial business risks in the international environment that they operate. Risks emanate from fluctuations in freight rates, bunker prices, the price of the investment ship, interest rates, exchange rates, etc. This chapter has put forward a framework for identifying and measuring these risks, and has proposed solutions on how to handle the question of risk management. In the process, a review of the literature and some new ideas about how risks can be managed in the shipping industry have been put together. At the same time the chapter provides the state of the art of where we stand now technically in calculating instruments that can be used to hedge risks, such as the calculation of time varying hedge ratios. It offers a review of where we stand research-wise in the area, and can provide a stepping-stone for further research and innovations in the area. Naturally, a lot of the details underlying the research have not been reproduced here, due to lack of space. However, these details can be found in the original papers, referenced here.

The ideas put forward in this chapter include: The sectoral disaggregation of the dry bulk, tanker and container sector of the cargo carrying shipping industry, based on distinct risk-return characteristics. As a consequence, it is suggested that shipowners can mitigate risks by holding portfolios of assets–ships– of different size; The possible risk diversification effects in ship operation by switching between contracts of different duration; The use of freight derivatives, such as futures and forward contracts to manage freight rate risks; The economic functions of price discovery and risk management of these financial instruments are discussed critically. The review looks back at BIFFEX and their role in serving the industry as hedging instruments for freight rates. It compares their performance with other financial instruments and finds it somewhat lacking. In a way, it identifies why the industry has turned gradually to OTC products and explains the withdrawal of freight futures contracts after 17 years of existence. Naturally it is impossible to cover all aspects involved in one chapter. The book by Kavussanos and Visvikis (see endnote 4) aims to close this gap and provide interested readers with all the relevant information in the area of risk analysis and management in shipping, particularly on the use of derivative instruments.

Acknowledgement

The origins of the ongoing research underlining the work in this chapter go back to 1991 when the author decided to get involved and develop the area of risk analysis and management in the shipping industry. Six PhD and a large number of MSc students have been introduced and undertaken research under the author’s supervision in the subject area. Special thanks are due to them for valuable assistance and feedback on various parts of the research underlying this chapter. Thanks are also due to colleagues in the industry who have offered their comments on parts of this work, while presented in conferences and professional meetings around the world. Naturally, all remaining errors or

omissions are the sole responsibility of the author.

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Endnotes

1. Gray, J.W. (1986): *Financial Risk Management in the Shipping Industry* (London, Fairplay Publications)
2. Gray, J. (1990): *Shipping Futures* (London, Lloyd's of London Press).
3. Contracts available to the owner/charterer include: (1) Voyage charters (paid as freight per tonne to move good(s) from A to B, all costs paid by the shipowner); (2) Contracts of affreightment (the shipowner carries good(s) in specified route(s) for a period of time using ships of his choice); (3) Time charters – trip/time (the shipowner earns hire every 15 days or month. He operates the ship under instructions from the charterer who pays voyage costs); (4) Bareboat charters (the ship is rented to another party for operation, usually for a long period of time).
4. Kavussanos, M.G. and Visvikis, I. (2006): *Derivatives and Risk Management in Shipping* (London, Witherbys Seamanship Publishing, A)
5. Kavussanos, M.G. and Visvikis, I. (2006): "Shipping freight derivatives: a survey of recent evidence", *Maritime Policy and Management*, Vol. 33, No. 3, 233–255, July.
6. Kavussanos, M.G. (1996): "Comparisons of volatility in the dry-cargo ship sector. Spot versus time-charters, and smaller versus larger vessels", *Journal of Transport Economics and Policy*, January 1996, Vol. 30, No. 1, 67–82.
7. Kavussanos, M.G. (1996): "Price risk modelling of different size vessels in the tanker industry using Autoregressive Conditional Heteroskedasticity (ARCH) models", *The Logistics and Transportation Review*, June 1996, Vol. 32, No. 2, 161–176.
8. Kavussanos, M.G. (1997): "The dynamics of time-varying volatilities in different size second-hand ship prices of the dry-cargo sector", *Applied Economics*, 1997, 29, 433–443.
9. Kavussanos, M.G. (1998): "Freight risks in the tanker sector", *Lloyd's Shipping Economist*, June 1998, 6–9. Also, July 1998, 9.
10. Kavussanos, M.G. (2003): "Time varying risks among segments of the tanker freight markets", *Maritime Economics and Logistics*, Vol. V, No. 3, 227–250.
11. Kavussanos, M.G. and Nomikos, N. (1999): "The forward pricing function of the shipping freight futures market", *The Journal of Futures Markets*, Vol. 19, No. 3, 353–376, May.
12. Kavussanos, M.G. and Nomikos, N.K. (2000): "Hedging in the freight futures market", *Journal of Derivatives*, 41–58.
13. Kavussanos, M.G. and Nomikos, N.K. (2000): 'Futures hedging when the composition of the underlying asset changes: the case of the BIFFEX contract", *Journal of Futures Markets*, 20, 775–801.
14. Kavussanos, M.G. and Nomikos, N.K. (2000): "Constant versus time-varying hedge ratios in the BIFFEX market", *Logistics and Transportation Review*, Transportation Research Part E 249–265.
15. Kavussanos, M.G. and Nomikos, N. (2003): "Price discovery, causality and forecasting in the freight futures market", *Review of Derivatives Research*, 6, 203–230.
16. Kavussanos, M.G., Menachof, D. and Visvikis, I. D. (2004): "The unbiasedness hypothesis in the

freight forward market: evidence from cointegration tests", *Review of Derivatives Research*, 7, 241–266.

17. Kavussanos, M.G., Batchelor R. and Visvikis, I. (2004): "Over the counter forward contracts and spot price volatility in shipping", *Transportation Research, Part E*, 40, 273–296.

18. Kavussanos, M.G. and Visvikis, I. (2004): "Market interaction in returns and volatilities between spot and forward shipping freight markets", *Journal of Banking and Finance*, 28, 2015–2049.

19. Kavussanos, M.G. and Visvikis, I.D. (2009): "The hedging effectiveness of non-storable commodities", Paper presented at the National University of Singapore, Centre for Maritime Studies, 9 July 2009.

20. Kavussanos, M.G. and Dimitrakopoulos, D. (2007): "Value at Risk models in dry bulk ocean freight rates", International Workshop in Economics and Finance, Tripoli, Greece, 14–16 June 2007. Also at 17th International Association of Maritime Economists (IAME) Conference, Athens, Greece, 4–6 July, 2007.

21. Kavussanos, M.G. and A. Alizadeh (2002): 'The expectations hypothesis of the term structure and risk premia in dry bulk shipping freight markets; An EGARCH-M approach", *Journal of Transport Economics and Policy*, May 2002.

22. Alizadeh, A., Kavussanos, M.G. and Menachof, D. (2004): "Hedging against bunker price fluctuations using petroleum futures contracts; constant vs time varying hedge ratios", *Applied Economics*, 36, 1337–1353.

23. Cullinane, K.P.B. (1992): "A short-term adaptive forecasting model for BIFFEX speculation: a box Jenkins approach", *Maritime Policy and Management*, 19(2): 91–114.

24. Haralambides, H.E. (1992): "A new approach to the measurement of risk in shipping finance", *Lloyd's Shipping Economist*, April.

25. Haralambides, H.E. (1992): "Freight Futures Trading and Shipowners Expectations", Conference Proceedings of the 6th World Conference on Transport Research (Lyon, France: Les Presses De L'Imprimerie Chirat), 2: 1411–1422.

26. Stopford, M. (1997): *Maritime Economics*, (2nd edn.) (London, Routledge).

27. These are known as unconditional variances as they are averages of the squared dispersions of freight rates over a period of time. Conditional variances on the other hand refer to variances, which are estimated from regression models, under which freight rates, are explained in terms of a set of explanatory variables.

28. Glen, D. (1990): "The emergence of differentiation in the oil tanker market" *Maritime Policy and Management*, Vol. 17, No. 4, 289–312.

29. Engle, R.F. (1982): "Autoregressive conditional heteroskedasticity with estimates of the variance of United Kingdom inflation", *Econometrica*, 50, 987–1007.

30. Bollerslev, T. (1986): "Generalized autoregressive conditional het eroskedasticity", *Journal of Econometrics*, 31, 307–327.

31. See Kavussanos (1996 endnote 6, 1997): for a complete set of results, including estimated coefficients.

32. Kavussanos M.G. and Alizadeh, A. (2002): "Efficient Pricing of Ships in the Dry Bulk Sector of the Shipping Industry", *Maritime Policy and Management*, Vol. 29, No. 3, 303–330.

33. See endnote 3 for definitions.

34. Kavussanos, M.G. and Alizadeh, A. (2001): "Seasonality patterns in dry bulk shipping spot and time-charter freight rates" *Transportation Research,* Part E, *Logistics and Transportation Review*, Vol. 37, No. 6, 443–467.

35. Kavussanos, M.G. and Alizadeh, A. (2002): "Seasonality patterns in tanker shipping freight markets", *Economic Modelling*, Vol. 19, Issue 5, 747–782,

36. Garbade, K. and Silber, W. (1983): "Price Movements and Price Discovery in Futures and Cash Markets", *Review of Economics and Statistics*, 65, 289–297.

37. Thuong, L. T. and Visscher, S. L. (1990): "The hedging effectiveness of dry bulk freight rate futures", *Transportation Journal*, 29, 58–65.

38. Johnson, L. (1960): "The theory of hedging and speculation in commodity futures", *Review of Economic Studies*, 27, 139–151.

39. Stein, J. (1961): "The simultaneous determination of spot and futures prices", *The American Economic Review*, 51, 1012–1025.

40. Ederington, L. H. (1979): "The hedging performance of the new futures markets", *The Journal of Finance*, 34, 157–170.

41. Gagnon, L. and Lypny, G. (1995): "Hedging short-term interest risk under time-varying distributions", *Journal of Futures Markets*, 15(7), 767–783.

42. Bera, A., Garcia, P. and Roh, J. (1997): "Estimation of time-varying hedge ratios for corn and soybeans: BGARCH and random coefficients approaches", *Office for Futures and Options Research*, 97–06.

43. Park, T. and Switzer, L. (1995): "Bivariate GARCH Estimation of the Optimal Hedge Ratios for Stock Index Futures: A Note", *Journal of Futures Markets*, 15, 61–67.

44. Clarkson Securities (1999): *FFAs: Forward Freight Agreements* (London, Clarkson Securities Ltd Publication) pp. 1–11.

45. For example, Barclays Capital, Morgan Stanley, Credit Lyonnais, etc., offer OTC bunkers derivative products.

46. Fuel oil futures were traded in Singapore Exchange during the period 1988–1992. However, due to the decline in trading volume and illiquidity of contracts, Singapore Exchange stopped the trade in fuel oil futures. The International Petroleum Exchange attempted to launch a bunker futures contract in January 1999. This proved unsuccessful and the contract was withdrawn after six months.

Selected References

Bollerslev, T. and Wooldridge, J. M. (1992): "Quasi-maximum likelihood estimation of dynamic models with time varying covariances", *Econometric Reviews*, 11, 143–172.

Chang, Y. (1991): "Forward Pricing Function of Freight Futures Prices," Unpublished PhD Thesis, Department of Maritime Studies, University of Wales.

Chang, Y. and Chang, H. (1996): "Predictability of the dry bulk shipping market by BIFFEX", *Maritime Policy and Management*, 23 103 – 114.

Cullinane, K. P. B. (1989): "The Application of Modern Portfolio Theory to Hedging in the Dry-Bulk Shipping Markets", PhD Thesis, Plymouth Polytechnic.

Cullinane, K. P. B. (1991): "Who's using BIFFEX? Results from a survey of shipowners", *Maritime*

Policy and Management, 18, 79–91.
Drewry Shipping Consultants (1997): *Shipping Futures & Derivatives: From Biffex to Forward Freight Agreements (FFAs) and Beyond* (London, Drewry Shipping Consultants Publications).
Gemmill, G. (1985): "The Behaviour of the Baltic Freight Index", Paper to BIFFEX Committee.
Gemmill, G. and Dickins, P. (1984): "An Examination of the Efficiency of the London Traded Options Market", Working Paper: 69 (London, City University Business School).
Johansen, S. and Juselius, K. (1990): "Maximum likelihood estimation and inference on cointegration – with applications to the demand for money", *Oxford Bulletin of Economics and Statistics*, 52, 169–211.
LIFFE (2000): "BIFFEX Futures and Options: Contract Information and Specification", Commodity Products Manual, London International Financial Futures and Options Exchange.
SSY Futures (1998): *Freight Rate Risks and Hedging: An introduction* (London, SSY Futures Ltd.) pp. 1–10.
Thierry, M. (1992): "The BIFFEX Revised: A Paper on the Function of the Futures Market for Dry Bulk Shipping", Conference Proceedings of the 6th World Conference on Transport Research (Lyon, France: Les Presses De L'Imprimerie Chirat), 2, 1411–1422.

Chapter 26

Managing Freight Rate Risk Using Freight Derivatives: An Overview of the Empirical Evidence

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1. Introduction

Over the last decade, the tramp shipping markets have undergone a fundamental transformation. This period is characterised by very high volatility in the level of freight rates as well as the emergence, and corresponding growth in the derivatives market for freight. Traditionally, this was a market that was used by players in the physical freight market, such as shipowners, operators and trading houses, to hedge their risks although this is now changing rapidly with the increasing participation of investment banks, hedge funds and other traders that may not be involved in the underlying physical market. This has resulted in the commoditisation of the freight market. Nowadays, freight rates can be bought and sold like any other commodity, despite the fact that freight rates essentially represent the cost of providing the service of seaborne transportation and, hence, are not classified as a tangible commodity.

Overall, this has created a shipping environment where market participants are more aware of the risks they face and also try to explore avenues to hedge or manage those risks. For a ship-operator, the most important source of risk is freight rate risk. Freight rate risk refers to the variability in the earnings of a shipping company due to changes in freight rates and the importance of this risk factor stems from the fact that volatility in the freight market has a direct impact on the profitability of a shipping company. The focus of this chapter therefore is to introduce and analyse the derivative instruments that are used in the market to control freight rate risk. In particular we focus on managing freight rate risk using forward and option contracts. We describe the structure and functioning of the Forward Freight Agreement (FFA) market, the trading practices, documentation and types of contract used in the trades, applications and uses of FFAs for risk management as well as how to deal with issues such as basis risk.

We also discuss freight options and their use in risk management and speculation. First, we consider the properties of freight options and present the profit patterns from buying or selling call and put options; we also discuss the practicalities of trading freight options and then examine risk management applications of freight options using caps, floors and collars. Finally, we also discuss the topic of options pricing and the different approaches that are currently used in the market.

It should be stressed that the emphasis on freight rate risk management in this chapter is on the tramp sector of the industry. Risk management techniques are markedly different across the liner and tramp shipping sector due to the unique characteristics of each one of those sectors. For example, while freight rates in tramp shipping are determined through the interaction of supply and demand for shipping services in a nearly perfect market, freight rates in the liner sectors are determined through "conferences" and "alliances" which are reviewed only periodically (see Stopford[1] and McConville[2]). As a result, liner rates are less volatile compared to rates in tramp shipping and therefore the approach

toward risk management used by liner operators is markedly different.[3]

The structure of this chapter is as follows. In the next section we present a historical overview of the freight derivatives market. In section 3 we discuss the FFA market, the practicalities of using FFAs for risk management and how to deal with the issue of basis risk. Section 4 presents the freight options market, how to use options for risk management and how to price freight options. Finally, section 5 concludes this chapter.

2. Historical Overview of the Freight Derivatives Market

The benefits of providing a futures market in freight rates had been recognised by shipping market practitioners as early as the 1960s (Gray[4]). However, such a market was eventually established only in 1985. The reason is that the underlying asset of the market – the service of seaborne transportation – is not a physical asset which can be delivered at the expiry of the futures contract; by its very definition, a futures contract is an agreement to deliver a specified quantity and grade of an identified asset, at a certain time in the future. This obstacle was overcome with the introduction of the cash settlement procedure for stock index futures contracts in 1982; when the underlying asset is not suitable for actual physical delivery then an alternative is to deliver the cash value of the asset at that time.

This innovation led to the development of the first exchange traded freight futures contract. Trading on the Baltic International Freight Futures Exchange (BIFFEX) contract commenced on 1 May 1985. The contract was traded at the London Commodity Exchange, which is now part of Euronext.LIFFE Exchange in London; the underlying asset of the contract was the Baltic Freight Index (BFI), a freight index that initially consisted of 13 voyage routes covering a variety of cargoes ranging from 14,000 metric tons (mt) of fertiliser up to 120,000 mt of coal. It quickly won worldwide acceptance as the most reliable general indicator of movements in the dry cargo freight market. Over the years, the constituent routes of that original index have been refined to meet the ever increasing and changing needs of the freight derivative markets. Trip-charter routes were added to the index and gradually, handysize and capesize routes were excluded from the index. As a result, in November 1999, the Baltic Panamax Index (BPI) superseded the BFI as the underlying asset of the BIFFEX contract.[5]

The asset which was delivered at the settlement date of the futures contract was the cash equivalent of the general level of the freight market at that time as represented by the level of the BFI. The settlement price was computed as the average value of the index over the last seven trading days of each contract month and the monetary value of the settlement price was $10 per index point. The introduction of the BIFFEX contract gave, for the first time, the opportunity to shipping market agents to control their freight rate risk in the physical market, through hedging. This was an entirely “paper” financial transaction and no real ships or cargoes were involved. Additionally, through the price-discovery function, futures prices could also help reveal information about expected spot prices and, hence, provide valuable signals to market agents regarding the likely future direction of freight rates in the markets; this was shown empirically by Nomikos[6] and Kavussanos and Nomikos.[6–8] Although the BIFFEX contract was quite innovative at its time, it quickly became apparent that the heterogeneous composition of the underlying index, affected dramatically the performance of hedges in the market. This was due to the fact that futures prices did not capture accurately the fluctuations on the individual routes that comprised the BFI but, rather, followed the movements of the BFI itself. Effectively therefore, hedging on BIFFEX was like a cross-hedge.

Unlike other futures markets, in which futures contracts are used as a hedge against price fluctuations in the underlying asset, in the BIFFEX market futures contracts are employed as a cross-hedge against freight rate fluctuations on the individual shipping routes which constitute the BFI. As such, there is the risk that fluctuations on these routes may not be accurately tracked by the futures prices, thus, reducing the effectiveness of the contract as a hedging instrument. Cross-hedging freight rate risk using an index-based futures contract is only successful when the freight rate and the futures price move together. However, when a large number of underlying routes constitute an index, then the relationship between these routes and the index will not be very strong. Therefore, BIFFEX market participants, who use the contract to hedge their freight rate risk on specific shipping routes, have small gains in terms of risk reduction. In a series of studies, Nomikos[6] and Nomikos and Kavussanos[10,11] have shown that the hedging effectiveness of the BIFFEX contract varies from 19.2 to 4% across the different shipping routes which constitute the underlying index. This is well below the risk reduction evidenced in other commodity and financial markets which ranges from 70–99%.

The poor hedging performance of the contract is also thought to be the primary reason for the low trading activity evidenced in the market. Figure 1 presents the volume of trade for the BIFFEX contract, for the period from 1994–2002. Over the period from February 1996 to June 2000, the average daily trading volume in the market was only 146 contracts. The daily monetary value of these contracts roughly corresponds to the average freight cost of transporting 108,000 tonnes of Grain from the US Gulf to Japan; market sources estimate that this level of futures trading activity corresponds to only 10% of the total physical activity in the dry-bulk shipping market, during the same period. As a result of the lack of trading interest in the market, the BIFFEX contract was eventually de-listed in April 2002.

The reduction in the trading activity of the BIFFEX contract after the mid-1990s was also due to the development of an over-the counter forward market for shipping freight called Forward Freight Agreements (FFA), which are cash-settled against an underlying shipping route. Because of the fact that these contracts are traded against specific routes, rather than a general index, they also eliminate the problem of basis risk,

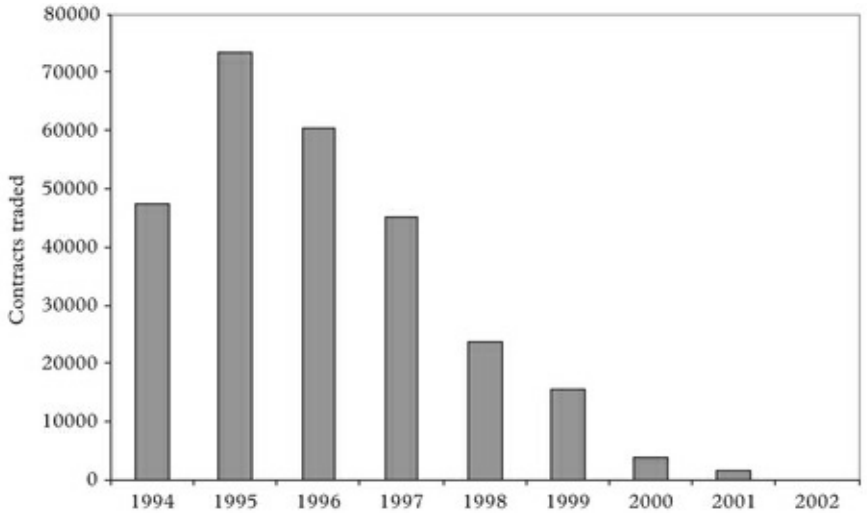


Figure 1: BIFFEX trading volume (1994–2002)

Source: Euronext.LIFFE. Each contract trades the expected value of the BFI. The value of each contract is $10 per index point.

evidenced in the BIFFEX market. The mechanics of the FFA contracts are described in the next

section.

3. Forward Freight Agreements

From the early 1990s a new market for trading the forward value of freight emerged, primarily as a response to the needs of market players who were aware of the deficiencies of the BIFFEX contract as a hedging instrument and wanted a hedging tool which would provide a more precise match to their exposure in the physical market and, hence, a more accurate hedging mechanism. A Forward Freight Agreement (FFA) is an agreement between two counterparties to settle a freight rate or hire rate, for a specified quantity of cargo or type of vessel, for one of the major shipping routes in the dry-bulk or the tanker markets at a certain date in the future. The underlying asset of the FFA contracts can be any of the routes or basket of routes which constitute the indices produced by the Baltic Exchange, or by other reputable providers of underlying market information, such as Platts.

Currently, the Baltic Exchange produces a wide range of shipping indices covering different vessel sizes and different cargo types, such as the Baltic Panamax Index (BPI), which reflects freight rates for Panamax vessels of 74,000 metric tonnes (mt) dead-weight (dwt); the Baltic Capesize Index (BCI) – for capesize vessels of 172,000 mt dwt; the Baltic Supramax Index (BSI) – for Supramax size vessels of 52,000 mt dwt; and the Baltic Handysize Index (BHI) – for Handysize vessels of 28,000 mt dwt. In addition, there are indices covering the movement of tanker cargoes: The Baltic Clean tanker Index (BCTI) and Baltic Dirty Tanker Index (BDTI). The current composition of the BPI is presented in Table 1. We can see that the index consists of four trip-charter routes; Route P1A_03 is the trans-Atlantic route for a voyage across the Atlantic; the charterer takes delivery of the vessel in the continent in the range between Cape Skaw (in North Continent) and Gibraltar; the vessel will go across the Atlantic to either US Gulf, East Coast South America or East Coast North America for transportation of cargoes back to the Continent, where the vessel will be re-delivered. Similarly, Route P2A_03 is the trip out to the Far East. The vessel is delivered in the Continent to perform a voyage to the Far East for redelivery in the region between Taiwan and Japan. Route P3A_03 is the Trans-Pacific panamax route where the vessel is delivered in the range between Japan and South Korea for a voyage to load cargo in Australia or North Pacific and then redeliver the vessel to the same region. Finally, route P4_03 is the return leg of Route P2A_03 where the panamax vessel is delivered in the Far East for a voyage to the continent via the West Coast of US. All these trip-charter routes are estimated on the basis that the trip is performed by a standard “Baltic Panamax” vessel, the particulars of which are presented in Table 1.[12]

FFAs are settled in cash on the difference between the contract price and an appropriate settlement price. The settlement rate is usually calculated as the average of the underlying route over the settlement month, although there are some exceptions to that general rule.[13] The calculation of an average settlement rate is used in order to ensure

Table 1: Baltic Panamax Index route definitions

Route number	Description	Weighting
P1A_03	Delivery Skaw–Gibraltar range for a Trans-Atlantic round voyage (including ECSA), redelivery Skaw–Gibraltar range. Duration 45–60 days.	25%
P2A_03	Delivery Skaw–Gibraltar for a trip to the Far East, redelivery Taiwan–Japan range. Duration 60–65 days.	25%
P3A_03	Delivery Japan–South Korea for a trans-Pacific round voyage, either via Australia or NOPAC, redelivery Japan–South Korea range. Duration 35–50 days.	25%
P4_03	Delivery Japan–South Korea for a trip to the Continent (via US West Coast–British Columbia range), redelivery Skaw–Gibraltar range. Duration 50–60 days.	25%

Notes:
- This table presents the definitions of the Baltic Panamax Index routes as of January 2010.
- ECSA stands for East Coast South America; NOPAC stands for North Pacific.
- Routes 1A_03, 2A_03, 3A_03 and 4_03 are based on a "Baltic Panamax" vessel of the following specifications: 74,000 mt dwt vessel, not over seven years of age with a cargo carrying capacity of 89,000 cbm grain. Max LOA 225 m and max draft 13.95 m; the vessel is capable of about 14 knots on 32 mt/day fuel oil when laden and 28 mt/day fuel oil when in ballast, with no diesel consumption whilst at sea.

Source: The Baltic Exchange

Figure 2: Spot, 1st, 2nd and 3rd quarter FFA rates for BPI 4TC
Source: The Baltic Exchange

that settlement rates are not susceptible to large moves due to very high volatility or market manipulation on any specific trading day. Although trades are possible for every route published in the market, there seems to be a tendency for trades to concentrate on certain routes only. For instance, in the Panamax market the majority of the trades are on the BPI four TC average, which is the equally weighted average of the four TC routes of the BPI.

Figures 2 and 3 present the spot and FFA rates for the first three quarters for the average of the four trip-charter routes of BPI and BCI, respectively. The graphs cover the period from March 2005 to January 2010. We can note that there is a strong degree of co-movement between the spot and FFA rates. The strength of the relationship is also evident during the collapse of the market in the fourth quarter of 2008 when freight rates for Capesize vessels dropped from a peak of 240,000 US$/day in July to a rate of less than 5,000 US$/day in November. We can see that during that period FFA rates followed the spot market very closely. Finally, we can also note that as we move from the spot to the

forward rates, the forward rates appear to be less volatile than the spot rates, which is indicative of a volatility term structure pattern in the forward rates.

The FFA market has evidenced considerable growth over the period from 2005 to 2008 as a result of the surge in freight rates, particularly in the dry sector, which also resulted in an increase in the use of freight derivatives for risk management purposes. Market volatility has also generated trading interest from players outside of the shipping markets; therefore, over the recent years we evidenced an influx of new participants in this market such as investment banks and hedge funds. Figure 4 presents the volume of trades in the FFA market for the period 1997 to 2009; these figures are

Figure 3: Spot, 1st, 2nd and 3rd quarter FFA rates for BCI 4TC
Source: The Baltic Exchange

estimates provided by the London-based FFA broker Freight Investor Services (FIS) (until 2007) and the Baltic Exchange (from 2007 onwards) and reflect the estimated number of lots which have been traded in the dry market; the market convention is to measure the volume of trades in terms of lots where one lot either represents 1,000 mt of cargo carried or one-day of trip-charter hire. From 2005 to 2008, the average annual growth in the FFA market was 10%. However, the sudden drop in freight rates during the fourth quarter of 2008 resulted in a corresponding reduction in the activity in the paper market. As a result, trading volume in the fourth quarter of 2008 was less than 15% of the total for the year; trading volume in 2009 also remained in low levels and was at half the level of trading in 2008, although the second half of the year saw an increase in trading interest, compared to the first half.

Since July 2007, information on the volume of trade has also been reported by the Baltic Exchange. This information is provided to the Baltic Exchange on a weekly basis by major international FFA brokers, Clearing Houses and Exchanges, and is then aggregated and reported to the market. In the dry sector, trading volume, defined as lots traded, is estimated for the Capesize, Panamax, Supramax and Handysize markets, and the trades are also classified as to whether they are cleared or not; as in the previous case, a dry lot is defined as either one trip-charter day or 1,000 tonnes of voyage-based ocean transportation. In each case a single transaction, although having a buyer and a seller, is counted only as one lot. Figure 5 presents the volume traded by contract type for 2009.

We can see that of the total volume, about 45% of the trades are on the Capesize market, 39% on Panamax, 10% on Supramax vessels and the remaining 6% in the

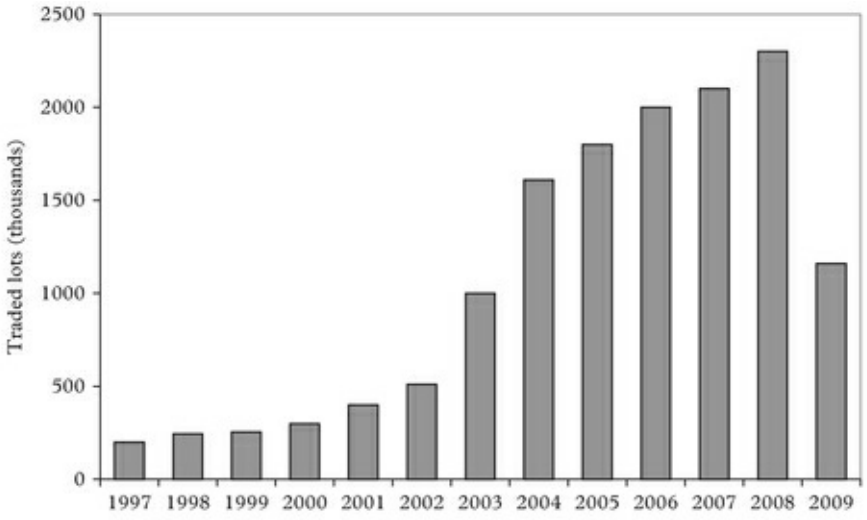
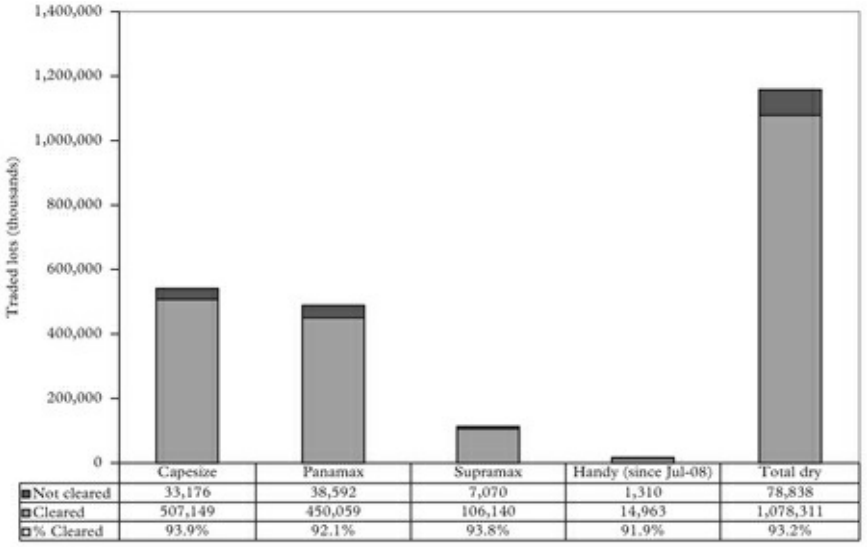


Figure 4: Estimated volume of trade in the dry FFA market

Note: Each lot corresponds to either 1,000 tons of cargo or one day of TC hire. *Source:* Freight Investor Services (FIS) and the Baltic Exchange. Reported figures are market estimates.



	Capesize	Panamax	Supramax	Handy (since Jul-08)	Total dry
Not cleared	33,176	38,592	7,070	1,310	78,838
Cleared	507,149	450,059	106,140	14,963	1,078,311
% Cleared	93.9%	92.1%	93.8%	91.9%	93.2%

Figure 5: Dry FFA trade volume for 2009

Source: The Baltic Exchange. Reported figures are market estimates provided by major FFA brokers and Exchanges. Each lot corresponds to either 1,000 tons of cargo or 1 day of TC hire.

Handysize sector. This pattern in the distribution of FFA trades amongst the different size vessels is not in line with the distribution of the world total fleet where currently 40% of the world trade is conducted by Handysize and Supramax vessels, 40% through Panamaxes and only 20% through Capesizes. The low volume in the Supramax and Handysize FFA sectors may be attributed to the fact that, for the smaller sizes, the underlying shipping market is more fragmented, with smaller trades not represented by the Baltic Indices, as opposed to the panamax and capesize sectors. Finally, it is also interesting to note that currently more than 90% of the contracts are cleared via one of the clearing houses. This increased considerably compared to 2008 and 2007, when the percentage of cleared contracts was only 40%, and reflects the tighter credit conditions that prevailed in the market in 2009.

3.1 How are forward freight agreements traded?

Forward Freight Agreements can be traded either over the-counter (OTC) or through an organised exchange such as the International Maritime Exchange (IMAREX), as shown in Figure 6. Trading in the OTC market, takes place though specialist FFA brokers via “traditional” telephone based broking. Trades can be either on the basis of a principal to principal contract between the two counterparties,

using one of the standard contract forms that are used in the market, such as FFABA 2007 or ISDA Master Agreement, or, alternatively, trades may be cleared through one of the clearing houses that provide services to the freight market, such as the London Clearing House (LCH.Clearnet), the Singapore Exchange (SGX) AsiaClear Service, the Norwegian Futures and Options Clearing House (NOS) or the New York Mercantile Exchange (NYMEX). In addition, FFAs can also be traded through a "hybrid" exchange, the most popular of which is the International Maritime Exchange (IMAREX);[14] IMAREX provide a trading screen where standardised contracts are traded, which are then

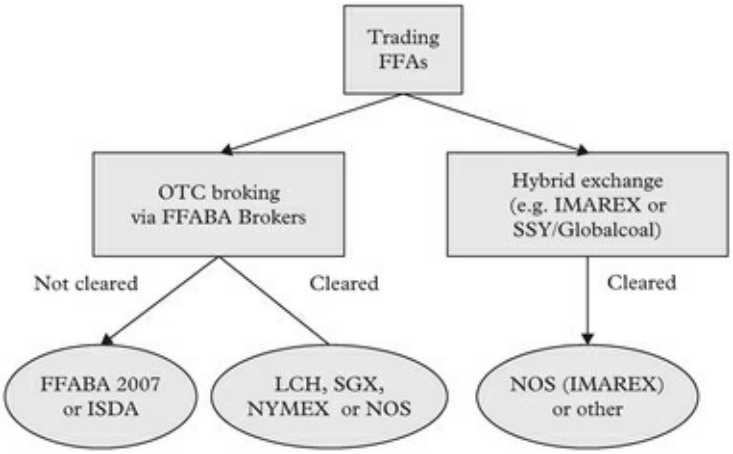


Figure 6: Trading structure of the FFA market
Source: Alizadeh and Nomikos[16]

cleared straight through NOS. A more detailed discussion of these trading options is presented in Alizadeh and Nomikos.[15]

3.2 Hedging using forward freight agreements

Market agents are confronted with risks that arise from the ordinary conduct of their businesses. Derivative markets provide a way in which these risks may be transferred to other individuals who are willing to bear them, through hedging. Hedges are either short or long. A *short* or *selling* hedge involves selling FFAs as a protection against an unexpected decline in freight rates; for instance, shipowners or ship operators who want to protect their freight income can sell FFAs – since when freight rates fall, the reduction in the freight income will be compensated through a gain in the forward position. A *long* or *buying* hedge, on the other hand, involves buying futures as a protection against a price increase. For instance charterers can buy FFAs; this enables them to protect their forward freight requirements, in case the physical market rises, thus forcing them to pay higher freight rates. FFAs were initially traded for risk management purposes by charterers and shipowners although, currently, they are also used for the purpose of speculating on the future direction of the freight markets. The following example illustrates the use of FFAs for hedging purposes.

3.3 Trip-charter hedge

This is an example where we consider the use of BPI FFA contracts to hedge panamax earnings for a period of six months. An owner operates a 65,000 mt dwt panamax vessel built in 1997. Currently, on 10 October 2005, the vessel is under a six-month time-charter for 22,000 $/day which will expire in three months, around the middle of January. Under the terms of the charter the vessel will be re-delivered to her owner at around 10–15 January 2006 in the Far East. The owner is worried about the possibility that the market may soften when the vessel will be open in the market and he, thus, decides to hedge the vessel's earnings for the first six months of 2006. Since he wants to hedge against the

volatility in the Panamax sector, the most appropriate strategy is to sell the four TC average of the BPI for Q1 and Q2 2006. Freight Investor Services (FIS) quote FFA rates of 21,750 $/day and 20,750 $/day for Q1 and Q2 2006, respectively, as shown in Table 2. Effectively each one of those contracts is a strip of three monthly

Table 2: Panamax 4TC FFA quotes on 10/10/05

Contract	FFA Rate ($/day)
Spot	22,762
Q4 05	23,825
Q1 06	21,750
Q2 06	20,750
Q3 and Q4 2006	17,775
Cal 06	19,550

Source: FIS

FFA, covering the respective quarter, at the given rate. He thus sells Q1 2006 at 21,750 $/day and Q2 2006 at 20,750 $/day which he holds until he can find suitable employment for his vessel. By selling the FFAs for January and February, the owner locks in a charter rate of 21,750 $/day for each day in January and February, which implies monthly earnings of $674,250 (=21,750 $/day* 31) for January and $609,000 (=21,750 $/day * 28) for February.

In order to illustrate how this hedging strategy can be implemented, we are going to consider two different variations regarding the owner's choices in the physical market. In the first case, the owner will be operating the vessel in the spot market and as he fixes a voyage he will be gradually unwinding some of his FFA positions; in the second case, the owner will fix his vessel on a period time-charter basis for the first six months of 2006 so that he will have to unwind his entire FFA portfolio at once. Consider each case next.

3.3.1 First case — Shipowner operates his vessel in the spot market

In the first case, the owner decides to operate the vessel in the spot market. He feels that the Pacific basin presents the most attractive employment opportunities, so he will be fixing the vessel for consecutive Trans-Pacific round voyages (i.e. route 3A of the BPI in Table 1) for the next six months. The first voyage is fixed at around the end of December 2005 for delivery to take place in the middle of January; the vessel will be chartered for a Trans-Pacific round voyage (route BPI 3A) for an estimated voyage duration of 47 days at around 16,500 $/day. In this case, the vessel is fixed approximately 15 days before the date it is actually delivered to the charterer, which corresponds to the laycan for that route.[16]

The owner has now secured employment for his vessel from the middle of January until the end of February (47 days) and, as a result, he no longer requires the hedging position for January and February. He thus unwinds the January 2006 and February 2006 contracts at a rate of 16,014 $/day and 16,276 $/day, respectively.[17] The outcome of this strategy is presented in Table 3. The hedging position is closed as soon as the owner has secured the next voyage for the vessel, at around the end of December 2005, and the FFA contracts for January and February are thus settled at 16,014 $/day and 16,276 $/day, respectively. For instance, for the January contract, this results in a profit of 5,736 $/day (=21,750 – 16,014) or a total profit of $177,816 (5,736 * 31) for the entire month of January. The vessel is then delivered to the charterer for the TransPacific round voyage at 16,500 $/day for a

voyage duration of 47 days resulting in trip earnings of $775,500, as shown in Panel B of Table 3.[18]

The vessel will be delivered back to her owner in early March, so the owner needs to make provisions for fixing her next voyage. Around the middle of February the vessel is fixed for another Trans-Pacific round voyage of 47 days for 18,500 $/day, for delivery in early March. Again, as soon as the owner has secured employment for his vessel for the next 47 days, he has to unwind his FFA positions for March and April. He thus settles his short March and April FFA contracts at a rate of $18,550 $/day and at 16,925 $/day, respectively, as shown in Table 3. Notice as well that by closing the April contract when he fixes the second voyage, the owner no longer has cover against freight rate changes for the second part of April. This can be important because the vessel will be open again after 18 April so the owner will be exposed to freight rate volatility for the period 18–30 April. One way round this, could be for the owner to close the

Table 3: Hedging Spot Panamax earnings using FFA

Panel A: FFA market							
FFA maturity	**Number of days**	**FFA rate ($/day)**	**Locked in monthly**	**Settlement**		**FFA P/L**	
				Date	**Rate ($/day)**	**Daily**	**Monthly**
January	31	21,750	$674,250	31 Dec 05	$16,014	$5,736	$177,816
February	28	21,750	$609,000	31 Dec 05	$16,276	$5,474	$153,272
March	31	21,750	$674,250	15 Feb 06	$18,550	$3,200	$99,200
April	30	20,750	$622,500	15 Feb 06	$16,925	$3,825	$114,750
May	31	20,750	$643,250	31 Mar 06	$17,533	$3,217	$99,727
June	30	20,750	$622,500	15 May 05	$20,945	–$195	–$5,850
Total paper			$3,845,750				$638,915
Panel B: Physical market							
Delivery	**Voyage duration**	**Freight rate ($/day)**					**Trip earnings**
13 Jan 06	47	16,500					$775,500
02 Mar 06	47	18,500					$869,500
18 Apr 06	44	16,000					$704,000
01 Jun 06	45	16,200					$729,000
Total physical	183						$3,078,000
Total paper and physical							$3,716,915

April contract later, when he fixes his third voyage; this of course would result in an uncovered or speculative short FFA position for the first part of April. Alternatively, the owner could settle half of his April contract (i.e. 15 days) when he fixes his second voyage and the remaining 15 days when he fixes his third voyage; this would provide a more accurate hedge but such a strategy could be hindered by the fact that liquidity in trading half months in the market is more limited.

Overall, by fixing his vessel spot, the owner would realise earnings of $3,078,000 for the first six months of 2006. Combining this with the total payoff from the FFA contracts, which is $638,915, results in a total income from the physical and the paper market of $3,716,915. Notice that the owner was aiming to lock in a total income of $3,845,750 for the first six months of 2006, when he entered the hedge back in October 2005. There is therefore a discrepancy of 3.4% between the expected and the actual freight income, which is the hedging error from implementing this strategy.

3.3.2 Second case — Shipowner charters his vessel for a period time charter of six months

In this case, the owner secures a period time-charter contract for the first six months of 2006. Therefore, around the end of December 2005 he fixes his vessel for a six-month time charter, with a duration of 183 days, for 15,500 $/day. At the same time, he offsets his FFA position by buying Q1 and Q2 06 contracts at a rate of 16,250 $/day and 15,500 $/day, respectively. Table 4 presents the outcome of this strategy. We can see that the six-month period time-charter provides earnings of $2,836,500; combined with the profit from the FFA position, this results in overall earnings of $3,809,250, which suggests a hedging error of 0.95% compared to the expected locked-in value.

Table 4: Hedging period time charter panamax earnings using FFA

Panel A: FFA market							
				Settlement		**FFA P/L**	
FFA maturity	**Number of days**	**FFA rate ($/day)**	**Locked in monthly**	**Date**	**Rate ($/day)**	**Daily**	**Monthly**
January	31	21,750	$674,250	31 Dec 05	$16,250	$5,500	$170,500
February	28	21,750	$609,000	31 Dec 05	$16,250	$5,500	$154,000
March	31	21,750	$674,250	31 Dec 05	$16,250	$5,500	$170,500
April	30	20,750	$622,500	31-Dec 05	$15,500	$5,250	$157,500
May	31	20,750	$643,250	31 Dec 05	$15,500	$5,250	$162,750
June	30	20,750	$622,500	31 Dec 05	$15,500	$5,250	$157,500
Total Paper			$3,845,750				$972,750
Panel B: Physical market							
Delivery	**Voyage duration**	**Freight rate ($/day)**					**Trip earnings**
13 Jan 06	183	15,500					$2,836,500
Total paper and physical							$3,809,250

Overall, we can note that the hedging strategy worked reasonably well with a relatively small hedging error. The magnitude of the hedging error and, hence, the effectiveness of a hedging strategy, depends on a number of factors, some of which include:

1. Timing mismatch between paper and physical contracts**:** paper contracts are settled at the end of each month, whereas fixtures in the physical market can be concluded any time in that period. Depending on the volatility of the underlying market this mismatch can have an important effect on the performance of the hedge; Alizadeh and Nomikos (see endnote 15) report this error to be as high as 17% for route 3A of the BPI.
2. Basis risk: basis risk arises due to the fact that the route underlying the FFA is different from the exposure that we have in the market. For instance, in the example presented here, we use BPI 4TC FFAs to hedge exposure on route P3A. Although one could use FFA on this route, the performance of the hedge could be affected by liquidity costs since FFAs on this route are less liquid than on the 4TC routes, particularly for longer maturities; basis risk is discussed more extensively in the next section.
3. Size mismatch: size mismatch could also cause basis risk when the vessel whose earnings we want to hedge is different from the reference vessel used in the calculation of the underlying rates. For instance, in this example we operate a eight-year old 65,000 mt dwt Panamax vessel, whereas the Baltic assessments are calculated on the basis of a 74,000 mt dwt “Baltic” Panamax type vessel, with a maximum age of seven years.
4. Relocation or non earning-day mismatch: this could arise if, for instance, the vessel is off-hire for some days during the six-month period; in this case there is a mismatch because the earnings period we hedge is actually different from the period over which we receive earnings from the operation of the vessel.

5. Liquidity Risk: finally, another type of risk that participants face in the market is liquidity risk. If liquidity in the market is low then, establishing a hedging position or unwinding a hedge will occur at a premium due to the nonavailability of counterparties to trade in the market at the specified rate. This can particularly be the case if one trades on routes where there is little trading interest, and also in cases when one trades at the far end of the forward curve where liquidity in general tends to be low.

3.4 Basis risk in the FFA market

Basis risk refers to the mismatch between the specification of the FFA contract and the exposure of the hedger in the physical market. Basis is defined as the difference between the spot and the forward or futures price for a commodity, at any point in time. For instance the basis for the BPI 4TC contract is the difference between the BPI 4TC spot Baltic Assessment and the BPI 4TC forward contract for a specific maturity; therefore, for each specific maturity we can have a different basis. Basis risk refers to the uncertainty about the level of the basis when a hedge is lifted and usually arises when the route we want to hedge is not exactly the same as the route underlying the futures contract or when we are uncertain as to the exact date on which a vessel is to be fixed, and we may have to close an FFA position before its expiry. In the latter case, the effectiveness of the hedge is somewhat reduced, because there is uncertainty about the level of the basis when the hedge is lifted.[19]

Basis risk also arises when there is a mismatch between the FFA contract and the exposure in the physical market. For instance this could arise when we use supramax FFAs to hedge exposure in the handysize sector; when using Panamax FFAs – which are based on a 74,000 mt dwt Panamax vessel – to hedge freight income on a 65,000 mt dwt Panamax vessel; or even using a basket of trip-charter routes, such as BPI 4TC, to hedge exposure on a specific panamax route, say route BPI 3A. In all these cases market participants could achieve better hedging results if they were to use the FFA which most closely matches their exposure in the market. However, this may not always be possible: for instance, when liquidity in the FFA market is low, as is the case for instance with the handysize FFAs; when the underlying physical route does not have a corresponding FFA market, as is the case particularly in the handysize market where the underlying physical base is highly fragmented and FFAs are available only for six representative trip-charter routes; finally, when the specification of the vessel we want to hedge is different from the representative “Baltic” type vessel used in the calculation of the indices. In all the above cases, there is a mismatch between the exposure of the hedger in the physical market and the forward contract that is used for hedging; and, as a result, the hedger will be exposed to a degree of basis risk.

In order to ensure that basis risk is minimised, there are two parameters which need to be considered. First, hedgers need to select an FFA route that has strong correlation with their exposure in the physical market and then use that FFA route to hedge their physical risk. The higher the correlation between the physical market and the FFA contract the lower the variability of the hedged cash flows and hence the more effective the hedge. Secondly, in order to implement the hedge effectively, the hedger also needs to calculate the ratio of the quantity or size of the FFAs to buy or sell to the size of the exposure in the physical market – which is known as the *hedge ratio*. In the hedging example we presented in the previous section, we implicitly used a hedge ratio of one; in other words, in order to hedge 1,000 mt of physical cargo we use 1,000 mt of FFAs, which is known as

a *one-to-one* or *naïve* hedge ratio (Ederington[20]). However, when the correlation between the FFA and the physical rate is imperfect, or when the level of the average freight rate is different between the physical and the FFA market, this ratio will have to be modified accordingly to take into account these differences. For instance, consider Figure 7 which presents the Baltic Handysize (BHSI) and Supramax (BSI) TC averages, as well as their ratio (measured on the right hand side axis). It is evident that there is a strong degree of co-movement between the two series, the correlation in levels between the two series being 98.5%. We can also note that the average BHSI/ BSI ratio is 70%; in other words, on overage, if the BSI increases by 1,000 $/day, it is expected that the BHSI will increase by 700 $/day. In addition, this ratio has been relatively constant during the period of investigation with a range of 10%, a maximum value of 77% and a minimum value of 67%.

Given that liquidity in the Handymax FFA market is relatively low, participants in the handysize market can use the much more liquid Supramax FFA market to hedge their exposure. In doing so they are exposed to basis risk and, since the average level of freight rates are different in the two markets as we can see in Figure 7, the use of an appropriate hedge ratio is required for this strategy to be effective. From the analysis presented here it seems that an appropriate hedge ratio is about 0.7 which suggests

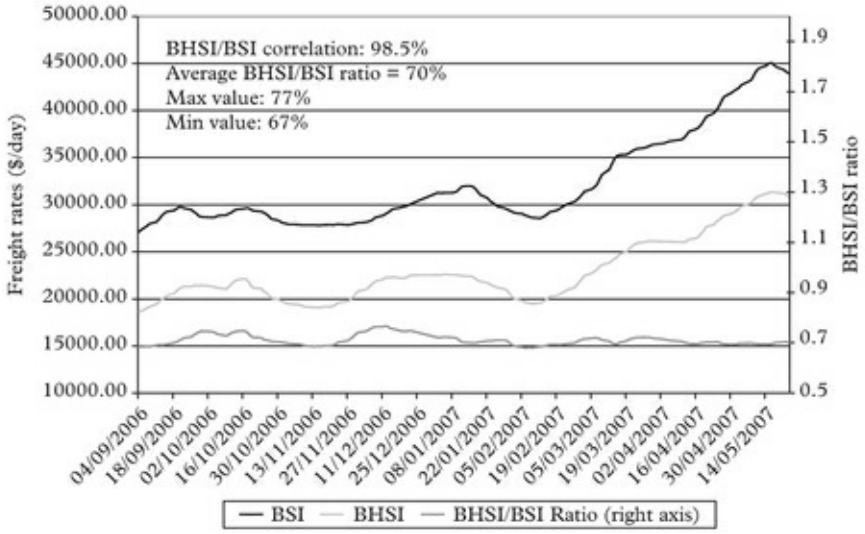


Figure 7: Baltic Handysize (BHSI) and Supramax (BSI) indices and their ratio
Source: Baltic Exchange

hedging the monthly BHSI exposure using 70% of a monthly BSI contract; this is equivalent to buying 0.70 * 30 = 21 days of the BSI contract.[21]

To illustrate how effective this strategy is, consider the case of Handysize operator in early September 2006, who wants to secure his freight income for the last quarter of 2006 (Q4 2006) and the first quarter of 2007 (Q1 07). In order to hedge his earnings from operating in the charter market for that period he sells **0.7** BSI 5TC FFAs for Q4 06 and Q1 07 at 30,500 and 26,000 $/day, respectively – which were the market rates at the time; in other words he sells 30 * 0.7 = 21 days of BSI 5TC contracts per month for each month of Q4 06 and Q1 07. This way he locks in a freight income of 21,350 $/ day (=30,500 * 0.7) and 18,200 $/day (=26,000 * 0.7) for Q4 06 and Q1 07, respectively. Table 5 presents the outcome of this hedge. The first two columns present the settlement rates, calculated as the monthly averages of the BHI and BHSI spot rates for each maturity month. The following two columns present the Profit or Loss from the FFA position. For instance, the owner sold the BSI 5TC October contract at 30,500 $/day and the settlement rate is 29,018 $/day resulting

therefore in a profit of 1,482 $/ day per contract or a total profit of 31,112 (=1,482 * 21) for the entire 21-day position. Therefore for the entire monthly hedge, this translates into an equivalent value of 1,037 $/day (=31,112/30) for the Handysize hedge. Consequently, the total income from the operation in the physical market plus the income from the FFA position is 22,185 $/ day (=21,148 + 1,037); since the locked value was 21,350 $/day, the deviation of the hedged position from the locked value is 3.84% (=22,185/21,350 − 1).[22] If we repeat this process for the remaining maturities, we can see that overall the deviation from the locked value remains at low levels and the maximum deviation in any given month is only 7.07%.

Table 5: Outcome of the BSI/BHSI hedge for Q4 06 & Q1 07 using hedge ratio of 0.7

Sold	0.7 Q4 06 BSI @ 30,500 to lock in an equivalent BHSI rate of 21,350 $/day for Q4 06					
Sold	0.7 Q1 07 BSI @ 26,000 to lock in an equivalent BHSI rate of 18,200 $/day for Q1 07					
	Settlement rates		**P&L**		**Hedged position**	
	(Monthly average)		**per contract sold**	**Total for 21 contracts**	**Hedged TC**	**Deviation from locked value**
	BSI	**BHSI**	**($/day)**	**($)**	**($/day)**	
Oct	29,018	21,148	1,482	31,112	22,185	3.84%
Nov	27,889	19,466	2,611	54,824	21,293	–0.27%
Dec	29,068	21,911	1,432	30,080	22,914	7.07%
Jan	30,936	21,958	–4,936	–103,657	18,503	1.65%
Feb	29,349	20,265	–3,349	–70,325	17,921	–1.55%
Mar	34,404	24,537	–8,404	–176,474	18,655	2.47%

Overall, this strategy seems to have been quite effective which is due to the fact that the correlation between the two routes is quite strong and the strength of this relationship does not change over the examination period; this is also evident by the fact that the ratio between the two routes remains almost constant at a level of 70% which is perhaps the most important factor in guaranteeing the success of this strategy.

For other routes it could be the case that correlations are less favourable, in which case the hedge ratios will need to be modified accordingly and alternative techniques for their estimation will have to be used, such as the Minimum Variance Hedge Ratio (MVHR). This is estimated as the ratio of the covariance between spot and FFA price changes (returns) over the unconditional variance of FFA price returns, as follows:

$$\gamma^{\star} = \frac{\mathrm{Cov}(\Delta S_t, \Delta F_t)}{\mathrm{Var}(\Delta F_t)} \qquad (1)$$

The MVHR is the hedge ratio that minimises the risk of a given position in the physical market (see endnote 20). Applications of this methodology in the freight futures (BIFFEX) market by Nomikos (see endnote 6) and Kavussanos and Nomikos (see endnotes 10,11) have shown that hedgers can achieve greater risk reduction by using the MVHR compared to a hedge ratio of 1.0. An extension of that approach is to estimate time-varying hedge ratios (TVHR). This procedure involves re-estimating the MVHR at frequent intervals, and re-adjusting the position in the forward market accordingly, as shown by Kroner and Sultan[23] and applied in the freight futures market by Kavussanos and Nomikos (see endnotes 10, 11) using Multivariate GARCH models. The motivation behind this process is the

fact that the variance and covariance between spot and FFA prices are time-varying and, consequently, the hedge ratios estimated through equation (1) should also be time-varying. Although theoretically the use of TVHR may improve the hedging results even further, in practice its implementation in the market presents some difficulties most notably the fact that it requires market participants to be able to buy or sell FFAs in smaller quantities than full cargoes. Also, since this strategy requires frequent rebalancing of the FFA position, the level of transaction costs should be considered which may consequently reduce the effectiveness of this strategy.

4. Options on Freight Rates

As we have seen in the previous section, the use of FFA as a trading and speculative instrument has been increasing on a constant basis since their introduction in the early 1990s. As the market grows and becomes more mature, market participants also look at ways of exploring the usefulness of other derivatives instruments, most notably options. Although FFAs provide reasonable hedging effectiveness and enable participants to lock in a given freight rate over a period of time, they lack the flexibility that would enable their users to maintain the hedge, if the market moves against them, and to be able to participate in the market when market conditions are favourable. Option contracts, on the other hand, offer this flexibility. Freight options are traded as OTC instruments, in the same fashion as FFAs, and over the recent years they have become more popular with shipping market practitioners. Shipping freight options were first introduced in 1990 when trading options on BIFFEX started. Like the BIFFEX contracts itself, however, trading on these options never picked-up and eventually, they were de-listed in April 2002. Therefore, in this section, we discuss freight options, their use in risk management as well as the techniques that are used for their pricing.

4.1 A primer on freight options

There are two types of option contracts: call options and put options. A *call* option is a contract, which gives its holder (or buyer) the right, but not the obligation, to buy an underlying asset (e.g. freight rate) from the seller (or *writer*) of the call option at a certain price, known as the *strike price* or *exercise price* and, at a certain point in time, known as the expiration date or the *maturity*. On the other hand, a *put* option gives its holder the right, but not the obligation, to sell an underlying asset to the writer of the put option at a certain strike price and at the expiration date. In order to have such a right, the buyer of the option pays a *premium* to the writer of the option. The premium is also known as the option price. Option contracts are also classified according to the date on which they can be exercised: a *European* option can only be exercised at the maturity of the option; an *American* option can be exercised at any time during the life of the option, including the maturity. Options give their holders the flexibility of buying or selling an underlying asset at a certain pre-specified price during – or at a certain – period. This is important as the holder is under no obligation to settle the contract, in contrast to futures, forward and swap contracts; whereas the writer is obliged to transact if the holder decides to do so.

Table 6 presents the option premia (in Worldscale points – WS) for call and put options written on route TD3 of the BDTI (260,000 mt of Crude oil from Persian Gulf to Japan) from Imarex, across three different maturities and three different strike

Table 6: Imarex option quotes for TD3 route on 23/08/2005

Strike price	Calls			Puts		
	Sep 05	Oct 05	Nov 05	Sep 05	Oct 05	Nov 05
70	14.4	15.3	20.1	3.4	9.2	13.4
80	8.9	11.0	15.9	7.8	14.8	19.1
90	5.2	7.8	12.5	14.1	21.6	25.7

Source: Imarex

prices. Consider, for instance, the September 2005 Call option with a strike price of 80 WS. The buyer of this option has the right, but not the obligation, to buy (settle) the freight rate for TD3, at the end of September 2005, as the difference between the strike price and the average of TD3 in September. For instance, if the average TD3 rate in September is 90 WS, the buyer of the option will exercise the option and receive 10 WS points per contract. If, on the other hand, the market goes down and the average freight rate is, say, 70 WS points, the option holder will let the option expire worthless, forfeits the premium, and will fix in the spot market at a reduced rate of 70 WS. Therefore, the holder of a call option essentially has the same positive payoff as a long FFA contract on TD3 but without the downside if the spot rate goes below the strike price. The payoff of the call option can, thus, be described mathematically as:

$$\text{Payoff} = \max(0, S_{ave} - X) \qquad (2)$$

Where S_{ave} is the average spot freight rate and X is the strike price. These options which are settled using the average freight rate over the settlement month, instead of the freight rate on the last day of the month, are called Average Price or *Asian* options.

In order to buy the contract, the option buyer has to pay the option premium of 8.9 WS points per ton of cargo to be hedged, upfront on 23/08/2005; assuming a flat rate for TD3 of 12.15 $/mt, the total premium is: $281,151(= 12.15 * 8.9/100 * 260,000). The payoff of the strategy is shown in Figure 8, Panel (a). We can see that if the freight

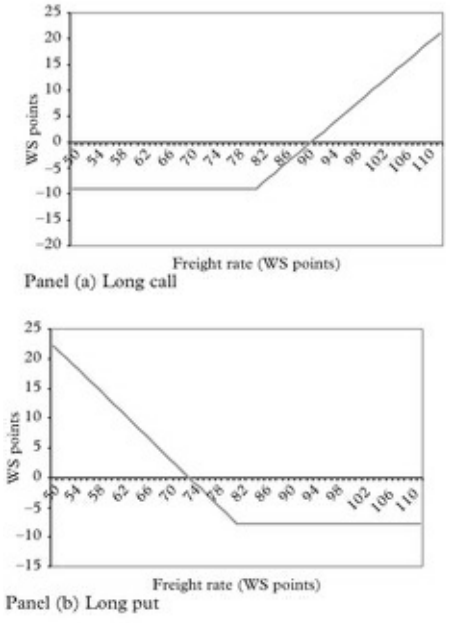


Figure 8: Long call and put option payoffs

rate at expiry is less than 80 WS points, the option expires worthless and the call option buyer loses the premium. If the average freight rate in September is more than 80, then the option is exercised and

for every WS point increase of the freight rates in the market, the call option buyer makes a corresponding WS point profit in the payoff, as shown by the 45° degree line on the payoff diagram; the option is settled in cash and the option buyer thus receives the difference, in cash, between the exercise price and the settlement price multiplied by the WS flat rate and the contract size.[24] Finally, for the option buyer to recover the cost of buying the option, the underlying market (TD3 rates) must rise above 88.9 WS points, which is the strike price plus the cost of the option premium, i.e. the break-even rate for the option.

Consider next the September 2005 put option with a strike price of 80 WS. The buyer of this option has the right but not the obligation, to "sell" or short TD3 freight rate at the end of September 2005. For instance, if the average TD3 rate in September is 70 WS, the buyer of the put will exercise the option and receive 10 WS points per contract. If, on the other hand, the freight rate increases to 90 WS points, then the option holder will let the option expire worthless in the market, as shown in Figure 8, panel (b). The payoff of the put option can thus be described mathematically as:

$$\text{Payoff} = \max(0, X - S_{ave}) \qquad (3)$$

Similarly, we can construct the payoff profiles for a short call or short put option contract. There are two parties for every option contract; the buyer (or long), and the writer (or short). This also implies that the buyer's and seller's payoffs from entering into an option agreement are reversed. In this case, the payoff of the short call is – min (0, $S_{ave} - X$) and is shown in Figure 9, panel (a). We can see that if the call option is not exercised, the option seller keeps the option premium which is also the maximum profit he can make by selling the option. However, if the option is exercised, then the seller of the option is obliged to transact at the price specified by the contract and this potentially may lead to very large losses. This, therefore, implies that the position of an option seller can be very risky due to potentially large and unbounded losses. This is also the reason why traditionally in the OTC market, there tends to be a larger number of option buyers than sellers. In addition, the very risky profile of a short option position also means that traders need to somehow hedge their exposure.[25] Finally, Figure 9 panel (b) presents that payoff profile of a short put option.

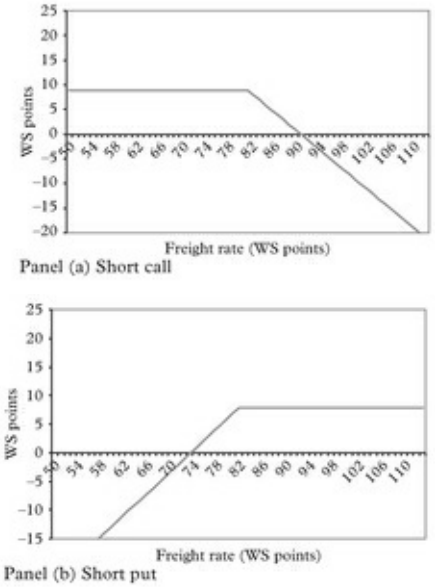


Figure 9: Short call and put option payoffs

4.2 Practicalities of trading options in the freight market

Freight options are traded in a similar way that the underlying FFAs are transacted and with similar maturities. Buyers and sellers of options agree on a strike price, and then negotiate a premium. The premium is quoted in $/day for trip-charter routes, in $/tonne for voyage routes and in WS points for tanker routes. Option contracts are executed between two counterparties through a broker, either as an OTC contract, or cleared through a clearing house (e.g. NOS, or LCH.Clearnet). In addition, freight options on certain routes are also available for trading through the IMAREX screen.

For options traded in the OTC market, the option premium is payable by the option buyer within five business days after the confirmation of the trade. At the settlement of the option, which is the last day of the maturity month, if the option expires ITM then, the option seller will have to pay the settlement sum to the option buyer within five business days following the settlement date. The broker in an OTC option trade will receive commission which is agreed in advance with the principals, and is typically 5% of the option premium. The contract documentation choices for freight options are similar to those available for the FFA market. There is a separate FFABA contract for trading freight options, known as the FFABA 2007 Freight Option Agreement. The contract is similar to the FFABA 2007 FFA contract, with some additional clauses which are specific to freight options trading. Options may also be cleared through a clearing house (e.g. LCH.Clearnet or NOS). For the option buyer, the maximum loss is the amount of premium paid which, as discussed earlier, will have to be paid within five business days after the option agreement. Since this is the maximum loss for a buyer, he is not required to maintain a margin and his position will not be marked to market. The option seller, on the other hand, will have to deposit in his clearing account the amount of premium that he receives and then the short option position will be marked-to-market accordingly.

4.3 Risk management strategies using options

Due to their flexibility and asymmetric risk profile, options are very effective hedging instruments since they enable hedgers to be covered on the downside, and participate in the market, on the upside. Hedging positions can be established by entering into long call or put option contracts. For instance, a shipowner who wants to protect his freight income against a decline in freight rates will be buying put options; in this case if freight rates decrease then the put option will expire in-the-money and will compensate the owner for the decline in freight rates and loss of earnings in the physical market. Similarly, a charterer who wants protection against an increase in the cost of transportation will be buying call options. The profile of these positions is shown in Figure 10, panels (a) and (b), respectively.

Consider for instance the shipowner's hedge. The shipowner is long on freight so his risk is that freight rates in the market may fall. Assuming that he does not want his freight income for September to fall far below 80 WS, he buys a September TD3 put with a strike price of 80, paying 7.8 WS premium. If he combines the long freight with the long put position, the payoff will be similar to a long call as shown in panel (a). This essentially means that if the freight rate in the market is below the strike price of 80 WS points in September, the option will be exercised and, as a result, the owner's income will remain at 80 WS points less the premium of 7.8 WS. Therefore, in this case the

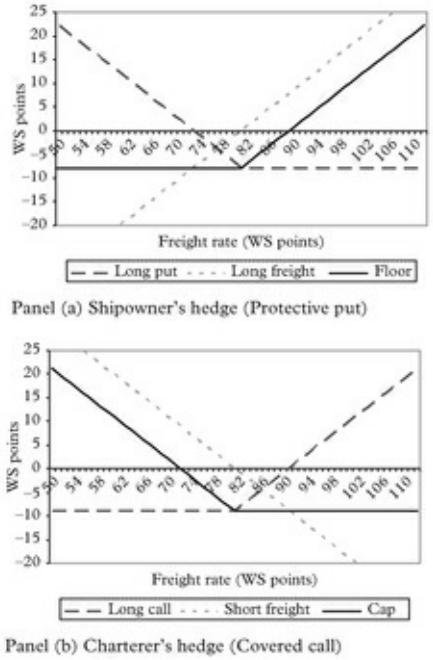


Figure 10: Hedging positions using long calls and puts

owner has created a floor at 72.8 WS. On the other hand, if freight rates in the market increase above the level of the strike price the put option will expire out-of-the-money and the owner will be able to take advantage of the higher freight rates in the market. In any case, his effective freight rate will be reduced by the level of the option premium, of 7.8 WS points, that he paid in order to buy the put. This strategy is also called a *protective put*.

Similarly, a charterer who is short physical freight can hedge his freight exposure using a long call position. Combination of the charterer's short freight with the long call position results in a payoff that looks like a put option as shown in Figure 10, Panel (b). In this case, the maximum freight cost will be the strike price plus the cost of the option premium; if the option expires OTM then the charterer will take advantage of the lower rates in the market. This strategy is also called a *covered call*. We can see therefore, that in both cases the long call or put positions are very similar to an insurance policy. The hedger pays the insurance premium upfront; if the option expires ITM, the insurance policy will indemnify the hedger. If, on the other hand, the market moves in favour of the hedger the option is not exercised and expires worthless. Therefore, the maximum loss is limited to the insurance premium; in this case, the hedger can take advantage of the more favourable conditions in the spot market.

In the previous examples we considered the long call and long put positions. It is also interesting to examine the positions that the sellers of these options would have. These are shown in Figure 11. Consider for instance Panel (a); an individual who sells a call option will be exposed to unbounded losses if the underlying market rises. He therefore, has to *cover* this potentially risky position by owning the underlying asset; hence the name *writing covered call*.[26] In the case of freight, this essentially means that the seller of the call should have a long position in the underlying freight route, either by holding tonnage or by having a long FFA, to cover the potential exercise of the option. "Covered" therefore means that the call seller owns the underlying asset which he can deliver, if the call is exercised, without incurring any further cost – apart from an opportunity cost in delivering it for less than the market price. Similarly, a short put position can be protected using a short freight position; i.e. by selling FFA; this strategy is known as *writing protective put*.

The above strategies can also be used to enhance the return of a given position. Generally, call options sellers would prefer to sell OTM calls. A call being OTM means

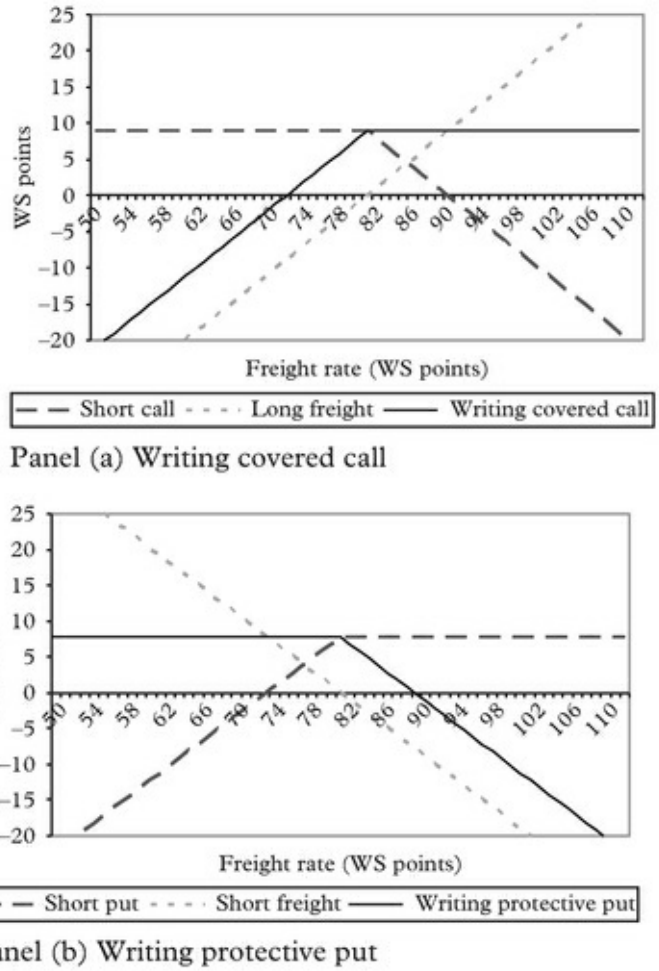


Figure 11: Writing covered and protective positions

that the price of the underlying asset must rise before the call is exercised against the seller; thus, the seller of an OTM call receives the premium, which is his maximum profit, along with some potential for profit from the underlying. For instance, consider again the case presented in Figure 11, Panel (a). Assume that a trader has bought an FFA contract at say, 80 WS points. He also has a subjective, maximum return that he would like to make on this position; this would depend on his risk-return profile and on his expected return on the market and, of course, is subjective and varies from trader to trader. In this example, we assume that the trader is happy to sell the FFA at say 100 WS points and thus realise a "maximum" desired gain of 20 WS points. He can then sell an OTM call option with a strike price of 100 WS points. In doing so he receives the option premium which enhances the return on his investment. If the market rises above 100 WS points, then the call option will be exercised and his profit will be capped to 20 WS points plus the option premium he received upfront. Therefore, in following this strategy, the investor has "enhanced" the yield of his investment; however, it should be noted that what is being enhanced is not the objective risk return characteristics but, instead, the *subjective* expected returns of the investor. These strategies are also called *yield enhancement* or *call overwriting* strategies and are frequently used by investors, particularly in stagnant markets, to enhance the yield on their investment. (see also Hull [27] and Neftci[28]).

4.3.1 Hedging example using options

Consider the following hedging example illustrating the use of Options on FFAs. It is late August 2005 and an oil trading company has sold a VLCC cargo of crude oil (2 million barrels or

approximately 260,000mt) to receivers in the Far East, for shipment in November. Shipment will take place in late November and under the sale agreement, the seller of the cargo will be responsible for paying the transportation costs; the cargo will be shipped from Persian Gulf to the Far East. The trading house is therefore worried over its exposure to freight risk since an appreciation in freight rates over the coming months will increase the transportation costs.

In an effort to control the freight rate costs, the charterer considers the use of freight derivatives. He could use FFA to "lock" in a certain freight cost, however, he is concerned that such an approach is inflexible and does not enable him to take advantage of a potential fall in freight rates. For that he decides to buy an October 2005 call option for route TD3 of the BDTI (260,000 tons crude from the Gulf to Japan); the choice of the October contract is due to the fact that the *laycan* for the route is 30–40 days ahead of the index, so the settlement in October reflects cargo liftings at the end of November. His broker advises him that there is a counterparty willing to "write" him an October 2005 call option with a strike price of 90 WS at a premium of 7.8 WS points. Therefore, the total premium that the trader will pay to the seller of the call is 7.8/100 * 260,000 * 12.15 = $ 246,402. In addition, the owner will have to pay a brokers commission which is 5% of the total option premium paid, (i.e. $12,320).

Table 7 presents the outcome of this hedge under two different scenarios. In the first case, the average freight rate in October is below the strike price; in this case, the option expires OTM and is not exercised so the trader takes advantage of the lower freight rates in the market. On the other hand, if the freight market increases to say, 110 WS points, the option expires ITM and the total freight cost is then capped to 90 WS points plus the cost of the option premium (i.e. 97.8 WS points or a total of $3,089,502) irrespective of how far above the strike price, the level of freight rates in the market is.

Therefore, options are a flexible hedging instrument since they enable the charterer to lock in a specific rate when freight rates increase, and to fix his vessels at the prevailing spot rate when freight rates decrease. More specifically, if the spot rate is greater than the strike price at the expiration of the call option, then the option is exercised

Table 7: An example of hedging freight rates using freight rate options

TD3 Call Option Hedge	
Physical market	**Options market**
August 2005	
TD3 Freight Rate : 70 WS points Freight Cost: $2,211,300 (= 70/100 * 12.15 * 260,000)	Option Details: October 2005 Call with a strike Price of 90 WS. Premium: 7.8 WS points
Charterer **buys** October 2005 call at a total cost of $246,402 (=7.8/100*12.15*260,000)	
31 October 2005 – falling market	
Average TD3 in October: 75 WS points Actual Freight Cost : $2,369,250 (= 75/100 * 12.15 * 260,000)	Strike Price (90) > Spot Price (75) Therefore Option is not exercised
Total Freight Cost (including option premium) = $2,615,652 (=$2,369,250 + 246,402) or 82.8 WS	
31 October 2005 – alternative scenario – rising market	
Average TD3 in October: 110 WS points Actual Freight Cost : $3,474,900 (= 110/100 * 12.15 * 260,000)	Strike Price (90) < Spot Price (110) Therefore Option is exercised Payoff from the Options Transaction (110 – 90) *260,000*12.15 – 246,402 = $ 385,398
Total freight cost (including option premium) = $ 3,474,900 – 385,398 = $3,089,502 or 97.8 WS	

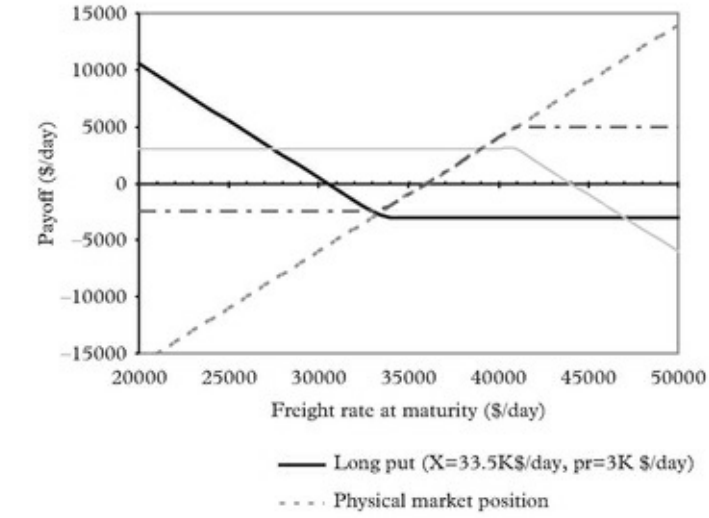
and, as a result, the effective freight rate for the company is the strike price plus the option premium. Similarly, if the spot rate is lower than the strike price, the option expires worthless, and the effective freight rate is the current spot rate in the market plus the option premium.

4.4 Hedging using collar

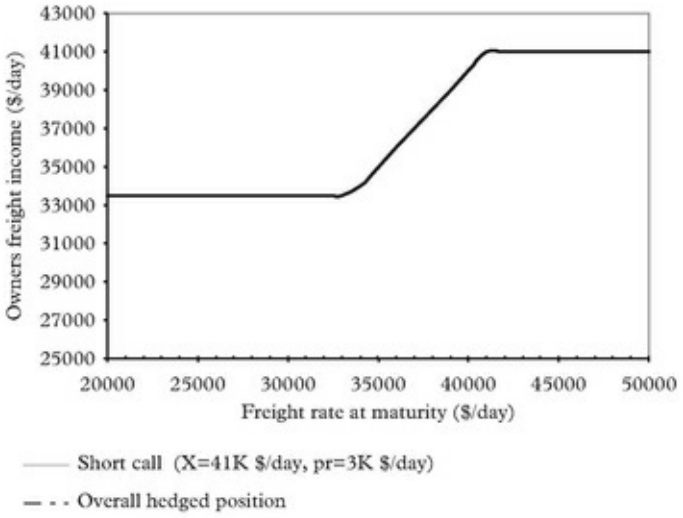
Although options provide an effective form of hedging, the fact that the hedger has to pay the option premium upfront may sometimes be a factor that decides against the use of the options as a hedging tool. For instance, in the previous example, the charterer would have to pay an upfront premium of $246,402. One way of reducing this cost would be for the charterer to "sacrifice" some of his upside potential when the market goes down in return for protection against possible freight rate up turns. That would, therefore, involve the charterer selling an OTM put option with a low strike price, say at 70 WS, on the same underlying and with the same maturity as the call option. Selling a put provides income which the charterer can use to offset the cost of the call. This strategy is known as a collar strategy. The most popular type of a collar is a *zero cost collar,* where the cost of the call is offset fully by the premium received from the short put so that the overall cost of the hedge is zero. By following this strategy, the charterer has a maximum freight cost of 90 WS points. If the market falls below the strike price of the put, then the put will be exercised against him and his total cost will be "floored" to the put strike price of 70 WS points. Thus, the charterer has financed the downside insurance protection provided by the long call, by selling part of the upside potential of the freight market, with a short put. Similarly, an owner could construct a collar by buying a put and selling an OTM, high strike price call.[29]

4.5 Constructing a zero-cost collar in the dry-bulk market

In mid-June 2007, a Panamax owner is concerned about the volatility in the freight market and wants to secure his freight income for 2008. There are a number of hedging choices available: first, the shipowner could sell a Calendar 2008 FFA contract for the BPI 4TC average, currently quoted at 36,500 $/day; however, he is uncertain about the direction of the market and, hence, does not want to lock in a forward rate, in case the market rises further than that. The second option would be to buy one Calendar 08 BPI 4TC put option. Currently there is a quote for a Cal-08 put with a strike price of 33,500 $/day for a premium of 3,000 $/day. This is essentially a strip of 12 monthly options for each of the 12 months in 2008. Each option will be settled separately at the end of each month and the settlement rate will be calculated as the average of the month for BPI 4TC; the total payoff for each month will therefore be: *max(33,500* S_{ave}*, 0)*number of days in the month,* where S_{ave} is the average freight rate over the settlement month. For instance, if the average freight rate in January is 30,000 $/day the payoff of the option would be $108,500 (= 3,500 $/day * 31). Although such a hedge would effectively guarantee the owner a minimum income of 33,500 $/day – minus the option premium – for 2008, he is also conscious of the fact that this is a rather expensive hedge since, in order to buy the options, he would have to pay an up-front premium of $1,098,000 (= 3,000$/day * 366 days). The third hedging option would



Panel (a) Payoff of the collar



Panel (b) Owner's freight income

Figure 12: Owner's zero cost collar

thus be for the owner to "sacrifice" some of his upside potential by selling an OTM call option at a higher strike price. The broker has identified a counterparty for this trade, who is willing to sell to the owner the Cal-08 4TC put with 33,500 $/day strike, and buy from the owner the Cal-08 4TC call at a strike of 41,000 $/day. Since the premia from the long put and short call positions exactly match, this strategy would effectively be a zero cost strategy.

The outcome from this strategy is shown in Figure 12. Panel (a) presents the payoff from the combined options and physical positions for any given maturity and panel (b) shows the owner's possible net freight income from the collar hedge; we can see therefore, that the income is guaranteed to be between 33,500 and 41,000 $/day for every month of 2008. This strategy guarantees that the shipowner's income will not fall below $33,500 $/day but, at the same time, the income is also capped at 41,000 $/day. If, on the other hand, the owner had opted for the FFA hedge, then his income would have been 36,500 $/day. Thus, the collar strategy provides more flexibility and also allows the owner to take advantage of any potential upside in the market whilst, at the same time, he is protected on the downside. We can also note that there is a link between the collar strategy and the FFA hedge. In fact, if the strike prices for the call and the put are identical then the collar hedge is identical to an FFA hedge and the strikes in that case should be equal to the FFA rate; this argument follows directly from the put-call parity which links the prices of calls and puts that are written on the same asset and have

the same maturity.

4.6 Pricing freight options

As discussed, freight options are becoming increasingly popular with practitioners and are used both for risk management and speculation purposes. From the point of view of traders in the market and particularly for option sellers, an important consideration is how to determine the fair option premium to charge when selling a freight option. This should reflect, among other things, the risks option sellers face in the market and should provide a fair level of compensation for those risks. The premium should be fair because if it is too high then the option will be overpriced; on the other hand, if the premium is too low then the premium will not provide an adequate level of compensation for the risks the seller is facing.

Pricing freight options, presents a number of challenges for researchers. First, the underlying asset of the option, which is the freight rate produced by the Baltic Exchange, is not a tradable asset since freight rates reflect the cost of providing the service of seaborne transportation which, by its own nature, cannot be stored or carried forward in time. As a result, arbitrage between the underlying spot freight market and options across time and space is limited. Although the spot Baltic rates are not tradable assets, the FFAs on these routes are regularly traded contracts which can be used in a replicating strategy, i.e. when delta hedging a short option position. Therefore the information contained in the FFA rates should be used when pricing derivatives on freight and, hence, the pricing model used for freight options should be based on the Black 76 model for pricing options on futures.[30]

Second, freight options are settled as Average Price Asian Options. Asian options are options whose final payoff is based on the average level of the underlying asset price over a period of time. As is the case with the FFAs, the calculation of an average settlement rate is used in order to ensure that settlement rates are not susceptible to large moves due to very high volatility or market manipulation on any specific trading day. For instance, an attempt to manipulate the underlying price, just before settlement, will have little impact on the settlement price if this is calculated as the average of the month and consists of 21 individual data points. This also explains why Asian options are quite popular in either thinly traded markets, or in markets where there is very high volatility, such as the market for freight. In addition, since the volatility of the average price is less than the volatility of the underlying, the premium for an Asian option will generally be lower than the premium for an otherwise identical European option.

Pricing Asian options is more complicated than pricing “plain vanilla” European options. The main reason for this is that, when the asset is assumed to be lognormally distributed as is the assumption in the Black 76 (see endnote 30) option pricing model, the arithmetic average of a set of lognormal distributions does not have analytically tractable properties. In this case, the distribution is approximately lognormal and this leads to a number of analytical approximations for the valuation of these options such as the Turnbull and Wakeman,[31] Levy[32] and Haug *et al.*[33] and Curran[34] approximations, as well as the valuation model of Koekebakker *et al.*,[35] for the valuation of average price freight options; Alizadeh and Nomikos (see endnote 15) find that the option premia generated from these models are very similar and approximate well the option premia generated using Monte Carlo simulation.

5. Conclusions

The role of risk management in shipping operations has become increasingly important in recent years. This is because the shipping industry has become an integral part of the world economy in connecting sources of supply and demand for raw materials and manufactured goods around the globe. Therefore, fluctuations and uncertainty in the global economy, whether short term or long term, are expected to affect the profitability and hence the long-term survival of shipowners and ship operators. The aim of this chapter was to review and discuss the risk management tools and instruments available to market practitioners to control freight rate risk.

In this chapter, we discussed the practicalities of trading FFA as well as how FFA can be used to risk manage a variety of exposures in the underlying freight market. We also analysed the issues that hedgers need to be aware of in setting-up their hedging strategies. Since their introduction in the early 1990s trading volume in the FFA market has increased constantly on a year by year basis. The continuous growth in the market and the influx of new traders, such as investment banks, trading houses, hedge funds etc., also led to the development of more sophisticated trading strategies using FFA – such as spread and arbitrage trades – as well as to the increasing use of freight options for hedging and speculative purposes.

The major advantage of freight options is that they enable market participants to be hedged if the market moves against them, but also to take advantage of favourable conditions if the market moves in their favour. Freight options are becoming more and more popular with market practitioners and are increasingly used for both risk management and speculation purposes. In this chapter we considered the profit patterns from buying or selling call and put options, the practicalities of trading freight options as well as risk management applications. Perhaps the major issue in the freight options market today is the issue of determining the fair premium to pay for a freight options and we briefly discussed the different approaches that are currently used in the market.

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Endnotes

1. Stopford M. (2008): *Maritime Economics* (3rd edn.) (London, Routledge Publications).
2. McConville, J. (1999): *Economics of Maritime Transport: Theory and Practice* (1st edn.) (Witherby Publishers).
3. It should be noted here that recently there have been some reported trades on the forward value of container freight rates (see "Shanghai Index Points to Recovery" *Lloyd's List*, Monday 25 January 2010).
4. Gray, J. (1990): *Shipping Futures* (London, Lloyd's of London Press).
5. For a more detailed overview of the changes in the structure of the BFI as well as the statistical linkages between the different routes see as well Nomikos N. (see endnote 6), Nomikos N., and Alizadeh, A. (2002): "Risk management in the shipping industry: Theory and Practice", in *The Handbook of Maritime Economics and Business*, pp. 693–730, (London, Informa). Haigh, M., Nomikos, N. and Bessler, D. (2004): "Integration and causality in international freight markets – modelling with error correction and directed acyclic graphs", *Southern Economic Journal*, Vol. 71, No. 1, 145–163; and Alizadeh (see endnote 15) "*History of the Baltic Indices*" published by the Baltic Exchange also contains detailed information about all the changes that

have been implemented to the various indices produced by the Baltic Exchange since their inception in 1985.

6. Nomikos, N. (1999): "Price Discovery, Risk Management and Forecasting in the Freight Futures Market", unpublished PhD Thesis, Cass Business School, City University London, UK.

7. Kavussanos, M. and Nomikos, N. (1999): "The forward pricing function of the shipping freight futures market", *Journal of Futures Markets*, 19, 353–376.

8. Kavussanos, M. and Nomikos, N. (2003): "Price discovery, causality and forecasting in the freight futures market", *Review of Derivatives Research*, Vol. 6, No. 3, 203–230.

9. Kavussanos, M. and Nomikos, N. (2000a): "Futures hedging effectiveness when the composition of the underlying asset changes; the case of the freight futures contract", *The Journal of Futures Markets*, Vol. 20, No 6.

10. Kavussanos, M. and Nomikos, N. (2000b): "Constant vs. time-varying hedge ratios and hedging efficiency in the BIFFEX market", *Transportation Research Part E,* Vol. 36, 229–248.

11. Kavussanos, M. and Nomikos, N. (2000c): "Dynamic hedging in the freight futures market", *Journal of Derivatives*, Vol. 8, No. 1, Fall 2000, 41–58.

12. For more detailed information about the composition of the various shipping routes please refer to the Baltic Exchange (www.balticexchange.com).

13. In general, for FFA on the average of the Trip-Charter (TC) routes of the BCI, BPI, BHSI and BSI – which represent the majority of the trades – the settlement rate is calculated as the average of the month; on the other hand, the settlement rate for FFAs on individual routes from the BCI or BPI is calculated as the average of the route over the last seven trading days of a month. This is because FFAs on individual routes are typically used to hedge specific voyages so averaging over a shorter period of time and, therefore, having better correlation with the underlying physical route during settlement, is preferred. On the other hand, market participants use basket routes, such as the average of the four TC routes of BCI or BPI, to hedge their average monthly earnings; in this case, calculating the settlement rate as the monthly average is preferred, since it provides a better fit to the requirements of the traders in the physical market and more closely matches the monthly earnings of the vessel. Finally, tanker FFAs are also settled as the average of the month.

14. IMAREX operates as an exchange, in the sense that it provides a regulated market place to trade standardised contracts, principals can trade in the market either directly or through an IMAREX broker, and all trades are guaranteed through a clearing house. However, the market is not open to brokers outside IMAREX. Therefore, FFA brokers cannot use the IMAREX system to post prices or to facilitate trades for their clients. In that sense therefore, IMAREX operates a "hybrid" or "almost-exchange" market system since the market is not open to all market participants, in particular non-IMAREX based competitive FFA brokers.

15. Alizadeh A. and Nomikos, N. (2009): *Shipping Derivatives and Risk Management* (London, Palgrave Macmillan).

16. In general there are two dates which reflect the delivery period to the charterer; these are known as *laycan* which is sort for laydays cancelling. For instance in the example presented here the laycan period could be laydays 13 January cancelling 16 January. This means that the charterer is not obliged to accept delivery of the vessel until after the first of these dates (i.e. 13 January)

and has the option to cancel the charter agreement altogether if the vessel arrives after the end of the second of the dates. All the Baltic Panamax indices have a laycan period of 15–20 days ahead of the index which effectively means that today's spot rate reflects a delivery period which is at least 15 days forward. For hedging purposes, this means that if one wants to hedge a voyage that will commence, say, in the middle of September, the appropriate contract maturity to use for hedging is that of August.

17. These rates are the BPI 4TC FFA assessment rates, reported by the Baltic Exchange, at the time the hedge is lifted.

18. In the example presented here we ignore broker's commission on both the physical and FFA markets.

19. Some textbooks also call this type of risk as *time basis risk* to distinguish it from basis risk arising form mismatches between the forward and the underlying asset (Eydeland, A. and Wolyniec, K. (2003): *Energy and Power Risk Management* (New Jersey, Wiley Finance). It should be noted that when the specification of the FFA contract matches exactly the underlying position and an FFA position is carried until the expiry of the contract then there is no basis risk since – due to the convergence of spot and forward prices – the basis of the contract at maturity will be equal to zero.

20. Ederington, L. H. (1979): "The hedging performance of the new futures markets", *The Journal of Finance*, 34: 157–170.

21. The implementation of this strategy may be limited by the fact that most of the BSI contracts are traded for a full calendar month and liquidity for buying part of the month is limited. However, a handysize operator can still use this strategy to hedge, for instance the monthly earnings of three Handysize vessels using two monthly BSI contracts, which roughly corresponds to a 70% ratio.

22. Some differences in the results may be due to rounding. In the example presented here we assume that the monthly Handysize earnings in the physical market are equivalent to the average monthly BHSI rate. Therefore, there is no mismatch between the "Baltic" Handysize vessel and the earnings of the vessel used in the example. In addition, we also need to consider broker's commission which is 0.25 of the total freight rate; in other words, 0.25% * 0.7 * 3 * 30 * (30,500 + 26,000) = $8,898.75. Finally, for simplicity we also assume that each month has 30 days; in practice, the October settlement would be calculated on the basis of 31 days.

23. Kroner, K. and Sultan, J. (1993): "Time-varying distributions and dynamic hedging with foreign currency futures", *Journal of Financial and Quantitative Analysis*, 28, 535–551.

24. Since these graphs present the payoff of the option at expiry and the premium is paid upfront, the graphs reflect the compounded future value of the option from the time the option was bought until its maturity.

25. This is normally done using the option price sensitivities, which are known as the "Greeks". For more details on how the "Greeks" can be used to hedge short option positions on freight see Alizadeh and Nomikos (see endnote 15).

26. In contrast, one who sells a call without owning the underlying is said to sell a "*naked call*". It is not always the case that the call seller will have to maintain the full underlying to cover his

short call position. His holding of the underlying will be determined by the sensitivity of the option price to changes in the underlying in what is known as the Delta of the option. Delta hedging strategies for freight are discussed in Alizadeh and Nomikos (see endnote 15).

27. Hull, J. (2008): *Options, futures and other derivatives* (8th edn.) (New Jersey, Prientice Hall International) US.

28. Neftci, S. (2007): *Financial Engineering* (New Jersey, Academic Press).

29. Another way market participants can use to reduce the cost of the option premia is to use exotic options that have more complex payoffs than those of standard European or Asian options. One example here are barrier option with knock-in features where the option contract comes into existence only if the underlying price crosses a predetermined price level. For more on the use of exotic options for trading and hedging, see Zhang, P. G. (1998): "Exotic options: a guide to second generation options" (Singapore, World Scientific).

30. Black, F. (1976): "The pricing of commodity contracts", *Journal of Financial Economics*, Vol. 3, 167–169.

31. Turnbull, S. M. and Wakeman, L. M. (1991): "A quick algortihm for pricing european average options", *Journal of Financial and Quantitative Analysis*, 26, 377–389, 167–175.

32. Levy, E., (1997): "Asian options", in L. Clewlow and C. Strickland (eds.) *Exotic Options: The State of the Art* (Washington, DC, International Thomson Business Press).

33. Haug, E. G., Haug, J. and Margrabe, W. (2003): "Asian Pyramid Power," *Willmott Magazine.*

34. Curran, M. (1992): "Beyond average intelligence," *Risk Magazine*, 5(10).

35. Koekebakker, S., Adland, R. and Sødal, S., (2007): "Pricing freight rate options", *Transportation Research: Part E*, Vol. 43, No. 5, 535–548.

Chapter 27
Revisiting Credit Risk, Analysis and Policy in Bank Shipping Finance

Costas Th. Grammenos[*]

1. Introduction

There are three main groups of sources of shipping finance: Equity finance, which includes retained earnings and equity offerings, either public or private;[1] mezzanine finance, which encompasses hybrids, such as warrants and convertibles, subordinated debt and preference shares;[2] and debt finance, which contains bank loans, export finance, tax leases, private placements (traditional and 144A) and public debt issues.[3]

This chapter concentrates on bank finance – which is still the largest source of capital in the shipping industry – with particular reference to commercial bank loans. Bank shipping loans are granted to borrowers by a number of different financial institutions, such as: export–import banks; development banks; banks specialising in shipping; and commercial banks. These institutions deal primarily with the major risk – the credit risk (or default risk) – which is the uncertainty over the repayment of the granted loan and payment of its interest, in full, on the promised date.

Shipping departments of a sizeable number of commercial banks, or banks specialising in shipping, have seen their profitability fluctuate substantially over the years. Increased profits strengthened the presence of commercial banks committed to shipping, and attracted newcomers. The early 1970s, the late 1980s, part of the 1990s and the second half of the current decade are good examples of high bank shipping profitability stemming from booming shipping markets. However, heavy losses over periods of shipping recession or depression have also been realised and have led a number of banks to abandon the finance of shipping. Here, the mid-1980s is a representative example to abandon ship financing.[4]

Loan losses may significantly reduce the return on equity (ROE) of a bank and, therefore, destroy value for the bank, or loan profits may increase the ROE and, consequently, create value for the bank.

The rest of this chapter is organised as follows. Section 2 focuses on credit risk, while Section 3 discusses key issues of credit risk analysis. Section 4 deals with collateral securities, including mortgage, assignment of revenue, assignment of insurance and guarantees. Covenants are covered in Section 5, while Section 6 presents a further discussion of credit analysis and issues, such as pricing of the loan, syndication and capital adequacy rules. The focus of Section 7 is loan monitoring; while Section 8 covers shipping credit policy. In Section 9, the conclusions are presented.

2. Credit Risk

The lending function of the bank deals with credit risk, and has four parts:[5] the first is the origination of the loan which includes initiation of the loan, analysis, documentation, due diligence and approval; the second is the funding, during which external and/or internal funds are used for the draw-down of the loan; the third is the follow-up part when principal and interest rate payments are made; and the fourth is the monitoring part, which is carried out in parallel with the “follow up” of the loan, through collecting, processing, and analysing data and information regarding the borrower. The objective of

the lending function is to create value for the bank, through granting sound loans; and sound loans are the ones which are paid off.

The main risk in bank shipping finance is the credit – or default – risk.[6] This is primarily due to the volatility of the vessel's income, which is the main source of the loan repayment; and the consequent fluctuations in the vessel's market value which is, in most cases, the main security for the loan.

The financial institutions provide loans of varying forms to shipping companies, the core being the term loan under which the bank lends a certain amount to the shipping company for vessel acquisition over a specific period (above one year), to be repaid normally from the income generated by the vessel(s) to be financed and, possibly, by its/their residual value. The loan is tailor-made to suit the needs of the borrower and the lender, in the particular circumstances.[7] Thus, equal or unequal instalments can be arranged and a moratorium for one or two years can be granted, whereby only interest payments are made for a certain period of time, to allow for poor shipping market conditions. Furthermore, a balloon payment can be approved for a loan – that is to say, a large amount of the loan, which reflects the residual value of the vessel (between 25 to 30% of the vessel's current market value), should be paid with the last instalment. In reality, the balloon payment is usually refinanced for one year or longer – provided the borrower has met his commitment and depending upon the amount of the balloon, the value of the vessel and the freight income of the vessel. In this way, the loan repayment period can be stretched further without the bank committing itself to doing so from the beginning, because the repayment period of the loan would be longer and this would increase further the uncertainty.

The interest rate normally fluctuates and is based on LIBOR (London Interbank Offered Rate), plus a margin (spread), which represents a significant part of the gross income of the bank from the loan. While the margin is fixed in advance, the LIBOR is renewed periodically, such as every three or six months, in the eurodollar interbank market, should the currency denomination be in dollars.[8] Such fluctuating interest rates, if un-hedged, prevent the shipping company and the bank from calculating, with certainty, the future interest payments. In comparison with a fixed interest rate for the entire loan repayment period – a rather infrequent feature in bank shipping loans nowadays – the fluctuating interest rate allows the bank to pass on the interest rate risk to the borrower, whose cost rises with increasing LIBOR or decreases with falling LIBOR.[9]

During the parts of the lending function the two cooperating parties, the bank and the borrower, may have different goals and division of labour. The bank wants its loan to be paid off and increase its profitability. The borrower wants to make its project a success. For this relationship to be sound, the accuracy and quality of risk analysis of the project is critical. The agency theory[10] deals with the two problems that may appear between the banker (as a principal) and the borrower (as its agent) in a relationship that the principal delegates work to the agent. The problems emerge due to asymmetry of information which may exist between the banker and the borrower regarding the project to be financed or already financed. Indeed, the borrower (as an insider) may have more accurate information than the banker in areas such as the financial accounts and the condition of the vessel. These problems are adverse selection and moral hazard. Adverse selection refers to uncertainty regarding the viability of the project; while moral hazard refers to the reliability of the borrower.

A characteristic example of adverse selection is the shipping loan portfolio of a relatively small

financial institution, at the end of the 1970s, which consisted almost exclusively of loans extended for the purchases of over-aged vessels, while charging high interest rates. In addition, many of the owners were small with only two or three vessels. When the shipping market conditions deteriorated, from 1982 onwards, the freight income decreased dramatically and was not enough to cover the vessels' running expenses, let alone the loan repayment. At the same time, the vessel market values had declined to their scrap value, while the vessels had been purchased, at the end of the 1970s, at quite high prices. This particular institution suffered great financial losses from its shipping loans.

Regarding moral hazard: Examples include when a borrower deceives the banker, or change his/her behaviour; false items in the running expenses of vessels; false statements regarding overall net worth; liquidity of the shipping group; or transfer of income from mortgaged vessels to other companies; this may be permissible in some circumstances, e.g. where a corporate guarantee is provided.

The financial institutions, in order to increase their value and also deal effectively with the agency problems, incur certain costs – the agency costs. These are related to – among others – the collection, processing and analysis of data for the loans granted and to be granted. However, one has to keep in mind the very special role of the financial institutions, as intermediaries between savers and users of funds. In this capacity, and due to the limited ability of the savers to obtain and analyse information regarding initial and continuing creditworthiness of the end fund users (borrowers), the financial institutions undertake this role on their behalf. Consequently, the financial institutions have a greater incentive to collect and process this information, due to the large number of savers who appoint them as their "delegated monitors".[11] In so doing, the financial institutions are also protecting the wealth of their shareholders, who are expecting to see it increase. Therefore, the lending function should guard the interests of depositors and shareholders, and increase the value of the bank.

The question that arises now, is, how does a the shipping banker dealing with the credit risk?[12]

There is an array of tools at the banker's disposal, to minimise credit risk: credit risk analysis; collateral securities; covenants in the loan agreement and the mortgage; monitoring of the granted loans; and shipping credit policy. These issues will be discussed in the following sections.

3. Credit Risk Analysis

Grammenos[13,14] introduced the five "Cs" of Credit in Bank Shipping Finance as a sound credit risk analysis method of assessing the probability of the repayment of the loan proposals for acquisition of secondhand vessels and newbuildings, based on five key words that start with "C": Character, Capacity, Capital, Conditions, Collateral. "Company" was added at a later date for reasons of clearer presentation. This credit analysis method has been adopted by a large number of financial institutions. Bearing in mind that the interest margin and fees are fixed and, therefore, the upside return of the loan is fixed and the downside risk is substantial, since the loan capital and interest may not be paid as promised, the credit risk analysis of the loan has to assess the probability of their payments in full. Table 1 summarises the main elements of the credit risk analysis that a loan officer has to carry out.

3.1 Character/capacity

The first column of Table 1 concentrates on the head of the shipping company and the management team. Their expertise accumulated over years, their resourcefulness during the lower parts of the shipping cycle, and their integrity, are areas of investigation. The head of the shipping company and

his/her team will specify the mission and goals of the company and the strategic plan for their materialisation. They are responsible for designing and applying the strategies to achieve the goals.

The head and team are assessed for their managerial quality as a team and their performance versus plan on strategies over a long period, for instance, over the last two or three cycles or last generation.[15] In particular, investment and finance, chartering, insurance, technical, cost management, risk management, creditors, and human resources strategies, are looked at for their overall return to the equity; and whether they managed to decrease costs, increase revenues and profits and create efficiencies. The head's and team's "modus operandi", in comparison with their peers in the same sector, may be useful.

3.2 Capital

The second column refers to Capital. When a shipowner has a relatively large shareholding stake it shows confidence in the company; while the financial structure shows the way the company has been financed. Shipping is a capital-intensive industry, requiring substantial funds primarily, for contracting placement of newbuilding orders; and, secondarily, the purchase of secondhand vessels. All elements in this column are important, but the gearing ratio, the hull (market value) to debt ratio, the net worth and the cash flow, are of paramount importance. A high gearing ratio (debt to total assets) is a double-edged sword: in a flourishing shipping market it may cause the profits and return to equity to soar, in a declining market it may endanger the existence of the company itself.[16] Retained cash flow over net debt is calculated after dividend payments and includes the capital component of operating expenses. The higher this measure, the more indicative it is of the ability of the business to generate cash, the availability of cash debt payments or its ability to undertake capital investments. Interest coverage shows how many times operating profit or Earnings before Interest, Taxes, Depreciation, Amortisation (EBITDA) covers the interest.[17] Hull-to-debt ratio[18] is important, not only in a declining or rising shipping market, but also when the time charter, or contract of affreightment ends. It shows the relationship between the loan and market value of the vessel. (See further on this ratio in Section 4.1.)

Table 1: Six Cs of credit analysis

Character/Capacity	**Capital**	**Company**	**Conditions**	**Collateral**
Head of Company, and Team Capacity and Integrity Company's Mission – goals Strategic Plan Strategies to Achieve them In Particular: – Investment & Finance – Chartering – Insurance – Technical – Cost Management – Risk Management – Creditors – Human resources Coherent Forward Looking & Learning from the Past	Shipowner/ Company's Head Shareholding Stake Financial Structure Analysis of Financial Statements Financial Ratio Analysis – Gearing Ratio (Total debt/total assets – Retained Cash Flow/ Net debt – Pre-Tax Funds Flow Interest Coverage – Hull to debt Cash Flow (Free Cash Flow to Debt) Cash Cushion (Cash Reserves)	Structure of Company Inflows: Forms of Employment Choice of Charterers Quality of Charterers Contracts with Charterers Effective Utilisation of Vessels Outflows: Operating Costs – Administrative – Technical – Insurance – Crew Voyage Costs Capital Costs Markets of Operation (1) Market Share (2)	Financial Markets Interest Rate Political Conditions and Governmental Decisions World Economy World Industrial Productions Seaborne Trade Specific Commodities Manufactured goods (Structural, Cyclical Changes) Shipping Markets Present and Future Demand & Supply Analysis Shipping Investment Cycle	Fleet's Composition Fleet's Condition Vessels' Economic Life Securities – Mortgages – Assignment of Income – Assignment of Insurance – Personal and Corporate guarantees

(*Continued*)

Table 1: (Continued)

Character/Capacity	Capital	Company	Conditions	Collateral
	Other Sources of Funds Banking Relationships Accounting Methods	1+2 = Company's Operating Position	Fragmentation of Markets Barriers to Entry Regulatory Framework: – Official International Organization(IMO) – Flag states – Port Authorities – ISM Code – OPA 90 Other Organisations' Requirements – Classification Societies – Insurance companies and P&I Clubs – Major Oil Companies	

As long as the bank knows that the real economic net worth – the difference between the market value of assets and the market value of liabilities, as opposed to book value – is positive, then it also knows that the loan is relatively secure. Cash flow is the main source for the loan repayment, while the cash cushion – the existence of accumulated cash from operating profits and/or sale of vessel(s) – is important to cover temporarily interest payments and capital instalments, should the freight market decline.[19] In a falling shipping market, other sources of finance – e.g. capital markets – and strong banking relationships may be necessary, hence, an analysis of the different ways that a shipping company is financing its projects and its relationships with different banks is essential. Finally, widely accepted accounting methods such as the Generally Accepted Accounting Principles (GAAP) give the comfort of an international accounting measure, but are not always used by shipping companies; while consolidated audited accounts, despite the fact that they give an overall view of a shipping group, are not always provided by the shipping companies.

3.3 Company

The third column refers initially to the ownership structure of the company. Very often one-vessel companies[20] registered in an open registry country, such as Panama, Liberia, Cyprus, Malta, are established and their vessels may be managed by a management company controlled by the shipowner/manager, or owned by a holding company. In the first case, the banker deals with an entity where there is no – or limited – recourse to the management company and the loan is paid by the income and secured by the mortgaged vessel, or some other form of security; while, in the second, he/she deals with a coherent group structure (corporate) that owns a fleet and the repayment of the loan may be only based on the cash flow of the company.

The column then scrutinises sources of income and expenditure. It shows the chartering strategy of the company and the stability – or the vulnerability – of its income. A company with time charters, or contracts of affreightment, has more secured income in comparison with a company that operates its vessels in the spot market, the income of which fluctuates. Bankers and investors are comfortable with the former case, nervous with the latter one. The chartering strategy also reveals the marketing ability of the company; the quality and efficiency of its services; the financial strengths and weaknesses of its charterers; the effective utilisation of the vessels in two, or all, legs of a voyage.

This column also investigates the managerial effectiveness regarding operating and voyage costs. The competitiveness of the company depends not only on its ability to produce income but also how it

operates within a competitive budget of costs. However, a record of detentions may indicate costs being cut too much, or insufficient maintenance expenditure. The capital costs are included in this column and, when they are the costs of debt financing, income stability is of paramount importance.[21] The last part of this column looks into the market(s), where the company operates, its market share, and the company's operating position against its competitors.

3.4 Conditions

The fourth column refers to the examination of the competitive and changing international economic, financial and political environment, within which the company makes decisions and operates. The conditions in financial markets; interest rates; the decisions of governments of exporting or importing countries; overall political conditions; developments in the world economy; world industrial production; international and seaborne trade, and the conditions in commodity markets, are issues of utmost importance for shipping markets and companies, since demand for shipping services is a derived one. As Metaxas[22] argues: "Vessels carry cargoes and goods that are imports and exports of various countries, the direction and volatility of which have a direct impact on the demand for shipping. Indeed, trade cycles in advanced economies and their resultant international trade cycles affect the magnitude of demand for tramp shipping services and, for this reason, their freight rate movements tend – to a certain degree – to coincide with those of international trade." Furthermore, structural changes in the above markets, and national economies, may have a more profound and lasting impact on the company's business than cyclical ones. Examples of these structural changes could be shifts of industrial production from one country to another, which may have an effect on the pattern of shipping trade flows and on the type and size of vessels that are employed or the technological changes that affect the vessel's efficiency, size and number of crew. Scenario analysis of demand and supply of shipping market(s) where the company operates, with sensitivity analysis, is required for the discussion of their current and future conditions. Volatility in freight rates and vessel market values, that is to say the market risk, is the major parameter for the creation of the loan's credit risk that the financial institution faces.

Shipping companies operate within a shipping investment cycle, the four stages of which (recovery, boom, recession, depression) are linked with the resultant freight rate as it is established by the demand for – and supply of – vessels.[23] When freight rates are high and profits increase, an over-investment in newbuildings is noticed, which may increase the level of supply of vessels and result in an imbalance between supply and demand. In a period of expansion of supply, even a check to the rate of growth of demand will be sufficient to trigger off a downward trend in freight rates. During recession and depression, speculative ordering may take place, often due to subsidised shipbuilding. This lowers the barriers to entry for shipping companies into newbuilding markets and may also prolong the low freight rates. On the other hand, purchase of a vessel, or placing a newbuilding order during this period of low market values, is excellent timing, since this shipowner may compete with vessels bought or ordered during a boom period at high prices.[24] Furthermore, the sale of this vessel during a following prosperity phase is very profitable. However, for the banker who undertakes credit risk analysis, stable cash flow is required for the repayment of the loan, not the asset play. In addition, owners may take advantage of low asset costs during a depression but will often be reluctant to mitigate revenue to volatility by fixing a long-term timecharter at the prevailing low rates. It is

important for the lending banker to figure out the stage of the shipping cycle, during which it provides finance. Financing over-valued secondhand vessels and newbuildings during a boom period, may result in problematic loans in a period of recession and depression (the comment in endnote 16 is very relevant).

Within the regulatory framework, the International Maritime Organization (the IMO) safeguards the international standards, safety and marine pollution of the shipping industry; flag states, where vessels are registered, impose the regulations of the IMO when they have ratified them; port authorities inspect vessels when they call in; the classification societies supervise the construction, safety and seaworthiness of the vessels during their life; the insurance companies and Protection and Indemnity Clubs deal with the insurance aspects of the vessels; and the major oil companies undertake their own detailed inspections of the tankers that they are going to employ. All these are major parameters for the developments in the shipping regulatory environment which, as time passes, becomes tighter. As such, new investments and their overall cost, sale and purchase market, vessels' operating expenses, and their revenue, may be seriously affected by the official and corporate regulatory environment. These demand the attention of the banker.

3.5 Collateral

The last column concentrates on the company's fleet. Its composition is important. Fleet specialisation may develop expertise, operational efficiency and better marketing. However, such a fleet may be vulnerable to market recession. The diversified one, which may offer higher income security, normally requires a larger fleet in operation. The fleet's condition and the company's maintenance and repair policy must be taken into account, as often the vessels are the mortgaged assets which produce the (often assigned to the bank) income that repays the loan(s) and they have to be operated safely within the required standards

Apart from the vessel and the mortgage on it, other forms of securities also strengthen the position of the banks: the assignment of income to the bank by which the capital instalments and the interest are paid; assignment of insurance in the case of a casualty or other specific circumstances; corporate guarantees of the holding or management company and personal guarantees of director(s) of the management company, which may cover the bank should the company default in its payment of the loan and/or payment of interest. All forms of security are discussed in Section 4.

3.6 Analysis of cash flow

Having analysed the specific areas of the six "Cs" of credit, the bank has to make a cash flow calculation to ascertain whether the total receipts will cover the total costs of the vessel(s) to be financed, allowing for a balance (cash cushion) sufficient to cover unexpected negative financial developments. The resulting breakeven estimates must be analysed to determine how lucky the vessel is going to need to be in the future spot market to cover its costs. This cash flow estimate[25] should be prepared for the proposed acquisition of vessel(s); also, for the group's fleet with – and without – the proposed acquisitions.

Assessing the stability of the fixed revenue of this statement, and its quality in terms of charterers, requires understanding the legal documents of time charters and contracts of affreightments; and assessing the creditworthiness of charterers.[26] While quality of future revenue, based on assumptions, requires an emphasis on the overall creditworthiness of the borrower as revealed through the six "Cs"

of credit analysis; and the use of appropriate securities and documentation which is, naturally, the job for the bank's lawyers. Now, the attention turns to securities and covenants, and credit analysis.[27]

4. Collateral Securities[28]

In granting a shipping loan, the bank has three possible areas from which to recoup its funds. The first or "intended" way out is from cash flow generated by the financed acquisition, second, from the mortgage on the financed vessel ("direct" security) and third, from additional securities ("indirect" security). It must be stressed that a bank, by taking securities, does so in the expectation that a problem loan will not develop and that sufficient cash flow will be generated by the project to service the outstanding debt without it being required to enforce its rights on the securities of the loan. The decision to be taken by the financial institution, on the appropriate security or securities, depends upon the individual case of the loan and shipping company to be financed. Among the securities are the mortgage, assignment of revenue, assignment of insurance, mortgagee interest insurance, assignment of requisition compensation, guarantees, comfort letters, cash collateral security, share security and the assignment of shipbuilding contract and refund guarantee. A short analysis follows.

4.1 Mortgage

A mortgage duly registered in the country whose flag the vessel flies, and carrying conditional ownership of the acquired vessel that becomes void when the debt is repaid, is the normal method of providing bank security for vessel acquisitions. Note that the type of mortgage will depend on the legislation applicable in the vessel's country of registry.

Statutory mortgages originated in the UK and adapted in jurisdictions modelled on the UK legal system, protect the mortgagee's rights by law. UK legislation[29] gives every registered lender or security trustee for group of lenders of a UK ship "the power absolutely to dispose of the ship or share in respect of which he is registered, and to give effectual receipts for the purchase money". In addition, under UK common law, the mortgagee has the right to take possession of the mortgaged vessel whenever the owner is in default of payment of the principal or interest secured by the mortgage, or creates an event of default under the loan agreement, or when the owner acts in a way which impairs the security of the loan. A preferred mortgage ensures the mortgagee's right by express provision in the mortgage agreement. It is usually detailed and flexible, while the statutory mortgage only stipulates general conditions.[30]

The convenience of a mortgage lies in the fact that the shipowner can run the business as a going concern, at the same time giving the mortgagee the following basic rights[31] to: take possession of the vessel and operate it or proceed to a jurisdiction for arrest; arrest the vessel; sell the vessel at auction or privately; appoint a receiver to handle the affairs of the vessel; and to assume absolute title of the vessel. All these measures aim at protecting the bank and represent an agreement between the borrower and the lender with respect to vessel maintenance, insurance and operation.

One of the major problems encountered in the area of mortgages is in establishing the vessel's market value, which represents the value of the bank's security. The market value can be regarded as the average price at which a willing seller could be expected to make an acceptable offer, at arm's length, to a willing purchaser on the open market, and is different from a vessel's fixed insurance value[32] or the depreciating book value.[33]

In order to protect against adverse fluctuations in vessel values, banks have attached great

importance to the hull-to-debt ratio (particularly when financing single companies):

$$HDR = \frac{MV}{D}$$

where, *HDR = Hull-to-Debt Ratio*
MV = Current Market Value of the Vessel
D = Outstanding amount of the loan (debt)

The hull-to-debt ratio represents the surplus of the market value of the vessel over the outstanding amount of the loan. If this ratio falls below a predetermined level – normally between 120–135%, the bank may require additional security from the borrower. As vessel prices can fall substantially in depressed markets, the availability of additional security may cause serious problems and friction between them. This has happened in the early 1980s and, recently, in 2009–2010. However, many banks accept the realities of depressed shipping markets and remain satisfied as long as loan instalments and interest are paid, so they temporarily freeze the ratio.

Vessels can also be subject to additional second, third, etc. mortgages. A second mortgage is defined as existing when a first mortgage already exists on a vessel. These mortgages lie behind preferred mortgages in creditor ranking and are usually offered as additional security, provided consent of the first mortgagee has been given.

4.2 Assignment of revenue

General assignment of revenue allows present and future revenue from the vessel(s) to be paid directly to the shipowner until an event of default occurs, and reflects the degree of confidence by the lender as to the likelihood of the debt service; while there is another format, the retention account where every month, the owner will transfer a pro-rata proportion of the next amount of interest and instalment from the earnings account to a blocked and pledged retention account with the bank; thus the mortgagee, accumulates the necessary monthly freight revenue to meet the next interest and principal payments.

Under the strict format of specific or legal assignment of revenue, all the specific rights of the borrower arising from a charterparty are assigned to the bank provided the charterer's consent has been given. Consequently, all charterparty payments are made directly to the bank, which will normally allow the shipowner to withdraw the necessary funds ensuring that the vessel remains operative to service the debt.

The effectiveness of the revenue assignment securities will be directly dependent upon the reliability of the revenue streams, which will in turn be determined by the relevant charterparties. Therefore, the quality, integrity, and financial condition of the charterer in terms of honouring obligations, and the quality of the charterparty itself in terms of drafting and inflation escalation or market adjustment clauses, are particularly important. Furthermore, sub-standard charterparty performance by the owner is often subject to deductions from freight and, as a result, may cause a reduction or cancellation in the level of assigned revenue.

4.3 Assignment of insurance

Insurance coverage is required as an additional security should the vessel be damaged, lost, or subject to a claim from third parties. Insurance protection in shipping finance primarily involves the assignment of all insurance payments due to the borrower, to be paid either directly to the bank or

requiring the bank's express consent before being paid to the borrower, subject to an agreed major claim threshold. Different types of insurance protection are: hull and machinery insurance which protects the bank by ensuring compensation if the vessel is lost or damaged, as does war and strikes cover; the loss of hire or earnings insurance which protects against interruption in cash flow; and other insurance protection important for the bank to ensure cash flow and debt service, include protection and indemnity,[34] which covers third-party risks, such as collision liability, loss of life, cargo liability; and freight, demurrage and defence insurance, which provides the shipowner with legal advice and assistance, and covers expenses in pursuing claims and resisting disputes of a more operational nature.

4.4 Mortgagee's interest insurance

Mortgagee's interest insurance is an additional insurance which protects the bank in the event of a policy becoming void if certain warranties are broken, (e.g. it covers the interest of the mortgagee in the case of a disputed claim by the underwriters on the grounds of fraud). The mortgagee's interest claim will usually be withheld, pending the conclusion of litigation. Since this can take some considerable time, and the outstanding loan plus the accruing interest are set at a default rate, the final interest claim may not cover in full the amount due. A solution to this problem is the simultaneous payments of mortgagee's interest during litigation, subject to return if underwriters are subsequently forced to pay. Alternatively, an escrow interest-bearing account can receive the mortgagee's interest claim and be subject to release, should the underwriters be compelled to pay.

4.5 Assignment of requisition compensation

This security consists of the borrower assigning to the bank, any compensatory payments in the event of vessel requisitioning, either in terms of absolute title, or for hire purposes during times of war, hostilities or nationalisation.

4.6 Guarantees

A guarantee is an undertaking, given to the bank by the guarantor, to be answerable for the loan and interest granted by the bank to a shipping company, upon the loan becoming defaulted. In accepting guarantees, the bank should also investigate the legal authority of the guarantor to give guarantees. Guarantees are normally personal or corporate.

Under a personal guarantee agreement, the guarantor is liable – on demand – for the discharge of all liabilities to the bank up to the stated amount or proportion, in the event of default on the part of the borrower. The personal guarantee is based on the guarantor's personal assets which may sometimes be registered in the names of other family members or "offshore" companies. Legal recourse, when necessary, against the borrower and the guarantor, who is usually the owner or major shareholder of the shipping company, is often questionable and difficult. Thus, personal guarantees are now often recognised by the banking sector as being an indication of good faith or moral commitment on behalf of the owner, rather than a cast iron legal security. They are currently out of favour, but they may well return for the family-owned entities.

Corporate guarantees are usually given by the group holding company in conventional structures, or by related management shipping companies in single vessel structures. These guarantees are becoming very important in the latter case, when the security is only the mortgage and the assignment of income. Should a payment default develop, the bank has recourse to the guarantor.

4.7 Comfort letters

Comfort letters are a form of intermediate, less strict, guarantees usually containing assurances and intent.

4.8 Cash collateral security

Cash securities usually comprise a special cash collateral account, blocked by the bank, which may be established on an initial lump sum or monthly payment basis. The reason for their existence is that the bank lowers its loan exposure and also holds cash, which can be used for the payment of interest and repayment of loan instalments should the shipping company be unable to cover them in a falling freight market, during which the vessel may face temporary employment problems. Cash collateral accounts are normally interest-bearing, subject to negotiation.

4.9 Share security

The share security, which is normally taken in addition to the mortgage, consists of the vessel-owning company depositing shares of the borrowing shipping company that he/she controls, with the bank, for a specific period or up to the final amortisation of the loan. This enables the lending bank, when a shipping company is in default for the loan repayment, to assume ownership of the vessel-owning company as opposed to the vessel itself, resulting in the bank becoming the new owner as opposed to a mortgagee, thus benefiting from any rights and assets of the company (e.g. charter parties, positive hedging arrangements, cash balances and other receivables such as insurance claims. Banks have a mixed view of share pledges. Some prefer the pledge as it gives them quick control of the company, but others do not as it comes with potential pollution liability and existing creditors.

A share pledge normally applies where the shares are in bearer form, So the title passes – on delivery of the shares – to the bank; while, a share charge applies to shares of registered form, and delivery will need to be accompanied by executed undated transfer forms.

4.10 Assignment of the shipbuilding contract and refund guarantee

Banks finance the construction of the vessels and grant loans to shipping companies for this purpose. The loan is granted in stages, from the signing of the shipbuilding contract to the delivery of the vessel – a period that may last for over two years. The number and the amount of instalments to be paid by the shipping company to the shipyard varies in time and countries. Five instalments, each one 20% of the purchase price is a scheme often used nowadays by shipyards and shipowners. Under this scheme, the bank may grant 60–80% of the instalments with the remaining 20–40% paid by the borrowing shipping company. Since during the construction period of the vessel (gestation period) the lending bank does not have any security for the loan granted, the shipbuilding contract is assigned by the borrowing shipping company – alongside all its beneficial interests, benefits, right and title in, to and under the shipbuilding contract – to the bank.

The assignment becomes very useful to the bank in case the borrowing company defaults in the payment of the instalment(s) to the shipyard, and abandons the transaction due to, for instance, the deterioration of the shipping market. Then the bank may be able to successfully re-negotiate with the shipyard and lower the price of the vessel; to replace the original shipping company which placed the construction order with another willing to purchase the vessel under construction and continue the completion of the transaction. Needless to say, the initiator of the construction order loses the money already paid in instalments and accepts its replacement by another company.

The refund guarantee is a security which is given by a financial institution to a shipping company

that has placed a newbuilding order to a shipyard and guarantees the return of all sums paid in instalments by the shipping company to the shipyard during the construction period if the vessel will not be constructed due to the inability of the shipyard to complete the order. In this case, the refund guarantee is assigned by the shipping company to the lending bank which becomes entitled to enforce its rights stemming from the guarantee.

5. Covenants

Covenants are contractual obligations of the borrower to the lender, that are included in the loan agreement and those referring to the vessel in the mortgage, and refer to certain actions that the borrower should or should not undertake. They, therefore, fall into one of two groups: affirmative or negative. In a non-shipping study, where financial differences between small and large firms are discussed, Walker and Petty[35] referred to four areas that are always covered by covenants in the loan agreements: liquidity, profitability, financial leverage, and dividend policy. Shipping is no exception.

According to Apilado and Millington,[36] covenants impose contractual limits on the action of the borrower and serve to reduce risk exposure. The prime objective behind the covenants is the protection of the assets' value of the borrower. Thus, the financial institution wants to maintain the market value of the assets at a higher rate than the market value of the liabilities. In such a case, when a positive net worth exists, the shipping company has a value for the borrower and serves as security for the lender. The problems are created when the market value of the assets (vessels and other assets) decreases and, when abstracting the liabilities from the assets, the net worth becomes negative. This is the reason that the hull-to-debt ratio covenant is imposed and regular valuation of the market value of the vessels, by reputable firms of independent shipbrokers, has to take place. In addition, further debt is not allowed without prior written consent of the bank and the vessel has to be well maintained and operated by the borrower.

Other covenants address: liquidity, such as the maintenance of minimum current account balances – this covenant may apply to the vessels that are financed by the bank and the accounts with the bank, or those held by other financial institutions; profitability, an example would include a ratio of EBITDA to net interest expense (e.g. not less than 2.5 to 1.0); and dividend policy, i.e. the distribution of dividends by the management to shareholders, which is not allowed without – again – the prior written consent of the bank.

Through these covenants, the bank oversees the liquidity and controls the cash flow of the company or the group, and watches over their further investment activities. Examples may include: the borrower will procure the prompt payment of operating expenses (including repairs, special surveys, maintenance and operating costs); the bank may, from time to time, and at the borrowers expense, require the borrower to obtain independent valuations of the vessel(s).

There is a wide variety of other covenants imposed by the loan agreement or the mortgage which is, of course, to be expected as protective measures in the lender's interest. This is because shipping companies operate in a very complex international business – and legal – environment and may be incorporated in one country; vessel(s) may fly the flag of another country (where the mortgage on the vessel will be registered); sail in various parts of the globe, often under dangerous conditions; the finance may take place by a bank in a different country and the loan agreement may be governed by the law of another country; and the crew may be nationals of other countries. Many of these

diametrically different conditions and factors, which may have an effect on the repayment of the loan, should be dealt with within the covenants section.

The bank's objective in using covenants is to maintain a positive net worth of the borrowing company, to create compliance incentives for the borrower, and to establish the legal background for loan monitoring. Failure of the borrower to comply with covenants is an event of default, which may accelerate the repayment of the loan or allow the lender to enforce its rights. According to Myers[37] borrowers accept the added costs of restrictive covenants as part of the price of acquiring funds needed for their business operations. However, shipping banks, when imposing covenants, should maintain a balance between their need to secure the shipping company's net worth and its operating flexibility and investment expansion. High restrictions may prevent a company's growth, whereas an approach that is too relaxed may occasionally lead to moral hazard.

6. Further Discussion on Credit Analysis

Having looked at the securities and covenants, we can further discuss some aspects of credit analysis. Table 2 shows the statistical analysis and results of a study[38] on the effect of the six "Cs" of credit, on individual companies. The study was based on a questionnaire, as well as on long and detailed personal discussions with the senior shipping finance staff of 14 international commercial banks in London, Piraeus, Hong Kong and Rotterdam.

From the bank finance viewpoint, shipping companies fall into two broad groups: corporate shipping companies and project shipping or single-vessel companies. In the first group, the company owns, leases, charters and operates its vessels and has a strong balance sheet, particularly with respect to liquidity and gearing. The paid-in capital, together with retained earnings, should provide a buffer against market price fluctuations. Additionally, cash flow should be relatively stable and cover debt service

Table 2: Ranking of individual factors and their effect on shipping loan decisions (the six Cs of credit)

Rank	Factor	1998 Weight (%)	2010 Weight (%)
1	Borrower integrity, reputation and managerial capacity	17.25	30.00
2	Creditworthiness & Loan Record	14.53	
3	Securities (Collateral)	7.02	
4	Project Cash Flow Projections	5.86	10.00
5	Ownership Equity Stake in the Project	5.36	
6	Experience and Time Length in the Market	4.70	
7	Borrower Investment Decisions	4.35	
8	Project Hull-to-Debt (H/D) Ratio	3.86	
9	Specific Sector Conditions (Prospects)	3.85	5.00
10	Condition of the Vessel(s) to be financed	3.79	
11	H/D Ratio of the Borrower's Fleet	3.79	
12	Cash Capacity of the Owner	3.43	
13	Shipping Industry Conditions (Prospects)	3.12	
14	Age of the Vessel(s)	2.96	
15	Chartering Policy	2.37	5.00
16	World Economy Conditions (Prospects)	2.32	5.00
17	Reputation of Charterers	2.16	5.00
18	Cost Control	2.06	
19	Future Default Loans	1.65	
20	Financial Statements	1.57	
21	Company Size	1.54	15.00
22	Company Structure	1.25	
23	Engineering (Technical Team Qualifications)	1.21	
Total 100			

Source: ©Antoniou, A., Thanopoulos, A., and Grammenos, C. Th. (1998), *An Attempt to Quantify Individual Factors of the six Cs of Credit Risk Analysis in Bank Shipping Finance*, Shipping Finance Working Paper No. 3, Department of Shipping, Trade and Finance, City University Business School, London

(interest payments and contracted amortisations) by a fair margin. Collateral securities depend on the financial standing of the shipowner as well as the repayment period. Exposure of up to one year may on occasions be unsecured. Furthermore, unsecured lending can be provided up to seven years to very low risk classes by a few banks or, alternatively, secured financing up to a level of 60–70% of the market value of the vessel.

A "shipping project", or single-vessel company, is an activity which can be considered separately from the activities of the sponsor (owner) of the project. In this case, the repayment of the loan is based on the cash flow of the venture, with security cover primarily on the assets of the venture, and with no (or limited) recourse to the sponsor. All such exposures are covered by collateral. In this case, the loan does not normally exceed 70% of market value at any time. Exceptions to this rule may be considered if, for example, a favourable time charter with a satisfactory charterer is in place. Loans are also considered with a tenor of up to 10 or 12 years, for newbuildings, to accommodate structures which are typically up to two years' pre-delivery and maximum 10 years' post delivery. This applies to both "corporate" and project loans.

In Table 2, two of the financial institutions put an emphasis on corporate financing or "near corporate financing" in the sense that the single shipping company proposals for financing are assessed as part of one larger group – above 15 vessels – and the qualitative analysis treats both the

credit risk of an individual project and that of the overall group. The other 12 financial institutions have both kinds of clients: large groups and smaller shipping companies, who own between four and 10 vessels.

According to Table 2, character, managerial capacity and creditworthiness, collateral and cash flow, account for 32% of individual factors; while collateral and cash flow account for 13%. It seems, indeed, that these banks focus – or, at least, want to focus – on name lending, where managerial capacity, expertise, past investment and loan record, resourcefulness and tenacity, during a recession and depression period, are highly appreciated by them.

In 2010 discussions were held with 10 banks out of the original 14 institutions in Table 2. There have been some interesting developments. First of all, eight of the banks, in addition to financing single-vessel companies, are now involved to a greater or lesser extent with financing shipping companies which have a corporate structure or near corporate structure (e.g. a large group which owns single-vessel companies). This is partially due to the influx of public companies listed at the various stock exchanges, and in particular the New York Stock Exchange, where $US15 billion was raised through IPOs and secondary issues between 2004 and 2009. A few of these companies have also raised funds in the US high yield bond market.

During the last 10 years the size of these shipping companies has also increased. This is mainly due to increased profitability, the purchase of newbuilding and/or secondhand vessels and mergers and acquisitions. Thus, banks have become accustomed to dealing with public shipping companies; private corporate entities; near corporate shipping companies which manage a large number of single-vessel companies; and smaller entities which operate single-vessel companies. As a result, the banks assess shipping loans on a corporate basis, on a single-vessel basis and on a combination of the two; with the six “Cs” of credit analysis covering all three cases.

Table 2 currently applies mainly to the single-vessel approach or the nearly corporate structure company. However, for the corporate case it seems that the weights for factors 1 and 2 remain almost the same; on the other hand, the weights of factors 20, 21 and 22 – namely financial statements, company size, and company structure – have increased to approximately 5% for each component. At the same time, the weights for factors 15, 16, and 17 – chartering policy, world economy conditions, and reputation of charterers – have been raised to 5% per item. This is due to the relatively weak and uncertain market conditions. The same applies for the specific sector conditions factor (Factor No 9).

Thus, changes in Table 2 are indeed a manifestation of the dynamic nature of credit analysis which follows the cyclical developments of the shipping markets. Generally speaking, Table 2 remains in most of its parts strong.

The six “Cs” of credit is an analysis which investigates the past and makes inquiries for – and projection to – the future. It requires meetings with principals of the company and key staff, analysis of financial statements and legal chartering contracts. It also necessitates the existence of a web of contacts for obtaining information about the shipping company, such as other banks that have provided finance for its vessels, its trade creditors and shipbrokers. In essence, the loan officer and his/her independent credit committee have to be in a position to assess the parameters of a qualitative model which, in a brief summary form, includes: the management’s expertise and integrity; the debt, equity and net worth; the cash flow; the mortgaged vessels and the guarantees for the loan; and the external economic and financial environment, where the company operates. This model provides a

deep knowledge of the borrower's company and its loans. The assessment should provide the probability of loan repayment or default.

Over the last two decades, a number of banks have rated the shipping companies, shipping groups, and the loans offered, in a similar way the rating agencies[39] rate the bond and other debt issues. Table 3 shows the rating scale of Standard and Poor's and Moody's.[40] The financial institutions undertake their credit risk analysis (based on the six "Cs" of credit), and they then feed with financial information – mainly ratios – their own rating model, in order to produce the rating of the project – and/or the company – to be financed. The rating indicates the default probability. A large number of smaller financial institutions do not use models,[41] but do use ratings provided by methodologies developed by rating agencies (such as Moody's and Standard & Poor's) based on the experience of both the rating agency and the lending bank. This has become a widespread practice in banking industries after the imposition of the new capital agency rules in 2008. (See Section 6.3.)

Table 3: Rating scale

Rating Scale	S & P	Moody's
Highest Quality	AAA	Aaa
High Quality	AA	Aa
Upper Medium Quality	A	A
Medium Grade	BBB	Baa
Somewhat Speculative	BB	Ba
Low Grade, Speculative	B	B
Low Grade, Default Possible	CCC	Caa
Low Grade, Partial Recovery Possible	CC	Ca
Default, Recovery Unlikely	C	C

Source: Standard & Poor's and Moody's Investor Service

The credit decision to grant the loan is, thus, based on the six "Cs" of Credit Risk Analysis and on the rating of the company. Other factors which impinge on decisions, such as pricing and capital availability, are discussed below. The shipping industry, due to the volatility of freight rates has a BB, Ba rating, which places it into the "somewhat speculative" group of Table 3. There are certainly companies which belong to AA, Aa; and companies and loans whose rating is CCC, Caa as well. It is for the financial institution to target the desirable group of clients and to attract them. Should a loan, in any way, have a low rating, the provision of appropriate securities may be required. In addition, the pricing will reflect the rating, which is the topic of the next section.

6.1 Pricing of the loan

The process of assessing the probability of credit risk, or default, is also linked with the pricing of shipping loans. In general, shipping companies, which are closer to risk-free business, should compensate the banks with lower returns on shipping loans, while the ones with an increased probability of default should reimburse the banks with a higher return. The difference between the risk-free loan and the risky one is the default risk premium, the compensation of the bank for the additional risk involved.

A pricing model for shipping loans may contain four components: the marginal cost of funding the loan, which is normally the LIBOR; the bank's administrative and overhead cost structure to initiate, analyse and monitor the shipping loan; the default risk premium of the shipping loan to be granted; and a profit margin that includes an acceptable return to shareholders. The bank, when charging the

interest rate on a shipping loan, uses LIBOR (or the cost of the customer deposits that will be converted into loans) which is the first component, as a basis, and adds a spread (margin) which contains all the other three components.

In addition to spread, the financial institution charges fees for the provision of the loan. Two usual forms of fees are "facility fee" and "commitment fee". The facility fee is normally a flat fee, rewarding the bank for administering the proposal and granting the loan. Commitment fee is the percentage fee paid from the time the Loan Agreement is executed until it is drawn. It usually lasts for a period between six months and a year. Finally, the borrower may be asked to maintain a compensating deposit balance in the current account of the shipping company, kept with the bank. This requires that a minimum balance of the account will be maintained by the borrower, either on an average annual basis or an absolute flat amount (e.g. the minimum balance of the account will never be below $1m). Since such accounts are interest-free, or may command a lower interest rate, the effective cost of the loan increases. Furthermore, the bank controls – or follows closely – the borrower's liquidity; thus, also the profitability of the bank.

When a financial institution is setting spread, fees, and compensating balances, the hard competition in the banking market for creditworthy and desirable customers is taken into account. The more competition that exists, the greater the probability that the bank will head for a leaner profit. In a competitive international banking environment, funding, administrative costs and default risk are determined by the bank's internal decisions, while the profit margin is also influenced by external competition

Bank Shipping Finance is, for many banks, primarily relationship banking, which refers to the provision to an existing borrower of an array of banking products – such as: cash management; derivatives; foreign exchange dealings; letters of credit; letters of guarantee; and advisory services. Here, the financial institution increases the fee income from the borrower and strengthens their relationship and mutual loyalty.

Financial institutions measure the overall profitability of the borrower and, for this reason, the following relationship can be established.[42]

$$\text{Net Before-Tax rate of return to the bank from the overall borrower's relationship during the year in question} = \frac{\text{Loan and other services income provided to the borrower} - \text{Costs of loan and other services provided to the borrower}}{\text{Average amount of loans to the borrower} - \text{Average deposit balances}}$$

The numerator of this formula includes all sources of income in a particular year, such as the expected interest rate, loan fees, commission from foreign exchange transactions, cash management, letters of credit less all the costs that are incurred in the same period, for the provision of the services. These costs include – among others – salaries, utilities, rent, expenses for the initiation, analysis and monitoring of the loan, interest on this borrower's deposits, and costs of funds to lend to this borrower. The denominator includes the average loan amount of the year in question minus this borrower's average amount of deposits after subtracting the reserves that may be required by the monetary authorities. However, in the eurodollar market, deposit reserves are not required. Should the rate of return be positive, the loan proposal may proceed from the profitability viewpoint, since the required income exceeds the expenses. In case the rate of return is negative, the income and cost items should be reconsidered.

Grammenos (1995)[43] investigates the profitability of the shipping departments of four international banks from 1988–1995. Table 4 shows the major components which are: interest and fees from loans; commission from foreign exchange dealings and remittances; collection of cheques and deposits; letters of credit and guarantee. It is evident that there is an increasing trend for non-interest activities, the volume of which – and therefore the profits – increase.

In a survey Grammenos[44] discusses, again, the profitability concept from 1998–2001 as he revisits the same departments, where he identifies two fundamental changes. The first is the very intense focus on the overall return to the departments, through relationship banking. This is evidenced by their target return imposed by the head offices

Table 4: Average gross income by source of four international banks

	1988	1989	1990	1991	1992	1993	1994	1995
Interest and fees from loans	60%	58%	57%	55%	54%	52%	52%	51%
Foreign Exchange	19%	21%	23%	23%	23%	25%	25%	26%
Commission*	21%	21%	22%	22%	23%	23%	24%	23%

*Charges on Remittances, Collection of Cheques, Deposits, Letters of Credit, Letters of Guarantee and others

Source: Grammenos, C.Th. (1994): "Financing the International Fleet", Nautical Institute Annual Lecture, Royal Society of Arts, London

and the detailed sourcing of the earnings and the costs. The second is the appearance of new sources, such as derivatives and advisory services, and the intensification of banking efforts for cash management of the shipping companies by large sophisticated banks. Thus, as is evident from the first column of Table 5, the main source of their income remains the loan (loan interest and fees), ranging from 45–60% of their total return from loan and services, while the borrower-related fee services account for 42–60%. These two fundamental changes are in line with the need for a rise in the banks capital base rate, which, through increased profitability, enables them to expand. It is partly a consequence of capital adequacy, a topic which is discussed in Section 6.3 of this chapter.

In 2010 the same four banks were revisited (after the credit crunch in 2008–2010). This followed the creation of toxic assets, initially from the USA and then internationally, and led governments to give a helping hand to some banks (which faced a solvency crisis) by recapitalisation through partial nationalisation; central banks to provide cheaper credit to financial institutions; banks to face serious difficulties with the granting of shipping loans due to lack of liquidity in the interbank market, which resulted in higher cost of funds for the banks and, consequently, for shipowners; and shipowners to cancel, postpone or convert their newbuilding orders into other vessels.

As a result, the income from loan interest has increased due to rising spreads (see Table 5 below).

Fees from syndication have decreased due to the fact that, in accordance with the accounting regulations, they have to be split equally over the repayment period of the loan. The income of cash management has decreased due to strong competition in the market. However, profitability continues to be one of the three major goals of senior and junior management (the other two are sound business and competitiveness) as a means to strengthen much-needed banking capital; expand the banking business; and attain an acceptable return for shareholders.

Table 5: Sources of income of shipping departments of four international banks, 1998–2001 and 2009–2010

	% 1998–2001	% 2009–2010
Loan Interest	30–40	45–55
Loan Fees including syndication	15–20	10–15
Derivatives: FFAS, Interest Rater, Swaps	10–15	5–10
Foreign Exchange	10–15	10–15
Cash Management (Deposits – Collection of Cheques – Remittances – Float*)	20–25	15–20
Financial guarantees; Letters of credit	2–5	2–5

* The total of non-interest bearing deposit balances at any particular day that is deposited overnight
Source: Grammenos, C. Th. (2002 and 2010): "Sources of Income of Shipping Departments of Four International Banks, 1998–2001 and 2009–2010", unpublished survey

6.2 Syndication

Syndication is a common method nowadays for bank shipping finance, when a loan is made by two or more financial institutions, on similar terms and conditions, using common documentation and administered by a common agent.[45] It can involve over 60 participating banks where the lead banks do the structuring and pricing and receive higher fees than participants. In shipping, it is mostly the smaller form, four to eight banks, all of them have shipping expertise and portfolio, all members are equal, all contribute to structuring and all receive same fees; this is known as "club syndication".

In the loan interest item of Table 5, interest is included from both bilateral and syndicated loans - but it has not been possible to specify the exact percentage of each, since the ratio of bilateral to syndicated loans is quite diverse, reflecting the bank's loan syndication policy.

The reasons for syndication lies in a number of factors, the most important of which are: the need for large amounts to be financed; the spreading of risk; the increased banking return (only for the bank (s) underwriting the syndication nor for the participating banks) which includes spread[46] and additional fees charged to the borrowers; and the opportunity for banks to gain experience, international reputation and opportunities which they might not have otherwise, to participate in the financing of leading shipping companies, who are the target clients for syndication. The main negative elements are a disagreement with a decided course of action; a slower decision-making process in comparison with bilateral financing, which involves only one bank; and ancillary business which is spread too thinly or a bank may only be lending cheap dollars and have no additional justification for the transaction.

Fees from syndication include the arrangement fee for the arranger, which is normally the leading bank of the syndication; the participation fee, which is given to each participating bank in accordance with its paid on amount; the commitment fee, which is based on the undrawn amount of the loan until its full drawdown; and finally, the annual agency fee, which is the amount of remuneration of the agent/bank which monitors and administers the loan and handles all payments of the borrower to the syndicate.

6.3 Capital adequacy rules

Traces of the emphasis on profitability can be partly found in the Capital Adequacy Rules imposed, on 1 January 1993, by the Basel Accord on International Convergence on Capital (Basel I). It was the first time that the capital of the bank – and therefore its solvency – had been linked with the varying degree of credit risk of the bank's groups of assets (e.g. cash, bonds, residential mortgages, commercial

loans) on and off its balance sheets. Each asset group was given a different weight of risk (e.g. cash 0%, municipal bonds 20%, loan mortgagees for residential properties 50% and commercial loans 100%) and the total capital of the bank – core capital and supplementing capital, or tiers I and II – should be a minimum, or higher, of 8% of the risk-adjusted total assets. This produces the Risk Asset Ratio, the formula of which is as follows:

$$\frac{\text{Total capital (Tiers I and II)}}{\text{Risk-adjusted assets}} \geq 8 \text{ per cent}$$

According to the 1993 Basel regulations, shipping (and all other commercial) loans had the same risk weight (100%), despite the fact that different companies and loans represent different degrees of risk (i.e. AAA, A, B- or CCC). However, it was later argued that a 100% weight may induce bankers to concentrate on more risky loans to boost their return on assets and increase their capital base, consequently creating value for the banks and at the same time increasing their risk exposure. This may result an escalation of their loan losses which could subsequently destroy value for the bank.

The new rules of the Basel Committee for Capital Adequacy Rules (Basel II) were introduced in January 2008. Two principal options are used for the measurement of credit risk: the standardised approach (SA) and the internal rating-based approach (IRB). Both apply to corporate exposures and include many shipping transactions. The SA introduced the use of credit risk ratings, similar to Moody's and Standard and Poor's, while it draws on external credit assessments for determining the risk weights. Table 6 shows that a wider range of weight groups has been introduced. Most of the shipping companies operating in a risky environment fall into the groups of 100 or 150% with a corresponding 8 or 12% capital adequacy requirement.

The IRB approach, on the other hand, has two variables: foundation and advance. Under foundation, the banks assess the risk of default of the borrower, but estimates of additional risk factors are derived through the application of standardised supervisory rules. To follow the foundation approach, a financial institution has to demonstrate that it has an appropriate internal rating system, risk management process and ability to estimate the risk components.

The advance IRB approach is for institutions that are currently using a well-developed risk management system to assess both their credit risk profile and their capital adequacy. As such, a central measurable concept is the probability of default (PD) of a borrower. This is in association with the magnitude of likely loss on the exposure, the loss given default (LGD), and with the amount the bank was exposed to the borrower at the time of default, the exposure of default (EOD). Finally the maturity of the exposure (M) is taken into account. The PD, LGD and M are estimated and used as inputs to calculate corresponding risk weights. The risk weights are multiplied by EOD and the resultant amounts are added across the portfolio of the bank. Thus, the required capital adequacy of the bank can be calculated. Needless to say, models are in use for this calculation.

In October 2001, "Object Finance" was included among other areas of finance in a Working Paper published by the Bank for International Settlements (BIS) on "Internal Ratings-Based Approach to Specialised Lending Exposures". Object finance deals with providing finance for equipment – such as ships, aircraft, trains; it is the method used in bank shipping finance for pledged vessel(s), which generate cash flow, assigned to the

Table 6: Risk weights for 2008 capital adequacy framework

Claim	AAA to AA–	A+ to A–	BBB+ to BBB–	BB+ to B–	Below B–	Unrated
Corporates	20%	100%	100%	100%	150%	100%

Source: Grammenos, C. Th. (2008): Unpublished survey on capital adequacy rules and bank shipping finance

bank. In this case, the concepts LGD, PD and M, in order to be quantified, and Capital Adequacy to be determined, an object rating, a client rating and an integrated rating, are required. The object rating takes into account the characteristics of the vessel(s) to be financed, the financing terms and the shipping market risks. The client rating considers parameters, such as, the borrower's management capacity, track record, and financial data (i.e. information contained in the six "Cs" of credit analysis). Finally, an integrated rating will be created, which combines both object and client rating.

IRB and object finance differ in that the first deals with corporate exposures and the second with specialised lending exposures. However, not all transactions will fit neatly into one group. The object finance method takes into account the collateral securities of the loan, while IRB does not.

A consequence of the 2008 Capital Adequacy Rules is that smaller shipping companies may be at a disadvantage, since the capital adequacy requirements may be higher for them than the current 8%, due to, for instance, a higher percentage of financing – over 60% – or the lack of sufficient secured income; or lack of transparency due to the bank being provided with annual non-consolidated (and often unaudited) accounts from the shipping company. This would result in an increase in the adequate capital of the bank, the cost of which would be passed on to the customer. In addition, these companies, being smaller, show a lower overall profitability in their banking transactions for their lending banks. As a result, they may not be included on the list of desirable clients of these financial institutions. Therefore, a number of banks have three customer tiers (I, II and III) based on the credit risk rating, the resulting capital adequacy requirement and overall profitability from relationship banking.

7. Loan Monitoring

Loan monitoring is essentially the periodic evaluation of the shipping loan portfolio, by the shipping department, through the qualitative model of credit risk analysis (referred to above) and the six "Cs". This may happen, for instance, twice a year or whenever there are developments in the loans that require the attention of the bank. The prime objective is for the loan officer to ensure:

a. the borrower's compliance with the covenants and also that his/her management capacity and integrity remain at the required levels;
b. the net worth is sufficient for the loan's overall security and/or the target hull to debt ratio remains as required;
c. vessel(s) continue to be employed efficiently;
d. cash flow is satisfactory for the payments of capital instalments and interest; and
e. the financial conditions of the personal or corporate guarantors have not deteriorated.

All these factors are scrutinised at the time of the periodic review of the loan and under future probable, economic, financial, and shipping conditions.

Management restructuring, splits and death, may have a negative implication for the operation and financial condition of a shipping company. While changes in an owner's character and integrity in a period of depression may be an exceptional event, moral hazard expects a demanding monitoring

requirement, particularly in a depressed shipping market. Debt repayment and cash flow of financed vessel(s), vessel(s) financed by other banks, and overall group fleet, should be analysed for the purpose of identifying over-borrowing and adverse revenue and cost developments, which may squeeze the cash flow available for the debt service.

Market movements are the main cause of a decrease in freight rate revenue, although likely reasons also include an aggressive chartering policy, (i.e. vessels are chartered in the spot market where income is higher for a short period) in comparison with the time charter market; unsatisfactory vessel performance in contrast to what is expected in accordance with the charterparties; default on the part of charterer; vessel inactivity from factors such as arrest, repair and blacklist. Costs may increase due to factors such as running cost escalation (mainly crew, technical and insurance), and adverse interest and currency movements.

The bank will normally monitor overall conditions in the world economy and international trade, related industry or commodities, and the shipping market, which may have implications for the repayment of its loan(s). These include: changes in economic policies (e.g. as anti-inflationary economic policies in the early 1980s); political events (e.g. the nationalisation of the Libyan oil assets in 1971 and the Iranian political unrest in 1979); new legislation the Oil Pollution Act of 1990 that was decided unilaterally by the USA, or the International Safety Management Code of the International Maritime Organisation); and vessel blacklisting. In addition, scenario analysis for the cash flow and repayment of the loan under different economic conditions and assumptions is part of the job. The unpredictable fluctuations of income and asset value levels mean that a constant review of a vessel's market value and the practical effectiveness of collateral securities is an essential part of the monitoring process. In terms of mortgages and vessel value, the main reasons for a decrease in value are current and expected or unexpected market conditions – although vessel condition, technology and new legislation are also relevant. A decrease in vessel value may result in the hull-to-debt ratio falling below permitted levels. This indicates an increase in the probability of default, as the real economic worth of the company decreases. Finally, falling freight rates and vessel market values – which may affect payments of loan instalments and securities of the loan, dry up compensating balances and postpone payments for trade creditors – are usually strong indicators of future problematic loans.

Once or twice a year, and whenever extraordinary conditions demand, a review of the shipping loan portfolio takes place as part of the monitoring process. Should loans be identified as having weaknesses regarding their repayment, they would be adversely classified according to the probability of loan loss.[47] This normally happens in a bad market. In this case, the bank may take immediate steps to minimise the loan loss effect.[48] However, this discussion is beyond the scope of this analysis.

Additional issues of importance for monitoring are the amount of a vessel(s) revenue assigned to the bank and the validity of insurance security in respect of paying premiums and complying with policy clauses. Liquidity problems may also arise from trade creditors. A sharp rise in the amount owed to trade creditors (they should not normally be in excess of 90 days) may indicate a difficulty in meeting short-term obligations. A bank being paid promptly may prove to be of limited use if the crew or creditors – such as suppliers – have serious outstanding debts. This could lead to arrests, disputes and non-performance of the vessel, which would affect liquidity and, in turn, the bank's loan.

8. Shipping Credit Policy

A shipping credit policy is a package of general and specific guidelines that refer to important factors for providing bank shipping loans, allocating responsibilities and creating a mechanism of control. It creates an internal shipping framework for the bank, within which loans are initiated, analysed, approved, granted and monitored and is a means of comparing the actual and projected performance. This may differ from bank to bank. For example, large commercial banks may have a credit manual for controls and responsibilities and procedures for all departments, then specific guidelines for shipping setting only credit boundaries for the portfolio; a financial institution that concentrates on shipping and transport may have a more detailed shipping credit policy.

The skeleton outline in Table 7 covers the fundamental areas of the content of a credit policy chart. The overall exposure of the bank to the shipping industry depends upon the decision for diversification or specialisation. The rule of thumb of portfolio theory is diversification. The extent of the bank's involvement in shipping finance, percentage-wise, versus other sectors, such as manufacturing, agriculture, energy, aviation and real estate, depends upon a number of factors, among which are the bank's size; its geographical position (small local bank or international bank operating in large business capitals); its shipping expertise; the strength of its shipping department and credit committee; the fact that the bank may be more energy focused and therefore the shipping department more tanker oriented; the bank's loan loss experience, the shipping loan(s)' perceived risk and its/their profitability compared to other sectors, and the shipping sector's overall security cover in comparison with that of other banks. Large international or regional commercial banks may have an exposure to shipping between 1 and 5%, although a higher exposure (such as 10%) is not totally unthinkable.

A financial institution may decide to allocate lending funds to different geographical locations and/or shipping markets and/or shipping companies to diversify its shipping portfolio. Geographical diversification involves traditional or newer shipping centres, such as London, New York, Piraeus, Oslo, Hamburg, Rotterdam, Nicosia, Istanbul, Tokyo, Hong Kong, Singapore, Seoul and Shanghai. Market diversification includes financing companies which operate different types of vessels, for instance, wet/dry, container, cruise, passenger and car. These factors, individually or in combination, may affect the overall risk profile and the bank's exposure to such risk, in particular during

Table 7: Contents of bank shipping credit policy

Size of Loan Portfolio
Fund Apportionment and Desirable Clientele
Facilities Offered: Terms and Conditions
Legal Aspects
Loan Documentation
Type of Bank Participation
Loan Granting, Lending Authority and Responsibility
Administrative Structure, Credit Committee

Source: Grammenos, C.Th. (1983), "Bank Shipping Finance: A Spherical Approach", paper presented at Europort Congress, Amsterdam

a falling shipping market when income decreases and payment of the loan capital and interest may become problematic.

A shipping credit policy may detail all types of shipping loans that the bank is to grant, the maximum percentage of the market value of the vessel(s) to be financed, in conjunction with the securities offered or the maximum amount to be lent to a low-risk shipping company, on the basis of a

stable and sufficient cash flow. In addition, the spread, maturity, amortisation schedules, interest rates and currencies may be discussed. The array of securities, their usefulness and limitations, in conjunction with properly documenting the loan, are part of the credit policy. Indeed, banks have been shocked to realise that poorly drafted loan agreements and mortgages, or lack of proper communication with insurance underwriters, have restrained or delayed them from enforcing their rights, as lenders, on the borrower's assets and other collateral.

In a credit policy document, the bank should clarify whether shipping loans will be financed on a syndicated or an individual basis. Syndication strengthens the collective financial power of the bank and increases its profitability through syndication fees. Individual financing by a bank, in combination with relationship banking offered services, strengthens profitability and loyalty.

Administrative aspects of loans, such as the maximum amount that can be granted by loan officers, or at a higher level, and the type of decision-making structure (centralised or decentralised), can be seen in a credit policy document. In the 1970s and 1980s, many European and Japanese banks were more "bureaucratic", while American banks followed the speedy decentralisation approach. In recent years there has been a distinct improvement in the decision-making process for bank loans, which recognises the need for a rapid reaction in the dynamic vessel sale and purchase market; the new banking generation seems to be more oriented (and receptive) to banking competition and, at the same time, is prepared to cooperate through syndication. Finally, the role of the credit committee and its composition should also be explained in a credit policy document, as a body which discusses, modifies, approves or turns down, credit proposals of the shipping department.

A powerful example of the usefulness of credit policy is given in Table 8. This shows the results of a survey on the shipping credit policy of 10 international commercial banks and how it progressed between 1979 and 1994.[49] In 1979, the results of the study indicated that three of the banks had quite clear (as detailed as in Table 7) shipping credit policies, while six had a vague policy and one did not have an established

Table 8: Shipping credit policy of 10 international commercial banks

Year	No. of Banks	Credit Policy
1979	3	Quite clear
	6	Vague
	1	Absence of credit policy
1994	9	Clear credit policy
	1	The bank no longer exists

Source: Grammenos, C.Th. (1994), "Financing the International Fleet", Nautical Institute Annual Lecture, Royal Society of Arts, London

shipping policy; in 1984, the two with a clear credit policy suffered small to moderate loan losses; the banks with a vague credit policy, and the third with a clear credit policy, suffered moderate to substantial loan losses; while the losses of the bank without credit policy were devastating.[50] In 1994 the credit policy of the same banks were reexamined. The results reveal that nine of these 10 banks had formulated a clear shipping credit policy, while the remaining bank, which did not have a credit policy in 1979, was no longer in business.

9. Conclusions

In this chapter, minimising credit risk in bank shipping finance, for the acquisition of vessels, has been discussed within the framework of the lending function. During this process, banks may be

challenged by information asymmetry, adverse selection and moral hazard.

Bank Credit Policy provides the framework within which credit risk analysis – as manifested by the six "Cs" of credit – of shipping loan proposals takes place. Both bank credit policy and credit risk analysis are the backbone of credit risk control. Banks also have other means – not cast iron, of course – to strengthen the soundness of shipping loans: securities, covenants and monitoring.

Credit risk, or credit default, may be measured by rating the loan and the shipping company. Rating is also linked to the default risk premium and thus, to pricing. Shipping loans are a substantial part of bank shipping revenue, which is based on a wider web of services offered to shipping companies – the relationship banking. As such it may increase the gross profits of banks, and may strengthen their capital base, a necessary path for increasing their value and a contributor to sound banking expansion. Capital soundness is a requirement of the Capital Adequacy Rules; in 2008 new regulations were introduced across the banking spectrum, on the use of rating and advanced statistical techniques.

In 1977 (see endnote 13) and in 1979 (see endnote 14) Grammenos stated that the market and credit risk in bank shipping finance can be minimised by the use of two basic tools.

"…the formulation of sound credit policy by the bank officials, after careful consideration of relevant factors; and accurate and prudent credit analysis of each shipping project proposed for finance."

These still remain the basic tools.

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Endnotes

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1. There are a limited number of studies in shipping finance. In the areas of IPOs, for instance, Grammenos, C. Th. and Marcoulis, S. (1996) Shipping Initial Public Offerings: A Cross-country Analysis, Empirical Issues in Raising Equity Capital, by M. Levis (ed.), Elsevier, 379–400; Grammenos, C. Th. and Arkoulis, A. G. (1999), "The Long-run Performance of Shipping Initial Public Offerings", *International Journal of Maritime Economics*, Vol. 1, 71–93; Cullinane, K., and Gong, X., (2002), "The Mispricing of Transportation Initial Public Offerings in the Chinese Mainland and Hong Kong", *Maritime Policy and Management*, Vol. 29, No. 2, 107–118; Merikas, A., Gounopoulos, D., and Nounis, C., (2009), "Global Shipping IPOs Performance", *Maritime Policy and Management*, Vol. 36, No. 6, 481–505; and Merikas, A., Gounopoulos, D., Karli, C., and Nounis, C., (2010), "Market Performance of US-listed Shipping IPOs", *Maritime Economics and Logistics*, Vol. 12, No. 1, 36–64.

On stock returns, Grammenos, C. Th. and Marcoulis, S. N. (1996), "A Cross-section Analysis of Stock Returns: The Case of Shipping Firms" *Maritime Policy & Management*, Vol. 23(1), 67–80; Grammenos, C. Th. and Arkoulis, A. (2002), "Macroeconomic Factors and International Shipping Stock Return", *International Journal of Maritime Economics*, 4, 81–99; Kavussanos, M. G. and Marcoulis, S. N. (1997), "The Stock Market Perception of Industry Risk and Micro-Economic Factors: The Case of the US Water Transportation Industry versus other Transport Industries", *Transportation Research*, Part E, Vol. 33(2), 147–58.

Other papers regarding equity capital markets include: Syriopoulos, C. T., (2007), "Financing Greek Shipping: Modern Instruments, Methods and Markets", *Maritime Transport*: *The Greek Paradigm*, in Pallis, A. A. (ed.), Research in Transportation Economics, Vol. 21, chapter 6, 171–219 (this paper also covers the high yield bond market for shipping companies); and Mourdoukoutas, P., and Stefanidis, A., (2009), "To List or Not to List: Expectations versus Reality for Greek Shipping IPOs", *South East European Journal of Economics and Business*, April, 125–134.

2. In the area of Mezzanine Finance, the following study is relevant, Grammenos, C. Th. and Dheere, M. J. (1990), "International and US Initial Public Offerings and Private Placements of Equity for Shipping Investments for 1987 – 1988", City University Business School (Study commissioned by Pegasus Group).

3. In the area of High Yield Bond Issues, there are only four studies: Leggate, H. K., (2000), "A European Perspective on Bond Finance for the Maritime Industry", *Maritime Policy and Management*, 27, 4, 353–362; Grammenos C.Th., Arkoulis A.G., (2003), "Determinants of Spreads on the New High Yield Bonds of Shipping Companies", *Transportation Research*: Part E, 39, 459–471; Grammenos C. Th., Alizadeh, A. H., and Papapostolou, N. C., (2007), "Factors Affecting the Dynamics of Yield Premia on Shipping Seasoned High Yield Bonds", *Transportation Research* Part E, 43, 549–564; Grammenos, C. Th., Nomikos, N. K., and Papapostolou, N. C., (2008) "Estimating the Probability of Default for Shipping High Yield Bond Issues" *Transportation Research* Part E, 44, 1123–1138.

4. A number of international banks realised shipping loan losses, during the heavily depressed shipping market between 1983 and 1986. Among them, National Westminster Bank, Bank of America and Hill Samuel. Which they decreased substantially or ceased their shipping finance activities.

5. Altman, E. I. (1980), "Commercial Bank Lending: Process, Credit Scoring and Costs of Errors in Lending", *The Journal of Financial and Quantitative Analysis*, Proceedings Issue, Volume XV, No. 4. In this paper, Altman refers to the following four steps of the lending function: (i) application for a loan; (ii) credit evolution; (iii) loan review; and (iv) repayment performance.

6. A financial institution that lends funds to shipping companies for acquisitions of secondhand vessels or placements of newbuilding orders may face additional risks – such as interest rate risk, where the probability of a change in interest rates may adversely affect the bank's profit margin (this happens when a financial institution converts a deposit into a loan and does not match the deposit's period of its customer, or the deposit's period that obtains from the Interbank Market with the period of the loan); liquidity risk which is the probability of the bank not having sufficient cash and proper borrowing capacity (cash destruction) to match deposit withdrawals, resulting in its paying higher interest rates on borrowed funds; or solvency risk which is the probability of a financial institution withdrawing from the market due to inadequate funds (capital destruction) to meet losses from bank loans or deterioration in the market value of the asset portfolio. Cash destruction leads to liquidity crisis; while capital destruction leads to solvency crisis.

7. Grammenos, C. Th. (1979), *Bank Finance for Ship Purchase*, *Occasional Papers in Economics*,

University of Wales Press, Ch.2.

8. The shipping industry uses mainly the eurodollar market, which is the largest unregulated market for deposits in dollars placed outside the United States; and for euroloans which are dollar denominated loans granted by banks outside the United States.

9. However, there are financial instruments such as interest rate derivatives, which can be used for hedging interest rate risk, offered by financial institutions, at a cost. For more details on how to use interest rate derivatives for hedging, see e.g. Hull, J. (2008), *Options, Futures and other Derivatives*, Prentice Hall International and Kolb, R. W. (2007), "*Futures, Options and Swaps*", Blackwell's Business Publishers, London, UK. Further, see Rebonato *et al*. (2009), "The SABR/LIBOR Market Model: Pricing, Calibration and Hedging for Complex Interest-rate Derivatives", Wiley. Chacko & Das (2002), "Pricing Interest Rate Derivatives", *The Review of Financial Studies*, Vol. 15, No. 1, pp.195–241.

10. For a general literature survey on asymmetric information in credit markets, see Bhattacharya, S., Thekor, A. (1993), "Contemporary Banking Theory", *Journal of Financial Intermediation* 3, 2–50, and Van Damme, E. (1994), "Banking: A Survey of Recent Microeconomic Theory", *Oxford Review of Economic Policy*, 10, 14–33. Also see Huang, G-L., Chang, H-C (2006), "A Comprehensive Study on Information Assymetry Phenomenon of Agency Relationship in the Banking Industry", *The Journal of American Academy of Business*, Cambridge, Vol. 8, No. 2.

11. Diamond, D. W. (1984), "Financial Intermediation and Delegated Monitoring", *Review of Economic Studies*, Vol. 42, Issue 3, 393–414. Diamond discusses his theory of banks as delegated monitors.

12. This chapter discusses the management of credit risk by using physical instruments (e.g. collateral securities); however, in corporate finance they quantify such a risk and often use very expensive credit derivatives. These derivatives have been mainly – and not widely – used, during the last decade, by major financial institutions for large shipping loans of higher perceived credit risk. For more details on credit derivatives, see for example Hull, J. (2008), *Options Futures and other Derivatives*, Prentice Hall International; and for a discussion on the use of credit derivatives by banks to secure the risk associated with loans, see Duffee, G. R. and Zhou, C. (2001), "Credit Derivatives in Banking: Useful Tools for Managing Risk", *Journal of Monetary Economics*, 2001, Vol. 48, No. 1, 25–55; and Minton *et al*. (2009), "How Much Do Banks Use Credit Derivatives to Hedge Loans?", *Journal of Financial Reserves*, Vol. 35, 1–31.

13. Grammenos, C. Th. (1977), "The Need for Credit Policy and Analysis in Bank Shipping Finance", Paper presented at Institute of European Finance, Bangor.

14. Grammenos, C. Th. (1979), *Bank Finance for Ship Purchase*, *Occasional Papers in Economics*, University of Wales Press. In this book, the author processed and analysed over 350 confidential files of loans granted by five international banks, and one regional, to shipping companies mainly for second-hand purchases, but also for newbuildings. Principles for granting sound loans were established through the introduction of credit analysis (the so called five C's of Credit Analysis) and credit policy.

15. See Section 3.4.

16. Grammenos, C. Th. (1994), Nautical Institute Annual Lecture, Royal Society of Arts, London. In

this presentation, the author referred to 100 problematic loans as they stood in 1984. The loans were granted between August 1979 and end 1980 to medium-size shipping companies, by international medium- to large-size banks. The striking common elements of all of them are that loans were provided when freight rates and market values of the vessels were high; the financing of the market value of the vessels was between 75 and 85%; and these vessels had to compete in a recessed or depressed shipping market from 1983–1986 with other vessels bought at much lower prices.

17. Pre-Tax Funds flow and Interest Coverage = Net Income (Loss) from continuing operations + Gross Interest Expense – Interest Capitalised + Income Tax Expense + Depreciation + Amortization ÷ Gross Interest Expense.

18. The market value of the vessel over the outstanding debt that the company incurs for the vessel's purchase. See for further explanation, section 4.1.

19. Two ratios related to cash flow and cash cushion, employed at a great extent by Moody's in their rating methodology of shipping high yield bonds, are the free cash flow (FCF) to debt and the cash reserves. The FCF-to-debt ratio reflects the cash flow after capital expenditure, and focuses on the assessment of debt repayment capacity. A company with a negative FCF-to-debt ratio is considered more vulnerable to liquidity shocks than a company with a positive ratio. Cash reserves, measured as cash and cash equivalents to total assets, is a snapshot measure of immediate cash availability (Moody's, 2010. Shipping Rating Methodology: Global Shipping Industry).

20. An important reason for the establishment of such companies is the "sister ship" principle, which is found in many jurisidictions, according to which a claim *in rem*, that is to say a claim in object, can be transferred to any other vessel, which belongs to the same beneficial owner. The creation of different shipping companies of limited liability, each one of which owns one vessel and all of these still controlled by the same owner, over-rides the "sister ship" principle. Claims which arise against a particular vessel of this fleet, for example, by a bank or trade creditors, cannot be transferred to any other vessel of the fleet.

21. Capital costs are affected by the capital structure of the company. The cost of banking loans is still the lowest, in comparison with bond and high yield issues, while the cost of equity is the highest. The overall cost of capital including debt, preferred stock and common equity, the weighted average cost of capital (WACC) decreases initially with marginal increases in debt until the point that the company reaches its optimal capital structure. Beyond this point, an increase in debt may result in increase of WACC. For more information on the WACC concept and estimation see Myers and Brealey (2005), Principles of Corporate Finance, McGraw-Hill/Irwin, Chapter 17 and Ferro (2009), "The Weighted Average Cost of Capital (WACC) for Firm Valuation Calculations", International Research Journal of Finance and Economics, Issue 26, 148–150.

22. Metaxas, B. N. (1971), *The Economics of Tramp Shipping*, The Athlone Press, chapter 7. In this quotation, Metaxas refers to "tramp shipping services", since his book is on tramp shipping. However, his quotation applies to liner as well.

23. For an analysis of fluctuations in shipping and shipping cycles, see Metaxas, B. N. (1971), *The*

Economics of Tramp Shipping, The Athlone Press, chapter 3; Stopford, M. (1997), *Maritime Economics*, Routledge, chapter 2; Grammenos, C. Th. (1979), *Bank Finance for Ship Purchase*, *Occasional Papers in Economics*, University of Wales Press, chapter 2. In addition, see Chapter 9 of this volume for a detailed analysis of shipping market cycles.

24. For a more detailed discussion on different types of shipping investment, including speculative asset play in relation to shipping cycles, see Chapter 23 of this volume.

25. The cash flow calculation for vessel(s) to be financed will be based on total cash receipts minus total operating and capital costs covering the period over which the loan will be repaid with a view to estimate the breakeven freight rate of the vessel(s) and the overall fleet and undertake a risk evaluation for the bank. Cash receipts include operating gross revenue, which could be fixed should there be contract of affreightment or time charter; while assumed revenue, should the vessel operate in the spot market, may be based on past (average over the last 10 years), prevailing, and expected, conditions in the vessel(s)' market. Operating expenses should be comparable to expenses of similar vessels; while projected ones should be escalated to take into account the rate of inflation. Debt service should be projected in accordance with actual loan repayment with assumed interest rates, should the interest be fluctuating. These items should be part of a scenario analysis (positive and negative), where sensitivity analysis is used.

26. In a depression phase of the shipping cycle, the charterers may be hit by the market as well. Thirty of the 100 problematic loans referred to in 16 of this chapter became problematic due to the financial troubles of the charterers of the vessels.

27. See section 6 of this chapter.

28. This section draws on Grammenos, C. Th. (1979), *Bank Finance for Ship Purchase*, *Occasional Papers in Economics*, University of Wales Press, chapter 2, and Grammenos, C. Th. and Xilas, E. M. (1988), *Shipping Investment and Finance*, V ol. II, unpublished notes for MSc Students in Shipping, Trade and Finance, City University Business School, London.

29. UK Merchant Shipping Act 1894.

30. The Statutory Mortgage is normally accompanied by further terms and conditions in a separate agreement that acts as back up.

31. However, holders of maritime liens have a priority over the claims of a mortgagee. Maritime lien is a claim against a vessel, which can be made effective by the seizure of the vessel. It is a right *in rem*, that is to say, it is attached to the vessel even after change of ownership. Among maritime liens are: salvage, seamen's and master's wages, master's disbursements, damages caused by the vessel (e.g. in collision). Possessory lien is the right of a holder of such claim, to retain possession of the vessel for any incurred expenses until the debt is paid. A typical example in this context is the ship repairer or shipyard. The possessory lien will be lost as soon as the claimant ceases possession of the vessel. Some rights of possessory liens may be created by statute (e.g. unpaid port and canal dues). The importance for the lender is that the holder of maritime, possessory and statutory liens will have – depending upon the jurisdiction – a priority over its claims.

32. The value for which a vessel is insured.

33. The value of a vessel in terms of historical cost minus accumulated depreciation.

34. Protection and Indemnity falls outside the scope of ordinary marine insurance. It is structured

through membership of Protection and Indemnity Associations (often referred to as P & I Clubs), which are formed and run by shipowners.

35. Walker, E. W. and Petty, J. W. (1978), "Financial Differences Between Large and Small Firms" *Financial Management*, Winter, 61–68.

36. Apilado, V. P. and Millington, J. K. (1992), "Restrictive Loan Covenants and Risk Adjustment in Small Business Lending", *Journal of Small Business Management*, Vol. 30, January, 38–48.

37. Myers, S. C. (1977), "Determinants of Corporate Borrowing" *Journal of Financial Economics*, 5, 147–175.

38. Antoniou A., Thanopoulos, A., and Grammenos, C. Th. (1998), "An Attempt to Quantify Individual Factors of the 5Cs of Credit Risk Analysis in Bank Shipping Finance, Shipping Finance Working Paper, No. 3, Department of Shipping, Trade and Finance", City University Business School, London.

39. According to Moody's (1991), Global Credit Analysis, IFR, "Ratings are intended to serve as indicators or forecasts of the potential for credit loss because of failure to pay, a delay in payment, or partial payment. Credit loss may be defined in general terms as the economic difference between what the issuer has promised to pay and what is actually received".

40. The rating agencies classify the bond issues according to capacity of the company to pay interest and repay principal. The distinctive division of the scale is between two groups: the investment grade (AAB, Aaa to BBB, Baa) and the speculative grade (BB, Ba to C,C). The first group ranges from extremely strong capacity (AAA, Aaa) to adequate (BBA, Baa), to pay interest and repay principal; while the second group ranges from less near-term vulnerability (BB, Ba), to default (C,C) to bonds on which no interest is being paid .

41. In the last decade, sophisticated quantitative techniques and portfolio theory have been utilised also for assessing credit risk of a bank's loan portfolio. Sinkley, J. F., Jr (2002), Commercial Bank Financial Management, Prentice Hall, in chapter 11 undertakes a presentation and discussion of these methodologies, while also voicing the strong criticism of others.

42. Rose, P. S. (2002), *Commercial Bank Management*, McGraw-Hill, chapter 19.

43. Grammenos, C. Th. (1994), Financing the International Fleet, Nautical Institute Annual Lecture, Royal Society of Arts, London.

44. Grammenos, C. Th. (2002 and 2010), Sources of Income of Shipping Departments of Four International Banks, unpublished survey.

45. Horn, S. (1990), *Syndicated Loans – A Handbook for Bankers and Borrowers*, Woodhead and Faulkner.

46. Grammenos, C. Th. (2000), An Analysis of Syndicated Loans, Granted between 1985–1999, to Tanker and Dry Cargo Shipping Companies. Unpublished paper, where 40 syndicated loans are analysed from collateral, covenants and spread viewpoints. Spread determinants were examined. These were: amount of the loan, tenor, balloon, and age of the vessels. Univariate and multivariate regression analysis were employed and the clearly statistically significant variable was tenor.

47. Grammenos, C. Th., Xilas, E. M. (1988, 2008), *Shipping Investment and Finance*, Vol. II, unpublished notes for MSc Students in Shipping, Trade and Finance, City University Business

School, London. Three categories may deal with loan losses. They are: “Loss” loans which appear uncollectable and will normally be charged to loss provisions in the financial statement of the bank; “Doubtful” loans which have considerable problems and are likely to result in losses for the bank; “Substandard” loans which have some deficiencies that may be corrected through the providing of additional security by the borrower, although there is some possibility of default. In addition, there is a further category, “Criticised” loans, which exist when they have smaller deficiencies (such as failure to provide financial statements) and appear to carry lower risk of borrower default. All other loans are considered to be sound.

48. The Problem Loan Treatment options available to banks is thoroughly discussed in Grammenos, C. Th., Xilas, E. M. (1998, 2008), *Shipping Investment and Finance*, unpublished notes for MSc Students in Shipping, Trade and Finance, chapter 12.

49. Grammenos, C. Th. (1994), Financing the International Fleet, Nautical Institute Annual Lecture, Royal Society of Arts, London.

50. One should add that the credit policy was going along, as their credit analysis (that is, from not well-established to almost non-existent in one case). Character, Capacity, was not thoroughly investigated; gearing ratio was too high, occasionally over 90%; lack of secured employment was also observed in a number of cases; while loans were granted against high vessel market values. Also, clear warnings of a recession in world economy were largely ignored by some of the banks in question. These warnings came after anti-inflationary measures taken by industrial countries, following the second major increase in oil price in 1979.

Chapter 28
Shipping Finance and International Capital Markets

Theodore C. Syriopoulos[*†]

1. Introduction

This chapter discusses key issues in modern shipping finance and explores the growing role of global capital markets in fund-raising for investment projects of shipping firms. We critically assess the attractiveness and efficiency of international equity and bond markets in particular, as important ship financing mechanisms that offer funding opportunities distinctive from traditional bank lending.

The structure of the chapter is as follows. Section 2 discusses the financial decisions in shipping and the implications of the capital structure mix for the financial performance of the firm. The major phases in modern ship finance are summarised and the dynamic role of global capital markets in shipping finance is assessed. Section 3 examines in details the function of equity markets as a financing mechanism, discusses the pricing of equity issues, analyses the risk return and volatility profile of shipping stocks and concludes with a brief presentation of alternative hybrid financing instruments. Section 4 covers the role and functions of bond markets with a focus on shipping bond credit rating and probability of default. Section 5 contributes a note on the important issue of efficient corporate governance mechanisms, emphasising on implications for shipping firms. Section 6 concludes.

2. Financial Decisions in Shipping

2.1 Strategic finance dynamics

An important shift has been seen recently in shipping finance instruments. International capital markets, predominantly equity and bond markets, have gradually gained a growing share in fund-raising for shipping firms (Syriopoulos, 2007). The capital intensity and magnitude of shipping investments requires capital availability at reasonable cost, but also careful project selection, based on a solid capital budgeting framework (Cullinane and Panayides, 2000). In a highly dynamic and volatile business environment, modern shipping finance becomes highly sophisticated, innovative and complex.

Shipping is a cyclical industry with idiosyncratic characteristics, highly leveraged assets, active second hand market and an estimated average ROA at 10% (Veraros, 2008). Market timing is critical to shipping investment decisions that bear high levels of risk and uncertainty. The behavioural pattern of shipping business is related to a number of factors, including, predominantly, the derived nature of shipping demand being sensitive to economic growth and trade, cyclicality in freight rates and vessel prices, demand and supply imbalances and fragmented business structure. The issue of optimal capital structure mix and the appropriate funding method is critical for an industry that is capital intensive and its operation employs real assets (vessels) of high commercial value.

Strategic decision making in shipping firms gradually shifts from simple profit maximisation to corporate value enhancement. To attain this, shipping firms require a selection of investment plans

that bear growth potential and produce positive returns higher than the respective cost of capital employed. Intensified competition and tighten margins in the shipping markets have led companies to constantly pursue managerial efficiency, operational flexibility, and robust financial liquidity. A shipping company can attain business growth by following either an internal or external course of development. Subject to freight market conditions, shipping firms can expand their fleet by building new assets or purchasing second hand vessels. On the other hand, mergers, acquisitions and strategic alliances can be an alternative external growth path. In any case, these corporate growth strategies, combined with replacement requirements of ageing fleets, require substantial capital funding and careful financial planning.

As shipping companies adjust to a dynamic and rapidly changing environment so do the financial methods and instruments available to funding their investments. Convenient, cheap and timely access to capital financing is a prerequisite for a flexible capital structure mix, competitiveness, undisturbed operation and sustainable growth, particularly for shipping business. Two broad approaches in fund raising can be distinguished: (1) self-sustained or internal funding, by own (shareholder) equity finance; and (2) external funding, by debt finance (borrowing). Increases in own equity are based on corporate profitability and robust retained earnings sufficient to finance prospective investment projects. This source of funding is directly affected by the dividend policy of the firm that defines profit share distribution to shareholders, albeit at the expense of potential reinvestment decisions. As to external financing, shipping firms can alternatively turn towards international capital markets in order to raise investment funding. Debt financing may come from bank lending of wide variety and sophistication (bank mortgages, leasing, mezzanine finance, securitisation). In fact, this has been the prevailing and dominant source of ship funding over the years. Alternatively, shipping firms can turn into international debt markets to issue corporate bond securities or commercial paper. Furthermore, global equity markets can enhance own equity funding by issues of Initial Public Offerings (IPOs) or Seasoned Equity Offerings (SEOs).

The role of capital markets is critical for the promotion of shipping business growth and the creation of corporate value, since capital markets perform the following fundamental functions. As ‘primary’ markets, capital markets act as intermediaries to provide the funds required to financing new investment projects and sustain business growth. Fresh funds are channelled to firms in need through the issuance of securities. Furthermore, as ‘secondary’ markets, capital markets provide an efficient mechanism for valuation and trading of outstanding equity and bond securities. Growth potentials then of the underlying shipping firm (issuer) are reflected on the price movements of the issued securities, signalling investors’ perception of the firm’s value creation prospects.

Despite the marginal participation of international capital markets in ship finance for a number of years, some revitalisation is seen in public equity and bond issues more recently, on top of dominant bank lending. However, the recent global financial crisis, escalated since mid-2008, may affect shipping firms’ priorities as to their sources of capital funding. This is related to the fact that this unprecedented crisis and the induced economic recessionary phase directly involve the international banking system as a cause of the problem rather than simply as a victim of it. Combined with pressures imposed by a much more demanding disciplinary framework, such as the Basel II Accord and governmental supervisory constraints, bank lending is expected to become more careful, selective, conservative (relative to commercial risks undertaken) and, ultimately, scarce.

2.2 Capital structure and financial performance

A company can obtain long-term financing in the form of equity (issuing shares), debt (borrowing), retained profits or some combination. There is a fundamental distinction between equity and debt as sources of capital: equity refers to firm's own funding by its shareholders and shares correspond to ownership rights. Debt, on the other hand, implies a core liability the firm has to meet over a plausible time horizon. A fundamental financial decision then relates to which of the two major fund raising approaches or mix should the firm prefer to finance its investment projects. The relative proportion of debt, equity and other outstanding securities constitutes the firm's capital structure.

When corporations raise new funds from outside investors, they must choose which type of security to issue. The most common choice is financing through equity alone or through a combination of debt and equity. Whatever the firm's choice, this affects the weighted average cost of capital (WACC) and has critical implications for the firm's ROE and risk. The firm can attain growth and enhance corporate value only in case it undertakes investment projects that produce returns higher than their cost of capital funding. An incorrect financing decision may result in many forms of higher direct or indirect costs, such as higher cost of capital, lower stock price and lost growth opportunities, increased probability of bankruptcy, higher agency cost and possible wealth transfers from one group of investors to another.

The seminal Modigliani-Miller (MM) theorem on the 'capital structure irrelevance principle' has been the cornerstone of the firm's capital structure decisions in perfect markets (Modigliani and Miller, 1958). According to the MM theorem, in an efficient market that follows a certain price process (random walk), in the absence of taxes, bankruptcy costs and asymmetric information, the value of a firm is unaffected by how that firm is financed. It does not matter if the firm's capital is raised by issuing stock or selling debt or what the firm's dividend policy is. In other words, the market value of a firm is determined by its earning power and the risk of its underlying assets and is independent of the way it chooses to finance its investments or distribute dividends (Pagano, 2005). However, as a firm's debt increases, critics of the MM theorem argue, the increased risk of bankruptcy is ignored, though it can be substantial. Bankruptcy costs have two components: (1) the probability of financial distress; and, (2) the costs that would be incurred given that financial distress occurs. This relates to the 'trade-off theory of leverage' in which firms trade off the benefits of debt financing (favourable corporate tax treatment) against higher interest rates and bankruptcy costs. In practice, managers often have better information than outside investors, implying asymmetric (and not symmetric) information effects. Financing decisions then indicate some signalling to market participants about the firm's prospects, according to the 'signalling theory'. For instance, the announcement of a stock offering is generally taken as a signal that the firm's prospects, as seen by its management, are not bright. A firm with positive prospects would try to avoid selling stock and seek to raise new capital by other sources instead; a debt offering is then taken as a positive signal. Issuing stock emits a negative signal, potentially depressing the stock price (even if the firm's prospects are positive), so the firm should maintain a 'reserve borrowing capacity' to finance exceptional investment opportunities. This in turn implies that firms should, in normal times, use more equity and less debt than is suggested by the trade-off theory of leverage. However, the presence of flotation costs and asymmetric information may cause a firm to raise capital according to a 'pecking order'. In

this case, a firm first raises capital internally by reinvesting its net income and selling its short-term marketable securities. When that supply of funds has been exhausted, the firm will issue debt and perhaps preferred stock. The firm will only issue common stock as a last resort.

To conclude, the optimal capital structure for the firm is that which maximises corporate market value (the firm's stock price). This generally calls for a debt ratio that is lower than the one that maximises expected earnings per share (EPS). As a brief illustration, Table 1 summarises the capital structure and financial performance of a diversified sample of shipping firms listed in the US equity markets (NYSE, NASDAQ), as they are depicted by the debt-equity ratio, Return on Equity (ROE) and Return on Assets (ROA). An anticipated, though striking, finding points to the extremely high debt/equity ratios for most of the shipping firms in the sample, albeit at diverging levels. This holds irrespective of the corresponding market segment and supports the view that shipping finance is heavily dependent on debt funding over time.

2.3 Major phases in modern shipping finance

During the last 30 years, international shipping markets have been moving through a volatile sequence of upward and downward swings but culminated in an extraordinary eight-year boom from 2001 to 2008. Over this period, daily earnings soared persistently from US $24,000 to US $50,000. Then, the global financial crisis and economic recession hit the world economy as well as the shipping markets. Freight earnings crashed down to a daily bottom of US $5,000 in (handymax) dry bulk markets before gradually adjust to US $8,500 by mid-2009, with many vessels though still earning less than operating costs. At the same time, the bulker fleet grew by a robust 10.8% rate and the balance in fundamentals worsened (Stopford, 2009, 2010). Diverging shipping demand and supply imbalances were already apparent in the 2007 figures; there were three times as many orders as deliveries (270 mln dwt vs 80 mln dwt). Based on end-2009 estimates the market value of a consolidated order book was standing at around US $300 bn, a figure which raises scepticism as to the recovery horizon of the shipping business. This gloomy international environment has captured shipping companies into unfolding capital investment programmes, abrupt earnings decline and excess tonnage

Table 1: Capital structure and financial performance of shipping firms

Shipping firm/ market segment	**Debt/equity (%)**			**ROE (%)**			**ROA (%)**		
	2006	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Dry Bulk									
Diana Shipping Inc	41	18	36	17	17	29	12	14	21
Dryships Inc	159	129	278	13	46	–28	5	20	–7
Excel Maritime Carriers Ltd	72	106	231	10	21	–4	6	10	–1
Navios Maritime Holdings Inc	245	156	180	8	35	15	2	14	5
TBS International Plc	80	75	74	17	31	32	10	18	18
Tankers									
Frontline Ltd	587	744	474	77	128	100	11	15	17
General Maritime Corporation	18	10	265	22	21	19	18	19	5
Nordic American Tanker Shipping Ltd	31	20	3	11	7	15	8	5	15
Overseas Shipholding Group Inc	92	129	126	18	12	18	9	5	8
Teekay Corporation	206	292	394	10	2	–23	3	1	–5
Tsakos Energy Navigation Ltd	161	176	186	26	21	22	10	8	8
Containers									
Danaos Corporation	129	232	1191	18	34	53	8	10	4
Horizon Lines Inc	499	681	708	19	3	–31	3	0.3	–4
Seaspan Corporation	81	199	342	5	–1	–27	3	–0.4	–6
LPG									
Stealthgas Inc	95	58	100	11	7	9	6	5	5

Notes: The sample shipping firms are listed on the US equity markets (NYSE, NASDAQ) and bear diversified corporate characteristics in terms of size, value, specialisation, profitability, growth prospects and capital structure. Debt = Book value of (short + long-term) liabilities;
Equity = Book value of total stockholder equity; ROE = Return on Equity; ROA = Return on assets; Profits = Net income;
Assets = Book value of total assets.
Source: Company Financial Statements

Table 2: Major phases of shipping finance

Period	Ship finance phase	Major characteristics	Shipping market environment
1945–mid-1950	Cash	Financing by retained earnings and cash liquidity – debt signalled weakness	Booming business
mid-1950–end-1960s	Charter back	Time-charter contracts collateral to bank finance; enhanced role of banks	Golden-age of growth; Up-swinging markets
early-1970s–start-1980s	Bubble	Ship vessel the favourable collateral to bank finance; extreme dwt overcapacity	Two oil crises; depression phase; market collapse; long-term impact
1980s–1990s	Distress	Extremely high default rates; extensive bank losses; disturbed relationships of banks vs. ship firms; reassessment of shipping risk	Profound demand–supply disequilibrium; business restructuring
1990s–2001	Convalescence	Reshaping of firms–bank relationships; further fund raising needs for shipping firms	Market consolidation; demand–supply convergence; gradual recovery; volatility
2002–2009	Super-cycle	Unique boom cycle; equity and bond markets attractive to shipping firms	Unprecedented earnings growth; the China factor; global financial crisis; overcapacity conditions

capacity, with an ailing global banking system under restructuring (Clarkson Research Services, 2009). This in turn raises market concerns about the critical adjustments required in shipping firms' capital funding decisions and the most appropriate financing instruments for the time being.

The methods, instruments and characteristics of ship finance are seen to change over time, adjusting accordingly to the prevailing economic, market and sectoral conditions. Five major phases in modern ship finance can be distinguished during 1950–2000, according to Stopford (2002); we expand this framework to add a recent, sixth, ship finance phase (see Table 2). These phases have been closely associated with shifts in shipping market fundamentals, predominantly international trade and fleet growth.

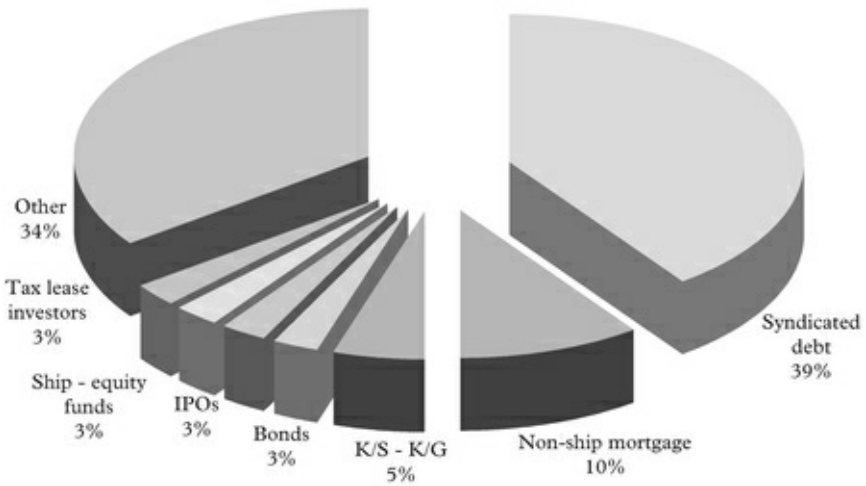

Figure 1: Major sources of ship finance
Source: Lloyd's Shipping Economist (2005)

Furthermore, according to Lloyd's estimates, the contribution of major capital funding sources to

shipping is seen to diverge substantially over time (Matthews, 2005). 'Debt financing', predominantly bank loans, continues accounting for the largest share of shipping finance. Over the last decade, the annual volume of syndicated debt gradually five-folded, from US $2 bn to over US $10 bn. A broad source of funding, termed 'other', corresponds to more than one-third of the pie and incorporates diversified financing instruments, such as bilateral loans, shipyard credit, governmental contributions and internal equity finance. International capital markets are seen to gradually gain an active role in shipping finance. The respective shares of global equity markets (IPOs) and debt markets (bond issues) are estimated at 2–3% each. The K/S partnerships in Norway and particularly the KG companies in Germany are also considered critical financing vehicles in shipping business. The remaining capital share is associated with a variety of funding sources (see Figure 1).

2.4 The dynamic role of capital markets in shipping

Following a period of fast and robust growth rates, shipping markets collapsed in the fourth quarter of 2008. Freight earnings evaporated abruptly, as the global financial crisis escalated. In an environment of severe adjustments in the banking sector, liquidity constraints and overcapacity conditions, shipping market players have been wondering what their next steps should be. Fundamental questions, as to whether to expand business operations, consolidate with a competitor or proceed to asset liquidation and exit the market, remain unanswered. These strategic decisions are examined against a consolidated order book of an estimated contract value exceeding $300 bn (end-2009). This, nevertheless, remains an attractive capital pie for financiers, shipyards and brokers (Clarkson Research Services, 2009). In this setting of recessionary conditions, banking restructuring and freight market swings, a key question remains where all this funding will come from. A convenient and timely response to the question of capital fund raising has critical implications for shipping firms' capital structure, cost of capital, cash flow liquidity, profitability and performance (ROA, ROE) and ultimately shareholder value. As has been invariably the case in past shipping market history, financial crises also imply entrepreneurial opportunities for prudent shipowners.

The shipping business consists of approximately 30,000 companies and is one of the most finance-intensive industries. Financing requirements per annum have been roughly estimated at US $80 bn for funding only new buildings (Goulielmos and Psifia, 2006). Traditional bank lending dominates ship finance over time, although some decline in its share has been recorded more recently at around 65%, in favour of alternative forms of financing (Petropoulos, 2009). Shipping finance techniques and instruments become more innovative and synthetic. An increasing number of shipping companies is seen to gradually switch towards international capital markets, to finance their ambitious investment projects by equity funding (stock markets) or debt issuing (bonds markets). Traditional and modern ship finance instruments can be distinguished into three broad classes: (1) equity finance: public funding (IPOs); seasoned equity offerings (SEOs); retained earnings (operations and sales), private equity funding; (2) debt finance: bank lending (wide variety and sophistication), corporate bond issues, specialised financial institutions, shipyard finance, private debt finance; (3) alternative finance: lease, mezzanine finance, securitisation, hybrid finance (Syriopoulos, 2007).

The year 2005 was declared 'the year of the shipping IPOs', as 12 new shipping firms raised more than US $4 bn in US equity market IPOs, most of them of Greek shipownership. In fact, from 2005–2007, Greek shipping companies alone raised total funds of about US $1.5 bn in the US markets. The

renaissance of shipping IPO market was confirmed by a tenfold increase in the funds raised by the industry, according to Lloyd's estimates. As market timing proved to be right, fund raising was further supported by freight rates sky-rocketed at record levels and international investors' appetite for 'fashionable' shipping stocks. Investors, after all, remain in constant search of attractive investment opportunities and alternative style investments (Bernstein, 1995). This trend underlines an important shift not only in shipping finance decisions and the capital structure of the firm but in the corporate governance front as well. Shipping companies, previously private, family owned and managed, introverted, with no disclosure constraints were now being transformed into publicly listed, extrovert, multi-shareholder entities with ownership dilution and extensive disclosure responsibilities (Syriopoulos and Theotokas, 2007). These issues have considerable implications for the growth prospects of shipping firms as well as for the risk-return profile of the listed shipping stocks and can directly affect shareholder value and investors' asset allocation decisions.

3. Equity Markets and Shipping IPOs

3.1 Shipping firms discover equity markets

Despite the fact that bank lending continues dominating shipping finance, a gradual shift in shipping firms' funding attitudes has been apparent more recently in favour of international equity markets. This shift has been associated with the interactive impact of critical factors, including internationalisation and integration of global capital markets; deficiencies and consolidation of major banking players; emphasis on capital adequacy and 'solvency ratios' by banks, shipping firms and investors; liquidity constraints and erosion of firm capital reserves; substantial funding requirements to replace ageing fleets; structural and cultural adjustment of shipping firms, partly induced by capital market requirements and investors' expectations; extrovert market approach and promotion of wider multi-shareholdership; market visibility and prestige towards institutional and private investors; emphasis on the concepts of corporate governance, social responsibility and business ethics.

Expanding on these issues, major advantages for shipping firms going public include: (i) access to capital markets that are not readily available to private companies; (ii) liquidity, at potentially higher valuations, if the company's fundamental are compelling enough to attract new investors; (iii) stock options as a means to attract and retain key personnel; (iv) opportunities for companies to utilise their stock to acquire other companies. However, the long-term attractiveness of international equity markets for shipping companies will only be sustained in case freight and equity market performance remains robust and corporate profitability is less volatile.

Until 2004, equity markets had played only a marginal role in shipping finance, despite their prime role as an investment funding mechanism. From an investor's point of view, historically, shipping stocks were not a particularly attractive choice for fund allocation but had a rather 'negative' reputation. This adverse attitude can partly be related to a series of shipping defaults in the 1990s, including, bank loans, high yield bonds and corporate bankruptcies. Other reasons include close family ownership ties, reluctance of shipowners to dilute company control, non-disclosure of sensitive company information and the unattractiveness of shipping stocks due to volatile earnings (Syriopoulos, 2007). Shipping companies only recently have discovered the virtues of public listing on international stock exchanges. The shipping IPO wave, during 2000–2007, has tackled investors' appetite, as the latter also discover the attractiveness of exchange traded shipping firms. This trend

has been supported by booming freight rates and strong balance sheets in an environment of bullish stock markets. Steady growth rates in the US economy and high growth rates in the Chinese economy, particularly during 2003–2007, led the shipping sector into a unique growth super-cycle during 2002–2008, generating strong earnings and cash flows.

Shipping IPOs are distinct from those of ordinary industrial or service companies. The market value of a shipping company is often closely associated with the underlying value of the physical assets (vessels). In this respect, shipping IPOs bear similarities with the respective IPOs of closed-end funds and property firms. Furthermore, due to extensive information flows in international vessel sales and purchase markets, shipping IPOs tend to exhibit lower information asymmetry. Due to the cyclical nature of shipping business, shipping firms tend to prefer listing on the equity markets whenever shipping market prospects appear to be robust.

3.2 Leading equity markets in shipping IPOs

In the 1980s, the universe of publicly listed shipping stocks was small and London was the principal equity market for shipping stocks. Apart from London, shipping stocks were also listed in the New York stock market. In the 1990s, Oslo took the top position in Europe as the leading stock exchange for shipping IPOs. Due to market shifts, London has gradually lost its leading role in shipping IPOs, partly due to companies going private or to mergers and acquisitions, such as the P&O acquisition by DP Ports World (Erdogan, 2005). In general, European equity markets have experienced declining trends in shipping market value from more than 1% in the early 1990s to 0.6% of total market value recently (Matthews, 2006). In the US equity markets, a series of de-mergers and spin-offs of shipping businesses led to the restructuring of the shipping sector. Shipping firms and investors have more recently switched towards a number of upcoming Asian stock markets that now attract shipping IPOs, including Hong Kong, Singapore, Bangkok and Taiwan.

The transportation sector, on aggregate, lags behind in global equity market values. The market capitalisation of global transportation companies increased substantially during the last 30 years. It reached a high of US $700 bn corresponding to a share of total market capitalisation of above 4% (end of 1980s), before declining to below 2% (2006). As a comparison, the oil and gas sector and the financial sector account for nearly 20% and 15% of global stock market capitalisation, respectively (Matthews, 2006). Against an estimated 8–9% of GDP in OECD countries, the low market share in capitalisation indicates that transportation remains persistently neglected in international stock markets. The shipping sector, in particular, has also seen a marginal capitalisation share at about 0.4% of global equity market value; liner shipping covers the largest share (Matthews, 2006). Despite the recent IPO activity, this figure reflects low shipping market participation, taking into account that the shipping sector is estimated at about 2% of world GDP. Only a limited number of about 30 shipping firms have been estimated to bear a market value of above US $1 bn, with A.P. Moller-Maersk Group, a Danish shipping conglomerate, the only firm accounting for about 20% (around US $30 bn) of total shipping stock market value globally (Syriopoulos, 2007).

More recently, the US stock markets (NYSE, NASDAQ) have seen some revitalised IPO activity, attracting jointly the largest number of shipping IPO issues and regaining their leading role as preferred equity markets to IPO launches. Oslo follows at a distance now, leaving London Stock Exchange behind (Merikas *et al*., 2009). Strong advantages of the US capital markets include fund-

raising depth, reputable position in the investment community, improved share liquidity, reliable pricing, high corporate prestige and exposure to an international investor base. According to Clarkson's data, there were about 170 shipping companies listed worldwide by 2006, corresponding to an estimated market value of US $210 bln, although pure shipping firms are only about half that number (Matthews, 2006). During the recent intensive IPO cycle (mid-2004 to end-2005), total shipping IPO value and secondary listings were estimated in excess of US $4 bln, whereas in the first half of 2006 alone, international shipping IPOs amounted to a value of more than US $100 bln (Matthews, 2006).

Table 3 presents a summary of major shipping IPO issues per country and per stock market, during 1984–2007. Over this time span, the US equity markets (NYSE, NASDAQ) confirm their leading position, as they have seen the largest IPO number (55 issues). The Oslo Stock Exchange enjoys persistently high levels of shipping IPO activity and follows with 15 IPOs but the London Stock Exchange (LSE) ranks lower (6 IPOs). Of these sample IPOs, only 38 firms were listed before 2000; most of these IPOs have come into equity markets after 2000, supporting the shift of shipping firms towards global equity markets, as discussed earlier.

Taking into account the leading role of the US markets and the upcoming Asian markets, European stock markets may see further declines in shipping market value.

Table 3: Shipping IPOs in global equity markets: 1984–2007

Country of domicile	Number of issues	Stock Exchange (SE) of listing	Number of issues
Belgium	3	Brussels SE	2
Bermuda	7	Over-the-Counter	4
China	5	Shanghai SE	1
Denmark	6	Copenhagen SE	5
Finland	4	Helsinki SE	3
Germany	3	Berlin SE	4
Greece	29	Athens SE	6
Hong Kong	4	Hong Kong SE	5
India	6	Bombay SE	6
Norway	15	Oslo SE	15
Singapore	6	Singapore SE	7
Sweden	5	Stockholm SE	6
UK	4	London SE	6
USA	27	NYSE	30
USA	19	NASDAQ	25
Other	19	Other SEs	18
Total	*143*		*143*

Source: Adapted from Merikas *et al.* (2009)

Major reasons that explain the limited presence of the shipping sector in the European markets include the highly fragmented industry structure, the concentrated ownership (as founding families remain major shareholders), the large number of relatively small private companies, the decision of some public shipping companies to go private and the limited number of IPOs in Europe compared with the US.

3.3 Key issues in shipping IPOs

3.3.1 Models of IPO pricing

A company can be listed and traded on a Stock Exchange by issuing new shares. Whenever this share

offering to investors takes place for the first time, it is known as an Initial Public Offering (IPO). The company 'goes public' and its shares can then be freely traded in the open equity market. The IPO price is the price at which the new shareholders buy the shares at issue. The initial return of an IPO relates to the difference between the equilibrium price following the issue and the IPO price. The IPO price is jointly decided by the underwriter and the listing firm at the end of the IPO procedure, according to financial analysts' valuations and the demand expressed for the shares. The definitive offer price is generally lower than the first equilibrium price; this is well known under the term of 'IPO underpricing' (Ljungovist, 2005). The IPO motives, pricing, initial market appraisal and long-run performance have been the focus of a large theoretical and empirical financial literature.

Alternative theoretical approaches, such as the information asymmetry and signalling models or the life cycle and market-timing models, have been proposed to explain these issues (Ritter and Welch, 2002; Drobetz *et al.*, 2005; Derrien and Kecskes, 2007). The primary motive as to 'why do firms go public' relates to their decision to raise equity capital and to create a public market in which the founders and other shareholders can convert part of the corporate value they possess into cash at a future date. In addition, being the first in an industry to go public sometimes confers a first-mover advantage, whereas IPOs allow more ownership dispersion with relevant advantages and disadvantages. Furthermore, by going public, entrepreneurs help facilitate the acquisition of their company for a higher value than what they would earn from an outright sale (Brau *et al.*, 2002). Market timing is also important to IPO decisions. An IPO may be delayed, if a bear market phase can potentially result to a low firm value; whereas a bull market may offer more favourable pricing conditions (Lucas and McDonald, 1990). It has been also argued that larger companies and companies in industries with high market-to-book ratios are more likely to go public and companies going public seem to have reduced their costs of credit. IPO activity is affected by investor sentiment and follows high investment and growth, not vice versa (Pagano *et al.*, 1998; Lowry, 2003). To recap, the evidence of large variation in the number of IPOs suggests that market conditions are the most important factor in the decision to go public. The other important factor seems to be the life cycle stage of the firm.

A large body of empirical studies documents a systematic price increase from the offer IPO price to the first-day closing price ('IPO underpricing puzzle'). Ritter and Welch (2002), for instance, study a sample of 6,249 IPOs from 1980–2001 and estimate an average 'first day' return of 18.8%. Approximately 70% of the IPOs end the first trading day at a closing price greater than the offer price. This pattern of underpriced IPOs is seen to apply in different firms, sectors, markets and countries. A possible justification of the IPO 'undepricing puzzle' relates to reasons of asymmetric information between market participants, as IPO issuers are expected to be more informed than investors. Better quality issuers deliberately sell their shares at a lower price than the market believes they are worth, which deters lower quality issuers from following. These issuers can recoup their initial value sacrifice post-IPO, either in future issuing activity, favourable market responses to future dividend announcements or analyst coverage. In line with a body of signalling models, firms demonstrate that they are high quality by throwing money away; one way to do this is to leave money on the table in the IPO. Empirical evidence indicated that the relationship between IPO price and underpricing may be U-shaped, whereas in contrast, post-IPO turnover may display an inverted U-shaped relation to IPO price (Fernando *et al.*, 2004). However, the conclusions produced on these issues remain rather mixed. Compared with the rich financial literature on a country level, the body of studies on individual

sectors, especially shipping, remains thin.

The long-run stock price underperformance in the years after the IPO offering is another key topic of interest in IPO research ('IPO long-run underperformance puzzle'). Measuring long-run performance can focus either on absolute (raw) performance, or relative performance (abnormal returns vs market benchmark). Empirical evidence indicates that IPOs underperform in the long run. A number of IPOs in the US, for instance, were seen to underperform significantly relative to non-issuing firms for three to five years after the listing date (Ritter, 1991; Loughran and Ritter, 1995). According to other estimates (Ritter and Welch, 2002), an investor who buys shares at the first-day closing price and holds them for an investment horizon of three years, would attaint IPO returns of 22.6%. However, compared to a market benchmark (CRSP value-weighted market index), the average IPO price underperforms by 23.4%. IPO long-run performance remains a controversial issue, sensitive to the empirical approach employed and directly dependent on the preferential theoretical stance of market efficiency or behavioural finance framework. Many studies have contributed international evidence on the long-term IPO underperformance consistent with what has been found for the US market, including Australia (Lee *et al*., 1996); Japan (Cai and Wei, 1997); Sweden (Brounen and Eichholtz, 2002); Germany (Jaskiewicz *et al*., 2005); United Kingdom (Goergen *et al*., 2006); France and Greece (Chahine, 2008). In a pan-European study, evidence of long-run underperformance has been documented for a sample of 15 countries, indicating long-term abnormal returns in Europe to be negative (Gajewski and Gresse, 2006).

3.3.2 Shipping IPO pricing

Capital markets can play a key role in promoting shipping business growth and value creation. They may act as an intermediary mechanism to provide funds required to finance new investment projects and sustain business growth. Fresh funds can be channelled to shipping firms in need through the issuance of new securities by an IPO process. As secondary markets, capital markets provide an efficient mechanism for trading outstanding securities. Following IPO market listing and trading, a shipping company has the privilege to regularly return to stock market investors and request additional funding through seasoned equity offerings (SEOs).

Major factors that contribute to corporate value creation, as reflected on the firm's stock price upward behaviour, include, *inter alia*: robust fundamentals; efficient and well reputed management; high cash flows/earnings; realistic market valuations; M&A corporate stories; and growth potential. The positive behaviour of shipping stocks can be further enhanced by upward freight markets, bullish stock market trends and rich cash liquidity conditions. Nevertheless, private and institutional investors have remained sceptical for years about shipping firms' stocks. This investors' attitude has been adversely affected by 'inward' family organisation, structure and management; ship-owners' reluctance to expand shareholder base; non-disclosure of critical corporate actions; low or no dividend yield; non-appealing risk-return trade-off; highly volatile freight markets, resulting to abnormal corporate earnings and highly risky investments.

A critical question relates to the motives driving shipping firms' shift towards listing on international equity markets. In the past, the strict requirements of transparency and disclosure that listed companies should meet was a constraint for many shipping firms, especially at volatile market times and earnings fluctuations. However, this is seen to gradually change. Equity markets appear now

to be an attractive choice for firms with stable income flows and growth potential. With interest rates remaining at low levels, banking finance may still appear to be a cheap funding alternative. However, a number of shipping companies have decided to go public recently and raise funds quickly (despite significant public listing costs), to take advantage of the robust freight markets and investors' positive sentiment towards shipping stocks. Still, a number of shipping firms have experienced substantial market value losses, since freight markers moved downwards amidst conditions of global financial crisis and economic recession.

These developments are anticipated to have an adverse impact on cautious investors' expectations, probably making it more difficult for shipping firms to raise financing from the equity markets in the near future. Good quality shipping IPOs can be successful, though there have been cases in the recent past that it was not always easy to sell shipping shares to investors. Despite the fact that investors' sentiment may not remain as positive as it was earlier, fair IPO pricing, backed by robust earnings cash flow streams and stable freight markets, can conclude to successful shipping IPOs. A critical advantage of shipping firms' listings is related to the fact that shipping is a real asset-backed business and certain risk levels can still be acceptable with some confidence by investors. The most risky bet appears to be on whether institutional and private investors will continue to consider shipping stocks as an attractive alternative 'style' investment class, hence, facilitating shipping firms' funding (Syriopoulos and Roumpis, 2009).

The pricing of IPO equity issues remains a central issue for shipping firms interested in raising equity funding in global stock markets. Since the majority of shipping IPOs refers to bulk shipping offerings, the issuer will set an IPO price at or near market-adjusted net asset value (NAV) per share. This is reasonable in cases where company earnings and cash flows fully support NAV (Stokes, 1997). In practice, however, ship prices in the second-hand market do not necessarily reflect operating cash flow and earnings generated by the ships. More frequently, ship prices represent a very high multiple of operating cash flow, whereas in certain bulk shipping segments operating earnings were negative for a number of years.

Equity financing can be an attractive source of capital for shipping companies, taking into account the relatively lower implied cost of capital against other sources of funding. This is related to the fact that shipping companies traditionally pay low or no dividend to investors and investors accept this practice, since, due to the capital intensive nature of shipping business, retained earnings are channelled to fleet replacement and expansion. On the other hand, investors' target of expected return on equity is set at high levels. Assuming that a shipping company can borrow at a spread over Libor (+1% to 2%), this can result to borrowing costs on senior debt of, say, 7%. Subordinate debt might cost 10–12% per annum, on a 10–year maturity. Investors, however, will typically seek a return on equity of 15–20% per annum, given the volatile freight markets and their risk exposure (Stokes, 1997). Taking into account that many shipping companies are rated below investment grade, this implies that they must attain return on equity well above average stock market returns to prevent their share price from declining.

The key role of equity markets in shipping business has been surprisingly neglected in past empirical research. A pioneer exception is Grammenos and Marcoulis (1996), who study shipping IPOs in a cross-country framework. A sample of 31 IPO cases is examined in seven different countries (US, Norway, Sweden, Greece, Luxembourg, Hong Kong and Singapore), over 1983–1995. Shipping

companies with prime business on vessel operations are mainly considered and critical factors associated with shipping IPOs are investigated. As these companies grow bigger over time, they reorganise their structures and meet their capital needs in the stock markets more frequently.

Table 4: Shipping IPOs: Investment purpose – Funds raised: 1983–1995

Issue purpose	Number of offers	Avg. gross proceeds (USD mln.)	Avg. company size (USD mln.)
Vessel acquisition	19 (63%)	59	153
Asset play	7 (24%)	61	72
Debt repayment	3 (13%)	62	203
Trading activities	1 (3%)	48	152

Source: Grammenos and Marcoulis (1996)

Table 5: Shipping IPOs: Cross-country analysis

Stock market	Vessel acquisition	Asset play	Debt repayment	Trading activities
USA	2	6	2	–
Norway	8	–	1	1
Sweden	4	–	–	–
Greece	3	–	–	–
Luxembourg	–	1	–	–
Singapore	3	–	–	–
Hong Kong	–	–	–	–

Source: Grammenos and Marcoulis (1996)

The following important factors are evaluated as to their impact on shipping IPO stock market performance: gross proceeds of the IPO issue; size of the company; proportion of equity offered; gearing level; age of the company; and, age of the fleet. Gearing is argued to be the single most statistically significant factor in explaining IPO stock market performance. Furthermore, the average initial day return of the sample shipping IPOs is found to be consistent with past empirical evidence. Shipping IPO underpricing of small magnitude is concluded at about 5.32% on average. IPO costs are estimated at 8% of the amount raised with a high fixed cost component in average direct costs; the highest direct costs are seen in the US stock markets and the lowest in Norway. The purpose of the issue, the number of offers, the average proceeds, the average company size and the cross-country listings of these IPOs are summarised in Tables 4 and 5. Vessel acquisitions receive by far the highest part of IPO funding and asset play strategies follow at a distance.

Shipping companies with high pre-IPO gearing levels are seen to experience more underpricing of their share issues than the companies with low pre-IPO gearing levels. In the context of reorganisation strategy, shipping companies may have to lower their gearing level to minimise potential stock market underpricing. Furthermore, shipping companies that offer more equity to the public exhibit higher underpricing than those offering less equity. This is related to information signalling to market participants, implying a kind of ‘private’ valuation by shipowners for the amount of equity retained. Risk averse shipowners would improve expected utility by holding a diversified portfolio and not only a large stake in their own firm. Since this argument does not seem to apply to the case of companies offering limited equity, it may signal that these shipowners are based on an implicit ‘fair’ firm value. In this case, shipowners of high value companies would prefer to forego diversification benefits but avoid selling undervalued stocks. As investors realise shipowners’ positioning, they would be keen to invest on shipping stocks of companies where owners are retaining larger holdings.

The topic of IPO underpricing and long-term performance in global shipping issues has been the subject of a recent study (Merikas *et al.*, 2009), the key points of which we now summarise. The study investigates the short- and long-term price performance of 143 global shipping IPOs, listed during 1984–2007, in major stock exchanges. It also tests whether relevant theories can adequately explain shipping IPO behaviour in the aftermarket. The study calculates estimates of 'Buy-and-Hold Abnormal Returns' (BHARs) of the IPOs for six months and up to 36 months after listing on the stock market and 'Cumulative Average Returns' (CARs) on a three-year basis to better test the stability and the Fama-French 3-Factor model. The empirical findings indicate that shipping IPO underpricing stands at an average adjusted first day return of 17.7%. This underpricing is positively related to the age of the firm, the reputation of the stock exchange the IPO is listed on and the market conditions prevailing at the time the firm went public, whereas it is negatively related to the reputation of the underwriters. In the long run, shipping IPOs are seen to underperform after a five-month holding period. As to the long-run shipping IPO performance, when BHARs is taken as a benchmark, the empirical findings indicate that investors, who buy immediately after listing and hold shares for three years, will make a loss of –9.91%, –4.40% and –15.72%, after the first, second and third year of listing, respectively.

The study incorporates several variables to explain cross-sectional variations of shipping IPO underpricing. First, the history of the firm prior to going public is anticipated to exert a negative impact on IPO underpricing, since a short history before the IPO increases the risk to investors so that a larger underpricing is required. Secondly, the regulated market and the respective segment in which the shipping IPO is listed, since firms that are listed in the parallel market segment (small capitalisation – high growth) will have their shares underpriced in order to attract a large number of shareholders. Thirdly, the reputation of the underwriter is a 'quality', lower risk, signal to the market and a banking syndicate or an established investment bank can attain a more efficient penetration to new shareholders. Empirical evidence indicates that underwriters proceed to stock price stabilisation during a short period of time after the IPO to avoid any issue failure (Rock, 1986). Furthermore, the mean long-term underperformance of firms introduced by more prestigious underwriters is found to be weaker (Ruud, 1993). Fourthly, the IPO size is argued to affect the post-IPO stock price reaction (Carter *et al.*, 1998; Stehle *et al.*, 2000). To gain a better insight on that, the sample was divided into four size categories. Fifthly, market conditions are also considered to be important for IPO price reaction. Empirical evidence indicates that the number of IPOs tends to increase in bullish markets because the placement of stocks is easier, the risk of failure for an IPO is lower and securities are priced higher, which softens the cost of initial underpricing (Helwege and Liang, 1999; Lowry, 2003). Furthermore, IPOs taking place in hot market conditions (robust investor interest for IPOs) are expected to yield larger returns in the first few trading days than IPOs made in a cold market.

Table 6: Shipping IPOs aftermarket performance: 1984–2007

Stock Exchange	6-months	12-month	24-months	36-months	Sample size
Athens	84.30	66.46	78.20	47.50	6
Bombay	–93.81	–97.73	–116.86	–134.05	6
Copenhagen	–43.15	–56.03	–75.98	–93.15	5
NASDAQ	7.97	16.98	28.79	13.85	25
NYSE	17.23	8.21	21.94	5.55	30
Oslo	–93.74	–98.63	–99.29	–103.56	15
Singapore	–33.98	–3.24	18.88	–16.05	7
Stockholm	–84.76	–90.31	–95.51	–96.64	6
Others	0.89	2.60	8.16	5.10	43

Source: adapted from Merikas *et al.* (2009)

Subsequently, IPO prices in a hot market reverse as a result of adjustments in investors' perception that excessive optimism may have been attributed to the new IPO issues (overvaluation) under hot market conditions. The average number of shipping IPOs per year in the sample under study indicates only two shipping IPOs per year over 1984–1987; around three shipping IPOs per year over 1988–1997; and, on average, 11 shipping IPOs per year over 1998–2007, rendering this decade a hot shipping IPO market globally. Finally, the reputation of the stock exchange where the IPOs are listed is considered to be an important factor in explaining IPO underpricing. For that, shipping IPOs are classified into two major groups: (a) IPO listings on the main global stock markets (NYSE, NASDAQ and LSE), to reflect strict listing requirement implications; and (b) IPO listings on other stock exchanges. A summary of the empirical findings is presented in Table 6.

Long-term performance estimates of shipping IPOs are produced by calculating returns over a three-year investment horizon. According to the 'buy-and-hold' trading strategy employed, each IPO is bought at the end of the first day of trading and is sold at the end of the first, second and third year of trading. The same amount of invested funds is allocated on every IPO (equally-weighted long-term returns). Table 7 reports the average BHARs of the global shipping IPO sample listed during 1984–2007 and summarises adjusted returns based on the listing price of the new issues.

3.3.3 Shipping stock returns, risk and volatility

The cyclical and highly volatile behaviour of shipping business and corporate earnings has been an issue of great concern for shipowners, bankers, charterers and investors and has raised an adverse sentiment against asset allocation to shipping stocks (Syriopoulos and Roumpis, 2009). The various forms of risks in shipping business can be broadly grouped into the following major classes: business risk; liquidity risk; default risk; financial risk; credit risk; market risk; political risk; and, technical and physical risk (Syriopoulos, 2007).

Table 7: BAHR for global shipping IPOs: 1984–2007

Return of	Mean return (%)	Standard deviation (%)	Number of observations	Median (%)	Minimum return (%)	Maximum return (%)
1st day	17.69	32.01	143	8.69	–25.56	201.45
6 months	–13.52	68.74	143	–6.74	–139.60	215.38
12 months	–9.91	81.76	141	–16.86	–139.02	311.78
24 months	–4.40	95.55	134	–15.76	–154.13	343.85
36 months	–15.72	104.48	127	–27.85	–220.79	309.78

Notes: Figures refer to excess or adjusted returns based on the listing price.
Source: adapted from Merikas *et al.* (2009)

Empirical work on shipping market behaviour remains limited in number and scope. More recently, few empirical studies have investigated the relationship between shipping business and stock markets from different perspectives. These include, *inter alia*, the performance of shipping stocks in the international equity markets; the identification of key risk-return characteristics in shipping stocks; and, the dynamic management of shipping equity portfolios. Other studies investigate certain aspects of shipping volatility patterns; validity of the efficient market hypothesis; and, risk-return comparisons with complementary or substitute transportation sectors (Kavussanos, 1997, 2003; Kavussanos *et al.*, 2003; Gong, 2003; Tvedt, 2003; Mulligan and Lombardo, 2004; Chen and Wang, 2004; Syriopoulos and Roumpis, 2006; Syriopoulos *et al.*, 2006; Andriosopoulos *et al.*, 2009). These studies follow a market or even a route-disaggregated approach to investigate volatility behaviour in dry bulk, tanker and container market segments. The empirical findings indicate that shipowners can diversify business risks by holding portfolios of ships of different size; switching between contracts of different duration; and, hedging with forward freight contracts; vessels of small and medium size were found to show relatively lower volatility compared with larger size vessels. Furthermore, the impact of trading volume (activity) on vessel price changes is assessed, since trading volume can contribute useful information to a market where real assets are traded.

The macroeconomic environment can exert a significant impact on shipping stock returns, according to Grammenos and Arkoulis (2002), who study a sample of 36 shipping companies, listed in 10 stock exchanges worldwide, during 1989:12–1998:3. The model employs returns on a world equity market portfolio as the dependent variable in the following pre-specified set of global macroeconomic variables: (a) industrial production; (b) inflation; (c) oil prices; (d) exchange rate fluctuations against the US dollar; and (e) laid up tonnage. Empirical evidence indicates several significant relationships between returns of international shipping stocks and global risk factors. Oil prices and laid up tonnage are found to be negatively related to shipping stocks, whereas the exchange rate variable to display a positive relationship. These macroeconomic factors are seen to exhibit consistent interrelationship patterns in the way they are linked to the shipping industry worldwide.

The dynamic asset allocation and active management of shipping stock portfolios has been the core objective in Syriopoulos and Roumpis (2009). Alternative dynamic

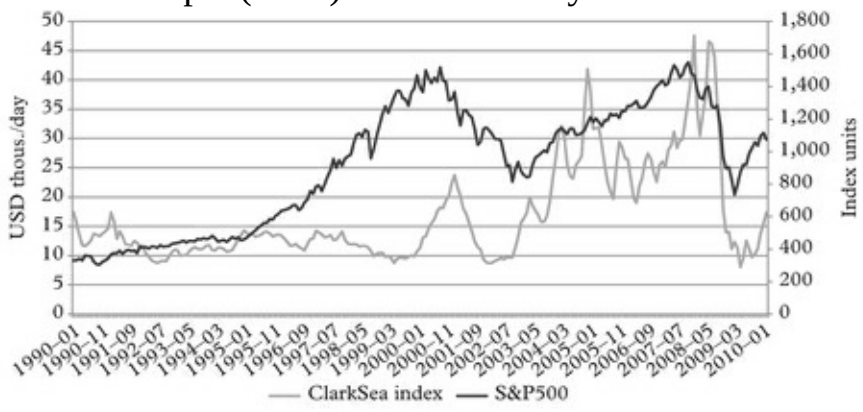

Figure 2: Shipping markets vs equity markets

volatility models investigate the risk and return characteristics of a carefully selected portfolio of shipping stocks, in order to gain some insight on potential asset allocation opportunities. As private and institutional investors are in search of alternative style investments, the assessment of stock volatility is a critical issue for efficient asset allocation, dynamic portfolio management and firm

valuation. Shipping stock portfolio returns are compared against representative stock market indices, since a key issue to portfolio investors remains whether shipping stock picking can potentially lead to superior stock returns relative to the market portfolio. Shipping stock selection may then be considered as an investment style that can add value to other styles such as value, growth, technology or emerging markets. According to the empirical findings, shipping stock returns exhibit a highly volatile profile, in accordance with the respective (tanker and dry bulk) earnings volatility. Sectoral and company fundamentals may affect shipping stock volatility that is found to be sensitive to asymmetric shocks. The results indicate superior portfolio returns for shipping stock portfolios relative to market benchmarks, albeit associated with higher risk levels (Figure 2).

As the shipping industry is exceptionally capital intensive, volatile and highly risky, alternative risk management approaches have been proposed to control for shipping risk (Kavoussanos and Visvikis, 2006; Alizadeh and Nomikos, 2009). To hedge against underlying risks, predominantly freight rate volatility, shipping market participants have gradually turned their attention into specialized derivatives products, particularly freight forward agreements (FFAs) and freight options. The freight derivatives market has grown rapidly in recent years and traded volumes have more than quadrupled since 2000 (Syriopoulos, 2007).

3.4 Alternative hybrid finance instruments

A number of innovative alternative methods have been employed more recently in ship finance, to take advantage of the benefits equity markets offer. We briefly discuss these shipping finance methods that have been well received by the capital markets. These are: (a) merger with a Specified Purpose Acquisition Company (SPAC); (b) the combination of reverse merging into a publicly traded corporation and funding through a Private Investment in a Public Equity (PIPE); (c) private equity funding; (d) mezzanine finance; and, (e) 'At-The-Market' (ATM) offerings. These financing options of accessing capital and going public are good examples of the creativity of the shipping business community when presented with funding challenges.

3.4.1 SPACs — PIPEs

A recent approach to financing a shipping firm is merging with a Specified Purpose Acquisition Company (SPAC). A SPAC is a newly formed industry-specific publicly traded buyout/venture capital fund. The purpose of the SPAC is to acquire an operating business in a specified industry, in this case shipping. The SPAC is managed by highly experienced management teams and advisors who are recognised leaders in their field. Performance results have been mixed for those SPACs that have announced or have completed deals.

An alternative method is the combination of reverse merging into a publicly traded corporation and funding through a PIPE. In essence, a reverse merger is a transaction in which a private company becomes public through a combination with an existing public company, with the private company ending up in control of the combined entity. More often than not, the public entity in a reverse merger is a 'shell' company, with neither operating business nor assets. Potential advantages of a reverse merger include: (i) ability to complete the transaction without engaging an underwriter, thus reducing overall costs; (ii) avoidance of IPO process rigors, including long road shows; (iii) less vulnerable than an IPO to the vicissitudes of the public markets and risk of being unsuccessful; and, (iv) the ability to complete the transaction in a shorter time, provided the private company has audited

financial statements and other required information available at the time of the transaction.

In the past, reverse merging into a public vehicle often resulted into a company only achieving one thing: increasing its legal and accounting expenses. Today, however, with the advent of PIPE financing, this has changed for many well-represented companies. The turbulent public markets of the last years have resulted to increased interest by private investors in PIPE transactions. PIPE investors purchase securities directly from a publicly traded company in a private placement transaction, typically at a discount to the market price of the company's common stock. This private sale of securities is often not pre-registered with the SEC; as a result these securities are 'restricted' and cannot be immediately resold by the investors into the public markets. Accordingly, the company will agree as part of the PIPE deal to promptly register the securities with the SEC. Thus, the PIPE transaction can offer the company the speed and predictability of a private placement, while providing investors with a nearly-liquid security at a discount from the current trading price.

3.4.2 Private equity funding

Private equity funding activity has been recently seen in shipping finance. Private equity funding is equity capital that is not quoted on a public exchange and can be considered to have a complementary, yet independent, financing function to equity markets. Private equity consists of funding by private investors and funds that make investments directly into private companies or conduct buyouts of public companies that result in a delisting of public equity.

Capital for private equity is raised from retail and institutional investors and can be used to fund new technologies, expand working capital within an owned company, make acquisitions or strengthen the balance sheet. The large part of private equity originates from institutional investors and accredited investors who can commit large sums of funding for long periods of time. Private equity investments often demand long holding periods to allow for a turnaround of a distressed company or a liquidity event such as an IPO or sale to a public company. The size of the private equity market has grown steadily since the 1970s. Private equity firms will sometimes pool funds together to take very large public companies private. Many private equity firms conduct what are known as leveraged buyouts (LBOs), where large amounts of debt are issued to fund a large purchase. Private equity firms will then try to improve the financial results and prospects of the company in the hope of reselling the company to another firm or cashing out via an IPO.

Private equity firms are seen to exhibit growing interest in shipping companies, as they are searching for new industries to invest and are backed by strong capital liquidity. In contrast to other sectors, the penetration of private equity funding in shipping remains at modest levels in the US, although it is anticipated to have potential for further increase. Since shipping business is an international activity, private equity firms seek to have a regionally dispersed presence worldwide. Private equity firms offer advisory and arranger services in diversified and innovative shipping finance structures, including US finance, UK tax leases and KG finance. A core objective for private equity firms remains whether their financial support to shipping companies results to enhancing the firm's corporate value. Part of the increasing attention paid to private equity finance is supported by the fact that investors are better informed and more diligent on fund investing relative to IPO investors. As investors' interest in listed shipping stocks is seen to slowdown and shipping companies become more experienced in the use of capital markets, private equity funds can take advantage of

new financing opportunities.

In spite of the high risk element seen in shipping investment returns, private equity funds have already financed a number of shipping companies, including, *inter alia*, Quintana, Eagle Bulk, US Shipping and Horizon (Syriopoulos, 2007). Still, a growing number of private equity funds are active in raising capital to shipping finance. AMA Capital Partners, for instance, has raised funding at US $100 mn to finance marine and rail transportation projects. Earlier funding (2000), at US $45 mn, raised jointly with fund partners NIB Capital and GATX, was used to acquire ships and succeeded in attaining a net IRR above 20% for its shareholders (Matthews, 2005). A number of US private equity firms (such as Carlyle, Wexford Capital, Castle Harlan, Stockwell Fund, Blackstone Group, and Sterling Investment Partners) have been involved in shipping finance. Navigation Finance Corporation (NFC), for instance, a joint venture between DVB Bank and Northern Navigation, entered into a US $181 mn sale-and lease-back deal with Singapore based offshore vessel operator Ezra Holdings (McGroarty, 2006).

3.4.3 Mezzanine finance

Mezzanine finance is a hybrid of equity and debt financing. It is typically used to finance the expansion of existing companies and has been also employed in shipping business as an alternative vehicle of finance (Harwood, 2006). Mezzanine finance is basically debt capital that gives the lender the rights to convert to an ownership or equity interest in the company, if the loan is not paid back in time and in full. It is generally subordinated to debt provided by senior lenders, such as banks and venture capital companies. Since mezzanine finance is usually provided to the borrower in short time with limited due diligence on the part of the lender and limited or no collateral on the part of the borrower, this type of financing is aggressively priced with the lender targeting a return at an estimated range of 20–30%.

Mezzanine financing is advantageous because it is treated like equity on a company's balance sheet and that may make it easier for the firm to obtain standard bank lending. To attract mezzanine financing, a company usually must demonstrate a track record in the industry with an established reputation and product, a history of profitability and a viable investment plan for the business (e.g. expansions, acquisitions, IPO).

3.4.4 ATM offerings

An at-the-market (ATMs) offering refers to securities offered on a continuous or delayed basis in the future, at a price that is not fixed at the time of registration. This is one of the latest techniques in financial engineering to raise capital in bad markets. They are also known as 'dribble programmes' or 'controlled equity offerings' and allow the issuer to 'dribble out' a share offering, when market or price conditions are more favourable. This is in contrast to a conventional secondary offering that takes place all at once. Hence, the issuer gains flexibility to set a floor below which will not sell and can seek best prices over time; or, the issuer can stop selling ATM shares. Apart from banks, other corporations that have found ATM offerings preferable recently include Delta Airlines, Carnival Corporation, UAL Corporation and the Ford Motor Company.

Ailing publicly listed shipping companies are also seen to employ this technique to raise capital and recapitalise their impaired balance sheets (Majarian, 2010). When a shipping company is interested in selling a large trance of shares in unfavourable equity market conditions, it will be extremely difficult

to attract investors' attention. Under these circumstances, institutional investors would make a placement only in case they can acquire a percentage of shares at a substantially discounted price. However, these offerings, when used to pay down debt and recapitalise, are highly dilutive. The firm's longer-term prospects and the prospects of the freight markets are important for investors' allocation decisions. Because the trading process is blind, investors do not really know whether they are buying existing shares or new shares being marketed by an underwriter. With no pressure to complete an issue within a tight time-framework, companies can proceed at their own pace and, ideally, have some control over what price the shares are sold at over weeks or months. At a recessionary market phase, many publicly listed companies (especially in the dry bulk sector) are under pressure to pay down debt in conformance to their debt/asset coverage covenants. Whether an ATM offering targets additional funding to repay debt is an important issue for investors to evaluate. According to market experts, increased trading volumes seen at times in a number of listed shipping companies may have been boosted by ATM share offerings rather than primary trading activity (Majarian, 2010).

4. Shipping Bonds and Yield Risks

4.1 The shipping bond market

A major alternative source of capital to fund shipping investments is debt finance, especially by issuing bond securities. This is a funding choice distinctive from equity finance, bears certain merits but is also associated with risks. Traditionally, financing shipping projects with bond issues has not been a prime choice for shipowners, as low interest rates have supported banking finance; furthermore, shipping IPOs have attracted substantial funding in the international capital markets recently. This section overviews the high yield bond market for shipping companies, as this capital market segment has also experienced some revitalised activity.

One important distinction of bond markets refers to that of primary and secondary bond markets. The primary bond market is the market where a new bond issue is initially offered to investors for the first time. The secondary market, refers to the market where a bond issue, following its initial offering (in the primary market), is already traded, driven by demand and supply forces. However, as liquidity in shipping bond issues has proven to be historically low in the secondary market and trading in a large sum has been difficult, shipping companies rely predominantly on the primary market. According to their credit rating grade – that signals lower or higher default risk – bonds can be broadly rated as of 'investment grade' or 'high yield' bonds (HYB). Due to their highly risky profile, many shipping bonds have been graded as 'high yield' bonds (speculative bonds).

Past empirical research on shipping debt and high yield bonds remains surprisingly thin. A pioneer exception is Grammenos and Arkoulis (2003), who examine significant determinants affecting primary pricing of new shipping high yield bond offerings in the US, during 1993–1998. Based on the empirical framework of Fridson and Garman (1998), the study investigates the impact of key factors on shipping high yield bond spreads, such as credit rating, callability, term (years to maturity), float (issue amount), default rate, security, gearing, fleet age, market conditions (laid-up tonnage), and, 144a status. Primary pricing refers to the determination of spread of the new high yield bond offerings. The spread is defined as the difference between the yield to maturity on a coupon-paying corporate bond and the yield to maturity on a coupon-paying government bond of the same maturity.

In a background of low interest rates over the past years, HYB markets have played a peripheral

only role in shipping finance until recently, when this capital market segment attracted anew the interest of shipping companies and international investors. The first high yield bond in shipping was issued in 1992 by Sea Containers, targeting an amount of US $125 mn in subordinated debentures. During 1992–2005, more than 60 shipping issues have taken place in the US HYB market alone (Table 8). Total funding in this speculative grade bond segment have come up to US $10.1 bn with an average coupon of 9.73% and an average term to maturity of 9.5 years (Grammenos *et al.*, 2008). The years 1993 (9 issues), 1997 (9 issues), 1998 (17 issues), 2003 (10 issues) and 2004 (5 issues) have shown intensive activity in shipping bonds. This translates into a total of 50 shipping high yield bonds and corresponds to 82% of the overall issues during 1992–2005. During 2003–2005 alone, 16 new shipping bond issues have come into play, pointing to a robustly revitalised interest of shipping firms in bond market financing. Major reasons that led to this exceptional activity in the revitalised HYB market in shipping include the relatively modest interest rate levels (1993);

Table 8: Shipping high yield bonds

Year	No. of issues	Total float (USD mln.)	Average float (USD mln.)	Average coupon (%)	Average term (years)	S&P average rating
1992	1	125	125	12.50	12.00	BB–
1993	9	1,235	137.2	9.13	10.77	BB
1994	1	175	175	11.25	10.00	BB+
1995	1	175	175	10.50	10.00	BB
1996	3	490	163.3	9.61	9.61	BB–
1997	9	1,190	132.2	10.39	8.44	B+
1998	17	2,738	161.1	10.11	9.41	B+
1999	1	115	115	10.75	7.00	BB–
2000	0	–	–	–	–	–
2001	1	250	250	8.80	10.00	BB–
2002	2	400	200	10.00	10.00	BB
2003	10	2,196.6	219.6	9.18	8.50	BB–
2004	5	843	168.6	8.35	12.00	BB–
2005	1	200	200	9.50	10.00	B–
Total	61	10,132.6	166.1	9.72	9.53	BB–

Source: Grammenos *et al.* (2008)

replacement needs of ageing fleets, backed with high gearing (1998); and a particularly positive performance of shipping and bond markets (2003–2005).

However, international investors remain sceptical towards shipping firms' bond issues in the HYB market, due to a range of concerns. Cyclicality, volatility and high leverage may jeopardise shipping companies' expected cash flows, especially in economic recessions. These conditions can further result to deterioration of corporate credit quality and increase the probability of default of shipping bonds. Financial crises and economic shocks exert a critical adverse impact on the shipping markets, as did, particularly, the Asian financial crisis and the Russian economic upheaval, during 1997–1998. The deterioration in global terms of trade affects mostly the shipping firms that are exposed to high gearing and operate mainly in the spot market, resulting to problematic servicing of high debt.

The adverse reputation of shipping bonds has worsened further by a series of defaults and bankruptcies seen in the sector during the 1990s. In the past, depressed market conditions hit shipping markets and led to dramatic declines in freight rates and vessel prices in most market segments. As a consequence, several shipping companies proceeded to default on their high yield bond issues. In

1999, for instance, ten shipping firms defaulted on their high yield debt issues. This negative performance overshot shipping bond default rates up at 38% against a corresponding figure of 1.28% for

Table 9: Bond rating standards

Moody's	S & P's	Characteristics	Comment	Class
Aaa	AAA	highest grade	maximum safety	*Investment grade*
Aa	AA	high grade	slightly lower standards	
A	A	upper medium	favourable but possible future problems	
Baa	BBB	medium grade	moderate security and protection	
Ba	BB	moderate protection	contain speculative elements	*Speculative*
B	B	potentially undesirable	low assurance of future payments	*'High Yield' or 'Junk' Bonds*
Caa	CCC	danger of default	dangerous elements present	
Ca	CC	likely in or to default	highly speculative	
CC	C	lowest class	extremely poor prospects	
C	D	bottom most grade	unlikely to attain any standing	
NR	NR	not ranked	no evaluation available	

Source: Fabozzi (2009)

overall public debt default rates (Grammenos *et al.*, 2008). Shipping industry issuers have been estimated to represent less than 0.5% of the overall public debt by issuer outstanding (January 2000). However, total shipping industry defaults reached nearly 9% of all defaults by issuer in 1999.

4.2 Shipping bond credit rating

4.2.1 Bond rating grades

Credit rating is a critical issue in fund raising through bond issues and we now discuss this topic briefly. Since the early 1900s, bonds have been assigned quality ratings that reflect their probability of going into default. The major US rating agencies are Moody's Investors Services (Moody's), Standard & Poor's Corporation (S&P), Fitch Investors Service (Fitch) and Duff & Phelps.

Bonds are rated either as of 'investment' or 'non-investment' grade (termed 'high yield' or 'junk' bonds). This distinction is based on the credit ratings these bonds receive from the rating agencies. Bonds rated in the range of Aaa/AAA (Moody's/S&P's) to Baa/BBB (Moody's/S&P's) are considered as 'investment grade'. Any bonds rated B (Moody's/S&P's) or below are included in the 'high yield' class (Table 9). Adjustments

Table 10: Bond rating criteria: Financial ratios (median)

Ratios (%)	AAA	AA	A	BBB	BB	B	CCC
EBIT interest coverage	23.8	19.5	8.0	4.7	2.5	1.2	0.4
EBITDA interest coverage	25.3	24.6	10.2	6.5	3.5	1.9	0.9
Funds from operations / Total debt	203.3	79.9	48.0	35.9	22.4	11.5	5.0
Free operating cash flow / Total debt	127.6	44.5	25.0	17.3	8.3	2.8	–2.1
Total debt/EBITDA	0.4	0.9	1.6	2.2	3.5	5.3	7.9
Return on capital	27.6	27.0	17.5	13.4	11.3	8.7	3.2
Total debt/Total capital	12.4	28.3	37.5	42.5	53.7	75.9	113.5

Source: Standard & Poor's (2009)

can be made within a rating category by adding a + or – (Moody's) or 1, 2 and 3 (S&P's) to indicate a higher or lower issue in its class.

4.2.2 Key factors to bond credit rating

Bond ratings are based on a number of both qualitative and quantitative factors, the most important of which are now briefly discussed: financial ratios (including debt ratio and EBIDTA coverage ratio); mortgage provisions (bond security by collateral); subordination provisions (bond subordination to other debt); guarantee provisions (guaranteed by third party); sinking fund (to ensure systematic repayment); maturity (longer maturity–higher risk profile); stability (in sales and earnings); regulation (regulated or not issuer and implications); antitrust (actions pending against issuer); overseas operations (overseas percentage of operations and earnings); environmental factors (heavy expenditures for pollution control); product liabilities (product safety); pension liabilities (unfunded pension exposures); labour unrest (labour tensions and problems); accounting policies (conservative approaches).

A strong correlation is apparent between high bond ratings and sound financial performance (predominantly relating to liquidity, operational profitability, debt exposure and debt servicing capability; Table 10). Plausibly, companies with lower debt ratios, higher cash flow to debt, higher returns on capital, higher EBITDA interest coverage ratios and EBIT interest coverage ratios typically gain higher bond ratings. In general, credit rating agencies take into account sovereign/macroeconomic issues, industry outlook, management quality, operating position, financial position, company structure, and, issue structure.

Market participants pay particular attention to bond ratings as a key factor that affects rate spreads and bond value. Since bond rating indicates competitive credit risk of any two investments within the group of rated instruments, rating also can support forecasts of probability of default. It is considered as an indicator of investors' protection in case a bond issuer faces adverse long-term economic conditions. To evaluate shipping bonds, credit rating takes into account a number of specific issues, including

Table 11: Bond spreads and ratings

Long-term bonds	Spread above a:			
	Yield (%)	T-Bond (%)	AAA (%)	BBB (%)
Investment grade				
US Treasury	5.08			
AAA	5.52	0.44		
AA	5.83	0.75	0.31	
A	6.18	1.10	0.66	
BBB	6.52	1.44	1.00	
High yield (junk) bonds				
BB	7.23	2.15	1.71	0.71
B	7.70	2.62	2.18	1.18
CCC	8.68	3.60	3.16	2.16

Source: Ehrhardt and Brigham (2009)

the impact of cyclicality and volatility on shipping markets; the uncertainty about the future direction of freight rates; the shipping business allocation into spot or chartered markets; the ability of the issuing shipping companies to attain sustainable future cash flows; and the issuer's vulnerability to economic cycles and implications for interest and principal payment (Standard and Poor's, 2009).

4.3 Spread determinants in shipping bonds

Bond ratings are important both to firms and to investors. Most bonds are purchased by institutional investors rather than individuals; many institutions are restricted to investment-grade securities. If a firm's bonds fall below BBB, it will be rather difficult to sell new bonds because many potential investors will not proceed to buy them. Furthermore, a number of bonds incorporate covenants stipulating that the coupon rate on the bond is to automatically increase, in case the rating falls below a specified level. In addition, because a bond rating is an indicator of its default risk, the rating has a direct, measurable influence on the bond's yield. Changes in a firm's bond rating affect the default risk premium on its debt, the ability of the firm to borrow long-term capital and the firm's cost of capital.

Table 11 indicates that yields increase monotonically as ratings become lower. In other words, investors demand higher required rates of return as a bond's risk increases. It is interesting that the AAA spread is only marginally (0.44%) above a Treasury-bond (T-bond), indicating that the two bonds are very similar except with respect to default risk and liquidity. Because AAA bonds often have good liquidity, this spread is an estimate of the default risk premium for AAA bonds. The spread between a bond and a T-bond of a similar maturity is often used as an approximation of the default risk for the bond. Based on that, it would be reasonable to estimate the default risk premium for a BBB bond at about 1.44%. The analysis of bond spreads could also take place between any two corporate bonds. It can be seen that spreads increase dramatically for junk bonds which reflects their risk and the fact that institutional investors are not allowed to hold junk bonds in many cases. Apart from rating, spreads also vary with respect to maturity; longer maturity bonds are expected to have higher spread reflecting a higher risk profile. For instance, a five-year AAA bond may have only a spread of, say, 0.37% while a 10-year AAA bond of 0.44% (Ehrhardt and Brigham, 2009).

In this framework, Grammenos and Arkoulis (2003) conclude that rating is a prime factor in pricing high yield shipping bonds and plays a key role in setting bond spreads. Significant correlation has been detected between bond rating and high yield bond spreads. Lower rated issues are associated with

higher default probabilities. Hence, one would anticipate a positive relationship between rating and the spreads on new shipping high yield bond issues. Callability of a shipping bond implies that the issue has a call option embedded and the issuer retains the right to retire (call back) the bond at specified prices before maturity. This option is of value in case of lower interest rate expectations, since the issuer may have the opportunity to refinance debt with a lower interest rate instrument, thus improving company debt terms. However, investors are exposed to reinvestment risk; hence, they would target higher returns for that. Primary pricing may be affected by the maturity term of a bond and a negative relationship between maturity and spread is anticipated. The float (issue amount) of a shipping bond indicates the liquidity of the issue. Larger bond issues are expected to have lower risk premiums than smaller bond issues traded in thinner markets. Hence, an inverse relationship is anticipated between float and spread (smaller issues – larger spreads).

The default rate is a measure of credit risk in the high yield bond market. It reflects relative likelihood that there may be a difference between what investors were promised and what they actually receive by the bond issuer. That is, a default implies any missed or delayed disbursement of interest or principal. It includes, furthermore, 'forced exchange', in case a bond issuer has offered a new instrument containing a diminished financial obligation, such as preferred or common stock or debt with a lower coupon or par amount (Fabozzi, 2009). Since higher default rates are associated with higher risk premium and investors demand a higher spread for compensation, a positive relationship between default rate and spreads would be plausible. The spread is also affected by subordination (in terms of debt claims priority) and is related to whether debt is secured (collateralised by assets) or unsecured; unsecured bond issues are expected to carry wider spreads.

Gearing has critical financial implications for shipping companies and is affected by high swings in freight rates and vessel prices. In periods of market growth, cash flow capacity may suffice to cover investment needs; however, in recession periods, external financing may be necessary. Shipping bonds issued by highly geared companies are associated with wider spreads. The fleet age can also be an important factor, since it affects vessel value. New vessels are usually more expensive and companies with younger fleet are seen to perform better in the capital markets. Nevertheless, in strongly upward markets and tight demand conditions, vessels can earn similar freight rates regardless of their age factor. High-yield bonds issued by companies with an older fleet (higher running costs) are associated with wider spread (higher risk). Finally, since larger laid-up tonnage reflects weakening demand interest and deteriorating industry conditions, the larger this factor the wider the associated high-yield bond spreads. Of the previous factors discussed, rating predominantly but also gearing and laid-up tonnage appear to be statistically significant in explaining shipping high-yield bond spreads (Grammenos and Arkoulis, 2003).

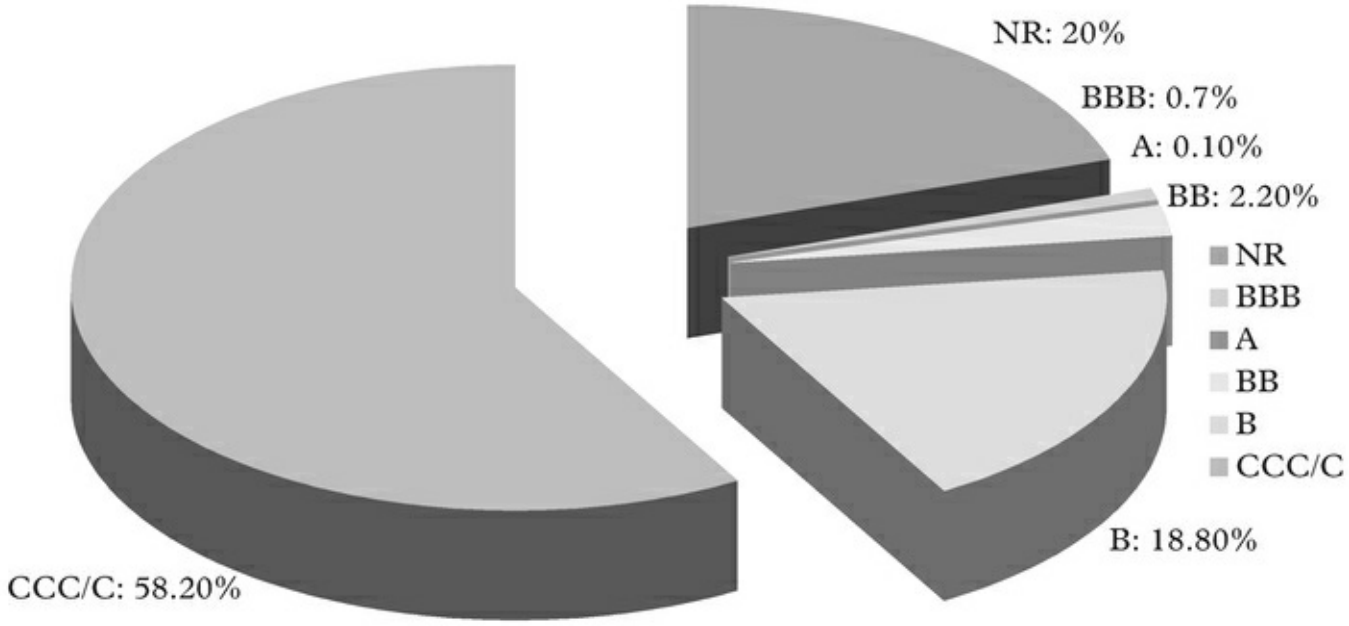

Figure 3: Default distribution prior to 'D': 1981–2008
Source: Standard & Poor's (long-term averages)

Table 12: Cumulative defaulters among global corporates: 1981–2008

	AAA	AA	A	BBB	BB	B	CCC/C
3-months	0.0	0.0	0.0	11.1	0.0	22.2	66.7
6-months	0.0	0.0	0.0	7.1	0.0	46.4	46.4
12-months	0.0	0.0	0.0	3.6	10.8	55.4	30.1
3-years	0.0	0.0	0.9	4.6	19.5	64.9	10.2
5-years	0.0	0.2	1.2	5.8	23.1	62.3	7.3
7-years	0.2	0.3	2.0	6.8	24.3	60.0	6.4
Total	*0.3*	*1.4*	*4.5*	*9.1*	*25.8*	*53.8*	*5.0*

Source: Standard & Poor's (2009) (as from original rating)

4.4 Probability of default in shipping bonds

Based on Standard & Poor's aggregate bond data, over 1981–2008, the (long-term average) default distribution of bond issues for ratings above 'D' indicates that the lower the rating grade of the bond, the higher the default vulnerability (probability). Whereas, for instance, bonds rated 'A' exhibited a marginal default rate (0.10%), more than half (58.2%) of the bonds rated 'CCC/C' proceeded to default (Figure 3).

Within the high yield (speculative) grade category, the lower the original rating on an issuer, the shorter the time to default over the long term. For example, for the entire pool of defaulters (1981–2008), the average times to default for issuers that were originally rated in the 'BB' and 'B' categories were 6.0 years and 4.6 years (from initial rating), respectively; whereas, issuers in the 'CCC' rating category or lower had an average time to default of 2.7 years. These empirical conclusions are further validated in Table

Table 13: Key sectoral characteristics and drivers of credit risk

Risk factor	Cyclicality	Competition	Capital intensity	Technology risk	Regulatory/ government	Energy sensitivity
Industry	H	H	H	L	M/H	H
Airlines (US)	H	H	H	L	M	H
Autos*	H	H	H	L	M	M
High Tech-nology*	H	H	H	M	M/H	H
Mining*	H	H	H	L	M	L
Chemicals (bulk)*	H	H	H	L	M	H
Hotels*	H	H	H	L	L	M
Telecoms (Europe)	M	H	H	H	H	L
Shipping*	H	H	H	L	L	M

Notes: *Global. Credit risk impact: High (H); Medium (M); Low (L)
Source: Standard & Poor's (2009).

12, where data on fastest cumulative defaulters among global corporates from original rating, during 1981–2008, are summarised in percentages of total defaults per rating category and time frame.

The evaluation of industry risk is an important prerequisite for the evaluation of respective corporate issuers, since it provides a robust understanding of the company's external business and operating environment (growth prospects, competition, risks, challenges). Although the characteristics significant to credit risk across industries are broadly similar, the impact of these factors can vary substantially between industries. As Table 13 highlights, a common set of industry characteristics/metrics can be applied to identifying the relative credit impact of key industry factors across some major industries in the US (Standard and Poor's, 2009). The nature and impact of key characteristics can vary markedly between countries for a given industry. Utilities, telecoms and retail tend to be more affected by national characteristics. By contrast, shipping, oil and gas, chemicals and technology sectors are more global in nature. Factors with a high level of impact on credit risk are cyclicality, degree of competition, capital intensity, technological risk, regulation/deregulation, and energy cost sensitivity.

As to the industry profile of bond defaults, some variation is seen by sector (Standard and Poor's, 2009). Of the 1,668 defaults recorded globally over the long-term, six sectors display an average time to default that is lower than the overall average of 5.7 years. These sectors are energy and natural resources, financial institutions, high technology, leisure time/media, real estate and telecommunications. If the median time to default is considered, then transportation should also be included in this group (Figure 4). The variation in industry stems partly from differentiation in the rating mix across sectors, since some sectors have a much higher representation of speculative-grade ratings than others (e.g., leisure/media vs financial institutions or insurance).

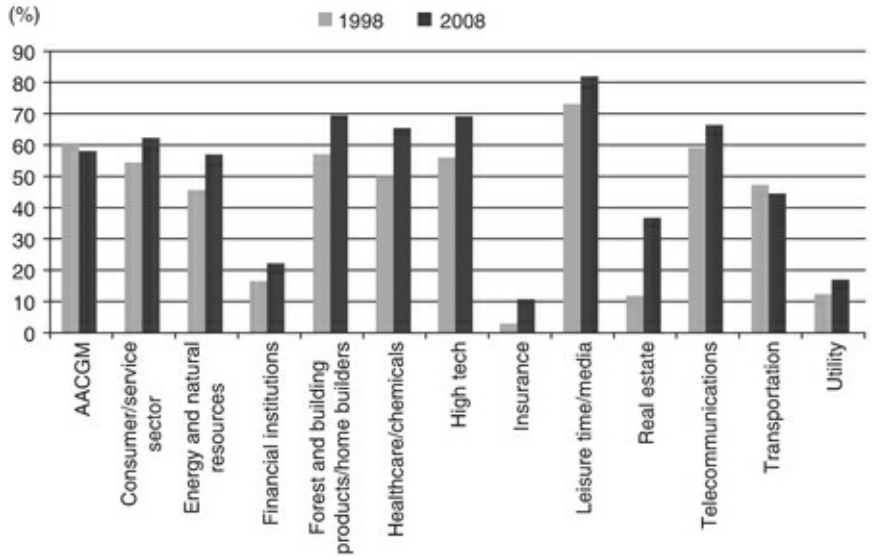

Figure 4: Share of speculative-grade rating to total by industry
Source: Standard & Poor's (2009)

As to the shipping sector, two recent complementary studies focus on a sample of shipping high yield bonds to identify factors that affect yield premia dynamics (Grammenos *et al.*, 2007); and, to assess the risk profile of these shipping bonds and estimate their probability of default (Grammenos *et al.*, 2008). The former study employs a sample of 40 seasoned high yield bonds offered by 32 shipping companies between April 1998 and December 2002 and investigates the impact of a set of microeconomic, macroeconomic and industry-related factors. Despite market perception about yield changes of corporate bonds, key determinants of credit spread changes have not been clearly identified (Collin-Dufresne *et al.*, 2001). Empirical evidence indicates that the dynamics of credit premia of seasoned shipping high yield bonds can be explained by credit rating; term-to-maturity; changes in earnings in the shipping market, as well as in the yield on 10-year Treasury bonds; and the yield on the Merrill Lynch single-B index. The second study focuses on an updated sample of 50 shipping high yield bonds, issued during 1992–2004 and employs a binary logit model to predict the probability of default. Furthermore, the explanatory power of critical factors in best predicting the probability of default for shipping bonds at the time of issuance is also statistically tested.

Of the total 50 shipping bond issues in the sample under study, 13 issues were defaulted as of the end of 2004 and the remaining 37 issues were still trading in the market or had expired. The respective credit ratings and the categorisation in defaulted and non-defaulted issues of this bond sample are summarised in Table 14. Most of the new shipping high-yield bonds were assigned a credit rating falling into the BB level (68% of the sample); few issues were rated at the B level (30%) and one issue at the C level (2%). Of this sample, 8.82% of the BB rated bonds defaulted compared to 53.3%

Table 14: Shipping high yield bond ratings

	All issues number	Defaulted issues		Non-defaulted issues	
		Number	% of Group	Number	% of Group
BB+	4	0	0	4	100
BB	5	1	20	4	80
BB–	25	2	8	23	92
Total BBs	*34*	*3*	*8.8*	*31*	*91.2*
B+	6	3	50	3	50
B	8	5	62.5	3	37.5
B–	1	1	100	0	0
Total Bs	*15*	*9*	*53.3*	*6*	*46.7*
CCC+	1	1	100	0	0
All Issues	50	13	24	37	76

Source: Grammenos *et al.* (2008)

of the B rated bonds. This outcome implies that investors that prefer higher rated shipping bonds in a shipping bond portfolio stand on average a lower probability of default. This, however, is not necessarily the case on an individual bond basis.

A number of important financial, industry and issue specific variables are considered, including issue amount raised to total assets (issue factors); current assets to current liabilities (current ratio); cash to freight revenue (liquidity indicators) and pre-issue gearing as a debt indicator (financial factors); and, laid-up tonnage to total fleet (industry factors). Shipping companies with low liquidity (current ratio), high gearing levels and operating in the spot market are anticipated to have difficulties in meeting short-term obligations to their bondholders. The lower the liquidity indicators of a shipping company, the higher the probability of default for its high yield bonds, particularly in adverse shipping market conditions.

The gearing level is a most important factor for the probability of default. Pre-issue gearing is calculated as the ratio of long-term debt over long-term debt plus shareholder equity. A higher exposure to debt indicates higher vulnerability of the shipping company during recession phases and higher risk for bondholders due to higher probability of default. These negative conditions have jeopardised the viability of several shipping companies in previous years, whereas a number of high yield bond issues have defaulted, as in 1998–1999. A substantially large amount raised in the high yield bond issue over the company's total assets indicates a higher risk exposure for bondholders; hence, a higher probability of default. High laid up tonnage over total fleet indicates weak demand and depressed market conditions, which in turn increases the probability of default for shipping bonds.

To conclude, despite some overcapacity conditions and demand–supply imbalances in the shipping markets recently, the shipping industry is anticipated to face considerable capital requirements over the coming years, as a result of ageing fleets, loan rescheduling and intensified trade flows (Leggate, 2000), whenever the global financial crisis will be over. This growth in demand will be in contrast to a potential contraction in the number of banks willing to support the industry and a general tightening of credit facilities. As a result, shipping companies will have to reconsider accessing the capital markets for equity and debt. The difficulties experienced particularly in the bond markets have led to an early dismissal of this relatively new form of ship finance. Debt finance with bond issues remains largely dependent on the perception institutional investors bear of the shipping industry.

5. Corporate Governance in Shipping

The issue of efficient corporate governance is a critical topic directly related to the firm's financial decisions and capital structure and has attracted increasing theoretical and empirical attention recently (Syriopoulos, 2007). This section explores briefly the topic of corporate governance and shipping firm performance.

Corporate governance, according to the OECD (2004), is the system by which business corporations are directed and controlled. In other words, corporate governance specifies the distribution of rights and responsibilities among different participants in the corporation, such as the Board of Directors (BoD), managers, shareholders and other stakeholders, and spells out the rules and procedures for making decisions on corporate affairs. The following main pillars can be distinguished: ownership structure and influence of major stakeholders; shareholder rights; transparency, disclosure and audit; and, board effectiveness. A variety of internal and external corporate mechanisms contributes to an efficient corporate governance model (Jensen and Meckling, 1976; Shleifer and Vishny, 1997; Mallin, 2007). These mechanisms include, *inter alia*, managers' monitoring by BoDs, independent BoD members, ownership structure and dispersion, committee formation, managerial remuneration (stock options) and transparent market disclosure processes (internal level); as well as, the market for corporate control (takeovers), external stakeholders' monitoring, shareholder minority rights or active institutional investor shareholder clauses (external level).

The shift seen in funding sources towards global capital markets and international investors brings about fundamental shifts in the corporate governance model of the shipping companies. This shift has been partly imposed by the institutional framework of the host capital markets, particularly the US. A fundamental prerequisite for shipping firms going public refers to compliance with a core set of corporate governance practices. A number of reasons justify the empirical interest in corporate governance of shipping firms. For a start, in a highly risky, capital-intensive industry, the business operation takes place on a global scale. The property of the shipping firms constitutes super-national subjects, whereas human resources can emanate from all over the world (Randoy, 2001). Shipping firms have been argued to gain comparative advantages from the combination of 'local' characteristics (internal environment) and 'international' characteristics (external environment) of corporate governance (Randoy *et al.*, 2003). Moreover, the earlier traditional private, family-owned and managed shipping firms are now transformed into publicly listed, multi-shareholder entities. On top of that, a gradual separation of ownership and management is seen to prevail in shipping firms' top management level. Empirical research in these issues remains, surprisingly, limited.

In this background, a recent empirical study investigates corporate governance implications for the financial performance of shipping firms (Syriopoulos and Tsatsaronis, 2009). Based on a carefully selected sample of Greek shipping companies listed in US equity markets, the study assesses the implications for and evaluates the impact on corporate value of the following: (1) managerial executives (CEOs) directly related to the founding family (founding family CEO); (2) the level of independence of the Board of Directors (BoD independence); and, (3) the Board of Directors' ownership stake in firm's equity (BoD ownership concentration). To sum up the main empirical findings, founding family CEOs are found to exert a positive impact on shipping firms' financial performance (measured by ROE or ROA ratios). Furthermore, a positive impact is confirmed between equity ownership of BoD members and the firm's financial performance. Despite the perception that

the participation of independent members in BoDs is a good corporate governance practice, this is not confirmed for the sample shipping firms. It should be noted though, that shipping firms have traditionally experienced strong growth rates based on the advantages of a family-type management and ownership model. On the other hand, listing on global stock exchanges has encouraged shipping firms to now follow more extrovert managerial strategies and modernise their corporate governance principles, including top management duality and separation of ownership from management. Empirical evidence supports that sound corporate governance mechanisms can mitigate the 'agency conflict problem' (divergence of managers' vs shareholders' interests) and can have a positive impact on corporate value (Panayides and Gong, 2002; Randoy *et al.*, 2003; Syriopoulos and Theotokas, 2007).

6. Conclusion

This chapter has discussed key issues on shipping finance and global capital markets and has assessed the attractiveness and efficiency of equity and bond markets as important financing mechanisms for shipping companies. Alternative financing vehicles, such as SPACS, PIPEs, private equity, mezzanine finance and ATM offerings have been also briefly presented.

The contribution of capital markets to shipping finance has evolved in a background of recent super-cycle trends in the freight markets and robust performance of international equity markets, before the global financial crisis affects both markets dramatically. The extraordinary growth rates seen in the shipping markets over the last years resulted to unprecedented corporate profits and robust liquidity reserves for shipping companies. Based on this booming environment, many shipping firms pursued an intensive fleet expansion strategy, albeit at high vessel values, building tense overcapacity conditions and creating serious demand-supply imbalances. In any case, this business growth was predominantly funded by external sources of financing and led many shipping firms conclude this period at alarming levels of leverage.

The recent shipping IPO wave in global equity markets indicates that an increasing number of shipping firms appear to discover the virtues of equity finance. Key factors for successful shipping IPOs include attractive valuation, efficient management, robust organic growth prospects, modern corporate governance and successful investment plans. Focusing on shipping firm valuation, the following parameters are critical: cash flows, net asset value, revenue and operational earnings, total book value and enterprise value. Empirical evidence supports that the well documented puzzle of IPO underpricing and long-run underperformance also applies in the case of newly listed shipping firms. Global bond markets offer alternative fund raising opportunities to shipping firms that have exhibited a revitalised interest with a number of bond issues traded over the last decade. Despite their high yield profile, the majority of the shipping bond issues have performed decently and credit default rates have remained low. Overall, the financing decisions of the shipping firm have important implications for its risk, profitability, growth and value creation. The choice between alternative capital funding sources, equity or debt finance, and the resulting capital structure mix is a complex issue and cannot be uniformly decided a priori for each shipping firm. It is guided by the optimal mix that enhances ultimately the firm's corporate value. As the number of shipping companies going public increases, interesting management issues come high in priority, especially, the implementation of efficient corporate governance systems, including the active role of BoDs, the application of duality between

BoD Chairman and CEO, information transparency and dissemination or shareholder rights protection.

To conclude, for companies interested in expanding their fleets, international capital markets and relevant financing instruments present interesting opportunities to fund raising. Shipping companies realise they should apply more outward-looking business strategies and take advantage of international capital mobility, following a more tailor-made use of global capital markets. Although the recent shipping IPO wave may not be repeated soon, further activity is anticipated in international capital markets by shipping firms. At the same time, shipping finance appears to have reached a stage where innovative financing methods are combined with traditional approaches to create new, sophisticated instruments.

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References

Alizadeh, A. and Nomikos, N. (2009): *Shipping Derivatives and Risk Management* (Basingstoke, Palgrave-Macmillan).

Andriosopoulos, K., Papapostolou, N. and Pouliasis, P. (2009): "Optimal portfolio selection and index tracking for the shipping equity market: An application of the differential evolution algorithm", *Working Paper*, Cass City Business School, International Centre for Shipping, Trade and Finance, London.

Bernstein, R. (1995): *Style Investing* (New York, John Wiley and Sons).

Brau, J., Francis, B. and Kohers, N. (2003): "The choice of IPO versus takeover: Empirical evidence", *Journal of Business*, 76(4), 583–612.

Brounen, D. and Eichholtz, P. (2002): "Initial public offerings: Evidence from the British, French and Swedish property share markets", *Journal of Real Estate Finance & Economics*, 24, 103–117.

Cai, J. and Wei, K. (1997): "The investment and operating performance of Japanese initial public offerings", *Pacific-Basin Finance Journal*, 5(4), 389–417.

Carter, B., Dark, F. and Singh, R. (1998): "Underwriter reputation, initial returns, and the long run performance of IPO stocks", *Journal of Finance*, 53(1), 285–311.

Chahine, S. (2008): "Underpricing versus gross spreads: New evidence on the effects of sold shares at the time of IPOs", *Journal of Multinational Financial Management*, 18, 180–196.

Chen, Y.S. and Wang, S.T. (2004): "The empirical evidence of the leverage effect on volatility in international bulk shipping market", *Maritime Policy & Management*, 31(2), 109–124.

Clarkson Research Services (2009): *Shipping Market Outlook*, Autumn Report, London.

Collin-Dufresne, P., Goldstein, R. and Martin, J. (2001): "The determinants of credit spread changes", *Journal of Finance*, 56, 2177–2207.

Cullinane, K. and Panayides, P. (2000): "The use of capital budgeting techniques among UK-based ship operators", *International Journal of Maritime Economics*, 2, 313–330.

Derrien, F. and Kecskes, A. (2007): "The initial public offerings of listed firms", *Journal of Finance*, 62, 447–479.

Drobetz, W., Kammerman, M. and Walchll, U. (2005): "Long-run performance of initial public

offerings: The evidence for Switzerland", *Schmalenbach Business Review*, 57, 253–275.
Erdogan, O. (2005): "IPO choice for maritime companies: Turkish evidence", *Eurasian Review of Economics and Finance*, 1, 7–18.
Ehrhardt, M. and Brigham, E. (2009): *Corporate Finance: A Focused Approach* (UK, Southwestern).
Fabozzi, F. (2009): *Bond Markets, Analysis and Strategies* (7th edn.) (New York, Prentice Hall).
Fernando, C., Krishnamurti, S. and Spindt, P. (2004): "Are share price levels informative? Evidence from the ownership, pricing, turnover and performance of IPO firms", *Journal of Financial Markets*, 7, 377–403.
Fridson, M. and Garman, C. (1998): "Determinants of spreads on new high yield bonds", *Financial Analysts Journal*, March/April, 28–39.
Gajewski, J. and Gresse, C. (2006): "A survey of the European IPO market", *ECMI Paper*, No. 2, August.
Goergen, M., Renneboog, L. and Khurshed, A. (2006): "Explaining the diversity in shareholder lockup agreements", *Journal of Financial Intermediation*, 15(2), 254–280.
Gong, S. (2003): "How risky are shipping and airline common stocks?", *Working Paper*, Shipping and Transport Logistics Dpt., Hong Kong Polytechnic University.
Goulielmos, A. and Xifia, M. (2006): "Shipping finance: Time to follow a new track?", *Maritime Policy & Management*, 33(3), 301–320.
Grammenos, C.T., Alizadeh, A.H. and Papapostolou, N.C. (2007): "Factors affecting the dynamics of yield premia on shipping seasoned high yield bonds", *Transportation Research Part E*, 43, 549–564.
Grammenos C.T. and Arkoulis, A. (2002): "Macroeconomic factors and international shipping stock returns", *International Journal of Maritime Economics*, 4, 81–99.
Grammenos, C.T. and Arkoulis, A. (2003): "Determinants of spreads on new high yield bonds of shipping companies", *Transportation Research Part E*, 39, 459–471.
Grammenos, C.T. and Marcoulis, S. (1996): "A cross-section analysis of stock returns: The case of shipping firms", *Maritime Policy & Management*, 23(1), 67–80.
Grammenos, C.T. Nomikos, N.K. and Papapostolou, N.C. (2008): "Estimating the probability of default for shipping high yield bond issues", *Transportation Research Part E*, 44, 1123–1138.
Harwood, S. (2006): *Shipping Finance* (3rd edn.) (London, Euromoney Books).
Helwege, J. and Liang, N. (1999): "Initial public offering in hot and cold markets", *Journal of Financial and Quantitative Analysis*, 39, 541–569.
Jaskiewicz, P., Gonzalez, V., Menindez, S. and Schiereck, D. (2005): "Long-run IPO performance analysis of German and Spanish family-owned businesses", *Family Business Review*, 18(3), 179–202.
Jensen, M. and Meckling, W. (1976): "Theory of the firm: Managerial behavior, agency costs, and ownership structure", *Journal of Financial Economics*, 3, 5–60.
Kavussanos, M. (1997): "The dynamics of time-varying volatilities in different size second-hand prices of the dry-cargo sector", *Applied Economics*, 29, 433–443.
Kavussanos, M. (2003): "Time varying risks among segments of the tanker freight markets", *Maritime Economics & Logistics*, 5, 227–250.
Kavussanos, M., Juell-Skielse, A. and Forrest, M. (2003): "International comparison of market risks

across shipping-related industries", *Maritime Policy & Management*, 30(2), 107–122.
Kavussanos, M. and Visvikis, H. (2006): *Derivatives and Risk Management in Shipping* (London, Witherbys Publishing).
Leggate, H. (2000): "A European perspective on bond finance for the maritime industry", *Maritime Policy & Management*, 27(4), 353–362.
Lee, P., Taylor, S. and Walter, T. (1996): "Australian IPO pricing in the short and long-run", *Journal of Banking & Finance*, 20(7), 1189–1210.
Loughran, T. and Ritter, J. (1995): "The new issues puzzle", *Journal of Finance*, 50(1), 23–51.
Lowry, M. (2003): "Why does IPO volume fluctuate so much?", *Journal of Financial Economics*, 67, 3–40.
Ljungovist, A. (2005): "IPO underpricing", in B. Eckbo (ed.) *Handbook of Empirical Corporate Finance* (Amsterdam, North-Holland) pp. 325–335.
Lucas, D. and McDonald, R. (1990): "Equity issues and stock price dynamics", *Journal of Finance*, 45, 1019–1043.
Majarian, D. (2010): "ATM share offering: Another 'bail-out' technique to recapitalize shipping companies". Available at www.tradewinds.no.
Mallin, C. (2007): *Corporate Governance* (2nd edn.) (Oxford, Oxford University Press).
Matthews, S. (2005): "Finance options", *Lloyd's Shipping Economist*, October, 9–13.
Matthews, S. (2006): "Taking stock", *Lloyd's Shipping Economist*, March, 28–30.
McGroarty, R.D. (2006): "Waves of demand", *Lloyd's Shipping Economist*, October, 7–10.
Merikas, A., Gounopoulos, D. and Nounis, C. (2009): "Global shipping IPO performance", *Maritime Policy & Management*, 36(6), 481–505.
Modigliani, F. and Miller, M. (1958): "The cost of capital, corporate finance and the theory of investment", *American Economic Review*, 48, 261–97.
Mulligan, R. and Lombardo, G. (2004): "Maritime businesses: Volatile stock prices and market valuation inefficiencies", *The Quarterly Review of Economics and Finance*, 44, 321–336.
OECD (2004): *Principles of Corporate Governance* (Paris, Organization for Economic Cooperation and Development).
Pagano, M. (2005): "The Modigliani-Miller theorems: A cornerstone of finance", Working Paper No. 138, Centre for Studies in Economics and Finance, University of Salerno, Italy.
Pagano, M., Panetta, F. and Zingales, L. (1998): "Why do computers go public? An empirical analysis", *Journal of Finance*, 3, 27–64.
Panayides, P. and Gong, X. (2002): "The stock market reaction to mergers and acquisition announcements in liner shipping", *International Journal of Maritime Economics*, 4, 55–80.
Petropoulos, T. (2009): "The day after ...What lies ahead for ship finance?", Petrofin Presentation Paper, December (Athens, Institute of Chartered Shipbrokers).
Randoy, T. (2001): "Choice of internationalization mode among Norwegian shipping firms", *International Journal of Maritime Economics*, 3, 259–298.
Randoy, T., Down, J. and Jenssen, J. (2003): "Corporate governance and Board effectiveness in maritime firms", *Journal of Maritime Economics and Logistics*, 5, 23–39.
Ritter, J. (1991): "The long performance of Initial Public Offerings", *Journal of Finance*, 46(1), 3–28.

Ritter, J. and Welch, I. (2002): “A review of IPO activity, pricing and allocations”, *Journal of Finance*, 57, 1795–1828.

Rock, K. (1986): “Why new issues are underpriced”, *Journal of Financial Economics*, 15, 187–212.

Ruud, J. (1993): “Underwriter price support and the IPO underpricing puzzle”, *Journal of Financial Economics*, 34(2), 135–151.

Shleifer, A. and Vishny R. (1997): “A survey of corporate governance”, *Journal of Finance*, 52, 737–783.

Standard and Poor’s (2009): *2008 Annual Global Corporate Default Study and Rating Transitions*, Global Fixed Income Research.

Stehle, R., Ehrhardt, O. and Przyborowsky, R. (2000): “Long-run stock performance of German initial public offerings and seasoned equity issues”, *European Financial Management*, 6, 173–196.

Stokes, P. (1997): *Ship Finance: Credit Expansion and the Boom-Bust Cycle* (London, LLP Publications).

Stopford, M. (2002): Setting the scene, identifying the objectives: Fifty years of ship finance, *Paper Presentation*, Marine Investments Financing Forum, Amsterdam.

Stopford, M. (2009): “Globalization and the long shipping cycle”, *Paper Presentation* (London, Royal Institute of Naval Architects).

Stopford, M. (2010): “Handy Bulkers: Is there really safety in numbers?”, *Weekly Shipping Marker Analysis Report* (London, Clarkson Shipping Research Intelligence Network).

Syriopoulos T. (2007): “Financing Greek shipping: modern instruments, methods and markets”, in A. Pallis (ed.), *Maritime Transport: The Greek Paradigm*. Research in Transportation Economics, Vol. 21 (London, Elsevier).

Syriopoulos, T., Merikas, A. and Roumpis, E. (2006): “Market interactions and volatility spillover effects between shipping, oil and stock markets”, *Working Paper*, IAME Conference, Melbourne.

Syriopoulos, T. and Roumpis, E. (2006): “Price and volume dynamics in second-hand dry bulk and tanker shipping markets”, *Maritime Policy & Management*, 33(5), 497–518.

Syriopoulos, T. and Roumpis, E. (2009): “Asset allocation and value at risk in shipping equity portfolios”, *Maritime Policy & Management*, 36(1), 57–78.

Syriopoulos, T. and Theotokas, I. (2007): “Value creation through corporate destruction? Corporate governance in shipping takeovers”, *Maritime Policy & Management*, 34(3), 225–242.

Syriopoulos, T. and Tsatsaronis, M. (2009): “Corporate governance and firm performance: The case of the Greek shipping firms”, *Working Paper* (IAME Conference, Copenhagen).

Tvedt, J. (2003): “A new perspective on price dynamics of the dry bulk market”, *Maritime Policy & Management*, 30(3), 221–230.

Veraros, N. (2008): “Modern issues in shipping finance”, *Paper Presentation* (Chios, University of the Aegean).

Chapter 29

Framing a Canvas for Shipping Strategy

*Kurt J. Vermeulen**

1. Introduction

A voluminous body of research and literature has been produced in the domain of strategy for non-shipping companies. Yet, the shipping industry which transports more than 90% in volume of those companies' physical output has been allotted an altogether humble share of strategy researchers' time. It is only in the 1970s and 1980s that we see strategy literature coming to the fore, perhaps not coincidentally in periods when shipping experiences its periodical crises. Recently, strategy for ocean shipping companies has enjoyed somewhat more of an interest from various angles including economic historiography, organisational behaviour, operational research, game theory, behavioural economics and quantitative finance. In the public's mind, shipping is readily associated with some of its charismatic denizens past and present like Aristoteles Onassis, Stavros Niarchos, Erling Naess, John Fredriksen and Chang Yung-fa. This is testimony to the entrepreneurial nature of the shipping industry, and entrepreneurs tend by nature, and out of business necessity, to take a holistic view. It is this wider, more holistic, approach which deserves more attention in future research. Prior to engaging in such a review, it is necessary to assess where shipping strategy stands in the literature to date and how holistic in nature this strategy analysis has been.

Section 2 sets out the approach this author adopted in finding and selecting the literature to review and analyse. Out of this analysis came a distinct three pronged approach consisting of: (i) a review and analysis of the strategy literature "proper"; (ii) the development of a conceptual framework for literature classification taking into account the holistic and entrepreneurial nature of a shipping entrepreneur's perspective; and (iii) a review and analysis of the literature with reference to the proposed conceptual framework. The section proceeds in outlining the proposed conceptual framework. Section 3 adopts this approach and makes a start with a review and analysis of the strategy literature "proper". It, firstly, gives a brief overview of key authors who have influenced the theory of strategy applied to shipping and, then, focuses in particular on Michael Porter's work whose strategy theory and concept of sustainable competitive advantage have come to dominate the field of shipping strategy. Section 4 discusses the strategy literature pertaining to shipping specifically. Section 5 draws some conclusions from this analysis, whilst Section 6 will complete the review by outlining broader areas for future research.

2. Data and Methodology

With a view to gather the largest possible body of literature on the subject matter, we performed an English language only database search on EBSCO Business Source and EconLit covering their full historical extent. The search string terms encompassed simply shipping, maritime and strategy keywords. This generated some 120,000 headlines which were summarily reviewed. Some 800 articles, all shipping specific, published between 1965 and March 2010 were retained for further screening. Of those, we retained for incorporation in this review nearly 100 articles published in peer reviewed academic journals. The remainder of articles is in use for the suggested future research.

Further, our literature review also encompasses material taken from various monographs or edited collective volumes. The author does not profess this and subsequent reviews to be exhaustive, but does believe it to be sufficiently encompassing to get a good understanding of the state of research in the ocean shipping strategy domain.

Having reviewed this literature, we found a very broad range of topics being addressed from a topical or discipline perspective, yet whose relevance to strategy does not seem to be explored further. Many journal contributions from a maritime economics perspective explore in a robust manner issues such as the value of time and flexibility, yet find little echo in the strategy literature with respect to the impact of the need for, and value of, flexibility. Or, still, corporate finance instruments such as the use of financial derivatives may be explored in great detail with respect to hedging efficiency yet find their relevance for paper based shipping activities, asset portfolio composition and risk management policies quasi ignored from a shipping strategy perspective. This author thinks this may be partly due to the specialist nature many of the social scientists have been led to adopt over time. Gone seem the times when Stanley Sturmey (1962) would report on the state of British shipping and review the whole field of maritime economics in the process, or Moreby (1975) would review the role of the human element in shipping and place such in a technoeconomic context whilst having also regard for relevant findings in the fields of psychology and organisational behaviour. But, have those times really gone? Stopford's (2009) authoritative work has grown from a maritime economics textbook (Stopford, 1988) into a veritable compendium of the economic history of the shipping industry and research pertaining to it. Wijnolst and Wergeland (2009) are in the process of doing the same in the field of shipping technology and innovation by bringing together various strands of research ranging from strategy to ship design to innovation theory. These are signs that the call for a return of "Renaissance Man" is being echoed in the field of maritime economics in particular and the study of shipping in general.

This author's attempt to contribute to this recent development is to seek to place the substantial extant body of literature in a more holistic framework reflecting the reality that shipping strategy pertains not just to the group level strategic objectives, but also to its implementation in specific market segments or its implementation through various operational and managerial functions. As such, it is proposed to classify the literature

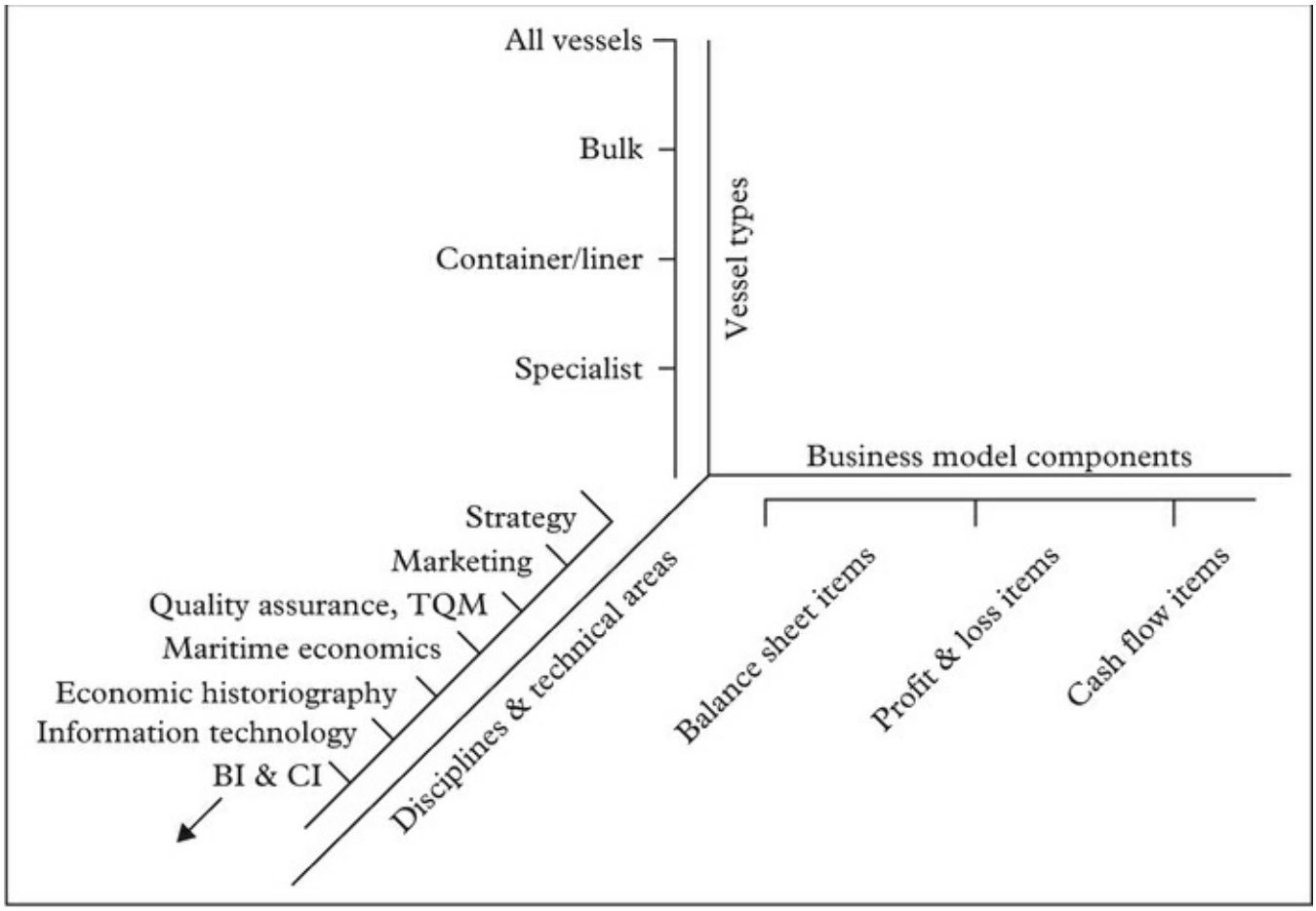

Figure 1

Source: Author

by means of a three-dimensional grid representing a holistic entrepreneurial approach (see Figure 1 above). It has as advantage that we cover not only the pure strategy literature, but also the non-strategy literature whose findings are of relevance to strategy or the very application of it.

The *first dimension* represents the key financial statements of any business enterprise; a balance sheet, profit and loss statement (P&L) and a cash flow statement. In this manner, any aspect of the strategy literature should be related back to any of the business attributes affecting a company's financial performance, but also vice versa. That is, one assesses the implications for strategy of the literature pertaining to topical non-strategy matters. Those financial statements can also be subdivided into their component business attributes. The subdivision this author proposes is for conceptual purposes and not necessarily compliant with accounting rules, such as IFRS. For examples we and the management science literature may treat a management team as a company's intangible asset albeit this would not meet IFRS classification requirements. The balance sheet encompasses assets, liabilities and Ordinary Shareholders' Funds (OSF). Assets in the shipping business would comprise tangible assets (e.g. vessels, offices, handling terminals) and intangible assets (e.g. brand name, know how, customer list, the team of key employees, software, patents, trademarks, design rights, database rights, trade secrets, rights under concession agreements and rights to berthing slots or container slots). The liabilities consist of debt whilst the OSF encompasses equity, reserves and minority interests.

The P&L components used in our proposed classification are not those commonly found in the eponymous financial statement, but three of the five key models constituting jointly a business model (Mullins and Komisar, 2009). They are the revenue model, the gross margin model and the operating

model. The two other models are the working capital model and the investment model, both of which fall under the cash flow component of this dimension of our classification. The revenue model pertains to questions such as: whom to sell to, what to sell, why does the customer buy this, when do they buy it, what services to provide as part of the sale and at what price? The gross margin model addresses the cost of sales such as brokerage fees payable to ship brokers, costs of goods sold (COGS) encompassing bunkers and labour, port fees, survey fees and, crucially, the choice of margin mix (time charter/COA/FFA vs. spot market, portfolio composition). The operating model (OPEX) addresses sales, general and administrative expenses (S,G&A) including ship management fees, freight rates payable, hedging costs and, importantly, those costs associated with the provision of non-standard specific services requested by the customer. Finally, the working capital model addresses the working capital components that influence timing of cash flows such as inventory (e.g. capacity), debtors (e.g. freight receivable) and creditors (e.g. supplier invoices owed) whilst the investment model addresses capital expenditure (CAPEX) on either new assets or Research and Development (R&D).

The *second dimension* of our proposed classification grid is composed of the shipping market as a whole, and could be considered as part of future research to be expanded to include specific shipping market segments, respectively bulk (dry bulk, liquid bulk, break bulk and neo-bulk), liner/container and specialty (e.g. chemicals). A *third, and final, dimension* of our proposed grid consists in effect of the various disciplines or technical areas whose practitioners have made contributions that are pertinent to strategic planning in the ocean shipping industry including in no particular order, law (competition law, antitrust law), organisational behaviour, behavioural economics, marketing, economic geography, scenario planning, governance, business intelligence, competitive intelligence, corporate social responsibility, information technology, operational research, logistics/supply chain management, quality assurance/total quality management and economic historiography and, of course, strategy. It is this variety of disciplines whose contributions are to be reflected in future research, which will most aptly illustrate the holistic nature of strategy.

In this contribution, we will now focus on the literature of strategy proper pertaining to the ocean shipping industry in general (i.e. to the exclusion of a review of strategy literature specific to a single shipping market segment).

3. About Strategy Proper and Shipping

3.1 What is strategy?

It is only fitting that we start our review with the literature pertaining to strategy proper. Strategic choices made by shipping companies will address the *Where* and *How* to compete and, therefore, consist of corporate strategy and business strategy (Grant, 2008). *Corporate strategy* addresses the markets within which a shipping firm decides to compete (e.g. dry bulk, chemicals, CPP, oil) and will address decisions on vertical integration, diversification, horizontal integration, new ventures, divestments and allocation of resources between the different businesses. The *business strategy*, *aka competitive strategy*, addresses how the shipping firm will establish a competitive advantage over its rivals. Finally, strategy gets implemented on the functional level or business line level. Strategy can fulfil a variety of functions in the firm, e.g. communication across organisational units, decision support, facilitating organisational learning and, most importantly, set targets. Strategy is not a

product, but a continuous process making use of strategy tools (e.g. industry analysis) in researching, devising, implementing strategy and controlling its execution.

3.2 The evolution of the theory of strategy

Before proceeding with a review of shipping strategy literature, it is perhaps appropriate to outline the evolution of the theory of strategy, as summarised by Michel Godet (Godet, 2007). Godet considers Henri Fayol (Fayol, 1916) as one of the founding fathers of "*planning*" . Fayol summarises management as anticipation, organisation, command, coordination and control. His contribution was to translate management into 14 principles including but not limited to, the division of labour, unity of command, the subordination of specific interest to the general interest, centralisation and decentralisation, unity of direction, remuneration, stable work force, initiative, solidarity with personnel, equity and order. It is notable that several of these ideas are only now coming back to the fore.

Contrary to Fayol's ideas and the then prevailing Fordism, Mary Parker Follett (1924) pioneered the behaviourist approach to management built on decentralisation, the role of the group as an integrating entity for individuals, competency-based authority and control through trust and communication. The Interbellum was characterised by the separation of strategic from tactical plans and the diffusion of statistical and financial techniques, a by-product of war time logistics planning by means of operational research. Note, in this respect, the genesis of modern day econometrics by Tjalling Koopmans, and its pioneering application to tanker freight rate forecasting and tanker shipping cycle analysis (Koopmans, 1939). DuPont de Nemours and General Motors, then under the chairmanship of Alfred P. Sloan, started applying those new principles to their respective organisations, which were characterised by divisional objectives setting. A Sloan contemporary contributed to the reorganisation of GM and subsequently wrote the "*Concept of the Corporation*" (Drucker, 1946) about the newly formed multi-divisional company.

Drucker (1955) then went on to posit the five fundamental activities of a manager: setting objectives, structuring the firm and organising personnel, motivating, communicating, setting performance targets, supervising and developing staff. The 1950s and 1960s feature the nascent discipline of *long-range planning* which adds a long term planning component to the annual budgeting cycle. This rapidly became *corporate planning* as the needs for corporate wide growth targets and diversification policies were acknowledged. Chandler (1962) observed the organisational setup changed only through trial and error in reaction to environmental changes. Ansoff (1965) argued for a proactive approach through reorganisation of the corporation based on the anticipation of environmental change. The feelings of insecurity engendered by the recession of 1973 reinforced the need for corporate planning, now *strategic planning*, taking into account the possible futures. Ansoff (1979) argued against the redundant character of planning based on *a priori* objectives and advocated *strategic management* (i.e. the capability to react and adapt to environmental change). Porter (1998b) developed approaches to competitive analyses of firms and industries around the concept of sustainable competitive advantage. Barney (1991) reoriented the concept of sustainable competitive advantage towards the unique internal resources of the firm, thus, creating a resource-based theory of the firm (Conner, 1991). The concepts posited by Porter, and more recently Barney, are the ones that have come to dominate the shipping strategy literature.

3.3 The market structure and features of ocean shipping

Strategy is a function of the market features in which the subject company is active. The demand for shipping services, as a transport function, is a derived demand correlated to the general economic development. Developments in shipping, such as technological innovation, and associated freight rate declines based on resultant economies of scale, cannot by themselves lead to enlargement of the demand for shipping services. Jacks and Pendakur's (2008) analysis of the 1870–1913 globalisation movement showed income growth and convergence were the drivers of world economy globalisation, and not the maritime transport revolutions of steamships, metal hulls and propellers. Maritime innovation and its corollaries are the result of a "demand" for economic growth.

The market structure of shipping is, firstly, characterised by serving mainly industrial consumers with an ocean going merchant fleet comprising 26,280 vessels owned by 4,795 companies (Stopford, 2004). In other words, the average shipowner has five vessels and is, thus, unlikely to be able to exercise influence over the market.

The market's main transactional currency was the US Dollar, albeit anecdotal evidence suggests this may be under review after the 2007/2008 credit crunch led to a severe decline in the dollar value. Vessels are high capital investment assets and have an economic lifetime of over 20 years. Earnings are highly volatile as the demand for shipping services is a derived demand linked to the world business cycle.

Bulk markets are very competitive, which competitiveness is aided by homogenous cargo, many market participants (both ship operators and shippers), low barriers to entry besides capital investment and adequate information flows ensuring market transparency. Specialist shipping markets have fewer customers and fewer market participants and competition is focussed on service and specialisation. There can be substitution between some vessels operating in specialised market segments and those operating in the bulk segments (e.g. combined vessels). Liner shipping serves both volume shippers directly (e.g. full truck load with truck meaning a TEU container) as well as lessthan-truckload [LTL] shippers through freight forwarders or Non Vessel Operating Common Carriers [NVOCCs]. Stopford (2004) considers liner competition mostly from a price perspective. Finally, in all market segments, shipping operators engage in various forms of collaboration including shipping pools with a view to improve service frequency, asset utilisation and transport efficiency. Fearnley Consultants (Fearnleys, 2007) estimated approximately 40 pools were in operation as of 2007, whereby the pool operator operates in nearly all cases independently from the pool members.

Further, there is an established view that going long, by entering into longer term chartering arrangements (COAs, FFAs, Time Charters) is a risk averse strategy whilst going short, i.e. trading spot, is more risky (Lorange and Norman, 1973). The recent shipping boom has shown, though, that going long may have its own risks, such as charter default risk. Charter default risk is, finally, one risk aspect of the shipping business in addition to business risk, liquidity risk, default risk, financial risk, non-charter credit/counterparty risk, market risk, political risk, technical risk and physical risk (Kavussanos and Visvikis, 2006). Any strategic plan should address how all such risks will be managed and compensated for through an appropriate return.

4. Strategy Literature Pertaining to Shipping Overall

This section reviews the strategy literature in relation to the ocean shipping industry as a whole (i.e.

addressing shipping as a single market, rather than specific shipping market segments).

4.1 The drivers of formal strategies and strategy processes

4.1.1 Internal drivers

Throughout countries, shipowners have operated for many years in a "club system" whereby the long-time practice of shipping, sometimes across many family generations, engendered trust between rival ship owners enabling cooperation. This is not new in itself, as shown by the history of Greek or Spanish shipping in late nineteenth century (Valdaliso, 2000; Theotokas and Harlaftis, 2009). The use of conferences and shared ownership and promotion of an idiosyncratic business culture would further the build-up of such confidence between parties even if they had never worked together before – the club membership vouchsafed for a common set of values (Miller, 2003). An increase in demand for maritime transport and technology-led operational improvements led to a heavy rise in capital requirements which were, initially, met by *horizontal integration* on the back of established social networks built around *trust* and *loyalty*. This club approach minimised transaction costs. It is only during a later stage shipowners sought *vertical integration* albeit with risk mitigation through transactions involving only other shipping related activities such as shipbroking and stevedoring, as Valdaliso (2000) illustrates with the evolution of Spanish shipping.

However, we can surmise that the club approach was no longer sufficient as the changing economic environment for shipping led to an increasing capital intensity of shipping and a concurrent rise in the concentration of tonnage supply. Whilst this concentration might to "a considerable extent" be indigenous, citing liner consortia as an example (Metaxas, 1978), its resulting requirement was for massive capital injections which were unlikely to have been met from within the "club". The time had come for seeking funds externally and plan for a business with more risk factors than before. This did not imply that shipping lost its human touch, as business development would remain for a long time dependent on the social networks built through the eponymous "business trip" (Miller, 2003).

The increasing internationalisation of shipping with respect to capital raising and market participants, the rise of offshore flag of convenience registries and shipping joint ventures between developing countries and the developed world also implied that shipowners were now exposed to a far wider range of risk factors whose assessment required a more structured approach (Metaxas, 1978; Frankel, 1982b). The increasing vessel sizes and technological complexity also led to more complex management (Frankel, 1982a).

Greek shipping, though, resisted the implications of those trends for a long time under influence of its fragmented ownership, familial character and idiosyncratic business philosophy (Theotokas and Harlaftis, 2009). For Greek shipowners, shipping was not so much a cash flow generating business as a lifestyle, an "arena". Professional managers were only hired in those businesses which had various non-shipping activities or had reached such a scale as to require non-familial assistance. In Greece, the outsourcing of ship management to third parties can be a reflection of disagreements among family members and the need to see those resolved by having independent third parties brought in (Mitroussi, 2004). It is those parties, in turn, who will insist on a strategic plan meeting with their approval.

A final consideration pertaining to the internationalisation of shipping is the oft quoted life cycle theory of industries by Vernon (1966). The starting point of all industrial innovation is that pioneering

business ideas are first executed in those markets where the entrepreneur, for it is the entrepreneur who pioneers, is privy to the most effective communication between the potential market (demand) and the potential supplier (supply). It is not the factor inputs and their cost which are important in an Early Stage market, for price elasticity is low, but the market feedback allowing for proper product specification and externalities. The product is unstandardised so that the producer can change inputs at leisure, and as a result production is not cost but specification driven based on effective market feedback. The Maturing Product exhibits a certain degree of standardisation to allow for production economies of scale (reduced labour cost, increasing capital cost), albeit some differentiation is retained as a competitive advantage with which to avoid price competition. The market has by now accepted a set of general standards and probability of demand is being complemented by increasing certainty of cost estimates and increasing price elasticity. Exports and production relocation are considered where labour cost advantages in target markets are lower than domestic labour and freight costs combined or, more importantly, where a strategic threat to future exports emerges. The Standardised Product is now highly standardised and has well established export markets whilst retaining further export potential. The price elasticity is very high and production processes are now "set" so as to allow for high capital investment in machinery allowing for maximum economies of scale (low labour input, high capital input). Competition is now fought on the basis of innovation induced by direct market feedback (information). Imports into the market are characterised by high labour input and vertical integration into "external economies" (i.e. capital inputs which are not readily available in the exporters' markets and thus need to be secured). Thus, the original export market will by now invest in low risk self-contained production processes for standardised products with little inventory risk.

The life cycle theory has been applied by some authors to shipping (Sletmo, 1989; Tenold, 2009; Thanopoulou, 1995). It has the merit to provide a simple canvas on which to draw a shipping strategy and suggests in essence that any industry will have to continuously reinvent itself as a pioneer if it does not wish to be superseded by competitors emanating from erstwhile export markets. This emphasises the need for any shipowner to possess at all times a clear strategic plan as to how to continue to innovate on the basis of ever more skilled labour inputs and differentiated service offerings so as not to wither away as a mature industry.

4.1.2 External drivers

The need for external funds, (i.e. funds from outside the traditional shipping community) required a vetting of the corporate strategy and shipping marketing approaches by third party financiers (Goss, 1987; Grammenos, 1979; Syriopoulos, 2007; Grammenos and Choi, 1999). This is especially so as the capital requirements are several magnitudes of the annual cash flow their investment may generate. It is ironic, then, that the availability of finance is also held responsible for the homogenisation of strategy in that easy credit has pushed investors to fund more and more "niche" operators turning the niche market into a "commoditised" shipping market (Lorange, 2005).

Regardless, it is one thing to have a strategy and quite another to successfully communicate such to third parties. Shipping companies have many difficulties in accessing the bond markets on competitive terms as a consequence of failing to obtain favourable ratings from the rating agencies. The latter is in turn being attributed to shipping companies' failure in getting rating analysts

sufficiently comfortable with the esoteric specificities of the shipping industry (Leggate, 2000). Thus, the strategy process should also address the ability of the shipping company to adequately communicate its adopted strategy to third parties with a view to obtain, *inter alia*, a lower cost of funding and better access to external funding.

In addition, shipping has become an increasingly regulated industry with its objectives coming under scrutiny of regulatory authorities. The increasing public involvement in service industries and the increase in complexity of shipping require shipping companies to frequently revisit their stated objectives (Frankel, 1982b).

4.2 Setting a strategic objective for shipping companies

Whilst some companies operate with their strategy emerging as they go along, others set a strategic objective and set out to achieve this through the strategy process. The wording of such an objective is critical as it needs to embody the current and future activities of the shipping company. Flexible objectives are, thus, argued for (Rich, 1978b). For example, state as objective the "provision of transport" rather than the provision of mere "ocean shipping". Frankel (1982a) considers too little attention is being paid to formulating objectives and, if any, to setting criteria of the shipping enterprise. Criteria such as profit maximisation, utilisation maximisation, market share maximisation can be internally conflicting and need proper drafting to facilitate planning implementation. To obtain flexibility, an effective feedback process needs to be devised so as to ensure the periodic or even continuous assessment, and if required, restatement of the strategic objectives of the shipping company (Frankel, 1982b).

To be motivational and permit a long-term perspective, the objectives should also target growth (Rich, 1978b). Whilst objectives should be internally consistent (i.e. not in conflict with one another) they should also be consistent with existing resource commitments, fit the company's capabilities and requirements, such as prior or traditional commitments (Frankel, 1982b). Also, prior to formulating its objective(s), the organisation should have assessed its strengths and weaknesses by means of a review of past and present performance and failures (Langley Jr, 1983). Langley also suggests a mission statement as a prerequisite to formulating strategic objectives. Note the absence in the shipping strategy literature of the concept of shipping companies having to articulate a "vision".

4.3 Process and organisational features of strategy development

The earlier literature (Rich, 1978a; Frankel, 1982b) on shipping strategy analysed the corporate planning process in selected shipping companies and placed their strategies

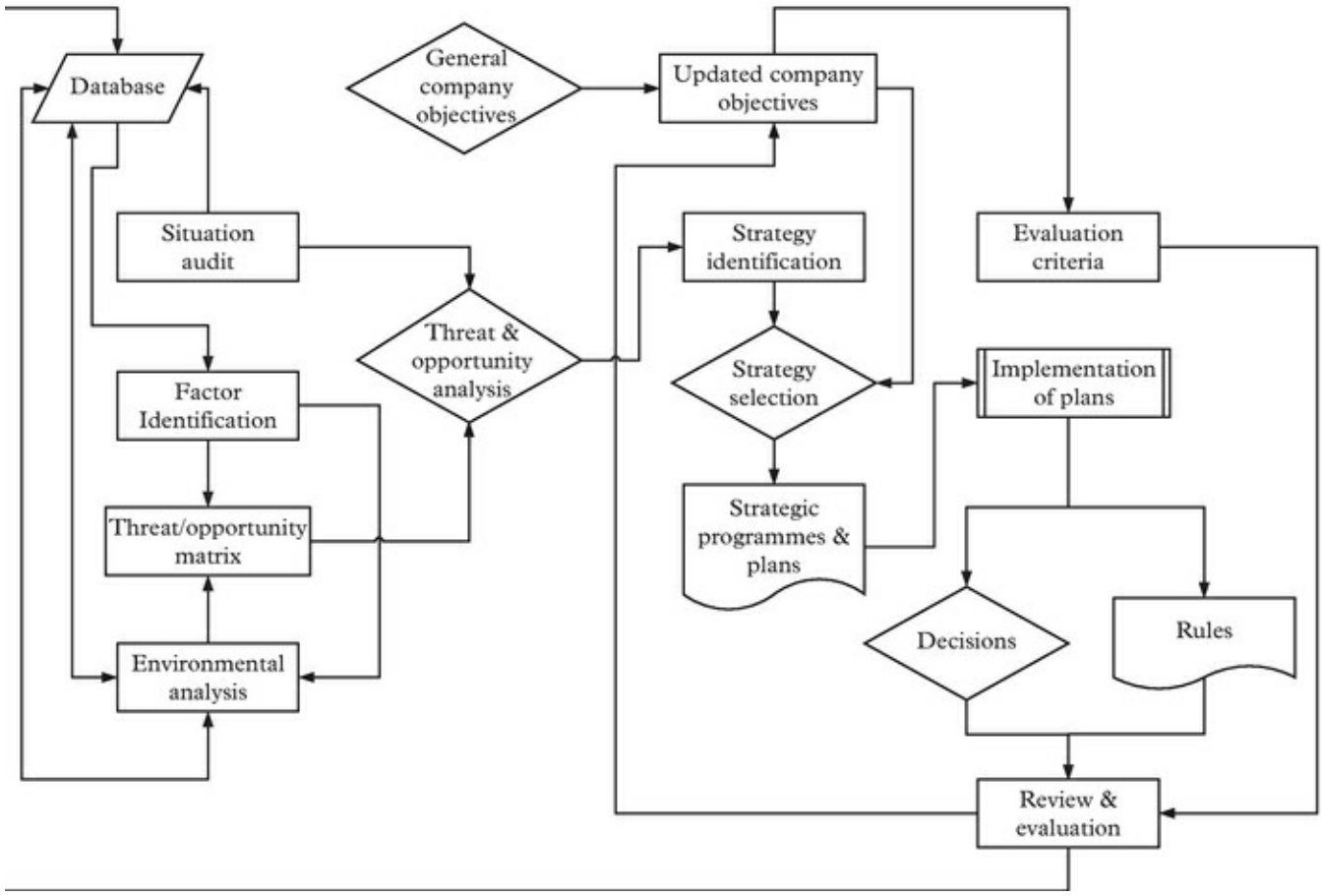

Figure 2

Source: Adapted from Frankel (1982b)

in the context of the frameworks developed by strategy authors, such as Drucker and Ansoff.

A graphical overview of a strategy process is shown in Figure 2 above.

4.3.1 Planning approaches

Two planning approaches are distinguished; a "*top down*" or hierarchical approach and the decentralised "*bottom-up*" approach. This establishes also the link between planning and organisational structure, the latter being a tool to enable the former. Frankel (1982a) distinguishes between two poles of organisation, the *traditional* centralised hierarchical structure and the *organismic* decentralised structure. The former is a hierarchy of command, control and communication paired to top level concentration of information. The latter is a network with distributed knowledge and those centres of knowledge become, on a topical basis, centres of control. A shipping company will use the former if dealing with a known slowly changing environment, and the latter when operating in changing conditions. In reality, acknowledges Frankel, a shipping company will opt for a mix of both management systems and approaches which can result in adoption of a matrix structure.

Notwithstanding, Frankel (1982b) is decisively in favour of the top down approach and argues the responsibility for planning lies with the elected Board of Directors regardless of the organisational setup (Frankel, 1982a). Note that Frankel uses terms such as policy and planning, with the former seemingly referring to strategic planning and the latter more to competitive planning and functional planning (*infra*). An alternative view of those respective approaches is to label them as *portfolio* approach (topdown) and *deal view* (bottom-up), as Lorange (2001) does. Put another way, the top down approach can address the shipping company's activities from a portfolio level, whereas the

bottom-up approach addresses the vessels (*aka* bottoms). Note in this respect that both Lorange (2001) and Stopford (2004) consider every single vessel as a business unit in its own right.

Hawkins and Gray (2000) developed a taxonomy of non-shipping specific strategies tailored for application to different organisational levels (i.e. the traditional distinction between *corporate planning* (at group level), *competitive* or business *planning* (at business unit level) and *functional planning* (at business line level)). However, the predominance of smaller shipping companies with a fleet size not exceeding five vessels suggests a flat organisation with single level planning activities, if at all. The planning process participants' hierarchical position may also provide some indications in this respect. Notwithstanding, planning at various organisational levels may occur within the minority of bigger shipping groups (e.g. liner shipping conglomerates).

In arguing for a top-down approach, Frankel reflects the established planning practice of Greek shipping where CEO involvement extends to setting aims and objectives, choosing alternatives, controlling and evaluating the company's operations (Koufopoulos *et al.*, 2005). Involvement of the CEO has a signalling function with respect to the importance of the process (Frankel, 1982b). The advantage of the top down approach is that it may also address venturing into new business areas which a bottom-up approach is less likely to contemplate due to a self-preservation instinct among divisional heads. This is in contrast to Rich (1978b) who argues hierarchical top-down planning processes are assessed as more risk averse, as reflected in the incremental nature of their strategy initiatives, whereas bottom-up approaches tend to be more entrepreneurial and risk-friendly. Lorange (2001) argues a balance should be struck between both approaches by adopting a complementary process.

The risk friendliness of the shipping company in choosing a strategy is argued by Rich (1978b) to be linked to the prevailing planning approach. The organisational structure is reactive to environmental changes and the strategic objectives are consequently affected by the interplay between ownership and management control. The hierarchical approach will typically be driven by a central planning staff (Rich, 1978a). The observed lack of participation of lower- and middle-management levels, as opposed to the key role played by the CEO, in Greek (Koufopoulos *et al.*, 2005) and Asian-Pacific (Hawkins and Gray, 1999) shipping companies' planning processes confirms this approach. However, planning approach should not be confused with the extent of participation of staff at all hierarchical levels in the planning process.

4.3.2 Planning process elements

A textbook strategy process proper, an illustration of which was shown in Figure 2 above, commences with an assessment of internal and external factors with strategic influence. In the process drawn by Frankel (1982b) this is termed factor identification. Various methodologies exists which are non-shipping specific and, hence, need not be elaborated on in this review. Notwithstanding, it is appropriate to briefly mention the relevance of competitive intelligence in this respect.

4.3.2.1 Competitive intelligence

Aristoteles Onassis was well known to carry around with him at all times a notebook in which he duly noted anything or everything that was relevant to his business. Onassis intuitively practiced a form of competitive intelligence (CI) gathering. In industries other than shipping, this intuitive CI gathering has been formalised and institutionalised and has become the preserve of competent professionals. In

those organisations, competitive intelligence is a systematic programme for gathering and analysing information about your competitors' activities and general business trends to further one's own company's goal (Kahaner, 1997). CI should not be confused with business intelligence (BI), which pertains to internally generated and thus company specific data devoid *per se* of relevance to the competitive environment. BI is, however, useful in benchmarking exercises whereby the shipping company can measure its strengths and weaknesses in operational and financial performance against those of its competitors.

To perform an assessment of internal and external factors with strategic relevance to the firm, CI gathering and analytical processes are the tools of the trade. It is notable that Asia-Pacific shipping companies' strategy processes tend to attribute more importance to informal discussions between experienced executives exchanging, in effect, internalised CI rather than practising formalised strategy development processes (Hawkins and Gray, 1999). By way of illustration, Evergreen's founder stated the management philosophy of his company is, *inter alia*, to stay well informed to ensure a company's sustained competitiveness. Evergreen's employees are the backbone of the company's long-term survival, suggesting in the process employees always need to keep their eyes and ears open for CI (Chang, 1999). It can be surmised the CI gathering and analysis process is well formalised in Evergreen. Onassis and Evergreen are therefore good illustrations of two of the three stages of competitive development as described by West (2001). Onassis was *competitor aware*, his data collection was informal in nature and based on a natural curiosity albeit without a reported organisational setup or systems backup for managing his CI. Evergreen is probably *competitor intelligent* with a formal data collection process, for application in anticipating competitor moves and industry trends, managed by a CI manager who enjoys the backup of dedicated IT-based CI systems. In between these two states is the *competitor sensitive* company, which combines both informal and formal approaches to gather CI on competitors with a view to emulate them. This responsibility often lies with the marketing management information officer who uses for this purpose an existing marketing information system. An example of the latter approach was documented for erstwhile chemical shipping company Panocean-Anco (Tomlinson, 1980).

Shipping is generally considered to be a secretive industry whilst the wide availability of data sources is only a recent phenomenon. Yet, shipping pioneered the gathering and use of competitive intelligence with the use of "cartographers" like Ortelius and Mercator. Or, the East India Company sending Hakluyt in 1602 to report in 500 volumes on navigation, geography, resources, politics and economics (Moeller and Brady, 2007). Zannetos is reported in Ronen (1980) to have said that the reason behind secrecy in shipping is the inability of those who possess the data to use it for managerial decisions. Ronen puts this comment in a context of a multitude of data sources (data overload), lack of data selectivity (lack of information), lack of comparisons and summaries (no topical analytical capabilities). This is a frequent problem with competitive intelligence gathering, or rather explaining the lack thereof. Ronen's (1981) case study reports on a successful implementation of a commercial intelligence system in shipping companies to gather competitive intelligence which in turn can be used in a strategy setting process including trade flow estimation, freight rate determination and competitor analysis.

There is, thus, some evidence that shipping companies have moved on from Onassis' CI practice towards becoming more competitor sensitive. This is particularly relevant as shipping strategies are

often considered to be imitative, as illustrated by Greek shipping (Theotokas and Harlaftis, 2009). However, it is noteworthy that some organisations have elevated CI gathering to formalised processes practiced by all employees with a view to maximise the intelligence gathered. This is in contrast to the documented practice (see below) of keeping strategy confined to top management with little to no participation by middle management and lower-level executives. This puts into question to what extent the resulting strategies are reflective of the evolving competitive environment as experienced first hand by those latter executives.

Once the internal and external data have been gathered, they will need to be categorised and structured in a framework after which suitable analytical methods can be applied with a view to deduce intelligence relevant to strategy development. Such methods are generic to all industries and need not be dwelled upon here, but comprise chronology lists, source listing, event analysis, alternative scenarios, analysis of competing hypotheses, opportunity analysis and linchpin analysis (Harkleroad and Sawka, 1996). There is a distinct need for future research in the area of CI pertaining to shipping with respect to a survey of existing literature, existing practices, development of new practices, applications and their results in terms of defining strategies and building sustainable competitive advantages.

Having highlighted the relevance to strategy of gathering CI, we can now address some shipping specific environmental factors that CI gathering should encompass and their framing for analytical purposes.

4.3.2.2 Environmental analysis

In practice, a survey of Greek shipping companies' planning processes indicates a bias towards operating performance, financial projections and functional budgets. Environmental analysis, e.g. PEST (Political, Economic, Social and Technology) analysis, and SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis are considered least important. Of those external elements taken into account, regulatory issues, general business climate and competitive climate score highest, followed closely by technological factors, customer preferences and supplier trends (Koufopoulos *et al.*, 2005).

The observed bias of those shipping companies in approaching planning as a finance-related matter could limit the benefits those companies can obtain from the planning process. This is also suggested by a 2009 McKinsey survey of non-shipping managers who admit to a focus of strategic planning on financial objectives (e.g. cash conservation), yet feel discomforted by the lack *viz.* absence of an adequate balance between short-and long-term perspectives in their planning process (Cheung *et al.*, 2009). It is noteworthy that Asia-Pacific managers also place financial resources as the second most important constraint on the strategy selection resulting from the strategic reflection process. However, differences in their planning process exhaustiveness did vary by market segment of the shipping company concerned, with liner companies doing more environmental analysis than bulk shipping companies. Similarly, tanker companies seem to do more planning than dry bulk companies (Hawkins and Gray, 2000). The minority who do use specific analytical techniques did so by using the SWOT model (Hawkins and Gray, 2000).

4.3.2.3 Planning formality

The Asia-Pacific shipowners have mostly no formalised strategic plans, but do have a high intensity

"discussion process" involving senior management (Hawkins and Gray, 1999). The content of this process is not detailed in the authors' articles. Asia-Pacific managers seem to pursue strategic objectives regardless of changes in the environment, and as such do not attach much importance to the use of external information, preferring to rely on personal knowledge, experience and intuition. Consequently, a majority see no use for decision support tools such as scenario analysis and simulations (Hawkins and Gray, 1999).

Greek shipping companies, again, do differ in their practice. Their planning formality is mainly geared towards creating a climate supportive of planning efforts and the development of a formal statement. The use of the company's plans for controlling managerial performance are considered least important as is the acceptance of such plans by the persons who are to attain the goals set out therein (Koufopoulos *et al.*, 2005). This is quite an evolution, as Grammenos and Choi (1999) found Greek shipping companies not to have any formal rules for strategic decision making at all. As such, planning in those shipping companies seems geared towards giving the organisation a sense of direction rather than to develop a detailed plan, (i.e forward looking). The forward-looking nature is also reflected in the perceived emphasis on development of internal capabilities as opposed to backward looking failure analysis (Koufopoulos *et al*., 2005). Notwithstanding, it is noteworthy that in a historical context Greek shipowners were also noted to have had an "emerging" asset play strategy i.e. it became a strategy after it had been tried and tested rather than adopted as a strategy by design (Theotokas and Harlaftis, 2009).

4.3.2.4 Environmental factors

Harding (1969) and Frankel and Marcus (1973) emphasise the inclusion of *technological planning* in ocean shipping-related planning to encompass interaction with interfaces, feeder systems, competing and complementary transport modes, the political social and physical environment, and the "economic realities".

Pallis (2007) strongly argues that the Greek paradigm of shipping has moved toward a horizontal view of shipping (i.e. *shipping as part of a process*) and thus emphasises the need for shipowners to consider those downstream (intermediate and end customers) and upstream (suppliers) trading partners in their strategy assessment.

Cafruny (1985) and Lorange (2009) posit any shipping strategy analysis should take into account *geopolitical factors* in light of history teaching us that any conflict over shipping reflects a general crisis over the political economy. This is pointedly illustrated by the changes in the political economy of Greece as a result of the changes brought about by the periodic realignment of the Greek shipping industry with the evolution of the world economy in general and international trade in particular (Serafetinidis *et al.*, 1981). Similarly, the promotion of container shipping by the USA can be seen as an element of its competitive maritime strategy aiming to erode the prominence of European liner shipping companies whilst the encouragement of vertical integration by natural resource mining companies into shipping aimed to achieve, *inter alia*, the same result in bulk shipping (Cafruny, 1985; Cafruny, 1987).

With respect to *regulatory matters*, due attention should be paid to the shift from national flag/port state regulation to polycentric and multi-level governance which allows for input from a wider circle of stakeholders (Roe, 2002, 2009). This implies a wider circle of environmental factors should be

scanned for.

With respect to the general business climate, attention should be paid to the "triple bottom line" (3BL) approach advocated by companies such as Wilhelmsen (Hargett and Williams, 2009), which approach advocates *Corporate Social Responsibility* (CSR) in shipping companies' activities. This is not insignificant in light of the highly publicised, and potentially value destroying, regular occurrences of oil pollution incidents involving the shipping industry. As such, all factors pertaining to CSR will also have to be part of an environmental scan and assessed for their impact on possible strategies.

4.3.2.5 Situation audit

Concurrently with the environmental analysis, Frankel (1982b, 1982a) and Cerit (2002b) argue for a concurrent situation audit to assess available resources, resources already used, market share, services performed and financial situation. The combination of factor assessment and situation audit allow for identification of appropriate strategic alternatives. The process should also be run periodically and a feedback process linked to an updating of a database which supports the strategy process.

4.3.2.6 Planning control

Finally, planning processes should have a control system so as to ascertain whether the shipping company is achieving its strategic objectives. Where shipping companies are active in the provision of logistics services, their measurement and control will entail the building of appropriate information systems for data gathering and reporting, the establishment of "good performance" measures, variance analysis and corrective action procedures (Mentzer and Firman, 1994).

4.3.3 Planning horizon

Koufopoulos *et al*. (2005) argue due consideration should be given to the planning horizon. The choice of an appropriate planning horizon should be with reference to the product life cycle, technological change, lead time, present value, organisation life cycle and the validity in time of the planning premises. Several of these factors, though, are interrelated. Indeed, the rate of technological obsolescence can have a determining impact on the economic life of a vessel. Lorange advocates a dual horizon whereby market driving strategies are developed with both longer term and shorter term market driven outlooks, respectively visionary and revenue oriented (Lorange, 2001).

In this author's opinion, though, one could argue the economic life time of the fleet of the subject business of the planning exercise should be a determining factor for strategic planning purposes. It should be noted this life time is very market segment specific and can vary over time within each segment. One should avoid confusing the planning horizon for strategic planning purposes with that for other strategy related planning processes, such as scenario planning, where the forecast horizon is determined with reference to the objective of the study (Van der Heijden, 2005).

The survey of Greek shipping companies indicated that only 41% of companies have a planning horizon in excess of five years. This suggests the majority of planning processes are considerably shorter than the economic life time of any vessel. Whilst this might be suggestive of the regularity with which the process is run, it could also suggest Greek shipping companies are mostly reactive to their environment (Koufopoulos *et al.*, 2005). The published survey data, however, did not indicate the standard deviation of the average planning horizon and as such do not indicate if some companies did have longer term planning horizons. Finally, this author speculates as to whether the survey data may

also not be suggestive of the fact that Greek shipping companies feel unsure about how to systematically analyse and interpret the external environment and, thus, prefer to focus on less abstract financial and operational data.

In their survey of Asia-Pacific shipowners, Hawkins and Gray noted a minority of companies did have formalised strategic plans whose planning horizon did not exceed five years (Hawkins and Gray, 1999). Both Greek and Asia-Pacific shipping companies review their plans annually.

4.3.4 Planning process participants

Langley argues for participation in the planning process by all those personnel levels involved in the implementation of the resultant strategic plans (Langley Jr, 1983). Boyce (2003) has pointed to historical precedents where British shipping industry networks facilitated structured information flows by connecting senior management with middle management possessing financial and technical expertise, not only on intra-firm or intra-group basis, but also on an inter-firms basis. However, we have seen above how the planning process in Greek shipping companies seems confined to the CEO and senior management levels, to the exclusion of middle and lower management staff. Koufopoulos *et al*. (2005) suggest in their article, with further literature references, that this may be reflective of the limited means such shipping companies make available for planning processes.

An alternative explanation might be found in the peculiar business philosophy and family character of Greek shipping companies (Theotokas and Harlaftis, 2009) which has resulted in even those few Greek shipping companies which hired professional managers to retain the strategy making function for the founding family. Perhaps, the small size of such companies – again, a result of the fragmentation of ownership characterising Greek shipping in general and tramp shipping in particular – with an observed average fleet size of five vessels precludes lower level staff from not attending to daily operational matters. Koufopoulos *et al*. refer to extant literature in asserting this exclusion of lower and middle management may affect the extent, quality and speed with which strategically relevant information from the external environment is taken into account in the planning process.

The situation is not different in Asia-Pacific shipping where corporate strategy is also the preserve of senior management. The absence of formalised plans and informal nature of strategy selection is facilitated by the informal nature of the strategy genesis by way of “intense discussions” amongst senior managers (Hawkins and Gray, 1999). The same authors note strategy selection is more decisive with those managers who are older (i.e. more experienced albeit with less formal education than their younger counterparts (Hawkins and Gray, 2000)).

4.4 Generic shipping strategies

Goss (1987) prosaically summarised, in the midst of another shipping downturn, “how money can be made” in shipping: (i) by buying vessels at a low and selling them high, i.e. an *asset play* strategy; (ii) to *do things much better than others* involving areas such as ship design, operations and general cost saving measures; or (iii) devising and adopting *technical advances* with concurrent economic benefits to exploit and sustain economies of scale and reduce turnaround times. Some 20 years later, the same author expanded on this with (iv) a strategy of *chartering tonnage in* but *not owning* it; (v) *buying cheap* second hand vessels, *operate* them *cheaply* to the point of abandonment with a view to maximise cash flow (Goss, 2008).

Lorange (2009) argues this buy low/sell high asset play strategy may no longer hold after the most

recent shipping boom, which seemed to have changed the duration of cyclical swings of freight rates. As a consequence, Lorange argues an increasing importance for shipowners to maintain cost efficient operations so as to be able to ride out uncertain freight outlooks. In this respect, Greek shipping companies should be well positioned as Theotokas and Harlaftis (2009) consider such to be following a cost leadership strategy, built on distinctive features of the Greek entrepreneurial shipping culture: business philosophy, organisational culture, advanced control and know how of ship operations and the familial character of firms. This strategy was as much by tradition and choice as by necessity given the post World War II industry structure of multiple owners operating an old and small fleet lacking in both specialisation and economies of scale. The familial character extended to outsourcing of ship management, where practiced, to "related" companies in a bid to extract the lowest possible cost. However, they recognise a smaller group of Greek shipowners has combined cost leadership with (i) innovation through e.g. constant upscaling of bulk vessels, development of combined carriers and mini-bulk-carriers; or (ii) market development by offering in-house ship management services to third parties.

Having outlined some of the generic strategies practiced in shipping, it is now appropriate to start reviewing the literature classifying such strategies with relevance to perceived industry shipping trends or features. An oft-used tool in this respect is the 2×2 matrix pioneered by consultancy SRI Inc. Its most well-known application is the product portfolio matrix, *aka* the BCG matrix, developed by Henderson (2006) at Boston Consulting Group and classifying products based on market share and growth outlook. The use of two classification dimensions allows for reduction of strategies to the bare essential drivers. But this simplicity is, perhaps, also its biggest weakness as strategy is multidimensional and not always easily reduced to just two dimensions.

4.4.1 A review of shipping-specific strategy matrices

The products/markets matrix approach (Rich, 1978b) suggests four generic strategies for shipping companies, as shown in Figure 3 below. A low risk *market penetration* strategy seeks to build on expansion in growth markets so as to avoid retaliation from competitors (e.g. Townsend's Thoresen then scale expansion in the existing Channel ferry

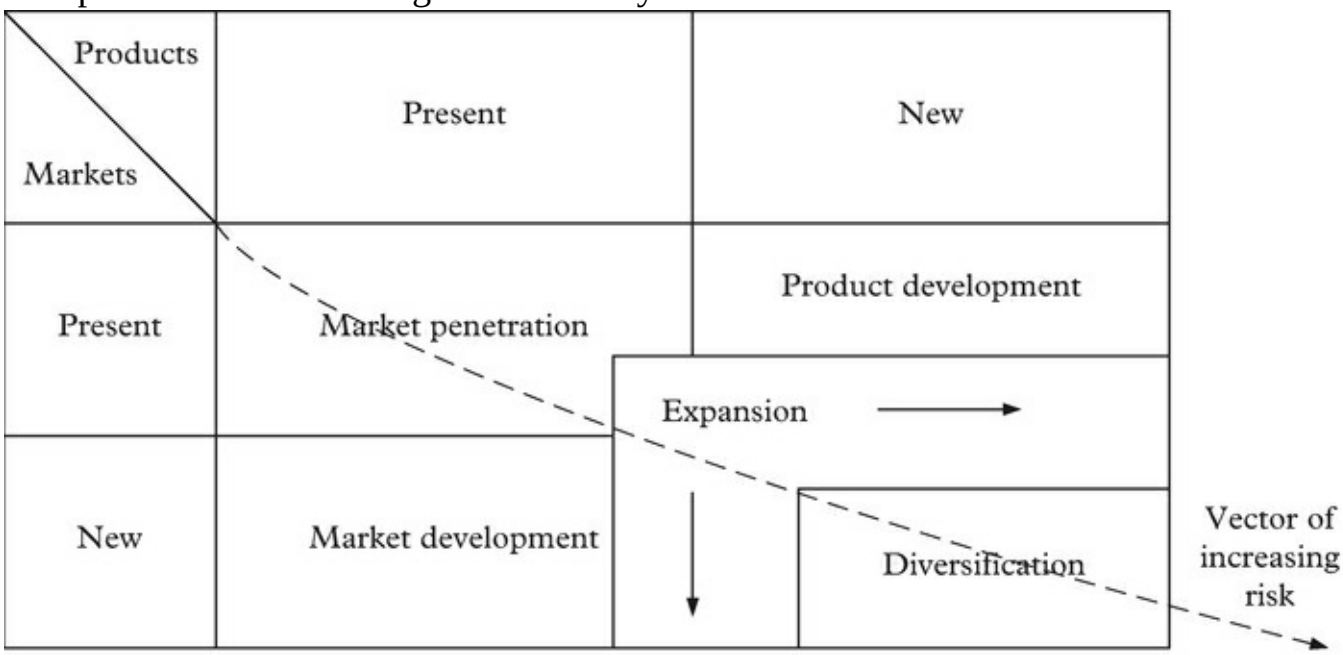

Figure 3

Source: Rich (1978b) with attribution to SRI

market). This strategy, *aka horizontal integration*, also benefits from immediate effects as opposed to longer term newbuilding programmes but comes with an acquisition premium price tag. *Market development* aims to develop new markets for an existing service, such as introducing existing vessels, or vessel types, on new routes (e.g. then Bell Lines' expansion of multimodal container transport from European to African destinations). This strategy aims for asset utilisation maximisation and exhibits limited risk insofar the existing organisation can handle this type of expansion. *Product development* strategies aim to introduce new products on existing markets such as new vessels on existing routes (e.g. P&O's introduction of container carriers on existing cargo liner routes, Restis's introduction of fast ferries on Greek-Italian routes). Rich notes disapprovingly that those UK operators who did introduce containers carriers did so with a view to obtain economies of scale, rather than aim for diversification by providing customers with an altogether new service offering and, thus, grow their market.

The *diversification* approach is the most risky insofar the right mix of existing and new activities requires optimisation by means of quantitative techniques such as sensitivity analysis, probabilistic returns assessment and scenario driven "outcome matrices". In support of this strategy, Rich documents P&O's acquisition of construction company Bovis, Ocean Transport and Trading's acquisition of inland transport and distribution services – a case of *vertical integration* – and London & Overseas Freighters (LOF) acquisition of shipbuilders – a case of *diagonal integration* – which allowed both companies, *inter alia,* to smooth out shipping induced cash flow volatility. Diagonal integration aims to link related activities which are not in a vertical supply relationship and achieve economies of scope, system gains and synergies. Diversification strategies are also motivated by synergies. Synergies encompass (i) sales synergies where common distribution channels are used (e.g. inland trucker MacLean selling Sea-Land liner shipping services to existing customers, or vice versa); (ii) operating synergies aiming for leveraging off the fixed cost base through increased volume and asset utilisation (e.g. former Denholm providing ship management services for third party ship owners); (iii) investment synergies aiming for joint use of fixed assets (e.g. former Silja Line using a passenger ferry for cruises); (iv) financial synergies (e.g. use of accrued tax loss credits and tax favourable vessel depreciation policies by P&O after acquiring cash rich Bovis) (Rich, 1978b, Casson, 1986); and (v) operating synergies (e.g. favourable access to shipyard slots for repairs, newbuildings) (Kindleberger and Johnson, 1985).

Another oft quoted matrix model was developed in 1989 by consultants McKinsey & Co. and the Centre for International Economics and Shipping at the Norwegian School of Economics and Business Administration with a view to advise the Norwegian government on shipping policy options. Both Lorange (2001) and Wijnolst and Wergeland (2009) describe this matrix (see Figure 4 below) having one axis accounting for *economies of scale* and another for *differentiation* potential, thus allowing for four types of shipping strategies. *Commodity shipping* prevails in a fragmented industry with few economies of scale, cost efficiency focus, homogenous service and a very liquid sale and purchase market for vessels suitable for asset plays. *Specialty shipping* seeks entry deterring local monopolies with limited scale effects and some tailoring of the service offering to customers. *Contract shipping* is a concentrated industry with significant scale effects, a homogenous but world class quality focused

service, close customer contact and a liquid S&P market enabling a life-cycle costing based asset renewal programme. Finally, *industry shipping* is equally concentrated, exhibits economies of scale, has lifecycle costing based asset renewal programmes and offers tailor-made services with specialised vessels for which the S&P market is illiquid. This matrix model seems a strategic operationalisation of Vernon's (1966) product life-cycle model, which sees an industry develop from "new product" to "maturing product" and finally to "commoditised" or "standardised product".

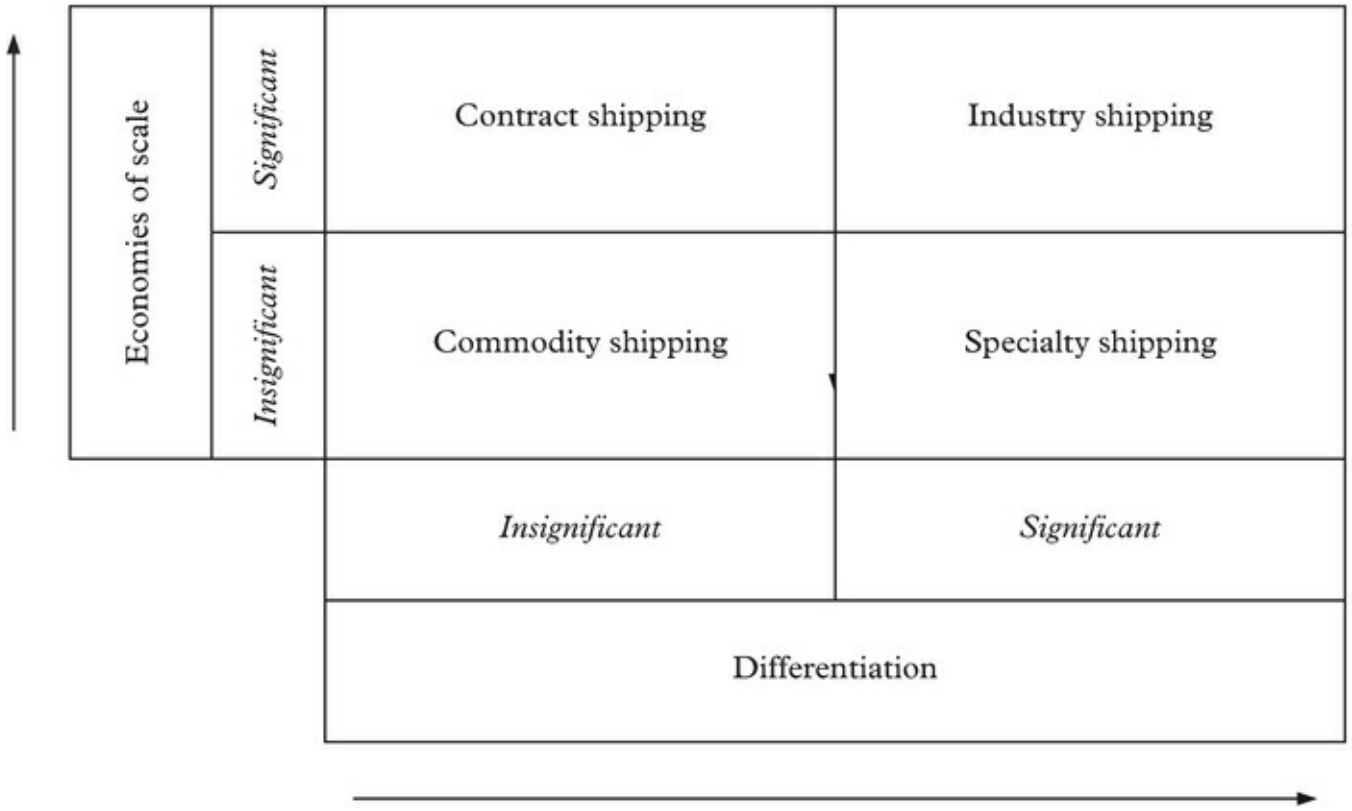

Figure 4

Source: McKinsey & Co (1985) reproduced in Wijnolst and Wergeland (2009)

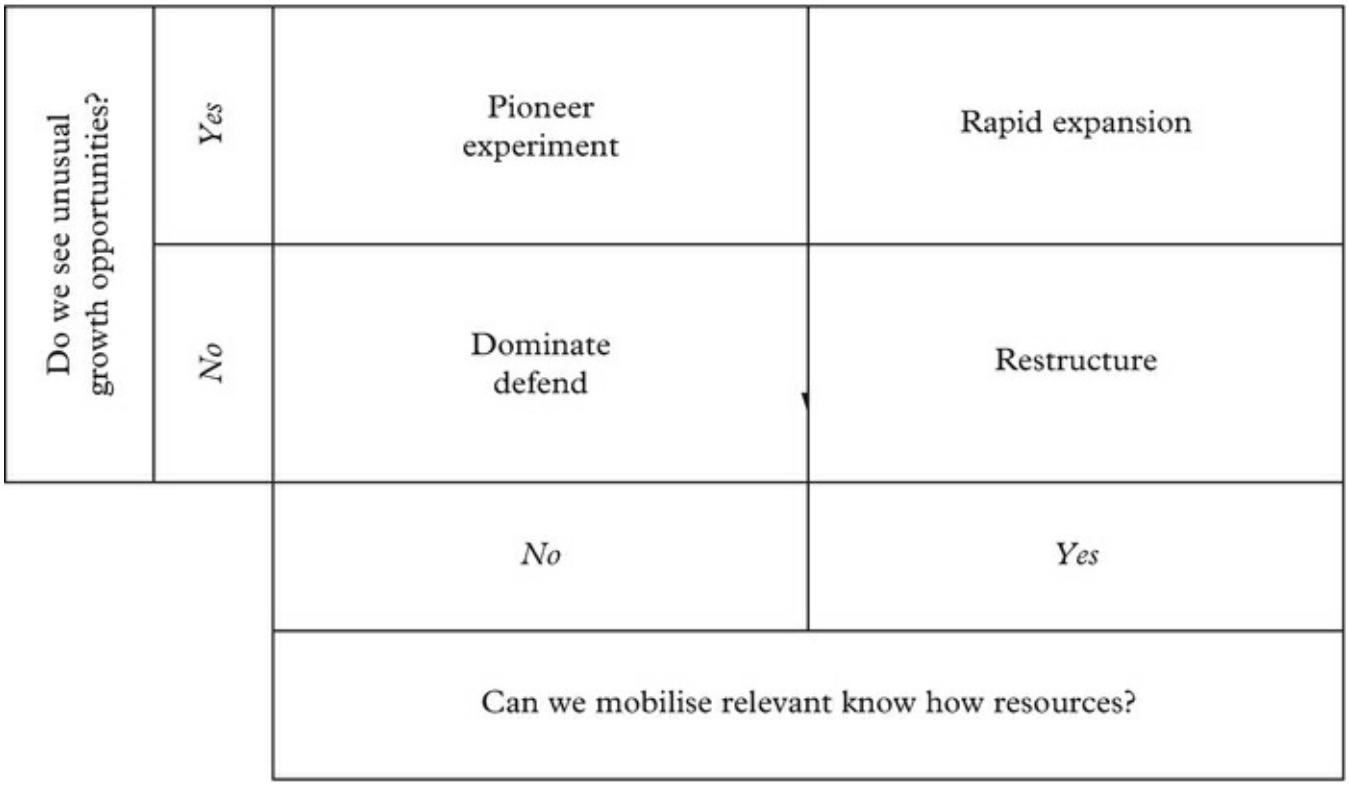

Figure 5

Source: Lorange (2001)

Lorange (2001) advocates for shipping the use of a growth opportunities/resource mobilisation potential matrix (see Figure 5 above), which offers four strategies mixing "brain" (software or know how) and "brawn" (hardware or assets, i.e. vessels). He argues shipping is erroneously seen as an overly mature industry where competition is mainly price driven whereas Lorange posits shipping, in line with other industries, is increasingly moving from an asset-driven to a brain-driven approach. The *pioneer* strategy is akin to that of product development. The *rapid expansion* strategy seems a variant thereof and aims for a first mover advantage by rapidly introducing the new product commensurate with the development of new marketing capabilities. The *restructure* strategy is a defensive strategy which aims for reducing costs so as to ride the cycle in a low growth environment. A variant of the market penetration strategy is the *dominate-defend* strategy which aims to strengthen execution skills with a view to rapidly reduce a cost base whilst seeking scale in a stagnant market with a view to crowd out existing competitors and deter new entrants. Alternatively, this type of asset play strategy could also lead to an exit event if neither objective can be reached in a timely fashion, i.e. well before the cyclical trough. Note that all strategies can equally apply to business/vessel level and portfolio level.

Lorange (2005) subsequently revised his strategy based on a conceptual model developed to further internally generated growth of industrial corporations, which model he co-developed with Bala Chakravarthy. In his adapted model for shipping, the strategy matrix (see Figure 6 below) has axes representing the know how resource of the shipping firm vs market understanding. The four resulting strategies are termed "leverage" or "commodity niche", "transform" or "speculation niche", "protect/extend" or "commodity" and "build" or "niche". The *commodity* strategy prevails in well understood

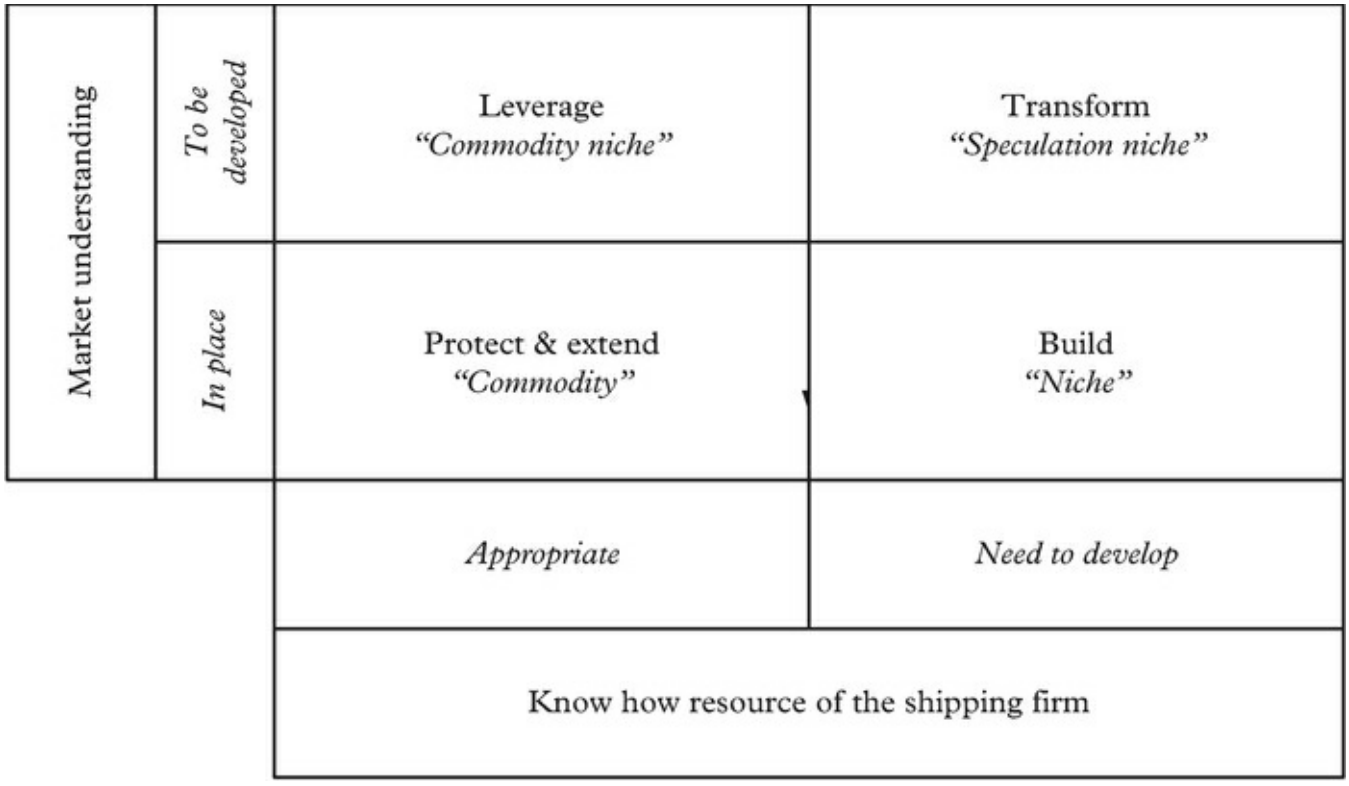

Figure 6

Source: Chakravarthy & Lorange (2004) reproduced in Lorange (2005)

and well-established market where actors have appropriate know how to compete against a wide range

of competitors. A commodity strategy is, thus, aiming at cutting costs, understanding the market better and marginally extending service ranges. The *commodity niche* aims to repeat a success story in a new market, whilst the *niche* strategy aims to add new technologies to a strategy already established through a commodity approach, and finally, a *speculation niche* aims to adopt new technologies whilst entering new markets concurrently.

In his latest work, Lorange (2009) has fundamentally revised the strategic options for shipping companies. Whereas his previous models were providing a descriptive context to shipping industry developments, his latest model adopts a more prescriptive approach (see Table 1 below). Fundamental to this review are the extraordinary market circumstances shipping has experienced over the preceding decade, and which were of such a scale and nature to have enlarged the market to an extent permitting new market entrants and new business models to be developed and experimented with. As a consequence, Lorange considers the traditional shipping business model with integrated vessel ownership, vessel operations and related shipping services such as broking, otiose. Shipping companies are moving to become "pure play" operators or diversified conglomerates composed of "pure play" businesses.

The *steel owning* business has a national business culture infusing a top-down management process focused on physical and financial resources and aiming for ever-increasing efficiency. The *steel using* business has a global culture guiding a people centric bottom-up management process aiming for customer service improvements through novel value creating processes. The *steel operating* business is, again, infused by national culture

Table 1: Types of "pure play" shipping companies

Feature	Shipowning	Trading	Operating	Product
Key factors	Owning steel push systems	Brokerage using steel pull systems	Operating steel pull systems	Innovator innovating around steel pull systems
Demand side	Anticipate, forecast	Highly uncertain	Predictable	Uncertain
Process Locus	Top-down	Bottom-up	Top-down	Bottom-up
Resource Focus	Physical, financial	People	Cost conscious people	Creative people
Efficiency?	Efficiency	Novel, customer service	Efficiency	Creativity
Options	Ship types	Novel, value creation	Operations key vessel types	Novel, creative
Culture	National	Global	National	Global

Source: abbreviated from Lorange (2009)

in its top-down management processes aiming for cost efficiency measures implemented by cost-conscious staff. Finally, the *steel-related product innovating* company has a global culture promoting novel and creative ways to bring about innovations generated by the company's creative human resources.

Hawkins and Gray surveyed the corporate strategies applied by commercial shipowners in the Asia-Pacific region and found five generic strategies: grow, develop, stabilise, turnaround and harvest (see Figure 7 below). The *grow* and *develop* strategies seem the equivalents of respectively Rich's market penetration and market development strategies. The *stabilisation* and *turnaround* strategies seem

similar to Lorange's dominate/defend approach whilst the *harvest* strategy is a sub-case of this (i.e. the divestment of an ailing business) (Hawkins and Gray, 1999). It is noteworthy that 65% of the shipowners surveyed owned ten or more vessels, of which nearly 20% own more than 35 vessels. This size is about nine times the world average fleet size per shipping company as calculated by Stopford (2004). The pecking order of strategies is pursuing growth, a combination of several strategies, stabilisation and, finally, develop/turnaround strategies. Only half of the shipowners would consider exiting the market (harvest) if the going got rough. Regardless, significant reservations were expressed in applying the grow and develop/turnaround strategies in the sense that up to one-third of shipowners would not fully follow such strategies or frequently modify them by means of adopting a combination of strategies. As a rule, Asian-Pacific shipowners would not adapt their plans to environmental changes unless the strategic objectives run counter to market conditions in which case the anticipated strategy changes would not be implemented.

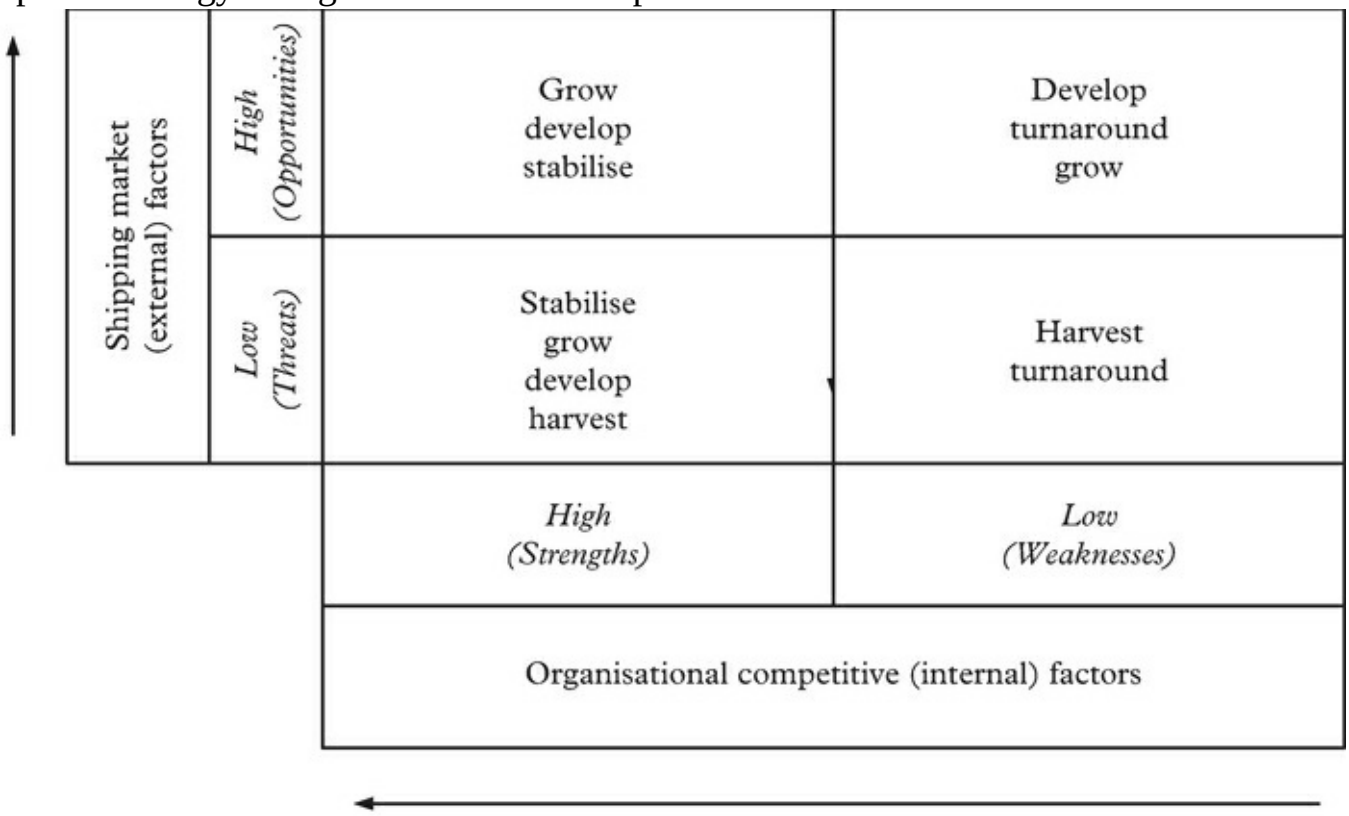

Figure 7

Source: Hawkins and Gray (1999)

4.4.2 Strategies specific to family controlled firms

Whilst the above generic strategies have been applied to the shipping industry, we cannot ignore the potential impact on strategy of the family controlled nature of many shipping companies. We have not found any literature pertaining specifically to the impact of this family controlled nature on the strategy setting within shipping companies. Zellweger (2007), however, has posited in an analysis of the lower cost of equity of family controlled firms how such cost of capital effects can provide options with respect to generic investment strategies. The author indicates how such firms, which have a longer term horizon, are in Europe disproportionately active in cyclical industries, and from there to argue such firms can pursue either a "perseverance strategy" or an "out-pacing strategy" which is not available to short-term oriented firms. The *perseverance strategy* consist of investments in lower return projects albeit with a risk profile equal to those projects of more short-term oriented

competitors. The resulting cash flow when discounted at a lower cost of capital for family firms results in a higher net present value. The *outpacing strategy* aims to invest in higher risk projects with a return equal to those opted for by short-term oriented competitors. The associated investment returns when compared to the lower cost of capital for family firms imply an excess return similar to those of short-term oriented firms.

Thus, family controlled firms can opt to participate in longer-term low-return projects or tolerate a higher degree of risk on short-term projects than their short-term oriented peers. Of course, these conclusions would not apply to those family shipping firms which have adopted a short-term investment horizon due to their investor requirements (e.g. listed family shipping firms or firms with publicly traded securities). In this respect, there would be merit to study how the issue of traded financial securities by family shipping firms has affected, if at all, their investment outlook.

4.4.3 Factors predisposing to a choice of strategy

Having formulated some generic strategies, it is appropriate to turn attention to some more specific factors which may lead to preference of one or other strategy. It is suggested a diversification strategy will depend on whether a company has a *tramping or liner background*. In this vein, liner companies are deemed to be lower risk/lower return whilst tramping is higher risk/higher return and the latter are thus less likely to diversify into lower yielding liner businesses with restrictive market practices (i.e. conferences) and require specific expertise. Tramping companies are thus more likely to expand "on the fringes" or outside of shipping (Rich, 1978b). This is confirmed by the situation in the Greek shipping industry, which has historically had a bias towards tramping in which market shipping companies have to this day remained small whilst diversifying into real estate and other activities so that no expertise was required from "outside the family" (Theotokas and Harlaftis, 2009). Similarly, Asia-Pacific companies conform to this pattern with tramping companies expressing a preference for more aggressive strategies and risk, whilst their liner counterparts play it safer (Hawkins and Gray, 1999).

Casson (1986, 1989) suggests vertical integration between cargo generators and shipping companies is typically favoured when shipping services are *government regulated*, when a *natural monopoly power* exists on a shipping route leading to a lack of price discrimination, when *transfer pricing opportunities* exist, when vertical integration can *deter new entrants by raising rivals' capital investment requirements*, when the *production requirements* for a secure timely shipping service require such, when there is a *requirement for a near-customised nature of the shipping service*, *technological development*, and the *need to ensure strict service quality* due to cargo perishability issues. The specialised shipping market segment seems to exhibit various cases of vertical integration (e.g. car carriers, reefer vessels). Vertical integration will be discouraged if there are differences in scale of operations between cargo generators and vessels which would result in capacity underutilisation, or the need to find cargo for the return leg. A detailed overview of vertically integrated UK shipping companies in 1984 is given by Casson, and he concludes therefrom that vertical integration is rare in practice and predominantly occurs where shipping companies wish to offer a comprehensive range of services of assured quality to their customers. In most other cases, alternative contractual arrangements can substitute for vertical integration.

Dutch shipbuilding up to 1800, though, offers a historical antithesis in that the concentration of the

shipbuilding industry was the result of widespread vertical integration with shipowners who were mostly also merchants generating their own cargo and sourcing their own wood supplies. The concentration was beneficial for achieving *economies of scale*, but adverse for *technological innovation* as production standardisation spread and shipwright training declined (Unger, 1975). This process, and the latter factor in particular, was to lose the then Dutch shipbuilding industry its competitive advantage just like it would lose Bergen's vertically integrated specialist shipping and shipbuilding firms their advantage in chemicals shipping and open hatch bulkers some 160 years later (Tenold, 2009). Kindleberger and Johnson (1985) argue exactly the opposite and find that integration into shipyards favours a more risk-friendly attitude with respect to developing more innovative vessels. This view finds support with Chida and Davies (1990) who cite the example of National Bulk Carrier's acquisition of the Kure shipyard in Japan which furthered significant innovations in Japanese shipbuilding technique.

Heaver *et al*. (2000) confirm the recent trend in the maritime industry to *seek greater control of the logistics chain*, and by doing so has encouraged the vertical integration between stevedores, inland transport and shipping companies with a view for all parties to avoid a ruinous price based competition built upon ever greater scale *cum* bargaining power.

Finance may also be a driver of choice of strategy insofar lack of finance will prevent acquisition of new tonnage and lead to strategies favouring use of second hand tonnage in, at least, the short term (Grammenos, 1979, Theotokas and Harlaftis, 2009). Similarly, the choice of investment in newbuildings is also indicative of a long term commitment by the shipowner and should, presumably, reflect a longer term strategy (Theotokas and Harlaftis, 2009). This is, however, not always the case as newbuildings could just be a technique to hedge against short term cost exposure by acquiring more efficient new vessels, obtain finance in those cases where risk averse fund providers prefer not to invest in second-hand tonnage and where the owner expects a shortage of tonnage in the short to medium term providing for an asset play exit, in some cases even before the build of the vessel is completed. The sale of shipyard slots over the past boom decade is an example thereof.

4.5 Competitive advantage in shipping strategy

At the core of many strategy plans is the pursuit of Michael Porter's concept of "competitive advantage", and more specifically "*sustainable competitive advantage*" (Porter, 1998b). This concept can be described as the firm employing its distinctive competencies, developed with the firm's resources and capabilities, to reach a cost advantage or differentiation advantage which leads to value creation. If this advantage is of a nature to allow the firm to sustain a degree of profitability in excess of the average of its industry, then the firm can be considered to have a sustainable competitive advantage. Barney (1991) argues a sustainable competitive advantage, whilst not everlasting, cannot be rendered ineffective by actions of actual or potential future competitors. It is appropriate in light of the prominence given by shipping strategy authors to Porter's theories (Hawkins and Gray, 2000; Wijnolst and Wergeland, 2009), we use his concepts in trying to identify the competitive advantage concepts associated with shipping companies. To do so, one firstly needs to assess the features of a sustainable competitive advantage.

Grant sets out various isolating mechanisms which can be used by companies to sustain their competitive advantage, i.e. to prevent competitive advantages from being challenged by competitors

through imitation or innovation (Grant, 2008). Those mechanisms can be to *obscure* its superior performance, *deterrence* through limit pricing, *pre-emption* by exploiting as the first mover in a small market all investment opportunities which could give rise to the same sustainable competitive advantage, *complexity* of the elements of which the advantage is to be composed disabling the establishment of a clear causal relation between element and advantage, as well as to ensure the *resources* and *capabilities* employed to ensure distinctive competencies are immobile and difficult to replicate. We will now use those criteria to review the literature with respect to sustainable competitive advantage in shipping. Please note this chapter reviews only the literature pertaining to the whole shipping market (i.e. not specific to any of its constituent market segments).

In identifying possible sources of a competitive advantage, we can either consider those advantages attributed as such to shipping companies as well as those sustainable competitive advantages attributed to shipping-related industries but of mutual benefit to shipping companies (e.g. a ship design patent jointly owned by a shipyard and the shipping company based on joint research and development). Due regard should be had to the specific market structure as some markets, e.g. regulated markets, can confer sustainable competitive advantage on different criteria than unregulated markets. Indeed, companies operating in regulated markets such as cabotage or the carrying of government cargo are more likely to be restricted in their entrepreneurial freedom and focused on satisfying regulatory authorities (Mulligan and Lombardo, 2008).

Sletmo and Hoste (1994) have argued the applicability of Porter's theory to shipping, albeit from a national shipping policy point of view, implying traditional maritime countries can further the survival of their national fleet by seeking to pursue either an absolute cost advantage (e.g. creation of international shipping registers) and/or differentiation through value-added services (e.g. furthering the integration of shipping with logistics/inland transport through multimodal hubs and favourable terminal operating conditions) and or seeking to operate in special niches (e.g. subsidising shipyards to build market segment specific shipbuilding expertise such as cruise vessels or chemical carriers). This in turn could encourage national carriers to explore those strategic options. These authors quote Svendsen in suggesting survival in shipping is strongly dependent on the existence of a "shipping milieu" or maritime cluster possessing shipping knowledge, maritime intelligence and technical competencies. Perhaps, it is in the presence of the latter that we find a hint of a possible company specific element of sustainable competitive advantage (i.e. the shipping company being a constituent part of a maritime cluster).

In this respect, Grammenos and Choi (1999) suggest ethnic homogeneity as a factor uniting the "club", in particular the Greek shipping community. The club structure permits a reduction in transaction costs due to common cultural concepts and values which can also be policed by the club members, which in turn can contribute toward establishing brand values *vis-à-vis* third parties. The club also establishes networks beyond its immediate members through which information can be channelled to club members. However, to what extent a homogeneic club makes for a sustainable competitive advantage is an open question in an industry where globalisation has brought a degree of internationalisation that stretches beyond the geographic borders of the Greek diaspora and where the diversity of crew nationalities aboard vessels proverbially rivals that of the United Nations. Boyce (2003) also pointed to the benefits of membership of a network, the establishment of network routines and the resulting reduction in transactional costs in addition to non-quantitative benefits such as

knowledge management, organisational learning and the furthering of personalised business. Veenstra and Bergantino (2000) analysed the flagging in and flagging out under the Dutch flag, re-stating the definition of flag with reference to any of the following links: beneficial ownership, ship management and vessel flag. They found that in the period 1994–1998 foreign vessels were actually still migrating to the Dutch flag and deduced this was related to the attractions offered by the Dutch maritime cluster to "local" shipping companies.

Further analysis on the importance of the cluster, defined as a peer group of companies combining a set of competencies, was put forward by de Langen and Nijdam (2003) who equally analysed the Dutch maritime cluster. Adopting a Porterian approach (Porter, 1998a) to identifying industrial clusters, they argue leader firms of the cluster exhibit mutual benefit to and dependency on the competitiveness of the cluster member companies. Key benefits are the sharing of innovative technologies, sharing of environmental intelligence, high quality of supplies and high degree of international competitiveness. These benefits are a result of the availability and quality of input factors, the qualitative and quantitative nature of local demand, the existence of an industrial network and the quality of the components (i.e. individual firms) thereof, and, finally, the domestic market structure, strategy oriented regulation and degree of competition within the cluster. It could, thus, be argued that the membership by a shipping firm of a competitive "domestic" industrial cluster could critically influence its ability to develop a sustainable competitive advantage. Midelfart Knarvik and Steen (2002) found that the cluster can generate those positive externalities only if all firms are at a similar level of development. They also argue that the cluster externalities did lead to performance improvements for Norwegian shipping companies and related maritime services providers. Wijnolst and Wergeland (2009) posit that membership of a cluster makes it more likely that shipping companies can succeed in integrating core competencies within and between firms and, thus, gain a sustainable competitive advantage. Jenssen (2003) argues that membership of a cluster furthers innovation which in turn may lead to a sustainable competitive advantage. Tenold (2009) illustrated how the existence of such a cluster in Bergen furthered the emergence of competitive advantage in specialist shipping, albeit not a lasting one. The commoditisation of advanced technology through S&P markets, in addition to competitors' own technological advances, cannot allow a cluster to sustain its competitive advantage unless the cluster can maintain its ability to out-innovate.

A cluster of an altogether different kind is the one surveyed by Shang and Sun (2004), i.e. Taiwanese manufacturing firms (not shipping) with extensive logistics competencies such as positioning, integration, agility and measurement. The findings were surprising in that the logistics competency cluster is not associated with employees, sales and industry but with the ability to leverage combinations of inimitable logistics competencies in producing sustainable competitive advantage. This echoes the competencies integration hypothesis put forward by Wijnolst and Wergeland. Shang and Sun argue conclusively logistics competencies can be regarded as a strategic source for acquiring sustainable competitive advantage, and quote a substantial body of extant literature in support of their findings. Durvasula *et al.* (2007) consider the ability to mix and match logistics service attributes with the maximisation of customer satisfaction in mind as critical to differentiation of the product offering. This may lead to loyalty and sustainable competitive advantage. The nature of this symbiotic relationship between shipper and shipping company, based on

quality of service and degree of customer satisfaction, is highlighted by the finding that the choice of carrier represents a hedge for shippers against their competition (Wagner and Frankel, 1999).

The importance of trust as an important ingredient of sustainable competitive advantage, esp. in an era of integration between logistics and shipping, has been highlighted early on. Neuschel (1987) argues that management's ability to create a climate of trust is key to instituting change and building the carrier/shipper relationship. Further success factors are the judicious use of information technology, a low-cost approach and customer service orientation or a "servant model of leadership". Lagoudis and Theotokas (2007) also expound the joint importance of cost and supply chain concepts of quality, service, cost and time in a shipping context by establishing those qualities as the hallmark of the competitive advantage of Greek shipping. More specifically, their survey reveals quality and time to be "qualifying" criteria and cost and service "winning" criteria. They caveat their conclusion with reference to differences in applications based on company size, single- or multi-segment operations and dominant philosophies with respect to supply chain strategies. Research into the nature and effects of supplier integration has since confirmed the validity of this approach (Kirst and Hofmann, 2007). Kirst and Hofmann formulate a caveat to deep integration between suppliers (shipping companies) and customers (shippers) in respect of the significant barriers to exit created by the commitment of substantial resources to an idiosyncratic relationship and the associated loss of flexibility due to a self-imposed reduced access to the market. The nature of such a sustainable competitive advantage is thus inherently linked to the successful balancing of both parties' objectives as opposed to being purely under the control of one party.

Panayides and Gray (1999) apply Porter's theory to shipping, based on their interpretation of Sletmo and Hoste (1994) and argue a ship manager's competitive advantage may consist of amongst others a relational competitive advantage (i.e. an intangible asset formed out of the established relationship between a ship manager and a shipowner). This asset is made up of a bond of trust, significant client-specific investments and service, investment of time in personal contacts and knowledge management about the client and the avoidance of conflicts. The authors did not indicate whether the financial performance of the ship managers exhibiting these features did lead to financial outperformance of their peers on a sustained basis. Also, the features quoted in support do not seem to meet the criteria to confer a sustainable competitive advantage as they can be replicated, do not deter new entrants and are not built on immobile distinctive competencies. This author considers ship management a professional service where the value of the relationship lies with the skill and knowledge of the inherently mobile ship manager. Consequently, it seems doubtful that the established relations between shipping companies and their ship managers could constitute a sustainable competitive advantage to either party. The analysis by Mitroussi (2004) also suggests that the true key motivators for hiring and selecting a third-party ship manager are their perceived expertise in certain market segments the shipping company wishes to move into on short notice, and the price of the service package. These two factors seem to this author neither unique to a specific ship manager nor sustainable. In addition, Mitroussi (2003) has noted the significant concerns shipowners have about ship managers' potential conflicts of interests if they were put in a position of commercial management. These concerns are, in the opinion of this author, unlikely to allow for a very deep integration between shipping companies and their ship managers, let alone turn this integration into a factor of sustainable competitive advantage for either party.

Pringle and Kroll (1997), in their analysis of the Royal Navy's win of the Battle of Trafalgar, posit the implications for the Royal Navy's strategy to date. Physical resources and environmental analysis do not constitute a sustainable competitive advantage as they can be duplicated or imitated. The key to success lies in the foci on intangible resources (especially know how), an enabling heritage (e.g. trust among staff), a change embracing corporate culture, the application of innovative strategies, the role of the CEO in leading by example, investment in training and empowerment of staff at all hierarchical levels. There is no reason why these lessons should not be applicable to today's merchant shipping environment. In this respect, it would seem that most of Greek and Asia-Pacific companies have failed to develop this type of sustainable competitive advantage given the top-down focus, lack of empowerment, inherent conservatism and focus on cost efficiency rather than intangibles.

The very concept of sustainable competitive advantage implies the firm has already exploited it to achieve sustained excess financial returns. However, future exploitation on a sustainable basis requires, according to Plomaritou (2008b, 2008a), the need for a proper effective marketing policy based on the marketing mix of competitive advantages. The constituent elements of a sustainable competitive advantage need to be combined and marketed in a manner so as to underpin the sustainable nature of the competitive advantage. Given the intangible nature of transport services, the effective marketing thereof could perhaps be considered as an enabling part of the sustainable competitive advantage *per se*. Cerit (2002a) points in this respect to the experience of shipyards in strengthening their competitive position through more developed marketing organisations and the resulting increased market orientation. This in turn might favourably affect performance, although that performance link has not been proven to date for the shipping industry. The experience of other industries suggests, though, that successful business strategy implementation is necessary to achieve superior performance. Marketing is instrumental in strategy implementation, although its implementation is contingent on the specific strategy in use (Olson *et al.*, 2005).

Finally, Zellweger (2007) argues that the lower cost of equity, and thus the lower cost of capital of long-term oriented family firms, can contribute towards establishing a sustainable competitive advantage. In itself, though, a lower cost of capital is no sustainable competitive advantage as it can be easily replicated by any firm adopting a longer-term investment horizon. This is also intimated by the findings of Pointon and El-Masry (2006) which suggest that dividend- and earnings-based estimates of the cost of equity over periods of competitive advantage are significantly different from those suggested by the traditionally used Capital Asset Pricing Model (CAPM).

4.6 Strategy tools in shipping strategy

Datz (1971) wrote that shipping company managers needed to base their intuitive decision making on timely and accurate information generated by a "practical data base" based on the World War II naval operations room concept. The database referred to was in effect a simulation game. Various strategy tools have since been developed and are applicable to all industries. They need not be analysed in this contribution. Tools discussed in detail by Coyle (2004) comprise mind maps, impact wheels, "why" diagrams and influence diagrams. The prime purpose of these tools is to model out a complex strategic environment exhibiting the broad variety of factors affecting strategy. The tools used to perform competitive analysis, as opposed to strategic competitor analysis, are the already documented matrices, tabular overviews, diagrams, strengths/weaknesses analyses, opportunities/threats analyses,

PEST analysis, SWOT matching, potential/resources analysis, price/service diagrams, "potential" analysis, life-cycle analysis, market attractiveness/competitive strength portfolio analysis, customer attractiveness/supplier position portfolio analysis, technology/resource availability portfolio analysis, price/customer satisfaction portfolio analysis, share of turnover/profitability portfolio analysis and multi-dimensional web analysis (Kairies, 2008). A combination of several of these techniques has also become popular with the creation of the "balanced scorecard" by Kaplan and Norton (1996). Finally, Luehrmann (2004) also conceptualised strategy as a portfolio of real options thereby establishing a direct link between strategy and value.

Yet, the tools used by the shipping industry and reported in the literature are quite different. Rich posits that corporate planning relies heavily on operational war time research techniques (Rich, 1978a) and this is probably reflected in the quantitative *viz.* financial orientation of the strategy processes of the time. Theotokas and Harlaftis (2009) confirmed this financial/operational orientation for Greek shipping companies and Hawkins and Gray (1999) for Asia-Pacific ones. The financial orientation is also exhibited in the application of real options analysis to maritime investment strategies (Bendall and Stent, 2003, 2007), strategic decisions pertaining to market switching (Sødal *et al.*, 2008), strategic/operational decisions pertaining to scrapping and lay-up decisions (Dixit and Pindyck, 1994) and trading of ships in the sale and purchase market (Sødal *et al.*, 2009).

For Asia-Pacific shipping companies, the survey by Hawkins and Gray (1999) suggested a lack of exposure to strategic management theory and a resulting lack of exposure to current developments in that discipline. In a later work (Hawkins and Gray, 2000), these authors also refer to literature highlighting the lack of credibility of traditional strategy tools with Asia-Pacific shipowners due to their untested character in a shipping context. This observation echoes the findings of Saxena and Joshi (1992) with respect to low level of usage of information technology (IT) by ship managers in Hong Kong and attributable to lack of "user seductiveness", lack of tailoring to the rigours and specifics of the shipping environment in addition to shipowners' inherent conservatism.

The lack of IT adoption has certainly not prevented the development of decision support tools. Fagerholt *et al.* (2009) developed a "strategic planning" decision support tool assisting with contract analysis and fleet size/mix issues by means of optimisation and simulation, albeit this pertains more to implementation of strategy than strategy planning. Similarly, an automated Multi Criteria Decision Model (MCDM) has been developed which can take into account a user-defined hierarchy of both qualitative and quantitative data analysis to assist in performance assessment by means of combining fuzzy set theory, Analytical Hierarchy Process and entropy concepts (Chou and Liang, 2001).

4.7 Organisational benefits of the strategy process

A textbook planning process can generate many benefits for shipping companies besides the planning output itself. Firstly, assuming a wider participation level encompassing all high to low management levels, would allow the company to identify potential intrepreneurs in its ranks. This may in time allow for avoidance of succession issues if the founding family is no longer to be involved in the business. Further, the process can identify cost efficient outsourcing opportunities which bring new capabilities to bear on the performance of the company, thereby building a network organisation. Finally, participation in the process constitutes a learning process for both the participants and the organisation in understanding the shipping market and managing knowledge residing with the

company's senior and more experienced managers (Lorange, 2001).

5. Conclusion

In this chapter, we suggested a holistic and entrepreneurial perspective in reviewing and analysing the strategy literature pertaining to shipping companies. It has as its objective to relate the literature subject matter back to the relevant financial statement items and business models and can take as input contributions from a broad range of disciplines and technical areas going well beyond the strategy literature proper. We then outlined the strategy concepts that have come to influence the authors of shipping strategy literature, in particular the theory developed by Porter. After this, we reviewed the extant body of strategy literature pertaining to shipping in general.

This contribution aimed to answer two key questions. First, where does shipping strategy stand in the literature? Secondly, how holistic in nature is the literature pertaining to shipping strategy? As this contribution was focused on the shipping market overall, we excluded from our review an extant body of research pertaining to specific shipping market segments, such as the strategy of container shipping companies. Yet, we found a limited amount of literature discussing the shipping strategy process, and some literature addressed generic shipping company strategies identified through the use of 2x2 matrices. Relations were identified between strategic orientation and organisational features, as well as between strategy type and type of trading/market segment. We also identified a limited number of internal and external factors furthering the development of strategies by shipping companies. The contribution also lists the factors identified in the literature as contributory towards the acquisition of a sustainable competitive advantage, and notes in this respect the increasing importance of brain-driven strategies as opposed to asset-driven strategies. As such brain-driven strategies are knowledge dependent, we observed such knowledge resides in the middle-management levels. The implication for strategy development is the need for such, and other related management processes, to become decentralised or at least made more accessible to personnel hitherto excluded from them. This is especially relevant as these executives also have first hand experience of market and competitive developments, which are highly relevant inputs into the competitive intelligence gathering process.

We noted in this respect the scarce literature regarding competitive intelligence in a shipping context and the relatively unsophisticated nature of CI gathering and analysis by shipping companies. This was related back to the organisational features of shipping companies which are typically small companies, locked into intent competition based mainly around cost efficiency and with seemingly little time left for strategising. Strategy seems predominantly finance oriented, echoing the importance of cost efficiency. We noted differences in focus and approach between Greek and Asia-Pacific shipping companies. This leads us to answer the second question in the negative – there is very little evidence of a holistic approach to shipping strategy.

The latter conclusion justifies in this author's opinion a tentative future approach to classify a wider body of literature with reference to implied strategic relevance. A classification structure was proposed to this effect which can be framed by the observations above.

6. Areas for Future Research

By framing the strategy process in shipping companies and proposing a literature classification approach for a wide body of shipping literature, we have made the first steps towards creating a canvas for drawing shipping strategies. This canvas should reflect the broad range of approaches and

issues pertinent to strategy making, establishing in the process the link to the strategy framework. This canvas can in due course serve to assess current strategic theories and, perhaps, assist with original future research in this domain.

The introduction to this chapter highlighted the delineation of the application area of our analysis with respect to the shipping market as a whole. This leaves considerable scope for expansion of the research into the more specific shipping market segments enumerated in section 2 above (i.e. bulk shipping, specialist shipping and liner/container shipping). The colossal capital investment and trade flows associated with the latter, and the concomitant degree of organisational institutionalisation, have also led to an increased amount of attention from the academic research community resulting in a substantial body of literature pertaining mainly to strategy and operational research. This volume of research dwarfs that pertaining to bulk shipping, traditionally the most fragmented market exhibiting perfect competition features.

By systematic review, we aimed to address the oft-repeated accusation that transportation strategy literature is no more than anecdotal evidence devoid of broader structural theories (Gibson *et al.*, 1993). Theotokas and Harlaftis (2009) have made a start with a more encompassing review of individual shipping companies' history with a view to distil common strategic and strategy related traits. Finally, this author also believes there is a need for review of the foreign language literature which has made equally relevant contributions to the shipping strategy domain.

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References

Ansoff, I. (1965): *Corporate strategy: an analytic approach to business policy for growth and expansion* (McGraw-Hill).

Ansoff, I. (1979): *Strategic management* (Wiley).

Barney, J. (1991): "Firm Resources and Sustained Competitive Advantage", *Journal of Management*, 17**,** 99.

Bendall, H. and Stent, A.F. (2003): "Investment strategies in market uncertainty", *Maritime Policy & Management*, 30**,** 293–303.

Bendall, H.B. and Stent, A.F. (2007): "Maritime investment strategies with a portfolio of real options", *Maritime Policy & Management*, 34**,** 441–452.

Boyce, G. (2003): "Network knowledge and network routines: negotiating activities between shipowners and shipbuilders", *Business History*, 45, 52–76.

Brooks, M.R. (1995): "Understanding the ocean container market–a seven country study [1]", *Maritime Policy & Management*, 22, 39–49.

Cafruny, A.W. (1985): "The political economy of international shipping: Europe versus America", *International Organization*, 39**,** 1.

Cafruny, A.W. (1987): *Ruling the Waves: The Political Economy of International Shipping* (London, University of California Press Ltd).

Casson, M. (1986): "The role of vertical integration in the shipping industry", *Journal of Transport Economics and Policy*, 20**,** 7.

Casson, M. (1989): "The quality of shipping services: an economic appraisal of strategies for the European liner shipping industry", in Yannopoulos, G.N. (ed.) *Shipping policies for an open world economy* (London, Routledge).

Cerit, A.G. (2002a): "Market orientation measures of the US and Turkish shipbuilding industries: a comparative study", *Journal of Ship Production*, 18**,** 19–32.

Cerit, A.G. (2002b): "Marketing strategies in shipping", in Grammenos, C.T. (ed.) *The Handbook of Maritime Economics and Business* (1st edn.) (London, Informa).

Chandler, A. (1962): *Strategy and Structure* (Cambridge, MA, MIT Press).

Chang, Y .-F. (1999): *Tides of Fortune – A Shipping Tycoon's Primer on Business Values and Ethics* (Singapore, Times Books International).

Cheung, A., Kutcher, E. and Wagle, D. (2009): "Strategic planning in a crisis", *McKinsey Quarterly***,** 122–123.

Chida, T. and Davies, P.N. (1990): *The Japanese Shipping and Shipbuilding Industries: A History of their Modern Growth* (London, The Athlone Press Ltd).

Chou, T.-Y. and Liang, G.-S. (2001): "Application of a fuzzy multi-criteria decision-making model for shipping company performance evaluation", *Maritime Policy & Management*, 28**,** 375–392.

Conner, K.R. (1991): "A historical comparison of resource-based theory and five schools of thought within industrial organization economics: do we have a new theory of the firm?", *Journal of Management*, 17, 121.

Coyle, G. (2004): *Practical Strategy – Structured Tools and Techniques* (Harlow, Pearson Education Limited).

Datz, I.M. (1971) *Planning Tools for Ocean Transportation* (Cambridge, Cornell Maritime Press).

De Langen, P.W. and Nijdam, M.H. (2003): *Leader firms in de Nederlandse Maritieme Cluster* (Delft, DUP Satellite).

Dixit, A.K. and Pindyck, R.S. (1994): *Investment under Uncertainty* (Princeton, Princeton University Press).

Drucker, P.F. (1946): *The Concept of the Corporation* (New York, John Day).

Drucker, P.F. (1955): *The Practice of Management* (London, Butterworth-Heinemann).

Durvasula, S., Lysonski, S. and Mehta, S.C. (2007): Competitive positioning in international logistics: identifying a system of attributes through neural networks and decision trees", *Journal of Global Marketing*, 20, 75–89.

Fagerholt, K., Christiansen, M., Hvattum, L.M., Johnsen, T.A.V. and Vabo, T.J. (2009): "A decision support methodology for strategic planning in maritime transportation", *Omega*, 12.

Fayol, H. (1916): *Administration générale et industrielle* (Gauthier-Villars).

Fearnleys (2007): "Legal and Economic Analysis of Tramp Maritime Services" (Oslo: Fearnley Consultants).

Follett, M. (1924): *Creative Experience* (Oxford, Longmans, Green & Co).

Frankel, E.G. (1982a): *Management and Operations of American Shipping* (Boston, Auburn House Publishing Company).
Frankel, E.G. (1982b): "Strategic decision making in shipping", *Marine Policy*, 6**,** 259–264.
Frankel, E.G. and Marcus, H.S. (1973): "Ocean Transportation", *MIT Sea Grant Program* (1st edn.) (Cambridge, MA, MIT).
Gibson, B.J., Sink, H.L. and Mundy, R.A. (1993): "Shipper-carrier relationships and carrier selection criteria", *Logistics and Transportation Review*, 29**,** 371.
Godet, M. (2007): *Manuel de prospective stratégique – Tóme 1: Une indiscipline intellectuelle* (Paris, Dunod).
Goss, R. (1987): "How to make money in shipping", *Maritime Policy & Management*, 14, 1–3.
Goss, R. (2008): "Social responsibility in shipping", *Marine Policy*, 32, 142–146.
Grammenos, C.T. (1979): *Bank Finance for Ship Purchase* (Bangor, University of Wales Press).
Grammenos, C.T. and Choi, C.J. (1999): "The Greek shipping industry", *International Studies of Management & Organization*, 29, 34.
Grant, R.M. (2008): *Contemporary Strategy Analysis* (Chichester, John Wiley & Sons).
Harding, A.S. (1969): "The effect of technological change on planning for international transport", *Long Range Planning*, 2**,** 30–35.
Hargett, T.R. and Williams, M.F. (2009): "Wilh. Wilhelmsen Shipping Company: moving from CSR tradition to CSR leadership", *Corporate Governance*, 9, 73–82.
Harkleroad, D. and Sawka, K. (1996): "Outthinking the competition: intelligence for strategic planning", in Gilad, B., and Herring, J.P. (eds.) *The Art and Science of Business Intelligence Analysis: Business Intelligence Theory, Principles, Practices and Uses* (1st edn.) (London, JAI Press Inc).
Hawkins, J. and Gray, R. (2000): *Strategies for Asia-Pacific Shipping* (Aldershot, Ashgate).
Hawkins, J.E. and Gray, R. (1999): "Making strategic choices for Asia-Pacific shipping", *International Journal of Maritime Economics*, 1, 57–71.
Heaver, T., Meersman, H., Moglia, F. and Van de Voorde, E. (2000): "Do mergers and alliances influence European shipping and port competition?", *Maritime Policy & Management*, 27, 363–373.
Henderson, B.D. (2006): "The product portfolio", in Stern, C.W. and Deimler, M.S. (eds.) *The Boston Consulting Group in Strategy. Classic concepts and New Perspectives* (2nd edn.) (Hoboken, John Wiley & Sons Inc).
Jacks, D.S and Pendakur, K. (2008): "Global trade and the maritime revolution" (Cambridge, National Bureau of Economic Research (NBER)).
Jenssen, J.I. (2003): "Innovation, capabilities and competitive advantage in Norwegian shipping", *Maritime Policy & Management*, 30, 93–106.
Kahaner, L. (1997): *Competitive Intelligence: How to Gather, Analyze, and use Information to Move your Business to the Top* (New York, Touchstone).
Kairies, P. (2008): *So analysieren Sie Ihre Konkurrenz: Konkurrenzanalyse und Benchmarking in der Praxis* (Renningen, Expert Verlag).
Kaplan, R.S. and Norton, D.P. (1996): *The Balanced Scorecard: Translating Strategy into Action*

(Boston, MA, Harvard Business School Press).
Kavussanos, M.G. and Visvikis, I.D. (2006): *Derivatives and risk management in shipping* (London, Witherby & Co. Ltd).
Kindleberger, C.P. and Johnson, H.G. (1985): "Multinational Ownership of Shipping Activities", *The World Economy*, 8, 249–266.
Kirst, P. and Hofmann, E. (2007): "Supplier integration and the challenge of relationship-exit strategies", in Otto, A. and Obermaier, R. (eds.) Logistikmanagement 2007 – Analyse, Bewertung und Gestaltung logistischer Systeme, 2007 Regensburg. Wiesbaden: Deutscher Universitäts-Verlag – Gabler Edition Wissenschaft, 397–425.
Koopmans, T. (1939): *Tanker Freight Rates and Tankship Building. An Analysis of Cyclical Fluctuations* (Rotterdam, Nederlands Economisch Instituut).
Koufopoulos, D.N., Lagoudis, I.N. and Pastra, A. (2005): "Planning practices in the Greek ocean shipping industry", *European Business Review*, 17, 151.
Lagoudis, I.N. and Theotokas, I. (2007): "Chapter 4: the competitive advantage in the Greek shipping industry", *Research in Transportation Economics*, 21, 95–120.
Langley Jr, C.J. (1983): "Strategic management in transportation and physical distribution", *Transportation Journal*, 22, 71–78.
Leggate, H.K. (2000): "A European perspective on bond finance for the maritime industry", *Maritime Policy & Management*, 27, 353–362.
Lorange, P. (2001). "Strategic re-thinking in shipping companies", *Maritime Policy & Management*, 28, 23–32.
Lorange, P. (2005): *Shipping Company Strategies – Global Management under Turbulent Conditions* (Amsterdam, Elsevier).
Lorange, P. (2009): *Shipping Strategy – Innovating for Success* (Cambridge, Cambridge University Press).
Lorange, P. and Norman, V.D. (1973): "Risk preference in Scandinavian shipping", *Applied Economics*, 5, 49.
Luehrman, T.A. (2004): "Strategy as a Portfolio of Real Options", in Schwartz, E.S. and Trigeorgis, L. (eds.) *Real Options and Investment under Uncertainty – Classical Readings and Recent Contributions* (Paperback edn.) (London, MIT Press).
Mangan, J., Lalwani, C. and Gardner, B. (2001): "Identifying relevant variables and modelling the choice process in freight transportation", *International Journal of Maritime Economics*, 3, 278–297.
Mentzer, J.T. and Firman, J. (1994): "Logistics control systems in the 21st century", *Journal of Business Logistics*, 15, 215–227.
Metaxas, B.N. (1978): "Notes on the internationalization process in the maritime sector", *Maritime Policy & Management*, 5, 51–61.
Midelfart Knarvik, K.H. and Steen, F. (2002): "Vertical industry linkages: sources of productivity gains and cumulative causation?", *Review of Industrial Organization*, 21, 3.
Miller, M.B. (2003): "The business trip: maritime networks in the twentieth century", *Business History Review*, 77, 1.
Mitroussi, K. (2003): "Third party ship management: the case of separation of ownership and

management in the shipping context", *Maritime Policy & Management*, 30, 77–90.
Mitroussi, K. (2004): "The ship owners' stance on third party ship management: an empirical study", *Maritime Policy & Management*, 31, 31–45.
Moeller, S. and Brady, C. (2007): *Intelligent M&A: Navigating the Mergers and Acquisitions Minefield* (Chichester, John Wiley & Sons Ltd).
Moreby, D.H. (1975): *The Human Element in Shipping* (Colchester, Seatrade Publications Ltd).
Mulligan, R.F. and Lombardo, G.A. (2008). "Entrepreneurial planning in a regulated environment: the U.S. Federal Maritime Commission and the maritime industry", *Quarterly Journal of Austrian Economics*, 11, 106–118.
Mullins, J. and Komisar, R. (2009): "Getting to plan B: breaking through to a better business model", *Harvard Business Review*.
Neuschel, R.P. (1987): "The new logistics challenge – excellence in management", *Journal of Business Logistics*, 8, 29–39.
Olson, E.M., Slater, S.F. and Hult, G.T.M. (2005): "The Performance implications of fit among business strategy, marketing organization structure, and strategic behavior", *Journal of Marketing*, 69, 49–65.
Pallis, A.A. (2007): "Chapter 1: The Greek paradigm of maritime transport: a view from within", in Pallis, A.A. (ed.) *Research in Transportation Economics* (Elsevier).
Panayides, P.M. and Gray, R. (1999): "An empirical assessment of relational competitive advantage in professional ship management", *Maritime Policy & Management*, 26, 111–125.
Plomaritou, E.I. (2008a): *Marketing of Shipping Companies – A Tool for Improvement of Chartering Policy* (Athens, Stamoulis Publications).
Plomaritou, E.I. (2008b): "A proposed application of the marketing mix concept to tramp and liner shipping companies", *Management*, 13, 59–71.
Pointon, J. and El-Masry, A. (2006): "Competitive advantage and the cost of equity in international shipping", *J Oper Res Soc*, 58, 1138–1145.
Porter, M.E. (1998a): "Clusters and the new economics of competition", *Harvard Business Review*, 76, 77–90.
Porter, M.E. (1998b): *Competitive Advantage: Creating and Sustaining Superior Performance. With a new introduction* (Free Press).
Pringle, C.D. and Kroll, M.J. (1997): "Why Trafalgar was won before it was fought: lessons from resource-based theory", *The Academy of Management Executive (1993)*, 11, 73–89.
Rich, C.A. (1978a): "Corporate planning in shipping: relating theory to practice – Part 1: Corporate planning defined and the setting of corporate objectives", *Maritime Policy & Management*, 5, 31–38.
Rich, C.A. (1978b): "Corporate planning in shipping: relating theory to practice – Part 2: Corporate strategy", *Maritime Policy & Management*, 5, 39–50.
Roe, M.S. (2002): "Shipping policy in the globalisation era: the inter-relationship between international, supra-national and national shipping policies", in Grammenos, C.T. (ed.) *The Handbook of Maritime Economics and Business* (1st edn.) (London, Lloyd's of London Press).
Roe, M.S. (2009): "Multi-level and polycentric governance: effective policymaking for shipping",

Maritime Policy & Management, 36, 39–56.
Ronen, D. (1980): "The role of information in ocean-shipping management", *Maritime Policy & Management*, 7, 133–137.
Ronen, D. (1981): "The potential of commercial intelligence in the ocean shipping industry", *Information & Management*, 4, 127–131.
Saxena, K.B.C. and Joshi, P.B. (1992): "Motivating ship managers to use management support technology", *Maritime Policy & Management*, 19, 55–62.
Serafetinidis, M., Serafetinidis, G., Lambrinides, M. and Demathas, Z. (1981): "The development of Greek shipping capital and its implications for the political economy of Greece", *Cambridge Journal of Economics*, 5, 289–310.
Shang, K.-C. and Sun, L.-F. (2004): "Taxonomy in logistics management: a resource-based perspective", *International Journal of Management*, 21, 149–165.
Sletmo, G.K. (1989): "Shipping's fourth wave: ship management and Vernon's trade cycles", *Maritime Policy & Management*, 16, 293–303.
Sletmo, G.K. and Hoste, S. (1994): "Shipper's councils: role and responsibility – a western view", *Maritime Policy & Management*, 21, 257–271.
Sødal, S., Koekebakker, S. and Adland, R. (2008): "Market switching in shipping – A real option model applied to the valuation of combination carriers", *Review of Financial Economics*, 17, 183–203.
Sødal, S., Koekebakker, S. and Adland, R. (2009): "Value-based trading of real assets in shipping under stochastic freight rates", *Applied Economics*, 41, 2793–2807.
Stopford, M. (1988): *Maritime Economics* (London, Routledge).
Stopford, M. (2004): *The Tramp Shipping Market* (London, Clarkson Research Studies).
Stopford, M. (2009): *Maritime Economics* (Abingdon, Routledge).
Sturmey, S.G. (1962): *British Shipping and World Competition* (London, The Athlone Press – University of London).
Syriopoulos, T.C. (2007): "Chapter 6: Financing Greek shipping: modern instruments, methods and markets", in Pallis, A.A (ed.) *Research in Transportation Economics* (Elsevier) pp. 171–219.
Tenold, S. (2009): "Vernon's product life cycle and maritime innovation: Specialised shipping in Bergen, Norway, 1970–1987", *Business History*, 51, 770–786.
Thanopoulou, H.A. (1995): "The growth of fleets registered in the newly-emerging maritime countries and maritime crises", *Maritime Policy & Management*, 22, 51–62.
Theotokas, I. and Harlaftis, G. (2009): *Leadership in World Shipping – Greek Family Firms in International Business* (Basingstoke, Palgrave Macmillan).
Tomlinson, D.S. (1980): "Developing a data base for planning – A shipping industry case", *Long Range Planning*, 13, 42–45.
Unger, R.W. (1975): "Technology and industrial organization: Dutch shipbuilding to 1800", *Business History*, 17, 56.
Valdaliso, J.M. (2000): "The rise of specialist firms in Spanish shipping and their strategies of growth, 1860–1930" *Business History Review*, 74, 267.
Van der Heijden, K. (2005): *Scenarios: The Art of Strategic Conversation* (Chichester, John Wiley & Sons).

Veenstra, A.W. and Bergantino, A.S. (2000): “Changing ownership structures in the Dutch fleet”, *Maritime Policy & Management*, 27, 175–189.

Vernon, R. (1966): “International investment and international trade in the product cycle”, *Quarterly Journal of Economics*, 80, 190–207.

Wagner, W.B. and Frankel, R. (1999): “Carrier service: shipper hedge against supply chain competition”, *International Journal of Logistics Research and Applications: A Leading Journal of Supply Chain Management*, 2, 75–85.

West, C. (2001): *Competitive Intelligence* (Basingstoke, Palgrave).

Wijnolst, N. and Wergeland, T. (2009): *Shipping Innovation* (Amsterdam, Delft University Press).

Zellweger, T. (2007): “Time horizon, costs of equity capital, and generic investment strategies of firms”, *Family Business Review*, 20, 1–15.

Part Ten
Port Economics and Management

Chapter 30

Port Management, Operation and Competition: A Focus on North Europe

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1. Introduction

In the past decades, the role of port management has changed quite fundamentally. It has gradually evolved from being a supervisory and determining capacity to a more subordinate function that often consists solely of providing the required facilities for the various parties involved in port operations.

The port landscape has also altered in many respects. New technologies and strategic developments have led almost automatically to greater port competition, both at port authority level and at the level of companies operating within the various ports. All port players, from authorities to terminal operators and agents, are looking for ways to maximise profits, to maintain or increase market share, or simply to survive. These goals are not so easily achieved in an era of internationalisation of production, consumption and trade.

National and regional authorities are also monitoring these developments closely. A strong and efficiently run seaport can be an important asset for a country or region in trying to improve its economic position. For one thing, port activities generate value added and employment. Moreover, a seaport can be an important point of attraction for a broad range of industries.

This in part explains why European ports, especially in the Hamburg–Le Havre range, are involved in such a fierce competitive struggle for attracting goods flows, shipping lines, and infrastructure and industrial investment. Economic resources are scarce, which explains the ferocity of the competitive struggle in which port authorities in particular were engaged until just a few years ago. Watching from the sidelines were a number of other “players”: consignors, goods-handlers, shipping companies, etc. This situation has now changed.

The supposed strategic importance of seaports to the economy of a country (or region) has prompted quite a few national and regional authorities to artificially protect their seaport(s), among other things through partial or full subsidising of port infrastructure and maritime access routes. This, in turn, has led to mutual accusations of (attempts at) distortion of competition. This seems quite understandable in a context where different ports within the same range have similar investment plans and are competing for the same goods flows.

The above demonstrates quite clearly that there is a connection between port management and the manner of competition. Each port management is concerned primarily with its own competitive position in the range to which it belongs. Decision making is geared towards safeguarding or preferably improving this competitive position. Strategic moves by competing ports are monitored very closely.

In this contribution, we shall discuss this issue in some greater detail. We shall deal consecutively with evolutions in port management, the ever-changing port environment and the need for an appropriate set of analytical tools. Finally, we shall consider some recent findings in research into port competition.

2. Evolutions in Port Management

Port management used to be almost exclusively in the hands of the port authorities. However, over the years, and especially in the past decade, this situation has changed quite profoundly. The power of the port authority has clearly dwindled. It must now undergo the might of the strong(er) port players, in particular the shipping companies and terminal operators. Still, it is interesting to consider how the theory and practice of port management has changed, especially in terms of the objectives pursued and the tools applied.[1]

The objectives of a port authority are closely connected with what is considered to be the economic purpose of a seaport. In the past, these goals were restricted mainly to increasing throughput, generating value added, creating local employment, or maximising operating profits. However, today's reality is more complex and more dynamic than that, primarily because of the specific nature of the "port product".

The port product is in itself a chain of consecutive links, while the port as a whole is likewise a link in the global logistics chain. In the course of time, the relative importance of these various links has clearly changed. This was due to, among other things, significant technological developments (e.g. increasing containerisation rate, larger vessels, more speedy handling …) which have increased efficiency. In other words, it no longer suffices to concentrate on one or just a few links in the chain.

However, to move beyond such a fragmentary approach and take full advantage of possible benefits of scale, clear insight is required into the generalised cost structure of the constituting links and of the chain as a whole. It is important to know how out-of-pocket costs and costs associated with loss, damage, and delay have an impact on the choice of port.

Within a logistics chain, the port cost usually constitutes only a fraction of the total cost. Overall demand for port services in a particular range will therefore be inelastic, especially in the absence of alternatives. On the other hand, competition between goods handlers, ports and countries within the same range is often fierce. The possibilities for substituting one port for another are often so great that the price elasticity for a specific port may be quite considerable after all.

In view of the considerable number of players in any given port (authorities, port management, consignors, shipping lines, trade unions …), each of whom has different objectives, the nature of port activities is inevitably heterogeneous. Consequently, the goals of a port authority are determined in part by the degree to which this authority is, directly or indirectly, subjected to foreign influences, external control or competition from other ports. Not surprisingly, then, these goals may differ quite considerably and indeed may change profoundly over the course of time.[2]

It is also striking in this respect that one often needs to search for a compromise between the priorities of the various important market players. As the relative strength of the different market players may change in the course of time, so might the objectives of the port authority. We shall return to this issue later on.

At the same time, evolutions in port managerial structures are also a direct consequence of technological developments and changes in the socio-economic environment. The British port sector is a very good example in this respect: it was nationalised after World War II and grouped in the British Transport Docks Board (privatised as Associated British Ports in 1981) followed by a government decision in 1991 that the most important ports could be privatised. While the situation did

not develop equally drastically in continental Europe, there was clearly a trend towards more autonomy for port authorities and a greater private stake in goods handling.

Far-reaching mechanisation and sweeping technological changes have also resulted in a sharp decline in the employment of dock workers and indeed in a thorough reorganisation of the work itself. A typical example of this trend is found in container transhipment. After all, the capital-intensive nature of liner shipping demands that capacity utilisation be maximised with a view to achieving an acceptable return on investment. Ports and terminal operators are thus forced to strive constantly for a further improvement of efficiency and productivity of labour. Under this considerable pressure, an important part of port activity has become capital intensive, with a very high level of investment in infrastructure and cargo-handling equipment.[3]

It follows from this evolution that the role of government has changed. Much attention has been paid in this respect to possible financial or other support from government for port authorities and the consequences this may have on the competitive balance between companies and ports.

However, it is very hard to make sensible comparisons between ports, as they usually operate in different economic, legal, social and fiscal environments. Consequently, there are until today considerable differences in the management of European ports: the Anglo-Saxon tradition of independent port authorities, the centralising Latin tradition in France, Spain and Italy, or the municipal Hanseatic tradition in Germany, the Netherlands and Belgium.[4]

These different traditions have resulted in two important, but diametrically opposed, philosophies. First, there is the continental approach whereby “the port in the limited sense of the word is managed and operated by the port authority, the maritime access routes and the connections with the interior are more the responsibility of the central authorities, and the cargo-handling and various other services are in private hands”.[5] Diametrically opposed to this continental tradition stand the ports that are run as ‘total organisations’ (e.g. such British ports as Felixstowe), whereby the maritime access, the port and cargo-handling are the responsibility of a single organisation that supervises all port operations.

Thus, seaports possess characteristics of public utilities on the one hand and of private enterprises on the other.[6] Cargo-handling and related activities are commercial operations that, under normal circumstances, do not need subsidising. By contrast, port infrastructure has many characteristics of public good and is thus approached from a socio-economic perspective (cf. the application of socio-economic cost–benefit analyses to determine whether or not an investment is justified).

Is it imaginable that we may evolve towards a port landscape in which government does not fulfil a regulatory role? For the time being, it would appear that the (national) authorities had best remained an interested party, if only for strategic and safety reasons, and to prevent that monopolies are abused by port authorities, terminal operators or dock workers. Goss[7] asserts in this respect that “the conclusion must be that there are likely to be many instances of ‘market failure’ in seaports, e.g. in the processes of planning, controlling externalities and promoting competition if these were left wholy to the private sector: but there are also many opportunities for ‘government failure’, whether in port authorities or in other official bodies, including government departments supervising the port authorities”.

In a fiercely competitive market such as the port business, the role of government may however continue to be hotly debated. Indeed, it may be the source of continual mutual accusations of

distortion of competition. Can a European port policy resolve this issue? Is Europe able to take due account of existing differences between its ports?[8]

One of the most important points of debate remains whether port infrastructure, particularly maritime access routes to ports, has the nature of public goods. These are defined as goods that would, in all probability, not be produced in a satisfactory manner and in sufficient amounts, if at all, by a competitive industry. It concerns goods for common or non-rivalrous consumption, whereby it is impossible to exclude those who cannot pay.

Goss[9] was quite clear on this matter when he asserted that: “non-rivalrous consumption occurs with all beacons, buoys and other fixed or floating navigational aids because their cost will be exactly the same no matter how many people are using them. The same is true of dredged entrance channels up to the point where they are congested. If the opportunity cost of using any of these is zero, then imposing any specific charge would have the effect of deterring the marginal user and reducing economic welfare.”

The kind of port infrastructure referred to has two important characteristics: the indivisibility of the enormous investments involved and their great longevity. No private company is assured of a sufficient return over such long periods of time. The amount of infrastructure provided would therefore lie below the optimum if such investments were left to the private sector. However, one can wonder whether the discussion about the public goods nature of maritime entrance is not outdated in an era of remote transhipment centres with natural deep-water sites.

It is apparent from the foregoing that theory and practice of port management have evolved quite dramatically. The role of government, and particularly the issue of government support, remains a point of considerable controversy.

3. The Radically Changed Port Environment

Until the 1990s, players in the port business acted very much as independent entities. Shipping companies competed for the same goods flows. Port authorities presented themselves as mainports, both to each other and to the market as a whole. Fierce competition unfolded between goods handlers operating within the same port. The hinterland modes (i.e. rail, road, inland navigation) were preoccupied with maximising their market shares.

Then a new trend emerged, as competition was unfolding increasingly at the level of logistics chains, in which port authorities, transhipment companies and the hinterland modes are the most important links. Those players who are able to contribute to the lowest generalised cost of the transport chain are most likely to be included. This also means that systematic mutual trade-offs are made between links in the transport chain. Consequently, it may still be the case that serving an inland port (e.g. Antwerp and Hamburg) is more expensive per tonne shipped, but that this higher cost is compensated for by cheaper hinterland transportation.[10]

This new market structure as such provides an incentive for establishing cooperation agreements and strategic alliances. Theoretically, the market players should after all benefit from gaining control of as large as possible a share of the logistics chain, be it for competitive purposes or for other reasons (e.g. stability).

Table 1 provides an overview of the cooperation agreements that exist within the maritime and port sectors. We shall restrict ourselves to the main actors (shipping companies, port authorities, terminal

operators, hinterland transport modes).

A detailed analysis of Table 1 shows that shipping companies in particular have been taking initiatives in this respect, forging forms of partnership with each other as well as with other market players. The mutual forms of cooperation are mostly cartels of various description, but takeovers and mergers have also occurred. Through these arrangements, the shipping companies hope to increase their degree of control over the total logistics chain. By means of price agreements, they also attempt to gain control over hinterland transportation and, as the case may be, goods handling. Consider the following examples.

In 1992, the North Atlantic route was marked by a considerable surplus loading capacity in liner shipping. This led to sharp losses for shipping companies, even though there were conferences where two or more shipping companies contributed vessels and shared loading space.

The shipping companies' response came in 1992 in the shape of the Transatlantic Agreement (TAA), which became operational in 1993. With this cartel, the main shipping companies intended to acquire greater control over the seriously loss making North Atlantic shipping market by jointly determining rates, capacity supplied and the transport conditions. The consequences were clear to see: over 80% of the market was controlled in this manner, and, partly because of a shrinking capacity, rates increased sharply (by between 30 and 50% in some years).

Consignors responded fiercely, as they suddenly found it much harder to obtain loading space and were now unable to negotiate directly with shipping companies. They demanded a sufficient degree of competition, coupled with free supply and demand and the possibility of negotiating with companies separately. As the Treaty of Rome prohibits cartelisation, the TAA was outlawed because of its manipulation of tariffs, the capacity policy pursued and the fact that cartel agreements also applied to pre-carriage and on-carriage.

It speaks for itself that these kinds of cartel agreements were regarded suspiciously by ports. The possibility of higher prices may, after all, result in less maritime transport (and thus in a decline in port throughput).

A similar reasoning is followed by ports in the case of mergers, as reorganisations and cost saving often result in fewer, but larger and stronger port users. This is illustrated

Table 1: Cooperation agreements between various market players

Market players	Shipping companies	Terminal operating companies	Hinterland transport	Port authorities
Shipping companies	⇒ Vessel sharing agreements ⇒ Joint ventures ⇒ Conferences ⇒ Consortia ⇒ Alliances (e.g. Grand Alliance) ⇒ Cartel agreements ⇒ Mergers/acquisitions			
Terminal operating companies	⇒ Financial stake of shipping company in stevedore (e.g. Tanger Med Gate) ⇒ Joint ventures (e.g. CHKY Alliance carriers and ECT at Rotterdam Euromax ⇒ Dedicated terminals (e.g. MSC at Antwerp Delwaidedock)	⇒ Mergers/acquisitions (e.g. Hutchison Whampoa in ECT, PSA in Voltri Genova) ⇒ Joint ventures (e.g. Baltic Container Terminal)		
Hinterland-transport modes	⇒ Block trains and capacity sharing (e.g. NYK between Rotterdam and Duisburg) ⇒ Acquisitions (e.g. Maersk acquired Roadways in UK)	⇒ Joint ventures (e.g. ECT in Duisburg)	⇒ Takeover strategy of railway companies (e.g. DB and NS cargo)	
Port authorities	⇒ Concessions for dedicated terminals (e.g. APM Terminals at Lazaro Cardenas)	⇒ Joint ventures (e.g. Ningbo Beilun Port)	⇒ Antwerp in Rhine shipping terminal of Germersheim	⇒ Alliances (e.g. Port of Rotterdam and Humber Trade Zone)

Source: Based on Heaver, Meersman, Moglia and Van de Voorde[11]

quite well by the merger in 1996 of the container liners P&O and Nedlloyd into P&O Nedlloyd Container Line. After the merger, the company had a fleet at his disposal of 112 vessels which it either owned or chartered, for 540,000 TEU containers and a turnover of USD 4 billion. Also, the merger implied that the company would be the same size as its main competitors (including Maersk, Evergreen, Sealand). This was achieved through cost saving and scale increases. Not taking into account the one-off restructuring costs, the annual cost saving was estimated at approximately USD 200 million, which amounted to about 5% of the total cost of container operations. In meantime P&O Nedlloyd has been integrated into Maersk.

Within the port perimeter, the competitive struggle between terminal operators, for example, has evolved in different directions. A first possibility was that existing competition was retained, resulting in a combination of low profit margins and large volumes. Another possibility was an evolution towards a single operator, as clients were growing increasingly large and handlers needed to increase the scale of operations accordingly. Scale increases among goods handlers is necessary in order to be considered as a fully-fledged partner by shipping companies. This is ultimately what happened in Antwerp in 2002, first with a merger between the two largest stevedores, Hessenatie and Noordnatie, into HesseNoordnatie, followed by a move in which 80% of the capital stock was taken over by Port of Singapore Authority (PSA). Thus, terminal operating companies also became subject to attempts at integration.

The above examples illustrate two important trends. First, there is a clear trend towards increasing the scale of operations by mergers, cartels and other cooperation agreements. At the same time, efforts are made to obtain greater control over larger parts of the logistics chain. Shipping companies in particular took the initiative in this respect, but other market players soon followed suit.

What is the intended purpose of such forms of cooperation? Is it connected with the market

structure (i.e. is it aimed at realising economies of scale or acquiring market power)? Is it aimed at management efficiency? Or do tax considerations come into play? Table 2 provides an overview of possible objectives and the tools used by the various market players for achieving these goals, as well as the possible consequences.

In the case of mergers between such companies as P&O and Nedlloyd, the most obvious motivation is achieving economies of scale. By merging, one intends to become an equally large market player as the main competitors and, at the same time, one aims at spreading the relatively high fixed costs over a more substantial output. However, Cowling *et al.*[13] already observed that economies of scale are often only achieved "through an active programme of rationalisation and investment by which the constituent of scale and scope were moulded into a new entity". Be that as it may, if realising economies of scale and scope is the reason for merging, it often takes a long time before this objective is achieved.

Another rational objective besides the realisation of economies of scale may be the acquisition of greater market power, perhaps even market dominance. By merging and cooperating, players may intend to obtain control over a greater share of industrial and commercial activities.

A further objective may be to increase efficiency. In order to ascertain whether or not this is the case, one would need to test whether the initiating party is more efficient than the party that is approached and whether merging is a profit-generating activity. There may also be tax benefits to take into account, in the sense that merging can, in the first instance, sometimes have the effect of reducing the aggregate tax basis.

Table 2: Objectives, tools and impact

Market players	(Possible) Objectives	Tools	Impact
Shipping companies	⇒ Profit maximisation ⇒ Market share ⇒ Control over logistics chain	⇒ Tariff ⇒ Cost control (capacity, volume, time, cooperation, ...) ⇒ Marketing ⇒ Service	⇒ Larger vessels ⇒ Rationalisation of sailing schedules ⇒ Alliances and consortia ⇒ Dedicated terminals
Stevedores	⇒ Profit maximisation ⇒ Long term customer loyalty, incl. through logistic services and value-added activities (e.g. stuffing and stripping, storage, pre-delivery inspection, ...)	⇒ Price setting ⇒ Technology of goods handling aimed at speed, quality, ...	⇒ Returns to scale for terminals ⇒ Industrial logistics
Hinterland transport modes	⇒ Profit maximisation ⇒ Market share	⇒ Tariffs ⇒ Speed ⇒ Flexibility ⇒ Capacity	⇒ Fierce modal competition
Port authorities	⇒ Contribution to cost minimisation for logistics chain (both through port dues and time costs) ⇒ Maximisation cargo handling (public company) ⇒ Maximisation of profit (private company)	⇒ Maritime access ⇒ Land and concession policy (cf. Reserve capacity of land) ⇒ Socio-economic negotiations ⇒ Price setting	⇒ Further information maritime access ⇒ Guaranteeing of social and economic stability ⇒ Industrial structure (cf. concession policy)
Shipping agents	⇒ Profit maximisation ⇒ Customer loyalty ⇒ Diversification (e.g. order picking, warehouses, ...)	⇒ Tariffs ⇒ Service	⇒ All-in-one price for door to door transport ⇒ Strong dependency (in both directions)
Owner of goods	⇒ Minimisation of total generalised logistics costs (incl. time cost)	⇒ Negotiating power (dependent on size)	⇒ Scale increase (positive impact on negotiating position ⇒ Greater volatility

Source: Heaver, Meersman, Moglia and Van de Voorde[12]

Finally, merging may also be regarded as a tool for achieving market entry, sometimes internationally, so that in a sense it stimulates competition. On the other hand, competition may be reduced or even replaced with a monopoly.

Now that we have identified a number of possible goals, the question arises: what are the possible consequences? Note that quite a few of the cooperation agreements presented in Table 1 have a direct impact on the internal functioning of the seaports and on the competition between ports.

Consider the example of a collaboration leading to the establishment of dedicated terminals. Obviously, other shipping companies will not be inclined to have cargo handled at terminals that are operated by potential competitors. In other words, such dedicated terminals may result in a diversion of freight traffic. So while a port authority may have intended to improve its competitive position by providing new transhipment infrastructure, the net result in terms of throughput may in fact be negative. Moreover, the port authority in question also runs the risk that future traffic evolutions may become dependent upon the competitiveness and strategy of a limited number of shipping companies that are tied to terminal operators. The success of a port, then, may eventually be determined by the competitiveness of the shipping companies concerned.

Vertical cooperation agreements aimed at obtaining control over a larger share of the logistics chain may also have an impact on port throughput. Productive ports, with low terminal handling costs and/or good hinterland connections, are at risk of being shunned as a port of call if they do not fit into the strategy of the group controlling the logistics chain. Cross-subsidising may also play a role in this respect.

In the past, there has always been relatively strong internal competition between transhipment companies in the Hamburg–Le Havre range. However, vertical mergers of logistics firms or horizontal mergers of, for example, terminal operating companies may destroy this historical advantage. After all, cooperation can have the effect of suppressing competition. Indeed, this argument has often been used to justify government regulation. Stead[14] asserts in this respect that many studies "include the assumption that not only is monopoly power itself socially undesirable but so too are resources spent on competition to acquire or maintain a dominant monopolistic position".

It would appear to be advisable in the relatively short term to conduct theoretical and empirical research on the possible consequences of cooperation agreements. Relevant research questions are:

1. How do market players in the logistics chain (shipping companies, transhipment t companies…) operate within different market structures? What is the relationship between company size and profitability on the one hand and the likely effects in terms of market concentration, market power and efficiency on the other? To what extent does government influence industrial organisation?
2. What is the strategic behaviour of the above-mentioned market players? To what extent is greater efficiency related to a lower production unit cost coupled with returns to scale and greater market power through collusion on the part of certain companies in order to keep prices high?
3. To what extent can other forms of alliances (e.g. licensing and cross-licensing, subcontracting …) be established that imply less commitment, control and mutual dependency?
4. What is the relationship between market control stemming from alliances and mergers on the one hand and pricing behaviour on the other? The existence of an oligopoly or a high level of concentration with one dominant company can result in different types of pricing mechanism: price leadership, price discrimination, limit pricing, collusion, predatory pricing …

Until empirical research proves otherwise, we may assume that the unique market structure in the maritime and port business does not exist. Nonetheless, certain developments are quite clear to see, e.g. the role of government in the discernible trend towards acquiring greater control over (a larger share of) the logistics chain.

4. Management in a Growth Environment

Until now world ports operated in a growth environment. This also holds for the principal ports in the Hamburg–Le Havre range. However, growth presupposes adequate capacity and the absence of bottlenecks that may cause congestion. The accumulation of sufficient capacity in turn demands correct decision making. In the past, one could count on unbridled government intervention, often resulting in excess capacity. This, however, is no longer the case. Today, ports bear responsibility for their own investment decisions.

From a long-term perspective, ports will be inclined to make sure that the available capacity does not present a limit to their growth potential. In order to be able to ascertain whether or not this is the case, one needs a constant supply of reliable forecasts of future goods flows[15]. However, predictions used by port authorities often consist merely in trend extrapolations of, among other things, throughput within a range under the assumption of a constant market share. If one takes general traffic forecasts as a starting point, it is equally important to acquire adequate insight into the factors determining this market share. Only on the basis of this knowledge can one arrive at correct decisions about whether or not extension of capacity is called for.

Modelling of port throughput, however, is complicated and, thus far, not always equally transparent. It requires a scientifically well-founded set of tools that allows one to simulate the consequences of policy measures and exogenous influences on the continuous struggle for goods flows and related activities (port transhipment, warehousing, distribution).

Although some general trends in the evolution of the world economy and maritime trade can be recognised, there remains a lot of uncertainty on a number of factors such as the speed of globalisation, the trade policies of the major economic blocks, the role of the emerging economies, the persistence of trade imbalances, the evolution of oil prices, the role of the public sector, etc. These factors will have an impact on the magnitude and direction of the trade flows of the different commodities. Therefore forecasts of maritime traffic and port activity should incorporate in one way or another the uncertainties the world economy is facing.

One way to handle the uncertainties when forecasting maritime traffic and port activity, is the use of scenarios as is done for example by the Dutch government for its long-term projections. The forecasts are based on four scenarios with plausible future developments for Europe and are described in detail in de Mooij and Tang.[16] They bring together two groups of uncertainties the European and the world economy might face. The first concerns international cooperation: to what extent are nation states willing and able to cooperate within international organisations like the WTO and the European Union? The second key uncertainty concerns national institutions: to what extent will the mix of public and private responsibilities change?

Table 3: Trade and GDP projections for four scenarios for Europe

	Strong Europe	Global economy	Transatlantic market	Regional communities
World trade	4.5%	5.6%	3.7%	2.4%
World GDP	2.5%	3.1%	2.3%	1.7%
Non-OECD GDP	4.6%	5.0%	3.2%	3.6%
EU15 GDP	1.6%	2.5%	1.9%	0.6%

Source: Levinga, Rozemeijer and Francke[18]

The scenarios are quantified using WorldScan, a computable general-equilibrium model for the world economy developed at CPB (Lejour[17]) to give among others the projections of world trade and economic growth of Table 3.

Starting from the trade flows, projections are made for freight flows to and from the Netherlands for different transport modes and for port throughput. Figure 1 gives for the four scenarios the Dutch port throughput projections for 2020 and 2040 split into containers and other traffic. The average annual growth over the period 2002–2020 of container throughput varies between 3.5% and 6.9%. For the period 2021–2040 it varies between 0.8% and 4.6%. In the Regional Communities scenario total port throughput in 2040 is even somewhat lower than in 2002. In the case of Global Economies however, the throughput in 2040 is projected to be nearly the threefold of the quantity of 2002. This clearly illustrates the importance of considering a number of scenarios to forecast maritime and port traffic.

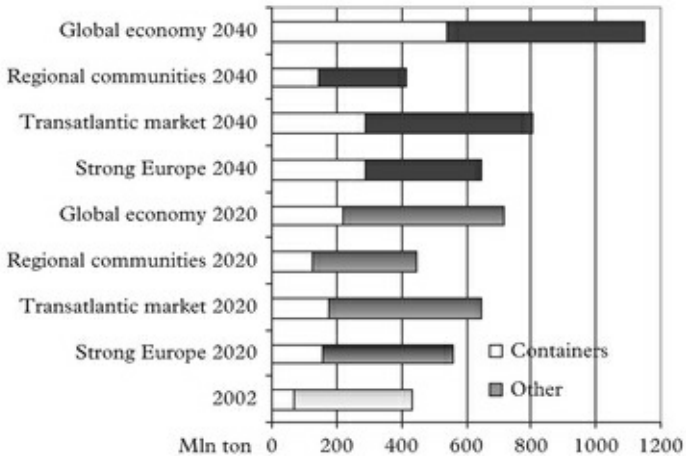

Figure 1: Port throughput projections for the Netherlands for four scenarios (2020 and 2040)
Source: Besseling, Francke and Saitua Nistal[19]

Both port management and companies located in ports require a set of tools that can help them resolve part of the uncertainty that exists in a rapidly changing environment. However, while demand forecasts based on (economic) models can provide a useful indication, they cannot explain reality in its entirety. Thus, additional explanations need to be sought, e.g. at the supply side and in cost analysis. This brings us back to such factors as available capacity, capacity utilisation, and productivity. It is after all quite clear that performance, yield and productivity of a port cannot be determined on the basis of a single measure. On the one hand, there is the complexity of port operations, while on the other there are interactions between various relevant factors (e.g. vessel configuration, shifts of workers, depth of quay walls, type of loading and unloading equipment, etc).

The above material may constitute a useful framework for further exploration of this topic. When considering potential traffic, for example, one needs to take into account the strategic behaviour of the various market players involved, including consignors of goods and transport firms. As regards the

competitive environment of ports, further attention should be paid to the choice of hinterland mode. With respect to further empirical research, a concerted effort is required to develop more and qualitatively more adequate databases.

5. Surviving in a Competitive Environment

Throughout this contribution, we have emphasised the importance of port competition and competitiveness. Indeed, most ports are engaged in a tough competitive struggle, not only for tonnage and volume, but also for shipping lines and investment in infrastructure and industry.

This explains why more and more attention is being paid in the European transport debate to the issue of port competition. Distortion, some would say "falsification", of conditions of competition between and within ports has become an important issue on the political agenda. The debate revolves around, among other things, the granting of concessions within ports (e.g. dedicated or other container terminals), traffic diversion between ports (e.g. Antwerp v Rotterdam), (illicit) subsidising of investments in port infrastructure (Rotterdam v Antwerp) and hinterland connections (e.g. the rail connections known as "Betuwe Line" and the "Iron Rhine", Antwerp v Rotterdam).

In terms of tonnage, value added or employment, the European port picture is quite clear: a strong concentration of activity in a limited number of ports in the Hamburg–Le Havre range, less so in the Baltic range, and a rapidly emerging Mediterranean range (e.g. considerable investments in container capacity at Giao Tauro, Taranto and Cagliari). This situation is connected not only with structural aspects (e.g. geographical location), but also with differences in terms of costs, productivity (and speed) and technologies applied.

In the literature, one still often refers to Verhoeff's definition of port competition.[20] He distinguishes between four levels of seaport competition: competition between port undertakings; competition between ports; competition between port clusters (i.e. a group of ports in each other's vicinity with common geographical characteristics); competition between ranges (i.e. ports located along the same coastline or with a largely identical hinterland).

The factors influencing competition may vary from level to level. The competitive strength of individual undertakings within a port is determined mainly by the factors of production (labour, capital, technology, and power). Competition between ports, port clusters and port ranges on the other hand is also affected by regional factors, such as the geographical location, the available infrastructure, the degree of industrialisation, government policy, the standard of performance of the port (measured in terms of proxy variables, such as the number and frequency of liner services, and the cost of transhipment, storage and hinterland transportation).

As we have already pointed out, this traditional approach to port competition must now make way for an approach based on competition between logistics chains, in which seaports (and seaport undertakings) are merely links. As the most important consideration is the overall cost of the transport chain, it is inevitable that, besides throughput, the industrial and commercial functions (including warehousing and distribution of goods) as well as hinterland transportation will come to occupy an increasingly important position.

A port and the undertakings established in it compete directly with a limited number of other ports, usually within the same range. There are few types of goods flows for which ports belonging to different ranges might compete directly (e.g. in the fixing of shipping schedules and in determining

ports of call). Consequently, the crucial question in port competition is what determines the choice of port? In other words, why is one port preferred to another? Why are certain undertakings located in that port chosen? What are the preferred hinterland transport modes and routes?

Port users think predominantly in financial and economic terms. Frankel[21] asserts in this respect that "they consider the net revenue contribution of a port call which is usually defined as the difference between the added revenue generated by the port call minus the costs of making the port call". Costs are understood to include all possible items: vessel-related costs (e.g. the time factor, taking into account possible delays), port-related costs (port dues, pilotage …), cargo-handling costs, cargo-storage costs, feeder costs.

Thus, the objective for management, be it of the port or of the undertakings concerned, is clear to see: to minimise the cost of terminal handling and delay of vessels. For that matter, the principle of cost minimisation applies to all links in the transport chain, in the sense that the ultimate goal must be to arrive at the lowest possible cost for the chain as a whole.

The port that contributes to the cheapest logistics chain is, in theory at least, most likely to be called at. The ultimate decision process of the port user would appear, then, to be a matter of common sense: does the port considered offer advantages compared to other ports serving the same hinterland? Does the port offer sufficient advantages in order to be considered as an additional port of call for an existing or yet-to-be-established liner or indeed feeder service? The decision process of the port user concerns the transport chain, but he will also have to take due account of market factors (e.g. potential customers, competition from other shipping lines and consignors of goods …).

It is important for a port authority to know who that port user is, who makes the choice of port and which factors influence this choice. However, the term "port user" covers quite a heterogeneous group that includes shipping companies, consignors of goods, owners of goods, goods handlers, … It is a group whose members would appear to depend on one another, but who are nevertheless often engaged in a fierce competitive struggle. Consequently, it is not always easy to determine who ultimately makes the choice of port. In addition, there is the question of which (cost) variables are most significant in the decision process (cf. the problem of factor assessment). In this respect, one needs to realise that the cost structure is determined by both exogenous factors (e.g. scale increases in world trade, or rapidly developing cargo-handling equipment) and endogenous factors within the port's direct sphere of influence.

Port competition has been the subject of much interdisciplinary research.[22] After all, the competitive position of a port is determined by strategic and legal factors besides purely economic variables. Research has shown that, in the case of the port of Antwerp, political and legal considerations rather than purely economic or geographical determinants are perceived as factors that may influence the position of the port negatively. Indeed, if a port has a fundamental weakness, this is often occasioned by a lack of clarity in terms of administrative responsibility. This lack of clarity may, for example, relate to who is the competent legislator and/or executor of an infrastructure project, and who is responsible for necessary amendments of existing legislation.[23,24]

A study by Huybrechts *et al.*[25] has shown that there is also an urgent need for a broader knowledge base with regard to the competitive environment in which individual ports, port clusters or port ranges operate. Research to this end should preferably be multidisciplinary in nature, grounded on a sound

theoretical basis, but taking an empirical approach. In order to make such research possible, qualitatively more adequate databases are an absolute necessity. Sound scientific research into the maritime business environment requires model-based simulations of various goods flows, transported to and from different ports, in different batch sizes and at various times. The knowledge that is thus acquired may contribute to a better understanding of, and more adequate response to, factors that influence port competition and competitiveness. Or, as is suggested by the title of this section, it may provide insight into the question of how best to survive in a competitive environment.

6. Conclusions

In this contribution, we have discussed the relationship between port management and operations by that management on the one hand and port competition on the other. All are agreed that the port landscape has changed very rapidly, partly as a consequence of ever-growing port competition at different levels.

In most ports, port management has found it hard (to continue) to keep up with the pace of change. Furthermore, an important aspect of the legitimacy of a separate port management is being undermined, namely the previously often heard argument of the strategic significance of seaports to the economy of a country or region.

There is clearly a connection between port management and the manner in which players compete within or between ports. Each port management is preoccupied with protecting and/or improving its competitive position in a fierce struggle with any party that is considered a potential threat. The question arises what are the remaining tools and degrees of freedom? In the first instance, one can help prepare and outline strategies in relation to additional port infrastructure. However, financially and legally, one is still dependent upon government. Furthermore, there is the aspect of granting concessions for dedicated or other terminals. Here one encounters increasingly strong opponents, i.e. ever more powerful shipping companies (and the alliances to which they may belong).

The question is therefore: what next? Will the role of port management be restricted to correctly enforcing regulation (e.g. with respect to “Port State Control”)? Or will port management be tempted to actively participate as a market player, by acquiring a stake in terminal operating companies? If one does enter into the market, there is the danger that conflicts of interest may arise and that the port community may, quite rightly, no longer consider the port management as a neutral regulator.

The present race for new port infrastructure and additional capacity suggests that port competition will become even greater in the near future. At the same time, the role and indeed the raison d’être of port management would appear to be becoming even more uncertain. Clearly, then, here lies largely unexplored territory for multidisciplinary research with a solid scientific basis but with empirical implementation and verification.

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Endnotes

1. Suykens, F. and Van de Voorde, E. (1998): “A quarter of a century of port management in

Europe: objectives and tools," *Maritime Policy & Management*, 25(3), 251–261.
2. Meersman, H., Van de Voorde, E. and Vanelslander T. (eds.) (2009): *Future Challenges for the Port and Shipping Sector (*London, Informa).
3. Haralambides, H., Ma, S. and Veenstra, A. (1997): "World-wide experiences of port reform", in H. Meersman and E. Van de Voorde (eds.) *Transforming the Port and Transportation Business* (Leuven/Amersfoort, Acco) p. 120.
4. Suykens, F. and Van de Voorde, E. (1998): "A quarter of a century of port management in Europe: objectives and tools", *Maritime Policy & Management*, 25(3), 255.
5. Suykens, F. (1986): "Ports should be efficient (even when this means that some of them are subsidized)", *Maritime Policy & Management*, 13(2), 120.
6. De Monie, G. (1996): "Privatization of port structures", in L. Bekemans and S. Beckwith (eds.) *Ports for Europe: Europe's Maritime Future in a Changing Environment* (Brussels, European Interuniversity Press) pp. 267–298.
7. Goss, R. (1990): "Economic policies and seaports: 3. Are port authorities necessary?", *Maritime Policy & Management*, 17(4), 269.
8. Pallis, A.A. (1997): "Towards a common ports policy? EU-proposals and the ports industry's perceptions", *Maritime Policy & Management*, 24(4), 375.
9. Goss, R. (1990): "Economic policies and seaports: 3. Are port authorities necessary?", *Maritime Policy & Management*, 17(4), 262.
10. Suykens, F. and Van de Voorde, E. (1992): "Het belang van de haven voor de uit-straling van Antwerpen. Of: een continu gevecht voor competitiviteit en marktaandelen", *Economisch en Sociaal Tijdschrift*, 46(3), 487.
11. Heaver, T., Meersman, H., Moglia, F. and Van de Voorde, E. (2000): "Do mergers and alliances influence European shipping and port competition?", *Maritime Policy & Management*, 27(4), 365.
12. Heaver, T., Meersman, H., Moglia, F. and Van de voorde, E. (2000): "Do mergers and alliances influence European shipping and port competition?", *Maritime Policy & Management*, 27(4), 368.
13. Cowling, K., Stoneman, P., Cubbing, J., Cable, J., Hall, G., Comberger, S. and Dutton, P. (1980): *Mergers and Economic Performance* (Cambridge, Cambridge University Press).
14. Stead, R., Curwen, P. and Lawler, K. (1996): *Industrial Economics. Theory, Applications and Policy* (London, McGraw-Hill).
15. Meersman, H., Moglia, F. and Van de Voorde, E. (2002): "Forecasting potential throughput", in Huybrechts, M., Meersman, H., Van de Voorde, E., Van Hooydonk, E., Verbeke, A. and Winkelmans, W. (eds.) *Port Competitiveness. An Economic and Legal Analysis of the Factors Determining the Competitiveness of Seaports* (Antwerp, Editions De Boeck Ltd) p. 35.
16. De Mooij, R. and Tang, P. (2003): *Four Futures of Europe* (The Hague, CPB Netherlands Bureau for Economic Policy Analysis).
17. Lejour, A. (2003): *Quantifying Four Scenarios for Europe*, CPB-document, (The Hague, CPB Netherlands Bureau for Economic Policy Analysis).
18. Levinga, E.A.R., Rozemeijer, S.P.J., and Francke, J.M. (2006): *Perspectief op logistiek* (The

Hague, Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, Adviesdienst Verkeer & Vervoer), p. 24.

19. Besseling, P., Francke, J. and R. Saitua Nistal (2006): *Aanpassing WLO scenario's voor het containervervoer*. CPB Memorandum (The Hague, CPB Netherlands Bureau for Economic Policy Analysis), p. 6.

20. Verhoeff, J.M. (1981): "Zeehavenconcurrentie: overheidsproduktie van haven-diensten", in *Vervoers- en haveneconomie: tussen actie en abstractie* (Leiden, Stenfert Kroese) pp. 181–202.

21. Frankel, E.G. (1991): "Port performance and productivity measurement", *Ports and Harbors*, 11–13.

22. Huybrechts, M., Meersman, H., Van de Voorde, E., Van Hooydonk, E., Verbeke, A. and Winkelmans, W. (eds.) (2002): *Port Competitiveness. An Economic and Legal Analysis of the Factors Determining the Competitiveness of Seaports* (Antwerp, Editions De Boeck Ltd).

23. Van de Voorde, E. and Winkelmans, W. (2002): "Conclusions and policy implications", in Huybrechts, M., Meersman, H., Van de Voorde, E., Van Hooydonk, E., Verbeke, A. and Winkelmans, W. (eds.) *Port Competitiveness. An Economic and Legal Analysis of the Factors Determining the Competitiveness of Seaports* (Antwerp, Editions De Boeck Ltd) p. 138.

24. Van Hooydonk, E. (2002): "Legal aspects of port competition", in Huybrechts, M., Meersman, H., Van de Voorde, E., Van Hooydonk, E., Verbeke, A. and Winkelmans, W. (eds.) *Port Competitiveness. An Economic and Legal Analysis of the Factors Determining the Competitiveness of Seaports* (Antwerp, Editions De Boeck Ltd) pp. 89–131.

25. Huybrechts, M., Meersman, H., Van de Voorde, E., Van Hooydonk, E., Verbeke, A. and Winkelmans, W. (eds.) (2002): *op. cit*.

Chapter 31

Revisiting the Productivity and Efficiency of Ports and Terminals: Methods and Applications

Kevin Cullinane[*]

1. Introduction

Over the past decade, there has been a proliferation of research which investigates the efficiency of ports and terminals. Given the increasing prominence of container shipping within the maritime sector and the relative ease of analysis in situations where unit cargoes are standardised, it is not surprising that the majority of this work has been applied to the container port sector. It is also justified by the fact that container ports form a vital link in the supply chains of trading companies and nations worldwide. In terms of the logistics cost which they account for within any given supply chain, the level of a container port's performance and/or relative efficiency will, to a large extent, determine the competitiveness of a nation and can ultimately have an influence upon industrial location decisions and the benefits derived from the economic policies of national governments. Thus, although productivity and/or efficiency analyses can provide a powerful management tool for port operators, they can also constitute a most important input to studies aimed at informing regional and national port planning and operation.

It is unfortunate, therefore that, in everyday use, the terms "productivity" and "efficiency" are used interchangeably. As a result, the precise meanings of the two terms have become blurred and indistinct. In the ensuing discussion of port and terminal productivity and efficiency, however, it is important to distinguish between them.

Productivity can very simply be defined as the ratio of outputs over inputs. This yields an absolute measure of performance that may be applied to all factors of production (inputs) simultaneously (as well as to all outputs) or to merely an individual factor of production. In this latter case, the outcome of such a calculation is more correctly referred to as a *partial productivity* measure. As is shown in the review contained in section 2 of this chapter, most historic analyses of port performance involved the calculation of partial productivity measures across a range of ports and/or terminals and the comparison of such calculated measures. Since the publication of the first edition of this handbook,[1] however, there has been a veritable explosion in the number of applications utilising the two main contemporary methods for the measurement of *technical* o r *productive efficiency*. These more rigorous, holistic and scientific methodologies are introduced and described in detail in sections 4, 5 and 6 of this Chapter. Sections 5 and 6 also contain reviews of the major applications of each of these methods to the derivation of technical efficiency measures in the container port and/or terminal sector. Prior to that, in section 3 of this chapter, the theory underpinning the study of economic efficiency is presented.

2. Lessons Learned from Traditional Port Performance and Productivity Studies

The measurement of port efficiency is complicated by the large variety of factors that influence port

performance.[2] The most obvious influences can be generalised as the economic input factor endowments of land, labour and capital. Dowd and Leschine[3] argue, in fact, that port and/or terminal productivity measurement is a means of quantifying efficiency in the utilisation of these three resources. However, there are other influences that are not so easily classified, nor indeed even capable of being quantified, for the purpose of empirical investigation. A few examples of these influences include: the level of technology that is utilised in the operations of a port or terminal; the industrial relations environment within the port or terminal (and, hence, the risk of disruptions to the supply of labour); the extent of co-operation or integration with shipping lines and, as analysed in Cullinane and Song,[4] the nature of the ownership of the port and the impact that this may have on the way that the port is managed and/or operated.

Despite these difficulties, attempts at estimating port or terminal productivity have been legion. This is particularly the case in container handling where, as might be imputed from the plethora of studies that focus on this sector, the need for high productivity or high efficiency levels is probably greater than in port facilities that concentrate on serving other forms of shipping.

Traditionally, the performance of ports has been variously evaluated by calculating cargo-handling productivity at berth (e.g.[5–7]), by measuring a single factor productivity (e.g. labour as in the case of[8–10]) or by comparing actual with optimum throughput for a specific period of time (e.g.[11]).

Dowd and Leschine[12] approached the issue specifically in relation to container terminal productivity and highlight the fact that, probably because of the standard nature of the cargo that is handled in such facilities, there is an incessant demand in the industry for some form of universal standards or benchmarks for container terminal productivity. For the better terminals, there are obvious marketing advantages to be had from this. One major stumbling block in seeking to achieve such a standard is the lack of uniformity in productivity measurement across the sector. By way of exemplifying this, while some terminals will count rehandles and hatchcover removals as “moves”, others do not.

A second problem exists in that each participating player has a different interest in port or terminal productivity. For the port or terminal itself, the main goal may be to reduce the cost per unit of cargo handled and, thereby, raise profitability. For the port authority, the main goal may be to maximise the throughput per unit area of land that it leases to the terminal operator, so as to maximise the benefits derived from the investments it makes. For the carrier, the goal may be to minimise the time that a ship spends in port.

In an effort to provide a more rigorous and holistic evaluation of port performance, several alternative methods have been suggested, such as the estimation of a port cost function,[13] the estimation of a total factor productivity index of a port[14] and the establishment of a port performance and efficiency model using multiple regression analysis.[15]

Chang [16] appears to have made one of the earliest efforts to estimate a production function and the productivities of inputs within the port sector. This was done for the port of Mobile in the US. In attempting to derive a port production function, the author focuses on general cargo-handling volume as a measurement of port performance and assumes that port operations follow the conventional Cobb-Douglas case as expressed by:

$$Y = AK^{\alpha}L^{\beta}e^{\gamma(T/L)}$$

where
Y = annual gross earnings (in real terms)
K = the real value of net assets in the port
L = the number of labourers per year and the average number of employees per month each year
$e^{\gamma(T/L)}$ a proxy for technological improvement in which (T/L) shows the tonnage per unit of labour.
The author argues that, for the estimation of a production function of this form, the output of a port should be measured in terms of *either* total tonnage handled at the port *or* its gross earnings.

De Neufville and Tsunokawa[17] undertook an analysis of the five major container ports on the east coast of the US and derived an estimate of a container port production possibility frontier on the basis of the panel data collected. They deduced that Hampton Roads and Baltimore were consistently operating inefficiently during the period 1970–1978 and attributed this to poor management as the root cause. The findings highlight the importance of economies of scale in port/terminal productivity and, as such, the authors conclude that, because of the economic returns to be reaped, policy makers should promote and place greater investment into large load centre ports, rather than into the proliferation of smaller, more regionally focussed port developments.

Suykens[18] points out that the measurement of productivity and subsequent comparison between ports is extremely difficult. Quite often, this is due simply to differences in the geophysical characteristics of the ports to be compared. For instance, there will be fundamental constraints on the productivity of ports where locks are needed, or which are located up river estuaries or in the middle of a port town as opposed to at a greenfield location. Difficulties also arise where the type of cargo handled at the comparison ports differ or when one port is primarily serving its own hinterland and another is primarily a transhipment port. Under all these scenarios, it would be fundamentally unfair and possibly misleading to make productivity comparisons on a straightforward basis. It may be argued, therefore, that in order to properly evaluate the performance of a port, it is important and necessary to place it within a proper perspective by drawing comparisons with other ports that operate in a similar environment.

Tongzon and Ganesalingam[19] applied cluster analysis to compare the port performance and efficiency of ASEAN ports with counterparts overseas. The rationale for this analysis lay primarily with a purported requirement for such a comparison to be conducted only amongst ports that are similar in terms of their management or operational environment. The results suggested that the ASEAN ports, especially Singapore, were more technically efficient in terms of the utilisation of cranes, berths and storage areas, but that they were generally less efficient in terms of timeliness, labour and tug utilisation. In addition, it was deduced that port charges in ASEAN ports were significantly higher than those of their overseas counterparts falling within the same cluster (i.e. comparable ports).

Tongzon[20] elaborated upon this benchmarking concept by utilising an approach based on principal components analysis for the identification of suitable benchmark ports. Ashar[21] is critical of this approach. In particular, the need for such an analysis to be conducted at the level of the terminal is highlighted by reference to the fact that several of the ports included in Tongzon's sample were, in fact, landlord ports (as defined in[22]).

Sanchez *et al.*[23] also apply principal components analysis to generate different port efficiency

measures based on data from a survey of Latin American common user ports. These efficiency estimates are then incorporated as one of the explanatory variables in the estimation of a model of waterborne transport costs. Their analysis reveals that port efficiency, liner shipping calls, distance and value of goods are all significant determinants of waterborne transport costs and, therefore, impact directly on a nation's competitiveness.

Braeutigam, Daughety and Turnquist[24] note that ports come in different sizes and face a variety of traffic mix. As such, they suggest, the use of cross-sectional time-series, or even panel data, may fail to show basic differences between ports; thus leading to a misjudgement as to each port's performance. They attest, therefore, that it is crucial to estimate econometrically the structure of production in ports at the level of the single port or terminal, using appropriate data such as the panel data for a terminal. This view and suggested alternative approach also receives support elsewhere.[25–27]

In undertaking the comparison of port productivities conducted within their study, Tongzon and Ganesalingham[28] compare ports on the basis of a basket of standard port productivity measures such as: shipcalls per port employee, net crane rate, ship rate, TEUs per crane, shipcalls per tug, TEUs per metre of berth, berth occupancy rate, TEUs per hectare of terminal area, port charges, pre-berthing time, berthing time and truck/rail turnaround time. Since the primary role of ports is to facilitate the movement of cargoes, the authors recognise that it is vital to evaluate port performance in relation to how efficient are their services from the perspective of the port user: the shipowners, shippers (importers and exporters) and the land transport owners. It is obvious, therefore, that port performance assessment cannot be based on a single measure. As is clear from the list of productivity measures employed, whilst it does contain certain operational productivity measures, it also recognises that this is only meaningful to port users when it translates into lower costs to them.

Frankel[29] is highly critical of the productivity measures that are applied in ports when he suggests that most port performance standards are narrowly defined operational measures that are useful only for comparison with ports that have similar operations or against proposed supplier standards. He asserts that port user interest in port productivity (and the service quality that it relates to) is much more wide-ranging and it is vitally important that ports attempt to address this disparity in outlook. Port users, he asserts, are concerned with issues such as the total time and cost of ship turnarounds and (increasingly) of cargo throughput. The realignment of what a port considers to be valid performance measures is required because the commercial environment of port operations is becoming increasingly competitive as hinterlands overlap. In such a context, port users have a real choice in the selection of the ports that they want to use.

The focus which Frankel advocates, on the port users' perspective of port efficiency, is particularly interesting and important in that it shifts the need for, and usefulness of, valid port and/or terminal productivity and efficiency measures away from the fulfillment of an internally-oriented managerial (cost minimisation) objective and towards an externally-oriented marketing (revenue-maximisation) objective.

Chapon[30] specifically states that the overall cost of cargo-handling in a port comprises two separate components: the cost price of the actual handling and the cost price of immobilizing the seagoing vessel for the period of its stay in port. In other words, this second cost is, in economic terms, the

opportunity cost associated with the revenue lost or, in the terminology of logistics, the cost of lost sales. This second component has risen to even greater prominence as ships have become increasingly expensive (i.e. exhibiting high fixed to variable cost ratios), a feature that is particularly relevant to the liner trades over recent years. Several studies of productivity have adopted this perspective in undertaking productivity measurement and comparisons.[31, 32] It is fundamentally this perspective which has prompted the plethora of OR-based analyses of ship–shore interactions aimed at optimal crane deployment and/or loading/unloading operations, a comprehensive review of which is provided by Stahlbock and Voss.[33]

All this points to the fact that productivity levels in ports have implications for the real cost of loading and discharging a ship. Suykens,[34] however, points to the need for caution in making such comparisons since the higher productivity in a port may be reflected in the wages it pays and/or the depreciation charges it incurs as the result of the investment in state-of-the-art equipment that has been made. Both of these influences on higher port productivity will be mirrored in the port tariff that is charged. Thus, there is a need for a balanced and joint view of both port pricing and productivity. Other commentators have pointed to the need to assess the range of prices payable for different levels of port productivity within the context of the *effectiveness* of service provision.[35] This, of course, has prompted empirical studies of the *quality* of port performance as an adjunct to the many analyses, using very varied methodologies, which focus on the quantitative assessment of relative port productivities.[36]

Ports have an interaction with other parts of the logistical chain. Indeed, the suggestion has been made that the real value of productivity improvements in ports depends upon whether this results in an improvement to the efficiency of the total logistical system or whether it merely shifts a “bottleneck” from one part of the system to another.[37] This calls for the adoption of a still wider perspective on the issue of port productivity and efficiency.[38]

In relation to the issue of technical efficiency rather than productivity measurement and comparison, it can be deduced that by the very nature of investments in cargo handling technology and the expansion of space in ports, additions to capacity have to be large compared to the existing facilities. In other words, when investments are made, they are made primarily on an *ad hoc* basis and with a view to future expectations of expanded demand. In consequence, since available capacity cannot be fully utilised in the years immediately following the time that such investments in additional capacity come on stream, then technical inefficiency is inevitable.

In any analysis of a single port’s time series of technical efficiency, therefore, the situation must be defined by numerous inefficient observations being bounded by a comparatively few observations that are deemed efficient. Because of this characteristic (i.e. that efficiency in operations cannot be assumed), De Neufville and Tsunokawa[39] point to the inadequacy of any approach that is based on a least squares regression analysis to estimate the production function for the industry. This is because any such analysis has to be based on the complementary assumptions that all observations are efficient but that any deviation of an observation from the production function is due to random effects. Without explicitly acknowledging the fact, this assertion points to the need for the adoption of contemporary approaches to the measurement of efficiency.

3. The Economic Concept of Efficiency

In simple terms, the performance of an economic unit can be determined by calculating the ratio of its outputs to its inputs; with larger values of this ratio associated with better performance or higher productivity. Because performance is a concept that is only meaningful when judged relatively, there are many bases upon which it may be assessed. For instance, a car manufacturer uses materials, labour and capital (inputs) to produce cars (outputs). Its performance in 2010 could be measured *relative to* its 2009 performance or could be measured *relative to* the performance of another producer in 2009, or could be measured *relative to* the average performance of the car industry, and so on.

Economic efficiency relates specifically to a *production possibility frontier*; an economic concept which is useful in explaining two distinctive concepts of efficiency*: productive (or technical) efficiency* and *allocative efficiency*. In economic theory, costs can exceed their minimum feasible level for one of two reasons. One is that inputs are being used in the wrong proportions, given their prices and marginal productivity. This phenomenon is known as *allocative inefficiency*. The other reason is that there is a failure to produce the maximum amount of output from a set of given inputs. This is known as *productive (or technical) inefficiency*. Both sources of inefficiency can exist simultaneously or in isolation. As implied above, these sources of inefficiency can be easily explained by using the concept of a production frontier.

An economic unit operating within an industry is considered *productively (technically) efficient* if it operates *on* the frontier, whilst the unit is regarded as *productively inefficient* if it operates *beneath* the frontier. When information on prices is available and a behavioural assumption (such as profit maximisation or cost minimisation) is properly established, we can then consider *allocative efficiency*. This is present when a selected set of inputs (e.g. material, labour and capital) produce a given quantity of output at minimum cost, given the prevailing input prices. An economic unit is judged *allocatively inefficient* if inputs are being used in the wrong proportions, given their prices and marginal productivity.

Fundamentally, however, the *technical efficiency* of an entity is a comparative measure of how well it processes inputs to achieve its output(s), as compared to its maximum potential for doing so – as represented by its production possibility frontier, which is widely used to define the relationship between inputs and outputs by depicting graphically the maximum output obtainable from the given inputs consumed. In so doing, the production frontier reflects the current status of technology available to the industry. By implication, therefore, the *production possibility frontier* of an entity may change over time due to changes in the underlying technology deployed.

In the container port sector, an example might be the greater reach of contemporary gantry cranes over their historic counterparts. Over the past decade in particular, this innovation in technology has facilitated a very significant improvement in partial productivity measures such as container moves per hour. Depending upon the relationship between the cost of investing in such cranes and the reduction in operating cost per container moved, it could also mean greater output for the same level of input at all scales of production (i.e. this represents an outward move in the production possibility frontier). If it could be established that this innovation has led directly to an improvement in the overall (total factor) productivity of the port (even where this compares favourably to that of other suitable benchmark ports), but that the new cranes like the old ones were still being optimally employed at full capacity, then a situation would exist where *technical efficiency* has remained the

same (i.e. at a maximum), but there has been an improvement in *productivity* (even comparatively).

In a similar fashion, the scale of output(s) or inputs can be altered to take advantage of efficiencies due to scale. This too may mean that an entity can remain at 100% *technical efficiency* (so that output is at the maximum possible level for a given level of input) by moving along the *production possibility frontier*, but that its (total factor) productivity can simultaneously increase. It may be inferred from this explanation that *technical efficiency* and *productivity* also have time-scale connotations, whereby the former is much more of a long-term phenomenon, while the latter is a concept that is grounded more firmly in the short-term (see Coelli, Prasada Rao and Battese[40] for a comprehensive treatment of productivity and the different forms of efficiency).

With respect to how to measure the different sources of (in)efficiency, let us suppose that the production frontier of an economic unit is as depicted in Figure 1 and can be denoted by $Y = f(x_1, x_2)$, where two inputs (x_1 and x_2) are used, in some combination, to produce one output (Y). It is also assumed that the function is characterised by constant returns to scale. In this case, the isoquants Y_A and Y_B indicate all possible combinations of x_1 and x_2 that give rise to the same level of output.

Assume that the firm's efficiency is observed at point A, rather than C. This position is neither *allocatively* nor *productively efficient*. Its level of *productive efficiency* is defined as the ratio of OB/OA. Therefore, productive inefficiency is defined as 1-(OB/OA) and can be interpreted as the proportion by which the cost of producing the level of output could be reduced given the assumption that the input ratio (x_1/x_2) is held constant. Under the assumption of constant returns to scale, productive inefficiency can also be interpreted as the proportion by which output could be increased by becoming 100% productively efficient. The level of *allocative efficiency* is measured as OD/OB (or C_1/C_2). Thus *allocative inefficiency* is defined as 1-(OD/OB) and measures the proportional increase in costs due to *allocative inefficiency*.

Consider position B in Figure 1. At this point, the firm is allocatively inefficient since it can maintain output at Y but reduce total costs by changing the input mix to that

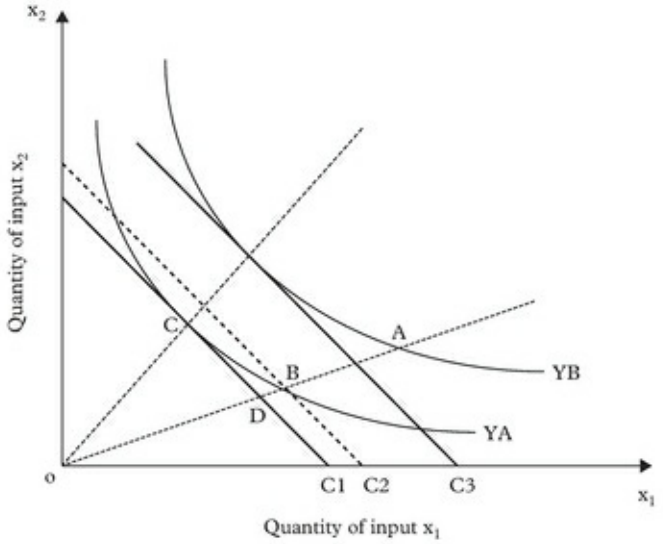

Figure 1: A firm's frontier production function

which exists at point C. At point B, however, the firm is productively efficient since it cannot increase output with this input combination of x_1 and x_2 and, given a suboptimal input mix (i.e. allocative inefficiency), the firm has minimised the cost of producing this level of output.

4. Introduction to More Contemporary Methods of Efficiency

Measurement

In the last decade of the twentieth century, a family of methods for measuring efficiency were proposed which revolve around utilising the economic concept of an efficient frontier. Under this concept, efficient decision-making units (DMUs) are those that operate on either a (maximum) production frontier or a (minimum) cost frontier. In contrast, inefficient DMUs operate either below the frontier when considering the production frontier, or above it in the case of the cost frontier. Relative to a DMU located on a production frontier, an inefficient operator will produce less output for the same cost. Analogously, relative to any DMU located on a cost frontier, an inefficient operator will produce the same output but for greater cost.

As suggested by Bauer,[41] there are several reasons why the use of frontier models is becoming increasingly widespread:

- the notion of a frontier is consistent with the underlying economic theory of optimising behaviour;
- deviations from a frontier have a natural interpretation as a measure of the relative efficiency with which economic units pursue their technical or behavioural objectives; and
- information about the structure of the frontier and about the relative efficiency of DMUs has many policy applications.

The literature on frontier models was inaugurated in the seminal contribution of Farrell,[42] who provided a rigorous and comprehensive framework for analysing economic efficiency in terms of realised deviations from an idealised frontier isoquant. The proliferation of attempts to measure economic efficiency through the application of the frontier approach can be attributed to an interest in the structure of efficient production technology, an interest in the divergence between observed and ideal operation and also to an interest in the concept of economic efficiency itself.

Within the family of models and methods that are based on the frontier concept, a distinction exists between those methods that revolve around a parametric approach to deriving the specification of the frontier model and those that utilise non-parametric methods. Another distinction exists with respect to whether the model employed is stochastic or deterministic in nature. With the former, it is necessary to make assumptions about the stochastic properties of the data, while with the latter it is not. The nonparametric approach revolves around mathematical programming techniques that are generically referred to as Data Envelopment Analysis (DEA). The parametric approach, on the other hand, employs econometric techniques where efficiency is measured relative to a frontier production function that may be statistically estimated on the basis of an assumed distribution.

Econometric approaches have a strong policy orientation, especially in terms of assessing alternative industrial organisations and in evaluating the efficiency of government and other public agencies. Mathematical programming approaches, on the other hand, have a much greater managerial decision-making orientation.[43–45] Several studies[46–48] have compared the performance of alternative methods for measuring efficiency, focusing on the econometric method (in particular, the stochastic frontier model) and the mathematical programming method. As measured by the correlation coefficients and rank correlation coefficients between the true and estimated relative efficiencies, the results show that when the functional form of the econometric model is well specified, the stochastic frontier approach generally produces better estimates of efficiency than the approaches based on

mathematical programming, especially when measuring DMU-specific efficiency where panel data are available. In addition, certain authors consider that the econometric approaches have a more solid grounding in economic theory.[49,50]

5. Data Envelopment Analysis

5.1 Method

Data Envelopment Analysis (DEA) can be broadly defined as a non-parametric method for measuring the relative efficiency of a DMU. The method caters for multiple inputs to, and multiple outputs from, the DMU. It does this by constructing a single "virtual" output that is mapped onto a single "virtual" input, without reference to a pre-defined production function.

There has been a phenomenal expansion of the theory underpinning DEA, the methodology itself and applications of the methodology over the past few decades.[51–54] A significant stimulus to this corpus of literature came with the publication of a seminal

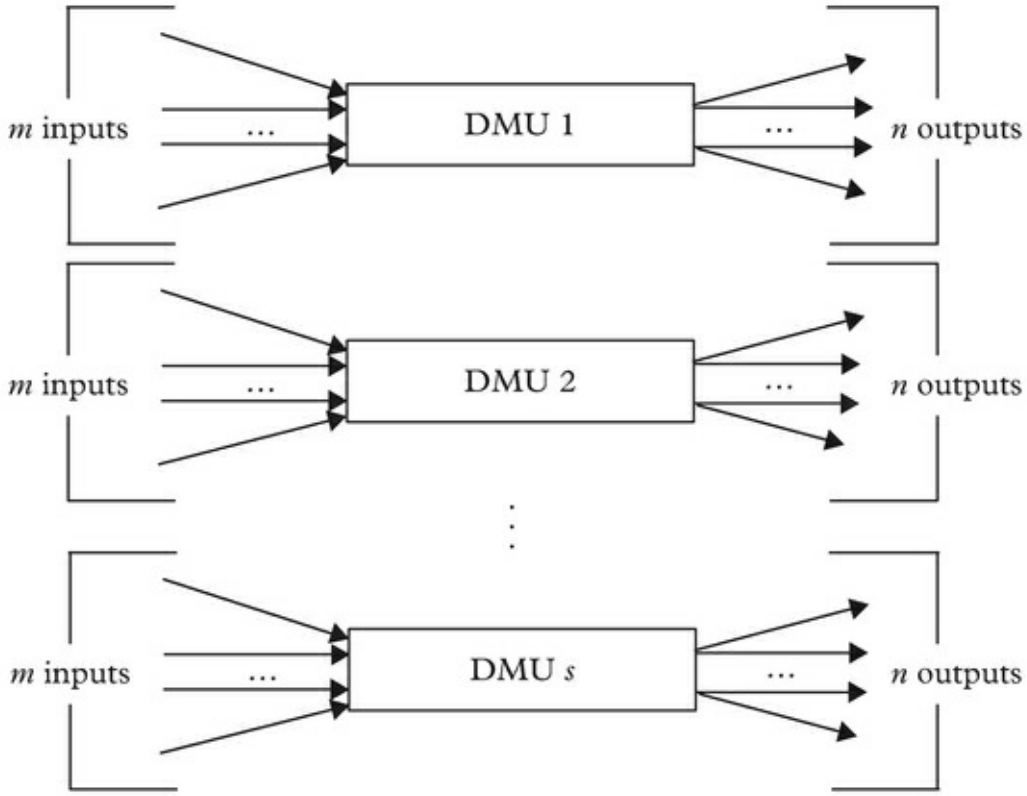

Figure 2: DMU and homogeneous units

work on the topic by Charnes, Cooper and Rhodes in 1978.[55] This work espoused a model for solving the DEA linear programming problem which has subsequently become widely known by the acronym of the authors' surnames; the CCR model. The significance and influence of this paper is reflected in the fact that by 1999, it had been cited over 700 times in other papers incorporating applications of the DEA methodology or concerned with the theory or methodology of DEA. [56]

In common with other approaches based on the frontier approach, the fundamental idea in DEA is that the efficiency of an individual DMU[57] or *Unit of Assessment*[58] is compared relative to a bundle of homogeneous units. Implicit in this idea is the assumption that each individual DMU exercises some sort of corporate responsibility for controlling the process of production and making decisions at various levels of the organisation, including daily operation, short-term tactics and long-term strategy.

Figure 2 illustrates that DEA is used to measure the relative efficiency of a DMU by comparing it

with other homogeneous units that transform the same group (types) of measurable positive inputs into the same group (types) of measurable positive outputs.

In the ports context, for example, DEA may be applied to compare the relative efficiency of a single container terminal to a set of other container terminals where the common output may be defined in terms of an annual throughput measured in TEU. Similarly, in this case, the common inputs may be the annual financial costs incurred in the provision of capital, land and labour or, alternatively, physical proxies for these factor inputs such as total length of berths, container stacking capacity, number of cranes, number of employees, total land available etc. The input and output data for Figure 2 can be expressed in terms of matrixes denoted by X and Y as shown below, where the element x_{ij} in the matrix X refers to the i^{th} input data item of DMU j, whereas the element y_{ij} represents the i^{th} output data item of DMU j. In X, there are m input variables and in Y, there are n output variables. In both input and output matrices, there are s DMUs considered.

$$X = \begin{pmatrix} x_{11} & x_{12} & \cdots x_{1s} \\ x_{21} & x_{22} & \cdots x_{2s} \\ \vdots & & \\ x_{m1} & x_{m2} & \cdots x_{ms} \end{pmatrix}$$

$$Y = \begin{pmatrix} y_{11} & y_{12} & \cdots y_{1s} \\ y_{21} & y_{22} & \cdots y_{1s} \\ \vdots & & \\ y_{n1} & y_{n2} & \cdots y_{ns} \end{pmatrix}$$

The basic approach to utilising DEA to measure the relative efficiencies of DMUs can be explained by the following example. Table 1 presents some basic production statistics for eight hypothetical container terminals. The "Throughput/stevedore" in Table 1 can be interpreted as a standard productivity measure. In an extremely simplistic sense that is useful for the purpose of illustrating the basic approach to DEA, this productivity measure can be employed to determine a simplistic and concise form of "relative efficiency" by comparing all DMUs against the best in the sample.

From Figure 3 it is clear that in terms of the particular relationship between inputs and outputs that we are looking at here (i.e. throughput/stevedore), *T2* is the most efficient container terminal compared with the others (as represented by the other points on the graph). The straight line from the origin that passes through *T2* can be termed an "efficient frontier" since all points along it have the maximum observed productivity measurement of one for throughput per stevedore. All the other points are inefficient compared with *T2* and are "enveloped" by the efficient frontier. Within the context of DEA, the relative efficiencies of these other container terminals, as shown in the bottom line of Table 1, are measured by comparing the productivity measure (i.e. in this case throughput/stevedore) for each of these "inefficient" container terminals with that of T2. The term "Data Envelopment Analysis" stems from the fact that the efficient frontier "envelops" the inefficient observations and that they, in turn, are "enveloped" by the frontier.

Table 1: Example single input/single output data

Terminal	T1	T2	T3	T4	T5	T6	T7	T8
Stevedores	10	20	30	40	50	50	60	80
Throughput	10	40	30	60	80	40	60	100
Throughput/ stevedore	1	2	1	1.5	1.6	0.8	1	1.25
Relative efficiency	50%	100%	50%	75%	80%	40%	50%	62.5%

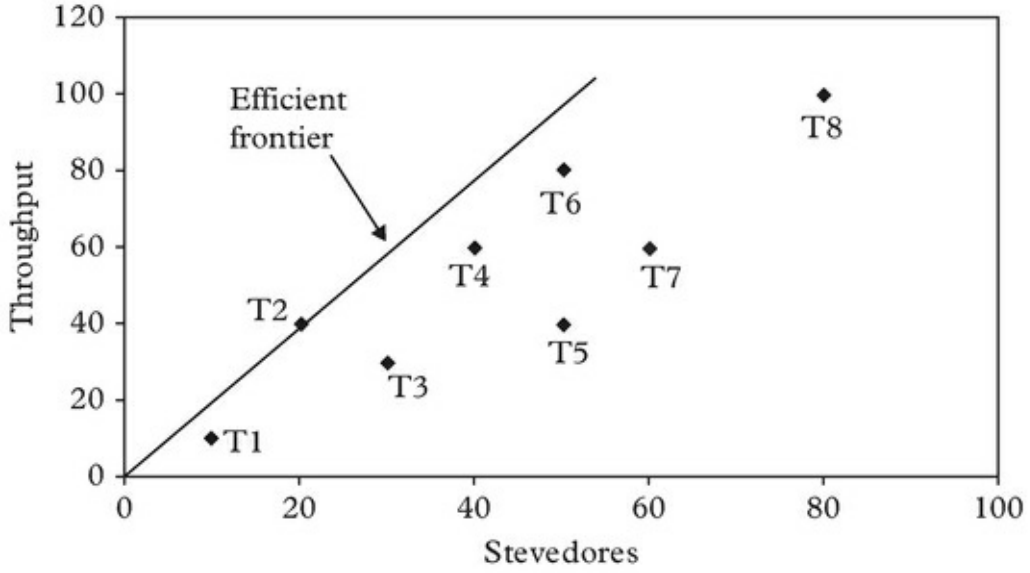

Figure 3: Theoretical comparison of efficiencies of container terminals (CCR model)

It should be apparent that the complexity of measuring true relative efficiency (or indeed of even simply portraying the problem graphically) increases exponentially as the number of total input and output variables increase. It is this difficulty that the CCR model overcomes. This is because it was specifically devised to address the measurement of relative efficiencies of DMUs with multiple inputs and outputs.

The CCR model can be expressed as the following fractional programming problem (1)–(4):

$$(FP_0) Max \quad \theta = \frac{u_1 y_{10} + u_2 y_{20} + \cdots + u_n y_{no}}{v_1 x_{10} + v_2 x_{20} + \cdots + v_m x_{mo}} \qquad (1)$$

Subject to:

$$\frac{u_1 y_{1j} + u_2 y_{2j} + \cdots + u_n y_{nj}}{v_1 x_{1j} + v_2 x_{2j} + \cdots + v_m x_{mj}} \leq 1 \quad (j = 1, \ldots, s) \qquad (2)$$

$$v_1, v_2, \ldots, v_m \geq 0 \qquad (3)$$

$$u_1, u_2, \ldots, u_n \geq 0 \qquad (4)$$

Given the data matrices X and Y shown earlier, the CCR model measures the maximum relative efficiency of each DMU by solving the fractional programming problem in (1) where the input weights $v_1, v_2, \ldots v_m$ and output weights $u_1, u_2, \ldots u_n$ are variables to be obtained. o in (1) varies from 1 to s in relation to the s optimisations that are required for all s DMUs. The constraint in (2) defines the fact that the ratio of "virtual output" ($u_1 y_{10} + u_2 y_{20} + \ldots + u_n y_{no}$) to "virtual input" ($v_1 x_{10} + v_2 x_{20} + \ldots + v_m x_{mo}$) cannot exceed unity for each DMU. This Fractional Programming (FP) problem represented in equations (1)–(4) has been proved to be equivalent to the following Linear Programming (LP) formulation shown in equations (5)–(9).[59]

$$(\mathrm{LP}_0)\ Max \quad \theta = u_1 y_{10} + u_2 y_{20} + \ldots + u_n y_{no} \qquad (5)$$

Subject to

$$v_1 x_{1j} + v_2 x_{2j} + \ldots + v_m x_{mj} = 1 \qquad (6)$$

$$u_1 y_{1j} + u_2 y_{2j} + \ldots + u_n y_{nj} \leq v_1 x_{1j} + v_2 x_{2j} + \ldots + v_m x_{mj} \quad (j=1,\ldots,s) \qquad (7)$$

$$v_1, v_2, \ldots, v_m \geq 0 \qquad (8)$$

$$u_1, u_2, \ldots, u_n \geq 0 \qquad (9)$$

It is important to recognise and note that the computation of the DEA CCR model has been greatly facilitated by the transformation from its original Fractional Programming (FP) formulation into a Linear Programming (LP) form of the model. This transformation has contributed greatly to the rapid development of the DEA technique and the proliferation of DEA applications. This has occurred because the solution of LP problems has a long-established history where numerous sophisticated computational methods have been developed and where commercial software packages are widely available. As such, calculating the complicated relative efficiencies of DMUs with multiple inputs and outputs is then rendered a comparatively simple task.

One assumption that underpins the early DEA approaches, including the CCR model, is that the sample under study exhibits constant returns to scale. There is a voluminous body of evidence that suggests that this assumption is particularly inappropriate to the ports sector where, it is quite commonly asserted, economies of scale are quite significant.[60–62] To cater for such situations where variable returns to scale may be more the norm, the CCR model has been modified so that scale efficiencies, for example, may be separated out from the pure productive (or technical) efficiency measure that the standard CCR model yields.

The main modified forms of the CCR model that are utilised in practice are referred to as the Additive model and the BCC model, the latter being named after its creators.[63] Accordingly, the efficient frontiers that are estimated by these models are different from that of the CCR model.

Figure 4 shows a hypothetical efficient frontier for situations when either the Additive or BCC models are applied to a sample of container terminals (i.e. there is an assumption that variable returns to scale prevail). In this illustrative example, the sample observations denoted by T_1, T_2, T_6 and T_8 lie on a non-linear efficient frontier and are all defined as efficient since each observation cannot dominate any of the others given the condition of variable returns to scale. The other points that are ‘enveloped’ by (i.e. lying below) these technically efficient points are deemed inefficient.

The Additive and BCC models are identical in terms of the efficient frontiers that they estimate. The main difference between them is the projection path to the efficient frontier that is employed as the basis for estimating the levels of relative (in)efficiency for those DMUs in the sample that are not located on the efficient frontier. For instance, in Figure 4, for the BCC estimate of inefficiency, the inefficient observation T3 can be projected either to T3I or T3O depending upon whether an input or output orientation is adopted. For the Additive model, however, T3 will be projected to T2 on the efficient frontier. This different approach to projection determines the different relative efficiencies for different inefficient DMUs. This is because the level of (in)

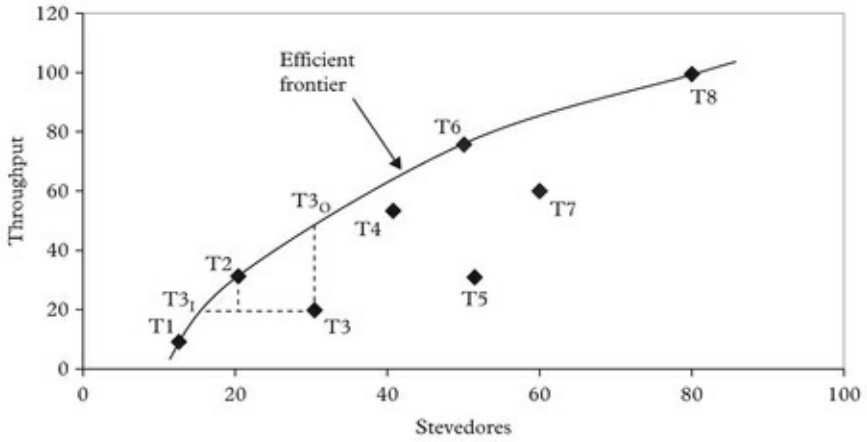

Figure 4: A comparison of container terminal efficiency (BCC and additive models)

efficiency for inefficient observations is derived from the distance it is located from the efficient frontier; a measure that is, of course, dependent upon the projection path that is utilised.

Irrespective of which model is selected for application, the main advantages of utilising a DEA approach to efficiency estimation can be summarised as follows:

a. both multiple outputs and multiple inputs can be analysed simultaneously;
b. more extraneous factors that have an impact on performance can be incorporated into the analysis (such as those relating to the commercial and competitive environment of the port operation, as well as other qualitative factors);
c. the possibility of different combinations of outputs and inputs being equally efficient is recognised and taken into account;
d. there is no necessity to pre-specify a functional form for the production function that links inputs to outputs, nor to give an *a priori* relationship (by pre-specifying the relative weights) between the different factors that the analysis accounts for;
e. rather than in comparison to some sample average or some exogenous standard, efficiency is measured relative to the highest level of performance within the sample under study; and
f. specific sub-groups of those DMUs identified as efficient can be ring-fenced as benchmark references for the non-efficient DMUs.

In the specific case of port efficiency, the ability to handle more than one output is a particularly appealing feature of the DEA technique, because a number of different measures of port output exist that may be used in such an analysis, with the selection depending upon what aspect of port operation constitutes the main focus of the evaluation. Surprisingly, however, this capability is rarely utilised in practice, with a clear preference amongst empirical analyses for focusing solely on a single output, most usually container throughput.

In addition to providing relative efficiency measures and rankings for the DMUs under study, DEA also provides results on the sources of input and output inefficiency, as well as identifying the benchmark DMUs that are utilised for the efficiency comparison. This ability to identify the sources of inefficiency could be useful to port and/or terminal managers in inefficient ports so that the problem areas might be addressed. For port authorities too, they may provide a guide to focusing efforts at improving port performance.

5.2 Applications

Applications of the DEA approach to efficiency estimation in the general transport industry are now

quite common and examples exist of applications to virtually all modes. (This section is based on Cullinane and Wang, (see endnote 76) but has been supplemented by a review of more recent applications.) For example, a comprehensive review of DEA applications and other frontier-based approaches to the railway industry was conducted by Oum *et al*.[64] Similarly, De Borger *et al*.[65] carried out just such a review for attempts to measure public transit performance. It is with the air industry, however, that the greatest proliferation of DEA applications may be found.[66–72] This is interesting because of the great similarity that exists between the air and maritime industries, particularly the analogous positions of ports and airports; a feature that would suggest that there remains great scope for further applications of the DEA approach to the port sector.

In relation to the applications of DEA to ports that have already been undertaken, it is particularly interesting that there has been very little correspondence between the studies as to the choice of input and output variables that are considered. As Thanassoulis points out,[73] this is significant because the identification of the inputs and the outputs in the assessment of DMUs tends to be as difficult as it is crucial. In addition, Ashar *et al*.[74] attribute a lack of transparency to the use of the DEA technique as applied to the estimation of port and/or terminal efficiency.

Roll and Hayuth[75] were the first commentators to explicitly advocate the use of DEA for the estimation of efficiency in the port sector. By presenting a hypothetical application of the methodology to a fictional set of container terminal data, they reveal what potential the approach might hold. They point particularly to the applicability of the DEA approach to the measurement of productive efficiency in the service sector. In addition, they highlight the fact that while the DEA approach does not require a pre-specified standard against which to benchmark the performance measurements pertaining to an individual port or terminal, such standards can be incorporated into the analysis should this be desirable. This latter characteristic is particularly important in countering the argument that the weights estimated by DEA might be either misleading or, indeed, fundamentally wrong as a result of the possibility that they may be different from some prior knowledge or widely-accepted views on the relative values of the inputs or outputs.[77]

Martinez-Budria *et al*.[78] use DEA to analyse the relative efficiency of the Spanish Port Authorities over the period 1993–1997. The methodology as they apply it involves the classification of the 26 different ports within their sample into three categories according to their “complexity”. This classification system would appear to be highly correlated to the size and/or throughput of the ports considered in the analysis. The results of the analysis reveal that the three groupings followed three distinct evolutionary paths in terms of relative efficiency. The most “complex” ports (i.e. roughly equating to those of largest size and throughput) display the highest levels of efficiency in absolute terms and a high growth rate in efficiency over time. Ports in the medium level of ‘complexity’ category displayed only low levels of efficiency growth over the sample period, while ports of low ‘complexity’ actually yielded a negative trend in relative efficiency levels during the period under study. This seems to suggest that not only are there significant economies of scale to be reaped in port operation, but also that this and other factors may be contributing to a concentration of cargo throughput in larger ports. It can also be inferred that the diminishing role of the smaller ports has an adverse impact upon their relative efficiency levels that, in turn, creates a vicious circle of cargo diversion away from this group of ports. By analysing the value of the slack variables to emerge from

solving the DEA Linear Programming problem, this study found that the worst source of inefficiencies were, in general, due to excess capacities.

Tongzon[79] uses both DEA-CCR and DEA-additive models to analyse the efficiency of four Australian and 12 other international container ports for 1996. This cross-sectional efficiency analysis incorporates two output and six input variables, the data for which was collected for the year 1996. The output variables are cargo throughput and ship working rate, where the former is the total number of containers loaded and unloaded in TEUs and the latter is a measure of the number of containers moved per working hour. The input variables considered in the analysis were the number of cranes, number of container berths, number of tugs, terminal area, delay time (the difference between total berth time plus time waiting to berth and the time between the start and finish of ship working) and the number of port authority employees (as a proxy for the labour factor input).

Without precise *a priori* information or assumptions on the returns to scale of the port production function, two sets of results – for the CCR and Additive DEA models – are presented and discussed. A comparison of the results reveals that the CCR model identifies slightly more inefficient ports (six vs three) than the Additive model. As the author points out, this is not a surprising result as the CCR model assumes constant returns to scale, while the Additive model is based on the assumption of returns to scale that are variable. In consequence, the latter will require a larger number of ports to define the non-linear efficiency frontier.

The results of the initial analysis seemed to suggest that the model was over-specified for the sample size (i.e. that the sample data were insufficient to estimate a meaningful frontier). Since it was impossible to increase the sample size for the study, a solution was to reduce the number of output variables considered down to just one; the number of TEUs handled. The results of the DEA analysis using only one output identified Melbourne, Rotterdam, Yokohama and Osaka as inefficient with both the Additive and CCR models. Felixstowe, Sydney, Fremantle, Brisbane, Tilbury and La Spezia were identified as efficient using the Additive model, but as inefficient under the assumption of constant returns to scale that is implicit in the CCR model.

The four ports judged to be inefficient with both DEA models have opposite characteristics in terms of size and function. The port of Melbourne is quite small relative to Rotterdam. The port of Rotterdam is a hub port, while the ports of Melbourne, Yokohama and Osaka generate most of their cargo internally. The findings imply, therefore, that the technical efficiency of this sample of ports does not depend solely upon size or function. The ports of Hong Kong, Singapore, Hamburg, Keelung, Zeebrugge and Tanjung Priok are found to be efficient irrespective of the returns to scale assumption and number of outputs employed in the analysis. Similarly, this seems to indicate (at least for the sample under study) that port size or function alone is not the primary determinant of port efficiency. The enormous slack variable values deduced for the number of container berths, the terminal area and labour inputs for the ports of Melbourne, Sydney and Fremantle confirm the particular need, according to the author, for the government of Australia to refocus its waterfront reform initiatives as an essential step towards improving port efficiency. Clearly plagued by a lack of available data and the small sample size (only 16 observations). More efficient ports than inefficient ports are naturally identified. Realising this serious drawback, the author concludes that further work should be done in collecting more observations to enlarge the sample analysed.

Valentine and Gray[80] use the DEA-CCR model to analyse data relating to a sample of 31 container ports from the top 100 container ports for the year 1998. This analysis yielded an efficiency measure for each of the ports in the sample, which the authors then compared to the port's ownership and organisational structures. It is suggested that the gap between the top three ports that are deemed to be efficient (Hong Kong, Singapore and Santos) and Houston in fourth place is quite considerable and that the reason for this may be that while the top three concentrate on the handling of container traffic, the other ports in the study seem to diversify substantially into the handling of other types of cargo.

The main objective of the study is to compare the efficiency ratings that are derived from the application of DEA to the categorisation of the sample ports into different forms of ownership and organizational structures. To this end, the study concludes that cluster analysis does make a viable tool for identifying organisational structures and that the ports sector exhibits three structural forms that seem to have a relationship to estimated levels of efficiency. The most efficient form of organisational structure (as assigned to individual ports on the basis of the output from a cluster analysis) is the *simple structure* (as defined in Mintzberg[81]). The authors suggest, therefore, that predictions can be made about the performance of a port and its likely associated efficiency rating by simply examining its organisational chart to determine which of the Mintzberg categories is applicable. On the other hand, the study finds that the ownership structure does not seem to have any significant influence upon efficiency; a conclusion that contradicts that of Cullinane and Song[82] who utilise an alternative methodology to arrive at their conclusion.

No details of the precise model form employed for the analysis are given. However, because only three ports (Hong Kong, Singapore and Santos) were found to be efficient, it is probably safe to assume that the linear CCR model was utilised. Since most studies of returns to scale in ports have found that significant scale economies are present, perhaps the utilisation of the BCC or Additive model for the analysis of this data might provide an interesting extension of the research.

For the period 1990–1999, Itoh[83] conducted a DEA window analysis using panel data relating to the eight international container ports in Japan. Tokyo was found to be consistently efficient in terms of its infrastructure and labour productivity over the whole period, while Nagoya performed well during the early part of the period covered by the analysis. At the other extreme, efficiency scores for Yokohama, Kobe and Osaka were found to be low throughout the duration of the period under study.

Barros[84] applies DEA to the Portuguese port industry in 1999 and 2000. The motivation for the analysis is to determine what relationship exists between the governance structure that has been established for the Portuguese port sector, the incentive regulation promulgated under this structure and the ultimate impact on port efficiency. The author concludes that extant incentive regulation has been successful in promoting enhanced efficiency in the sector, but that this could be improved upon by the implementation of recommendations aimed at redefining the role of Portugal's Maritime Port Agency, the regulatory body responsible for port matters.

This time using data for 1990 and 2000, Barros[85] again applies DEA to the Portuguese port industry to derive estimates of efficiency that can then be utilised to determine the source of any inefficiency that may be identified. One of the results of the analysis is that while Portuguese ports have attained high levels of technical efficiency over the period covered by the analysis, the sector has generally not kept pace with technological change. The author concludes that the financial aids to investment that

form part of the EU's Single Market Program have stimulated greater efficiency in the port sector, particularly as the result of the greater competition that is faced; a feature that is particularly relevant for Portuguese ports located near the border with Spain. Through the application of Tobit regression analysis, it is also found that container ports are more efficient than their multi-cargo counterparts (suggesting that there are diseconomies of scope in cargo handling), that efficiency is positively related to market share and, finally, that greater public sector involvement is negatively related to efficiency.

In yet another extension of this work, Barros and Athanassiou[86] apply DEA to the estimation of the relative efficiency of a sample of Portuguese and Greek seaports. The broad purpose of this exercise was to facilitate benchmarking so that areas for improvement to management practices and strategies could be identified and, within the context of European ports policy, improvements implemented within the seaport sectors of these two countries. The authors conclude that there are economic benefits from the implementation of this form of benchmarking and go on to evaluate their extent.

Bonilla *et al*.[87] apply a version of DEA that includes a statistical tolerance for inaccuracies in input and output data to the investigation of commodity traffic efficiency within the Spanish port system. Their sample comprises 23 ports and annual data are collected for 1995–1998 inclusive. The analysis is unusual in that the sample ports handle a range of cargoes–solid bulk, liquid bulk and general break-bulk–rather than being restricted to a single form of cargo (most usually containers). Given a calculated high level of correlation between prospective input variables, a single input encapsulating infrastructure endowment is incorporated into the analysis. The most and least efficient Spanish ports are identified and, using an "incidence analysis", the authors conclude by identifying which ports are most sensitive to variations in traffic volumes among the different types of cargo handled.

Given the characteristics of the container port industry and the random effects associated with a single measured value of production for each port or terminal in a sample and the level of measured efficiency associated with it, Cullinane *et al*.[88] recognised that the analysis of cross-sectional data will inevitably provide inferior estimates of efficiency than those based on panel data. In seeking to allow for this potential, they applied alternative DEA approaches based respectively on cross-sectional and panel data analysis. The authors conclude that by so doing, the development of the efficiency of each container port or terminal in a sample can be tracked over time and that this provides interesting and potentially useful insights for both policy formulations and management.

Recognising the limitations in assessing the efficiency of ports solely on the basis of capital and labour inputs, Park and De[89] develop what they refer to as a "Four-Stage DEA Method". This involves the disaggregation of the overall efficiency model into its constituent components, so that better insight can be gained into the real sources of efficiency. The model comprises individual DEA components that determine the respective efficiency related to productivity, profitability, marketability and overall. In applying their method to a sample of Korean ports, the authors conclude that improving the marketability of Korean seaports should be the utmost priority of port authorities.

Turner *et al*.[90] applied DEA to the determination of changes in infrastructure productivity in North American ports over the period 1984 to 1997. They then went on to use the productivity estimates as the dependent variable within a Tobit regression model which sought to determine the causal factors affecting the scores they derived. Perhaps most significantly, the authors conclude that there are

significant economies of scale present within the North American sector, both at port and at terminal level–a finding that concurs with the outcomes of most research investigating economies of scale in the port sector. They also find that access to the rail network is a pivotal determinant of container port infrastructure productivity in North America, but that there is no evidence to suggest that specific investment in on-dock rail facilities is a productive use of the land-take involved.

DEA was applied by Estache *et al*.[91] to measure the changes in, and sources of, efficiency following the decentralisation of control over the Mexican port system from central government to regional port authorities. Analysing data from Mexico's 11 main ports using data from between 1996 and 1999, the findings suggest that total factor productivity rose by an average of 4.1% per annum over the period of analysis. Disaggregating the results, in all but a single case, Mexican ports either maintained or improved their pure technical efficiency during the sample period. The authors propose the outcomes of this sort of analysis as a rationale for, and justification of, policy decisions to deregulate.

Cullinane *et al*.[92] empirically examine the relationship between privatisation and relative efficiency within the container port industry. The sampling frame comprises the world's leading container ports ranked in the top 30 in 2001, together with five other container ports from the Chinese mainland. DEA is applied in a variety of panel data configurations to eight years of annual data from 1992 to 1999, yielding a total of 240 observations. The analysis concludes that there is no evidence to support the hypothesis that greater private sector involvement in the container port sector irrevocably leads to improved efficiency.

Barros[93] used DEA on a combination of financial and operational variables to evaluate the performance of Italian ports using data from 2002 to 2003. The author concludes that the sample under study exhibited relatively high levels of efficiency and goes on to isolate the influence on port efficiency of factors such as size, the degree of containerisation of cargo and labour.

Rios and Gastaud Macada[94] apply a DEA-BCC model to derive estimates of relative efficiency for 23 container terminals in the Mercosur region (15 Brazilian, 6 Argentinian and 2 Uruguayan) using data from 2002, 2003 and 2004. The analysis incorporated five inputs (number of cranes, number of berths, number of employees, terminal area, amount of yard equipment) and two outputs (TEUs handled and average number of containers handled per hour/ship). The results suggested that 60% of the terminals under study were efficient over the study period, with terminals in the ports of Zarate, Rio Cubatão and Teconvi revealed as the benchmarks to which inefficient terminals should aspire.

Using cross-sectional data for 2002, Cullinane and Wang[95] apply DEA to the derivation of estimates of relative efficiency for a sample comprising 69 of Europe's container terminals with annual throughput of over 10,000 TEUs. The sample was distributed across 24 European countries. The main finding is that significant inefficiency pervades the European container handling industry, with the average efficiency of container terminals under study amounting to 0.48 (assuming constant returns to scale) and 0.42 (assuming variable returns to scale). Most of the container terminals under study exhibit increasing returns to scale, with large container terminals more likely to be associated with higher efficiency scores. A further conclusion was that there was significant variation in the average efficiency of container terminals located in different regions, with those in the British Isles found to be the most efficient and Scandinavia and Eastern Europe the least efficient. These findings were validated in a follow-up study[96] that investigated the efficiency and scale properties of 104 of

Europe's container terminals with annual throughput of over 10,000 TEUs in 2003, distributed across 29 European countries. Again, the main finding was that significant inefficiency was present within most of the terminals under study and that large scale production tends to be associated with higher efficiency.

As part of their competitive strategies to extend their hinterlands, Spain's regional Port Authorities have invested heavily in port infrastructure with a view to increasing the efficiency of the services offered. Garcia-Alonso and Martin-Bofarull[97] apply DEA with a focus on the ports of Bilbao and Valencia; not only are they important Spanish ports, but their investments in new infrastructure have also been significant. On the basis of inter-port traffic redistribution from the land side before and after the investments are made, the authors determine the extent to which improvements in efficiency have occurred and to what extent any efficiency gains translate into an enhanced ability to attract traffic. They conclude that the differential effect on the two ports has been quite marked and that the influence of port location on port efficiency and the capacity to attract traffic is quite significant.

Lin and Tseng[98] apply five different DEA models to acquire a variety of complementary information about the operational efficiency of major container ports in the Asia-Pacific region and to identify trends in port efficiency. By applying efficiency value analysis, the root causes of any empirically-determined inefficiency are established and an analysis of slack variables is then conducted to reveal potential areas of improvement for the set of inefficient ports. Finally, the returns to scale status of each of the ports in the sample is assessed and a a sensitivity analysis is implemented to identify which input or output variables have the greatest influence over efficiency levels.

Liu[99] applies the DEA-CCR and DEA-BCC models, as well as a three-stage DEA model, to evaluate the changes in efficiency that took place between 1998 and 2001 in 10 ports in the Asia-Pacific region. The main finding of this work was that different models led to different results. An attempt is made to explain why this should be the case. Similarly, Hung, Lu and Wang[100] also derive DEA efficiency estimates for Asian container ports, taking into account both scale efficiency targets and the variability of the estimates.

In Italy, Port Authorities exercise some discretion over terminal concession fees. However, the way these fees are charged in practice does not provide terminal operators with the necessary incentives to boost throughput. In a relatively novel application of the methodology and with a focus on the port of Genoa, Ferrari and Basta[101] utilise DEA efficiency estimates as the basis for setting terminal concession fees under a price-cap rule.

Cheon[102] evaluates the relationship between the different types of global terminal operators (GTOs) – defined as global stevedores, global hybrids and global carriers – and the level of efficiency which they exhibit. The author applies a tiered DEA to determine both crane and relative technical efficiency of the ports in the sample. The results suggest that the involvement of "global stevedores" in a terminal operation induces higher crane efficiency, but that this efficiency is not effectively transformed into port-level technical efficiency. In contrast, terminal operations run by "global carriers" in dedicated leased terminals result in significantly lower levels of efficiency. The most important implication of this work is that port authorities may be motivated to increase levels of intra-port competition to address efficiency concerns at a port level.

One important motivation for applying DEA to the issue of port and/or terminal efficiency estimation is in order that inefficient DMUs in a sample can benchmark themselves against their efficient counterparts. This aspect of DEA studies is becoming increasingly popular. For example, Sharma and Yu[103] highlight the problem that the reference set of efficient ports or terminals may be very diverse in terms of their size, location, operating environment and operational practices. Based on the fusing of data mining with DEA, they outline an approach for overcoming this problem that prescribes a step-wise projection of inefficient units onto the production frontier which takes into account maximum capacity and similar input properties. The same authors are similarly motivated to operationalise the benchmarking role of DEA[104] by identifying and prioritising target factors for efficiency improvements and prescribing improvement paths for inefficient units. This involves the development of a decision-tree based DEA model that differentiates between the performance of each inefficient DMU and identifies DMU-specific, significant attributes that are most pivotal for improving these different performance levels.

6. The Stochastic Frontier Model (SFM)

6.1 Method

As has already been stated and as in the case of DEA, the econometric approach to efficiency measurement is also based on utilising the concept of an efficient frontier. This section represents a summary of the theoretical background to the analysis undertaken in Song, Cullinane and Roe (see endnote 111). The econometric approach, however, involves the specification of a parametric representation of technology. The early parametric frontier models[105–106] are deterministic in the sense that all DMUs share a common fixed and pre-determined class of frontier. This is unreasonable and ignores the real possibility that the observed performance of the DMU may be affected by exogenous (i.e. random shock) as well as endogenous (i.e. inefficiency) factors. The fact that there is no allowance for the possible influence of statistical noise is also widely regarded to be the most serious limitation of DEA.[107] To allocate all influential factors, whether favourable or unfavourable and whether under or beyond the control of the DMU (i.e. either endogenous or exogenous), into a single disturbance term and to refer to the mixture as inefficiency is clearly a dubious and imprecise generalisation.

As an alternative, the now much more widely applied stochastic frontier model (SFM) is motivated by the idea that deviations from the production frontier might not be entirely under the control of the economic unit being studied.[108] Both Aigner *et al.*[109] and Meeusen and van den Broeck[110] independently constructed a more reasonable error structure than a purely one-sided one. They considered a linear model for the frontier production function as follows:

$$Y_{it} = f(X_{it}; \beta) \exp(\varepsilon_{it}), \qquad i = 1, 2, \ldots, N; t = 1, 2, \ldots, T \qquad (10)$$

where

Y_{it} denotes the appropriate form of output for the ith DMU at time t

X_{it} is a vector of inputs associated with the ith DMU at time t and β is a vector of input coefficients for the associated independent variables in the production function.

Their disturbance term ε consists of the following two parts:

$$\varepsilon_{it} = v_{it} - u_{it} \qquad (11)$$

The component v_{it},represents a *symmetric disturbance term* permitting random variation of the production function across economic units due not only to the effects of measurement and specification error, but also due to the effects of exogenous shock beyond the control of the economic unit (e.g. weather conditions, geography or machine performance). The other component u_{it} (≥ 0) is a *one-sided disturbance term* and represents 'productive inefficiency' relative to the stochastic production function. The nonnegative disturbance u_{it} reflects the fact that output lies on or below its frontier. The deviation of an observation from the deterministic kernel of the stochastic production function (equation 10) arises from two sources: (i) symmetric random variation of the deterministic kernel f (X_{it}; β) across observations that is captured by the component v_{it}; and (ii) asymmetric variation (or productive inefficiency) captured by the component u_{it}. The term u_{it} measures productive inefficiency in the sense that it measures the short-fall fall of output Y_{it} from that implied by its maximum frontier given by $f(X_{it}; \beta) \exp(v_{it})$. The measure of a DMU's efficiency should be defined, therefore, by:

$$\frac{Y_{it}}{f(\mathrm{X}_{it};\beta)\exp(v_{it})} \qquad (12)$$

relative to the stochastic frontier f (X; β) exp(v).

Nevertheless, any estimate of a DMU's efficiency level is not consistent, as it contains statistical noise as well as productive inefficiency. In addition, stochastic frontier models suffer from two other difficulties. One is the requirement of specific assumptions about the distributions underlying productive inefficiency (e.g. half-normal and exponential) and statistical noise (e.g. normal). The other is the required assumption that regressors (the input variables contained in the vector X) and productive inefficiency are independent. This may well be an unrealistic assumption since if a DMU knows its level of inefficiency, then this should affect its input choices as it attempts to address the problem. Figure 5 is a graphical representation of the basic idea that underpins stochastic frontier model estimates of productive (technical) efficiency.

A further development in the modelling of frontiers lies with the use of estimation techniques that involve panel data. Initially, the stochastic frontier model (10) was developed for cross-sectional data. Hausman and Taylor,[112] Baltagi,[113] and Blundell[114]

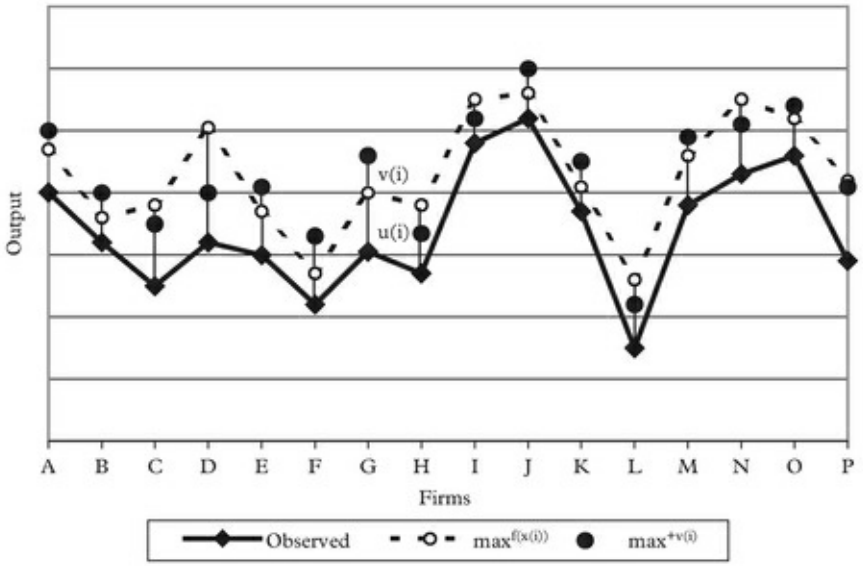

Figure 5: A conceptual representation of the Stochastic Frontier Model Approach to efficiency

estimation

list a number of attractive features of using panel data, one of which is that panel data allows for the control of individual effects which may be correlated with other variables included in the specification of an economic relationship, thus making the analysis of relative efficiency on the basis of single cross-sections extremely difficult.

With respect to the frontier model, consistent estimates of the productive efficiency of a DMU can be obtained as the number of time periods tends to infinity. As a result, strong distributional assumptions are not necessary. Moreover, the parameters and the DMU's level of efficiency can be estimated without assuming that the input variables are uncorrelated with productive inefficiency. Therefore, as Schmidt and Sickles[115] note, a variety of different estimates will be considered, depending on what the analyst is willing to assume about the distribution of productive inefficiency and its potential correlation with the regressors.

Initially, it was claimed that productive efficiencies for individual DMUs could not be estimated and predicted. In an effort to explore this unresolved problem with the previous models, along with attempting to reap the benefits of the aforementioned advantages of panel data, Pitt and Lee[116] were the first to develop techniques using panel data to estimate the frontier production function. Jondrow *et al*.[117] presented two estimators (i.e. for half-normal and exponential cases) for the DMU-specific effect for an individual DMU under the assumption that the parameters of the frontier production function were known and cross-sectional data were available for given sample DMUs. Schmidt and Sickles[118] suggested three different estimators for individual DMU effects and productive efficiencies for panel data.

A major breakthrough in the area of panel data models was achieved by Battese and Coelli,[119] who presented a generalisation of the results of Jondrow *et al*.[120] on the assumption of a more general distribution for DMU effects to be applied to the stochastic frontier model. Their model is given by:

$$Y_{it} = f(X_{it}; \beta) \exp(v_{it} - u_i), i = 1, 2, \ldots, N; t = 1, 2, \ldots, T \qquad (13)$$

The main difference between models (10) and (13) is the absence of the subscript t associated with u in the latter. Thus, u captures DMU-specific time-invariant variables omitted from the previous function. The symmetric terms v_{it} are assumed to be identically and independently normally distributed with mean zero and variance σ_v^2, i.e., $v_{it} \sim N(0, \sigma_v^2)$. The one-sided terms u_i (≥ 0) are assumed to be identically and independently distributed non-negative random variables which capture a *DMU* effect but no *time* effect.[121] In addition, the error terms v_{it} and u_i are assumed to be independently distributed of the input variables as well as of one another.

The most frequently defined distribution for the u_i is the half-normal (i.e. $u_i \sim |N(0, \sigma_u^2)|$ though other distributional assumptions for the u_i terms have been proposed by several researchers. For example, the exponential,[122] the truncated normal[123] and the gamma.[124]

As far as the productive efficiency of a DMU is concerned, Battese and Coelli[125] define it as the ratio of the DMU's mean production, given its realised DMU-specific effect, to the corresponding mean production with the DMU effect being equivalent to zero. The productive efficiency of the ith DMU (PE_i) is defined, therefore, as:

$$PE_i = \frac{E(Y_{it}^* \mid u_i, X_{it})}{E(Y_{it}^* \mid u_i = 0, X_{it})} \qquad (14)$$

where Y_{it} * represents the output of production for the *i*th DMU at time *t*, and the value of the PE_i lies between zero and one ($0 \leq PE_i \leq 1$).

If a DMU's productive efficiency is calculated as 0.65, for example, then this implies that, on average, the DMU realises 65% of the production possible for a fully efficient DMU having comparable input values. From the perspective of efficiency measurement, the definition contained in equation (14) has a thread of connection with that of equation (12).

If the model (13) is transformed to a logarithm of a production function, such as:

$$\ln Y_{it} = \ln f(X_{it}; \beta) + v_{it} - u_i \qquad (15)$$

then the measure of productive efficiency for the *i*th DMU is defined by:

$$PE_i = \exp(-u_i) \qquad (16)$$

The measure shown in equation (16) does not depend on the level of the input variables for the DMU, while the definition provided by equation (14) for calculating the productive efficiency of a DMU clearly shows that its estimation depends significantly on inferences concerning the distribution function of the unobservable DMU effect u_i, given the sample observations.

This technique is relevant to a case where productive efficiency is time-invariant. Schmidt,[126] however, states that unchanging inefficiency over time is not a particularly attractive assumption; a criticism which is readily admitted by Battese and Coelli. With the assumption that productive efficiency does vary over time, an alternative approach has been adopted by econometricians such as Cornwell *et al*.[127] and Kumbhakar.[128] None of these studies succeed, however, in completely separating inefficiency from individual DMU effects[129] and, in any case, the methods proposed thus far are too complicated for empirical application.[130]

6.2 Applications

Liu[131] was the first to apply the stochastic frontier model to a maritime context. He set out to test the hypothesis that public sector ports are inherently less efficient than those in the private-sector. A unique set of panel data relating to the outputs and inputs of 28 commercially important UK ports over the period 1983 to 1990 is collected for analysis. Ownership is hypothesised as a potential factor input to the frontier production function and the effect of its presence on inter-port efficiency differences is investigated by applying the stochastic frontier model to derive the required efficiency estimates.

The results reveal that the efficiency difference between ports in the public versus the private sector is negligible and insignificant between trust and municipal ports on the one hand (the public sector) and private ports on the other. Capital intensity is found to have little relationship to efficiency and the impact of size is found to have a small, but significant, impact. Taken together with the scale elasticity that is estimated as part of the analysis, this is not really supportive of the expectation that substantial economies of scale exist within the sector. A peculiarity of this analysis of the UK situation is that port location was discovered to be a significant influence on efficiency, with ports on the west coast of the UK (i.e. on what many shipping commentators have described as the "wrong" side of the country) being 11% less efficient, on average, than the rest of the sample.

Cullinane and Song[132] were among the first to specifically address the unique characteristics of the

container port sector by providing a framework for, and recommended approach to, the application of the stochastic frontier model within this context. They enumerated the required data for collection, the alternative possible forms which this might take and the likely sources of data. Banos-Pino *et al.*[133] were the first to implement a fully fledged application of the stochastic frontier model to the container port context. They adopted a translog functional form to develop a cost frontier based on panel data from 27 Spanish container ports over the period 1985–1997. The main conclusion drawn was that Spanish container ports were generally inefficient due to large levels of overcapitalisation during the period of analysis.

Notteboom *et al.*[134] apply a Bayesian approach based on Monte-Carlo approximation to the estimation of a stochastic frontier model aimed at assessing the productive efficiency of a sample of 36 European container terminals located in the Hamburg–Le Havre range and in the Western Mediterranean. The data analysed relates to 1994. The robustness and validity of the estimated model is tested by comparing the results with those of four benchmark terminals in Asia (Singapore, Kaohsiung and Hong Kong's MTL and HIT terminals).

This study found that 10 of the terminals, including all four Asian terminals, have efficiency levels of about 80%, with the majority of ports in the Hamburg–Le Havre range falling into the 75–80% efficiency category. The Belgian container terminals were found to be some of the most efficient in the sample, as were the Spanish terminals included in the analysis. Container terminals in Italy were generally found to be the most inefficient. The results also suggested that small terminals do tend to be less efficient than large ones, although a more thorough secondary analysis revealed that small terminals located in large ports are, in general, more efficient than small terminals located in smaller ports.

Several relationships can be inferred from the results of this study. For instance, situations where intra-port competition is formidable (with no single terminal predominant) seem to have a positive effect upon average terminal efficiency within the port. In addition, hub ports tend to be more productively efficient than typical feeder ports. However, whether the terminal is publicly or privately owned seems to have no bearing upon the level of efficiency derived. Finally, terminals in the North of Europe were found to be generally more efficient than those in the South of Europe. All of these relationships were investigated, however, on an individual basis and no insight was gained into the potential impact of joint effects. This would appear to constitute, therefore, an interesting avenue for the extension of this research.

Coto-Millan *et al.*[135] applied a stochastic frontier model to estimate the economic efficiency of 27 Spanish ports. Panel data for the period 1985–1989 was collected and analysed using the Cobb-Douglas and translog versions of the model. The study finds that the translog version of the stochastic frontier model best represents the level of technology within the industry. Quite surprisingly, it appears *prima facie* that large ports are found to be rather more economically inefficient than their smaller counterparts, despite the fact that the analysis also reveals the simultaneous existence of significant scale economies within the sector. Indeed, in order of efficiency, the top five positions are occupied by the smallest ports, while the worst five in the efficiency rankings are relatively the largest ports with the greatest degree of autonomy. A more detailed second-stage analysis of the findings, however, reveals that it is not really size which explains the levels of economic efficiency that have

resulted from the analysis. Rather, it is the degree of autonomy in management that is the critical determining factor, with those ports that are highly autonomous being less efficient than the rest. Technical progress was ascertained to be insignificant over the period covered by the analysis.

The efficiency effects of the port reforms that were implemented in Mexico in 1993 are assessed by Estache *et al*.[136] The authors estimate a stochastic production frontier based on port data covering the period 1996–1999. The results show that Mexico's ports achieved, on average, a 2.8–3.3% average annual efficiency gain since the reform programme was instigated. Port-specific measures of efficiency over the whole period of analysis reveal consistent levels of performance for individual ports. The authors point to a significant advantage of the adopted approach by suggesting that the identification of individual port "leaders and laggards" would not have emerged from a simple analysis of common partial productivity indicators. They conclude that derived measures of relative efficiency of this sort can promote yardstick competition between port infrastructure operators, particularly if the information could be built into an explicit incentive-based regulatory regime.

Cullinane, Song and Gray[137] use the "port function matrix" due to Baird[138] to analyse the administrative and ownership structures of major container ports in Asia. The relative efficiency of these ports is then assessed using the cross-sectional and panel data versions of the stochastic frontier model. The estimated efficiency measures are broadly similar for the two versions of the model tested. From the results of the analysis, it is concluded that the size of a port or terminal is closely correlated with its efficiency and that some support exists for the claim that the transformation of ownership from public to private sector improves economic efficiency. It is concluded that while this does provide some justification for the many programmes in Asian ports that aim to attract private capital into both existing and new facilities, it is also the case that the level of market deregulation is an important intervening variable that may also exert a positive influence on efficiency levels.

Cullinane and Song[139] assess the success achieved by Korea's port privatisation policies in increasing the productive efficiency of its container terminals. The UK container terminal sector provides a useful benchmark for comparison since privatisation and deregulation have formed an integral part of UK port reforms for nearly 20 years and the effect on efficiency, having had time to mature, is much easier to gauge. The stochastic frontier model is justified as the chosen methodology for estimating productive efficiency levels and is applied to cross-sectional data under a variety of distributional assumptions. A panel data model is also estimated. Results are consistent and suggest that: (1) the degree of private sector involvement in sample container terminals is positively related to productive efficiency; and (2) improved productive efficiency has followed the implementation of privatisation and deregulation policies within the Korean port sector. Even though not categorical, these conclusions are important because the market for container throughput is internationally competitive and if policies which promote competition between Korean container terminals lead to greater productive efficiency, this will inevitably make the sector as a whole more competitive internationally.

Tongzon and Heng[140] use the SFM as the basis for quantifying the relationship between port ownership structure and port efficiency to determine whether port privatisation is a necessary prerequisite to ports gaining a competitive advantage. The study is based on a sample of selected container terminals around the world, The results of the analysis are utilised in a supplementary

principal component analysis (PCA) and linear regression model to identify the determinants of port competitiveness and to examine the influence they exert. The authors conclude that greater private sector participation in the port industry can improve port efficiency, which will in turn enhance port competitiveness.

Using the SFM to estimate a cost frontier for the industry, the extent of technology change and changes in technical efficiency within Portuguese ports between 1990 and 2000 is analysed by Barros.[141] He assumed a translog function and employed a maximum likelihood technique to estimate the model. The results show that the average inefficiency score over the period analysed was 39.6%, signifying a high degree of wastage in the resources deployed. This is despite the fact that technological change had contributed to a significant reduction of costs over the period.

Cullinane and Song[142] estimate the relative technical efficiency of a sample of European container ports using the cross-sectional version of the SFM under the assumption that the functional form of the production frontier is the log-linear Cobb-Douglas function. The estimated efficiency measures are broadly similar for the three assumed error distributions that were tested. From the results of the analysis, it is concluded that the size of a port or terminal is closely correlated with its efficiency. Ports in the United Kingdom were found to have the most efficient infrastructure usage; a finding consistent with the shortage of container handling capacity. Scandinavian and Eastern European container terminals yielded the lowest estimates of relative efficiency. Geographical location (i.e. the deviation distance from the mainline intercontinental container trades) and below average size are proposed as possible explanations for this result.

Rodriguez-Alvarez *et al.*[143] test the hypothesis that, having controlled for changing levels of technology and prices, terminal inputs within the port of Las Palmas in Spain are not optimally allocated in the sense that costs are not minimised. To achieve this aim, the authors estimate a system of equations based on the SFM under the assumption of a translog input distance function to calculate both technical and allocative efficiency of cargo handling firms within the port. From a methodological perspective, this work is highly innovative in that the model applied allows for the unbiased estimation of allocative inefficiency of input use in two ways: an error components approach and a parametric approach. The approach also deals simultaneously with both firm and time varying technical and allocative efficiency of port terminals.

Gonzalez and Trujillo[144] quantify the evolution of technical efficiency in port infrastructure service provision in the major Spanish container ports and analyses the extent to which port reforms that took place in the 1990s had an impact on the efficiency of the Spanish container ports. They apply a SFM based on a translog distance function with multiple outputs. The results from the analysis reveal that Spanish port reforms resulted in significant improvements in technological change, but that technical efficiency changed little on average over the period of analysis. However, as a result of these reforms, the results also showed a significant movement of efficiency within ports over time.

The relationship between the size of a port, its level of efficiency and growth in transhipment is investigated by Sohn and Jung.[145] This work tests the hypothesis that the higher the share of transhipment traffic within a port's traffic make-up, then the higher will be the throughput level of the port, as long as the size effect guarantees better "relative" container handling efficiency as compared to direct competitors. The SFM is applied to analyze overall changes in the efficiency of major Asian

container ports and to produce relative efficiency indices for the sample ports. Panel data analysis is then employed to investigate the relationship between efficiency indices and container transhipment volumes. The results suggest that larger Asian ports have higher levels of relative efficiency in container handling and larger market shares in container transhipment. It is deduced that this size effect begins to become a factor in this, once annual container throughput reaches 5 million TEUs.

In a very novel application within the maritime field, Odeck[146] uses data on 82 Norwegian ferries over the period 2003–2005 to estimate technical efficiency using the SFM and input productivity using subsequently derived Malmquist indices. His results point to great potential for efficiency improvements (in the range 19–20%) in the Norwegian ferry sector. It is also found that while Norwegian ferries have a general tendency to improve their technical efficiency over time, because of their age, there is simultaneously a general failure to adopt new technologies. Since ferries in Norway are considered as part of the nation's road network, they are subsidised by the government because they operate at a loss. It is therefore important for government agencies to assess and understand the potential for efficiency and productivity improvements. The results of this analysis imply that any change in the subsidy system alone will not be sufficient to ensure efficiency improvements and that incentives for investments in new ferries are required.

Yan *et al.*[147] build an empirical SFM to assess production efficiencies of container terminal operators from the world's major container ports in the years between 1997 and 2004. The empirical model measures efficiencies, efficiency changes and time-persistence of efficiencies after controlling for individual heterogeneity in technology and technical change. The results point to a mean efficiency level in the range of 70–90%, with a marginal improvement in the mean over the period of analysis. The number of terminal operators working at maximum efficiency has increased, however, since 1997. Testing the robustness of the model, the authors find that results can alter dramatically if individual heterogeneity and technical change are not properly controlled for.

7. Concluding Remarks

This chapter has defined the fundamental nature of port productivity and efficiency and, in so doing, has reinforced the difference between them. It has also illustrated how practical and policy-relevant research into the measurement of port and/or terminal productivity and efficiency has developed over time. In so doing, it is clear that the progression of applications to the port sector has mirrored, and corresponded closely with, the theoretical and empirical evolution of techniques for productivity and efficiency assessment.

In particular, over the past five years or so, there has been a mushrooming of applications to ports and terminals that utilise either DEA or stochastic frontier models. So much so, in fact, that this surfeit of port efficiency studies has prompted two major reviews of the literature – that of Panayides *et al.*[148] in relation to DEA specifically, and that of Gonzalez and Trujillo[149] who focus primarily on the methodological characteristics of port efficiency research. However, it should be emphasised that since both DEA and SFM approaches have their own unique pros and cons, there can be no clear-cut "best" method for deriving efficiency estimates for the sector. This is evidenced in empirical works, such as those by Cullinane *et al.*[150, 151] which compare the outcomes from applying different methods.

There exists great scope for the continued expansion and further development of port efficiency studies:

- Port efficiency studies have thus far been overwhelmingly concerned with the container sector. This is not without justification; not only does it provide the largest proportion of worldwide port revenue, it is also (arguably) the most straightforward sector to analyze (in terms of standard cargo forms, access to data etc). However, ports often encompass the handling of other forms of cargo and other activities. Even though certain of the extant efficiency estimation methodologies do have the capability of catering for multiple outputs, it is not a feature that has very often been utilised in empirical work. As such, scope exists for adopting a more holistic approach to port efficiency estimation that really does account for multiple outputs. Such a development would sit well with the contemporary perspective of ports as the *foci* for logistics activities[152, 153] and with the theoretical framework for assessing port performance from a logistics and supply chain management perspective proposed by Bichou and Gray.[154] In this respect, Zhu[155] presents a DEA-based supply chain model to measure both the overall efficiency of a supply chain and its individual components or members.
- Even without diversifying into the efficiency analysis of port activities other than container handling, there remains scope for differentiating the outputs in relation merely to container throughput. Cochrane[156] has demonstrated that exogenous market differences can have a significant effect on the throughput of terminals managed and operated at similar levels of efficiency and that, therefore, aggregate analyses of container terminal efficiency should disaggregate the output measure into separate components. The most obvious example where such disaggregation may be advantageous is between transhipment and gateway traffic. Such an approach has the distinct disadvantage, however, of requiring larger sample sizes and more comprehensive data sets, particularly if varying returns to scale are to be assessed.
- The selection of input and output variables has been the subject of significant theoretical discussion and a number of potential approaches have been suggested, many of which have yet to be applied within the port context. Examples include: determining the most appropriate set of input variables based on the actual influence they may hypothetically exert over container handling efficiency; how to take account of context-dependent,[157] environmental, qualitative[158, 159] and/or non-discretionary[160] variables and; how to reduce the number of variables under consideration etc.
- There are a number of issues in relation to the estimated weights that are attached to variables within efficiency analysis. Most of this research effort has been aimed at incorporating weight restrictions into the estimations, but some is more innovative. For example, cross-efficiency estimation[161, 162] aims at accounting for optimal peer multipliers to supplement the self-evaluation that is a fundamental characteristic of mainstream DEA. This approach has already found its way into the port efficiency literature in a recent application by Wu *et al*.[163] where it is used to account for regional disparities in the nature of port locations and/or environments. However, the cross-efficiency approach has recently been extended by Liang *et al*.[164] to encompass a game-theoretic perspective where individual DMUs are viewed as players in a competitive game of efficiency maximisation. Such an approach would seem to fit well with the container port context, particularly in relation to shared hinterlands and transhipment traffic.

- Having derived a set of efficiency scores for DMUs within a sample, researchers have been motivated to explain these scores in terms of a set of hypothesised causal factors. Early efforts at doing so within the port sector involved the application of the tobit regression model.[165] The application of bootstrapping techniques has been advocated by Simar and Wilson[166] as a more analytically rigorous approach to this problem.
- Despite a few applications to the container port sector that specifically address the issue of how to deal with time series data,[167] there remains significant potential for the application of the DEA Windows[168] and other alternative approaches.
- Specifically in relation to DEA, an emergent family of models that can be applied within the port sector to cater for multiple outputs includes multistage/serial models (encompassing the previously referred to supply chain model), parallel models (where resources are shared as would be the case for the gateway/transhipment split of container throughput) or hierarchical/nested models.[169]
- Specifically in relation to SFM applications, there is always the potential to select alternative and more flexible functional forms as the specification of the empirical model to be applied. Gonzalez and Trujillo[170] point to the potential of the translog distance function for port applications.

Irrespective of how exactly port efficiency research develops into the future, what is very clear is the continued critical need for efficiency estimation and partial productivity comparison. The continuous monitoring of comparative measures of performance (in all relevant forms) is pivotal to the successful management of port and terminal operations. The pressure for this comes from the relentless trend towards ever-greater competition, both in the inter-port and intra-port contexts. Despite a tendency towards increasing concentration in the worldwide container handling sector, competition regulation and the trend towards the privatisation of state-owned assets will ensure that this characteristic of the contemporary port industry is unlikely to be curtailed in the short- to medium-term.

Where comprehensive information on port productivity and efficiency is available, there are also significant advantages accruing to the formulation of macroeconomic policies. At this point in time, the most relevant use to which such information is put is deciding on national port planning issues, including the likely effectiveness of port devolution policies.[171]

Finally, it is important to bear in mind that port productivity and efficiency cannot be assessed and judged in isolation. While such measures do play a major role in the evaluation of service quality, it is also the case that quality comes at a price. As such, port charges need to be evaluated within the context of the quality of service that is being offered by a port. Balancing the price/efficiency trade-off has become a major consideration of both port managers in their supply-side decisions and of shipping lines in their procurement of container handling services. Indeed, it is this trade off that lies at the heart of the recent trend towards incentive-based contracts for container handling services in ports.

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Endnotes

1. C.T. Grammenos (ed.) (2002): *The Handbook of Maritime Economics and Business* (1st edn.) (London, Lloyd's of London Press) pp. 803–831.
2. De Monie, G. (1987): *Measuring and Evaluating Port Performance and Productivity*, UNCTAD Monograph No. 6 on Port Management (Geneva, UNCTAD)
3. Dowd, T. and Leschine, T. (1990): "Container terminal productivity: a perspective", *Maritime Policy and Management*, 17(2), 107–112.
4. Cullinane, K.P.B. and Song, D-W. (2002): "A stochastic frontier model of the productive efficiency of Korean container terminals", *Applied Economics* (forthcoming).
5. Bendall, H. and Stent, A. (1987): "On measuring cargo handling productivity", *Maritime Policy and Management*, 14(4), 337–343.
6. Tabernacle, J.B. (1995): "A study of the changes in perfromance of quayside container cranes", *Maritime Policy and Management*, 22(2) 115–124.
7. Ashar, A. (1997): "Counting the moves", *Port Development International*, 25–29 November.
8. De Monie, G. (1987): *Measuring and Evaluating Port Performance and Productivity*, UNCTAD Monograph No. 6 on Port Management (Geneva, UNCTAD).
9. Ballis, A. Golias, J. and Abakoumkin, C. (1997): "A comparison between conventional and advanced handling systems for low volume container maritime terminals", *Maritime Policy and Management*, 24(1), 73–92.
10. Chen, T. (1998): "Land utilization in the container terminal: a global perspective", *Maritime Policy and Management*, 25(4), 289–303.
11. Talley, W. (1988): "Optimum throughput and performance evaluation of marine terminals", *Maritime Policy and Management*, 15(4), 327–331.
12. Dowd, T. and Leschine, T. (1990): "Container terminal productivity: a perspective", *Maritime Policy and Management*, 17(2), 107–112.
13. De Neufville, R. and Tsunokawa, K. (1981): "Productivity and returns to scale of container ports", *Maritime Policy and Management*, 8(2), 121–129.
14. Kim, M. and Sachish, A. (1986): "The structure of production, technical change and productivity in a port", *Journal of Industrial Economics*, 35(2), 209–223.
15. Tongzon, J. (1995): Determinants of port performance and efficiency", *Transportation Research*, 29A(3), 245–252.
16. Chang, S. (1978): "Production function, productivities and capacity utilisation of the port of mobile", *Maritime Policy and Management*, 5, 297–305.
17. De Neufville, R. and Tsunokawa, K. (1981): "Productivity and returns to scale of container ports", *Maritime Policy and Management*, 8(2), 121–129.
18. Suykens, F. (1983): "A few observations on productivity in seaports", *Maritime Policy and Management*, 10(1), 17–40.
19. Tongzon, J.L. and Ganesalingam, S. (1994): "An evaluation of ASEAN port performance and efficiency", *Asian Economic Journal*, 8(3), 317–330.
20. Tongzon, J.L. (1995a): "Systematizing international benchmarking for ports", *Maritime Policy*

and Management, 22(2), 171–177.
21. Ashar, A. (1997): "Counting the moves", *Port Development International*, November, 25–29.
22. Goss, R. (1990): "Economic policies and seaports: 2. The Diversity of Port Policies", *Maritime Policy and Management*, 17(3), 221–234.
23. Sánchez, R.J., Hoffmann, J., Micco, A., Pizzolitto, G.V., Sgut, M. and Wilmsmeier, G. (2003): "Port efficiency and international trade: port efficiency as a determinant of maritime transport costs", *Maritime Economics & Logistics*, 5, 199–218.
24. Braeutigam, R., Daughety, A. and Turnquist, M. (1984): "A firm specific analysis of economies of density in the US railroad industry", *Journal of Industrial Economics*, 33, 3–20.
25. Kim, M. and Sachish, A. (1986): "The structure of production, technical change and productivity in a port", *Journal of Industrial Economics*, 35(2), 209–223.
26. Song, D.W. and Han, C.H. (2004): "An econometric approach to performance determinants of Asian container terminals", *International Journal of Transport Economics*, 31(1), 39–52.
27. Tovar, B., Jara-Diaz, S. and Trujillo, L. (2007): "Econometric estimation of scale and scope economies within the Port Sector: a review", *Maritime Policy & Management*, 34(3), 203–223.
28. Tongzon, J.L. and Ganesalingam, S. (1994): "An evaluation of asean port performance and efficiency", *Asian Economic Journal*, 8(3), 317–330.
29. Frankel, E.G. (1991): "Port performance and productivity measurement", *Ports and Harbors*, 11–13 October.
30. Chapon, J. (1974): *Comment Définir une Politique Portuaire* (Trieste, France).
31. Robinson, R. (1978): "Size of vessels and turnround time: further evidence from the port of Hong Kong", *Journal of Transport Economics and Policy*, 12(2), 161–178.
32. Edmond, E.D. and Maggs, R.P. (1987): "Container ship turnround time at UK ports", *Maritime Policy and Management*, 14(1), 3–19.
33. Stahlbock, R. and Voss, S. (2008): "Operations research at container terminals: a literature update", *OR Spectrum*, 30(1), 1–52.
34. Suykens, F. (1983): "A few observations on productivity in seaports", *Maritime Policy and Management*, 10(1), 17–40.
35. Brooks, M.R. (2007): "Issues in measuring port devolution program performance: a managerial perspective", in M.R. Brooks and K.P.B. Cullinane (eds.), *Devolution, Port Governance and Port Performance*, Chapter 25, Research in Transportation Economics, Vol. XVII (Amsterdam, Elsevier) pp. 619–650.
36. Bassan, S. (2007): "Evaluating seaport operation and capacity analysis: preliminary methodology", *Maritime Policy and Management*, 34(1), 3–19.
37. Dowd, T. and Leschine, T. (1990): "Container terminal productivity: a Perspective", *Maritime Policy and Management*, 17(2), 107–112.
38. Bichou, K. and Gray, R. (2004): "A logistics and supply chain management approach to port performance measurement", *Maritime Policy & Management*, 31(1), 47–67.
39. De Neufville, R. and Tsunokawa, K. (1981): "Productivity and returns to scale of container ports", *Maritime Policy and Management*, 8(2), 121–129.
40. Coelli, T., Prasada Rao, D.S. and Battese, G.E. (1998): *An Introduction to Efficiency and Productivity Analysis* (Boston, Kluwer Academic Publishers).

41. Bauer, P. (1990): “Recent developments in the econometric estimation of frontiers”, *Journal of Econometrics*, 46, 39–56.
42. Farrell, M. (1957): “The measurement of productive efficiency”, *Journal of the Royal Statistical Society*, 120(3), 253–290.
43. Aigner, D. and Schmidt, P. (1980): “Specification and estimation of frontier production, profit and cost functions, editors’ introduction”, *Journal of Econometrics*, Supplement to the Journal of Econometrics, 13, 1–3.
44. Fare, R., Grosskopf, S. and Lovell, C. (1994): *Production Frontiers* (Cambridge, Cambridge University Press).
45. Lovell, C. (1995): “Econometric efficiency analysis: a policy-oriented review”, *European Journal of Operational Research*, 80(3), 452–462.
46. Gong, B.H. and Sickles, R. (1992): “Finite sample evidence on the performance of stochastic frontiers and data envelopment analysis using panel data”, *Journal of Econometrics*, 51, 259–284.
47. Yu, C. (1995): *A Comparative Study of Alternative Methods for Efficiency Measurement with Applications to Transportation Industry*, unpublished PhD Dissertation, University of British Columbia, Canada.
48. Oum, T. H. and Waters, W. (1996): “A survey of recent development in transportation cost function research”, *Logistics and Transportation Review*, 32(4), 423–463.
49. Forsund, F., Lovell, C. and Schmidt, P. (1980): “A survey of frontier production functions and of their relationship to efficiency measurement”, *Journal of Econometrics*, 13, 5–25.
50. Pitt, M. and Lee, L. (1981): “The measurement and sources of technical efficiency in the indonesian weaving industry”, *Journal of Development Economics*, 9, 43–64.
51. Seiford, L.M. (1996): “Data envelopment analysis: the evolution of the state of the art (1978–1995)”, *Journal of Productivity Analysis*, Vol. 7, 99–137.
52. Sarafoglou, N. (1998): “The most influential dea publications: a comment on Seiford”, *Journal of Productivity Analysis*, Vol. 9, 279–281.
53. Charnes, A., Cooper, W.W., Lewin, A.Y. and Seiford, L.M., (1994): *Data Envelopment Analysis: Theory, Methodology and Application* (Boston, Kluwer Academic Publishers).
54. Forsund, F.R. and Sarafoglou, N. (2002): “On the origins of data envelopment analysis”, *Journal of Productivity Analysis*, Vol. 17, 23–40.
55. Charnes, A., Cooper, W.W. and Rhodes, E. (1978): “Measuring the efficiency of decision making units”, *European Journal of Operational Research*, Vol. 2, 429–444.
56. Forsund, F.R. and Sarafoglou, N. (2002): “On the origins of data envelopment analysis”, *Journal of Productivity Analysis*, Vol. 17, 23–40.
57. Charnes, A., Cooper, W. W. and Rhodes, E. (1978): “Measuring the efficiency of decision making units”, *European Journal of Operational Research*, Vol. 2, 429–444.
58. Thanassoulis, E. (2001): *Introduction to Theory and Application of Data Envelopment Analysis* (Boston, Kluwer Academic Publishers).
59. Cooper, W.W., Seiford, L.M. and Tone, K. (2000): *Data Envelopment Analysis: A Comprehensive Text with Models, Applications, References and DEA-Solver Software* (Boston,

Kluwer Academic Publishers,).
60. Robinson, R. (1978): “Size of vessels and turnround time: further evidence from the port of Hong Kong”, *Journal of Transport Economics and Policy*, 12(2), 161–178.
61. Tabernacle, J.B. (1995): “A study of the changes in performance of quayside Container Cranes”, *Maritime Policy and Management*, 22(2), 115–124.
62. Cullinane, K.P.B. and Khanna, M. (1999): “Economies of scale in large container ships”, *Journal of Transport Economics and Policy*, 33(2), 185–208.
63. Banker, R.D., Charnes, A. and Cooper, W.W. (1984): “Some models for estimating technical and scale inefficiencies in data envelopment analysis”, *Management Science*, 30, 1078–1092.
64. Oum, T.H., Waters, W.G. and Yu, C.Y. (1999): “A Survey of Productivity and Efficiency Measurement in Rail Transport”, *Journal of Transport Economics and Policy*, Vol. 33, No. 1, 9–42.
65. De Borger, B., Kerstens, K. and Costa, A. (2002): “Public transit performance: what does one learn from frontier studies”, *Transport Reviews*, Vol. 22, No. 1, 1–38.
66. Gillen, D. and Lall, A. (1997): “Developing measures of airport productivity and performance: an application of data envelopment analysis”, *Transportation Research E*, Vol. 33, No. 4, 261–273.
67. De La Cruz, F.S. (1999): “A DEA approach to the airport production frontier”, *International Journal of Transport Economics*, Vol. 26, No. 2, 255–270.
68. Sarkis, J. (2000): “An analysis of the operational efficiency of major airports in the United States”, *Journal of Operations Management*, Vol. 18, 335–351.
69. Adler, N. and Berechman, J. (2001): “Measuring airport quality from the airlines’ viewpoint: an application of data envelopment analysis”, *Transport Policy*, Vol. 8, 171–181.
70. Adler, N. and Berechman, J. (2001): “Airport quality and the hub location question”, *Proceedings of the 9th World Conference on Transport Research* , 22–27 July, Seoul, South Korea.
71. Adler, N. and Golany, B. (2001): “Evaluation of deregulated airline network using data envelopment analysis combined with principal component analysis with an application to western Europe”, *European Journal of Operational Research*, Vol. 132, 260–273.
72. Fernandes, E. and Pacheco, R.R. (2002): “Efficient use of airport capacity”, *Transportation Research A*, 36A(3), 225–238.
73. Thanassoulis, E. (2001): *Introduction to Theory and Application of Data Envelopment Analysis* (Boston, Kluwer Academic Publishers).
74. Ashar, A., Stopher, P. and Appfel, C. (1994): “Defining performance measures for an intermodal management system”, *Journal of Transportation Research Forum*, November.
75. Roll, Y. and Hayuth, Y. (1993): “Port performance comparison applying data envelopment analysis (DEA)”, *Maritime Policy and Management*, 20(2), 153–161.
76. Cullinane, K.P.B. and Wang, T-F. (2007): “Data envelopment analysis (DEA) and improving container port efficiency”, in M.R. Brooks and K.P.B. Cullinane (eds.) *Devolution, Port Governance and Port Performance*, Chapter 23, Research in Transportation Economics, Vol. XVII (Amsterdam, Elsevier) pp. 517–566.
77. Allen, R., Athanassopoulos, A., Dyson, R.G. and Thanassoulis, E. (1997): “Weights restrictions

and value judgements in Data Envelopment Analysis: Evolution, Development and Future Directions", *Annals of Operational Research*, Vol. 73, 13–34.

78. Martinez-Budria, E., Diaz-Armas, R., Navarro-Ibanez, M. and Ravelo-Mesa, T. (1999): "A study of the efficiency of Spanish port authorities using data envelopment analysis", *International Journal of Transport Economics*, Vol. XXVI, No. 2, June.

79. Tongzon, J. (2001): "Efficiency measurement of selected Australian and other international ports using data envelopment analysis", *Transportation Research*, 35A(2), 107–122.

80. Valentine, V.F. and Gray, R. (2001): "The measurement of port efficiency using data envelopment analysis", *Proceedings of the 9th World Conference on Transport Research* , 22–27 July, Seoul, South Korea.

81. Mintzberg, H. (1979): *The Structuring of Organizations* (Englewood Cliffs, NJ, Prentice-Hall).

82. Cullinane, K.P.B. and Song, D-W. (2003): "A Stochastic Frontier Model of the productive efficiency of Korean container terminals", *Applied Economics*, 35(3), 251–267.

83. Itoh, H. (2002): "Efficiency changes at major container ports in Japan: A window application of data envelopment analysis", *Review of Urban and Regional Development Studies*, 14(2), 133–152.

84. Barros, C.P. (2003): "Incentive regulation and efficiency of Portuguese port authorities", *Maritime Economics and Logistics*, 5(1), 55–69.

85. Barros, C.P. (2003): "The measurement of efficiency of Portuguese sea port authorities with DEA", *International Journal of Transport Economics*, XXX(3), 335–354.

86. Barros, C.P. and Athanassiou, M. (2004): "Efficiency in European seaports with DEA: Evidence from Greece and Portugal", *Maritime Economics and Logistics*, 6(2), 122–140.

87. Bonilla, M., Casasus, T., Medal, A. and Sala, R. (2004): "An efficiency analysis of the Spanish port system", *International Journal of Transport Economics*, XXXI(3), 379–400.

88. Cullinane, K.P.B., Song, D-W., Ji, P. and Wang, T. (2004): "An application of DEA windows analysis to container port production efficiency", *Review of Network Economics*, 3(2), 186–208.

89. Park, R-K. and De, P. (2004): "An alternative approach to efficiency measurement of seaports", *Maritime Economics and Logistics*, 6, 53–69.

90. Turner, H., Windle, R. and Dresner, M. (2004): "North American containerport productivity: 1984-1997", *Transportation Research E*, 40, 339–356.

91. Estache, A., Tovar de la Fe, B. and Trujillo, L. (2004): "Sources of efficiency gains in port reform: a DEA decomposition of a Malmquist TFP index for Mexico", *Utilities Policy*, 12, 21–230.

92. Cullinane, K.P.B., Ji, P. and Wang, T. (2005): "The relationship between privatization and DEA estimates of efficiency in the container port industry", *Journal of Economics and Business*, 57(5), 433–462.

93. Barros, C.P. (2006): "A benchmark analysis of italian seaports using data envelopment anaysis", *Maritime Economics & Logistics*, 8, 347–365.

94. Rios, L.R. and Gastaud Maçada, A.C. (2006): Analysing the Relative Efficiency of Container Terminals of Mercosur using DEA, *Maritime Economics & Logistics*, 8, 331–346.

95. Cullinane, K.P.B. and Wang, T.-F. (2006): "The efficiency of European container ports: A cross-sectional data envelopment analysis", *International Journal of Logistics: Research and Applications*, 9(1), 19–31.
96. Wang, T. and Cullinane, K.P.B. (2006): "The efficiency of European container terminals and implications for supply chain management", *Maritime Economics & Logistics*, 8(1), 82–99.
97. Garcia-Alonso, L. and Martin-Bofarull, M. (2007): "Impact of port investment on efficiency and capacity to attract traffic in Spain: Bilbao versus Valencia", *Maritime Economics & Logistics*, 9, 254–267.
98. Lin, L.C. and Tseng, C.C. (2007): "Operational performance evaluation of major container ports in the Asia-Pacific region", *Maritime Policy & Management* 34(6), 535–551.
99. Liu, Chun-Chu (2008): "Evaluating the operational efficiency of major ports in the Asia-Pacific region using data envelopment analysis", *Applied Economics*, 40(13), 1737–1743.
100. Hung, S-H., Lu, W-M. and Wang, T.P. (2010): "Benchmarking the operating efficiency of Asia container ports", *European Journal of Operational Research*, 203(3), 706–713.
101. Ferrari, C. and Basta, M. (2009): "Port concession fees based on the price-cap regulation: A DEA approach", *Maritime Economics & Logistics*, 11, 121–135.
102. Cheon, S. (2009): "Impact of global terminal operators on port efficiency: a tiered data envelopment analysis approach", *International Journal of Logistics: Research and Applications*, 12(2), 85–101.
103. Sharma, M.J. and Yu, S.J. (2010): "Performance based stratification and clustering for benchmarking of container terminals", *Expert Systems with Applications*, 36(3), 5016–5022.
104. Sharma, M.J. and Yu, S.J. (2010): "Benchmark optimization and attribute identification for improvement of container terminals", *European Journal of Operational Research*, 201(2), 568–580.
105. Afriat, S. (1972): "Efficiency Estimation of Production Functions", *International Economic Review*, 13(3), 568–598.
106. Aigner, D. and Chu, S. (1968): "On estimating the industry production function", *American Economic Review*, 58(4), 826–839.
107. Ray, S.C. (2002): "William W. Cooper: A Legend in His Own Times", *Journal of Productivity Analysis*, Vol. 17, 7–12.
108. Greene, W. (1993): "The econometric approach to efficiency analysis", in Fried, H., Lovell, C. and Schmidt, S. (eds.), *The Measurement of Productive Efficiency: Techniques and Applications* (New York, Oxford University Press) pp. 68–119.
109. Aigner, D., Lovell, C. and Schmidt, P. (1977): "Formulation and Estimation of Stochastic Frontier Production function models", *Journal of Econometrics*, 6(1), 21–37.
110. Meeusen, W. and van den Broeck, J. (1977): "Efficiency estimation from Cobb-Douglas Production functions with composed error", *International Economic Review*, 18(2), 435–444.
111. Song, D-W., Cullinane, K.P.B. and Roe, M. (2001): *The Productive Efficiency of Container Terminals: An Application to Korea and the UK* (UK, Ashgate).
112. Hausman, J. and Taylor, W. (1981): "Panel data and unobserved individual effects", *Econometrica*, 49, 1377–1398.

113. Baltagi, B. (1995): *Econometric Analysis of Panel Data* (Chichester, John Wiley & Sons).
114. Blundell, R. (1996): "Microeconometrics", in Greenaway, D., Bleaney, M. and Stewart, I. (eds.) *A Guide to Modern Economics* (London, Routledge) pp. 508–536.
115. Schmidt, P. and Sickles, R. (1984): "Production frontiers and panel data", *Journal of Business and Economic Statistics*, 2(4), 367–374.
116. Pitt, M. and Lee, L. (1981): "The measurement and sources of technical efficiency in the Indonesian weaving industry", *Journal of Development Economics*, 9, 43–64.
117. Jondrow, J., Lovell, C., Materov, I. and Schmidt, P. (1982): "On the estimation of technical inefficiency in the Stochastic Frontier Production Model", *Journal of Econometrics*, 19, 233–238.
118. Schmidt, P. and Sickles, R. (1984): "Production frontiers and panel data", *Journal of Business and Economic Statistics*, 2(4), 367–374.
119. Battese, G. and Coelli, T. (1988): "Prediction of firm-level technical efficiencies with a generalised frontier production function and panel data", *Journal of Econometrics*, 38, 387–399.
120. Jondrow, J., Lovell, C., Materov, I. and Schmidt, P. (1982): "On the estimation of technical inefficiency in the Stochastic Frontier Production Model", *Journal of Econometrics*, 19, 233–238.
121. Schmidt, P. and Sickles, R. (1984): "Production frontiers and panel data", *Journal of Business and Economic Statistics*, 2(4), 367–374.
122. Aigner, D., Lovell, C. and Schmidt, P. (1977): "Formulation and estimation of Stochastic Frontier Production Function Models", *Journal of Econometrics*, 6(1), 21–37.
123. Stevenson, R. (1980): "Likelihood functions for generalised Stochastic frontier estimation", *Journal of Econometrics*, 13, 57–66.
124. Greene. W. (1980): "Maximum likelihood estimation of econometric frontier functions", *Journal of Econometrics*, 13, 27–56.
125. Battese, G. and Coelli, T. (1988): "Prediction of firm-level technical efficiencies with a generalised frontier production function and panel data", *Journal of Econometrics*, 38, 387–399.
126. Schmidt, P. (1985): "Frontier production functions", *Econometric Reviews*, 4, 289–328.
127. Cornwell, C., Schmidt, P. and Sickles, R. (1990): "Production frontiers with cross-sectional and time-series variation in efficiency levels", *Journal of Econometrics*, 46, 185–200.
128. Kumbhakar, S. (1990): "Production frontiers, panel dataand time-varying technical inefficiency", *Journal of Econometrics*, 46, 201–211.
129. Kumbhakar, S. and Hjalmarsson, L. (1993): "Technical efficiency and technical progress in swedish dairy farms", in Fried, H., Lovell, C. and Schmidt, S. (eds.), *The Measurement of Productive Efficiency: Techniques and Applications* (Oxford, Oxford University Press) pp. 256–270.
130. Ferrantino, M. and Ferrier, G. (1995): "The technical efficiency of Vacuum-Pan sugar industry of India: an application of a Stochastic Frontier Production function using panel data", *European Journal of Operational Research*, 80, 639–653.

131. Liu, Z. (1995): “The comparative performance of public and private enterprises: the case of British ports”, *Journal of Transport Economics and Policy*, 29(3), 263–274.
132. Song, D-W. and Cullinane, K.P.B. (1999): “Efficiency measurement of container terminal operations: an analytical framework”, *Journal of the Eastern Asia Society for Transportation Studies*, 3(2), 139–154.
133. Banos-Pino, J., Coto-Millan, P. and Rodriguez-Alvarez, A. (1999): “Allocative efficiency and over-capitalization: an application”, *International Journal of Transport Economics*, 26(2), 181–199.
134. Notteboom, T., Coeck, C. and van den Broeck, J. (2000): “Measuring and Explaining the Relative Efficiency of Container Terminals by means of Bayesian Stochastic Frontier Models”, *International Journal of Maritime Economics*, 2(2), 83–106.
135. Coto-Millan, P., Banos-Pino, J. and Rodriguez-Alvarez, A. (2000): “Economic efficiency in Spanish ports: some empirical evidence”, *Maritime Policy and Management*, 27(2), 169–174.
136. Estache, A., Gonzalez, M. and Trujillo, L. (2002): “Efficiency gains from port reform and the potential for yardstick competition: lessons from Mexico”, *World Development*, 30(4), 545–560.
137. Cullinane, K.P.B., Song, D-W. and Gray, R. (2002): “A Stochastic Frontier Model of the efficiency of major container terminals in Asia: assessing the influence of administrative and ownership structures”, *Transportation Research A*, 36(8), 743–762.
138. Baird, A. (1997): “Port privatisation: an analytical framework”, *Proceedings of International Association of Maritime Economist Conference*, 22–24 September, City University, London.
139. Cullinane, K.P.B. and Song, D-W. (2003): “A Stochastic Frontier Model of the productive efficiency of Korean container terminals”, *Applied Economics*, 35(3), 251–267.
140. Tongzon, J. and Heng, W. (2005): “Port privatization, efficiency and competitiveness: Some empirical evidence from container ports (terminals)”, *Transportation Research A*, 39(5), 405–424.
141. Barros, C.P. (2005): “Decomposing growth in portuguese seaports: a frontier cost approach”, *Maritime Economics & Logistics*, 7, 297–315.
142. Cullinane, K.P.B. and Song, D-W. (2006): “Estimating the relative efficiency of European container ports: a Stochastic Frontier analysis”, in K.P.B. Cullinane and W.K. Talley (eds.) *Port Economics*, Research in Transportation Economics, Vol. XVI (Amsterdam, Elsevier) pp. 85–115.
143. Rodrıguez-Alvarez, A., Tovar, B. and Trujillo, L. (2007): “Firm and time varying technical and allocative efficiency: an application to port cargo handling firms”, *International Journal of Production Economics*, 109, 149–161.
144. Gonzalez, M.M. and Trujillo, L. (2008): “Reforms and infrastructure efficiency in Spain’s container ports”, *Transportation Research A*, 42(1), 243–257.
145. Sohn, J-R. and Jung, C-M. (2009): “The size effect of a port on the container handling efficiency level and market share in international transhipment flow”, *Maritime Policy & Management*, 36(2), 117–129.
146. Odeck, J. (2008): “Efficiency measurement of ferries serving road networks in norway: a

stochastic frontier approach", *Maritime Economics & Logistics*, 10, 409–428.

147. Yan, J., Sun, X. and Liu, J.J. (2009): "Assessing container operator efficiency with heterogeneous and time-varying production frontiers", *Transportation Research B*, 43(1), 172–185.

148. Panayides, P.M., Maxoulis, C.N., Wang, T. and Ng, K.Y.A. (2009): "A Critical Analysis of DEA Applications to Seaport Economic Efficiency Measurement", *Transport Reviews*, 29(2), 183–206.

149. Gonzalez, M.M. and Trujillo, L. (2009): "Efficiency measurement in the port industry: a survey of the empirical evidence", *Journal of Transport Economics and Policy*, 43(2), 157–192.

150. Cullinane, K.P.B., Wang, T., Song, D-W. and Ji, P. (2005): "A comparative analysis of DEA and SFA approaches to estimating the technical efficiency of container ports", *Transportation Research A: Policy and Practice*, 40(4), 354–374.

151. Cullinane, K.P.B., Song, D-W. and Wang, T-F. (2006): "The application of mathematical programming approaches to estimating container port production", *Journal of Productivity Analysis*, 24(1), 73–92.

152. Robinson, R. (2002): "Ports as elements in value-driven chain systems: the new paradigm", *Maritime Policy & Management*, 29(3), 241–255.

153. Mangan, J., Lalwani, C. and Fynes, B. (2008): "Port-centric logistics", *International Journal of Logistics Management*, 19(1), 29–41.

154. Bichou, K. and Gray, R. (2004): "A logistics and supply chain management approach to port performance measurement", *Maritime Policy & Management*, 31(1), 47–67.

155. Zhu, J. (2003): *Quantitative Models for Performance Evaluation and Benchmarking: Data Envelopment Analysis with spreadsheets* (Norwell, MA, Kluwer Academic Publishers).

156. Cochrane, R.A. (2008): "The effects of market differences on the throughput of large container terminals with similar levels of efficiency", *Maritime Economics & Logistics*, 10, 35–52.

157. Simonson, I. and Tversky, A. (1992): "Choice in context: tradeoff contrast and extremeness aversion", *Journal of Marketing Research*, 29, 281–295.

158. Cooper, W.W., Park, K.S. and Yu, G. (1999): IDEA and AR-IDEA: Models for dealing with imprecise data in DEA, *Management Science*, 45, 597–607.

159. Cook, W.D. and Zhu, J. (2006): "Rank order data in DEA: A general framework", *European Journal of Operational Research*, 174, 1021–1038.

160. Banker, R.D. and Morey, R. (1986): "Efficiency analysis for exogenously fixed inputs and outputs", *Operations Research*, 34(4), 513–521.

161. Sexton, T.R., Silkman, R.H. and Hogan, A.J. (1986): "Data envelopment analysis: critique and extensions". in R.H. Silkman (ed.) *Measuring Efficiency: An Assessment of Data Envelopment Analysis* (San Francisco, Jossey-Bass) pp. 73–105.

162. Doyle, J. and Green, R. (1994): "Efficiency and cross efficiency in DEA: Derivations, meanings and uses", *Journal of the Operational Research Society*, 45(5), 567–578.

163. Wu, J., Yan, H. and Liu, J. (2009): "Groups in DEA-based cross-evaluation: An application to Asian container ports", *Maritime Policy and Management*, 36(6), 545–558.

164. Liang, L.F., Wu, J., Cook, W.D. and Zhu, J. (2008): "The DEA game cross-efficiency model and its Nash equilibrium", *Operations Research*, 56(5), 1278–1288.

165. Turner, H., Windle, R. and Dresner, M. (2004): “North American containerport productivity: 1984–1997”, *Transportation Research E*, 40, 339–356.
166. Simar, L. and Wilson, P.W. (2000): “A general methodology for bootstrapping in non-parametric frontier models”, *Journal of Applied Statistics*, 27(6), 779–802.
167. Cullinane, K.P.B, Song, D-W., Ji, P. and Wang, T-F. (2004): “An application of DEA windows analysis to container port production efficiency”, *Review of Network Economics*, 3(2), 186–208.
168. Charnes, A., Clark, C.T., Cooper, W.W. and Golany, B. (1985): “A developmental study of data envelopment analysis in measuring the efficiency of maintenance units in the U.S. Air Forces”, *Annals of Operation Research*, 2, 95–112.
169. Cook, W.D. and Seiford, L.M. (2009): “Data envelopment analysis (DEA) – thirty years on”, *European Journal of Operational Research*, 192, 1–17.
170. Gonzalez, M.M. and Trujillo, L. (2009): “Efficiency measurement in the port industry: a survey of the empirical evidence”, *Journal of Transport Economics and Policy*, 43(2), 157–192.
171. Brooks, M.R. and Cullinane, K.P.B. (eds.) (2007): *Devolution, Port Governance and Port Performance*, Research in Transportation Economics, Vol. XVII (Amsterdam, Elsevier).

Chapter 32
Organisational Change and Effectiveness in Seaports from a Systems Viewpoint

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1. Introduction

Ports are not only the intersection points between land and sea transport systems, but they are regarded as more complex, logistics and multimodal transport centres and value added organisations. Seaports are the main links in the supply chain systems that add value to the port users and final customers. Ports play an important role in the management and co-ordination of materials and information flows, as the transport is an integral part of the entire supply chain (Carbone and Martino, 2003).

Ports play the significant role in this system by providing effective functioning of the whole system and creating value to the players of the supply chain. The instigation of new logistics patterns of maritime and intermodal transportation means that modern ports can now compete for far-reaching cargoes with far-distant counterparts (Bichou and Gray, 2005). Therefore, overall organisational effectiveness should be achieved in seaports for maintaining the competitive positions in the port industry.

While the seaports have uncertainty and complexity in their environments their effectiveness can be achieved by the flexibility of the ports against the changing conditions, intensive communication between the parties in the supply chain, quality and efficiency of the operations and in brief the integrity of the whole system. However, these measures of effectiveness are not the only ones. From the earlier stages of organisational theory on effectiveness to present, there is still an ambiguity about the definition and measurement criteria of effectiveness.

In the port system, there is a direct link between the change and effectiveness concepts. A port cannot be effective without adapting to the changes in its environment. As a sub-system of the supply chain, the seaports are affected from the changes in the logistics and supply chain, transport industry and in a broader concept the trade and manufacturing industry. The fluctuations in these markets have direct and indirect effects on port organisation and managements.

Seaports are open systems interacting with their turbulent environments and affecting world trade with their maritime transport and technological developments. They are like living organisms being exposed to change every day. As Darwin claimed in “Origin of the Species”; “it is not the strongest species that will survive, nor the most intelligent, but the one most responsive to change”, the ability of responsiveness and flexibility to the changing market and environmental conditions is a must for the survival of seaport organisations. However, survival is not enough in today’s competitive transport market. The important point here is how to manage change to achieve organisational effectiveness and sustain competitive advantage.

When we look at the organisation theories of change and effectiveness, the direct link can easily be seen. Main objective of organisations conducting change is to achieve effectiveness. These two terms

can be analysed from the systems viewpoint which perfectly fits with the nature of the seaport systems.

In this study first of all, the systems approach to management is widely explained containing the theories developed and methods conducted. The meaning of effectiveness and its differences between the terms efficiency and performance are stated. Then the meaning of and approaches to organisational effectiveness are explained. The main approaches to and measures of organisational effectiveness are stated by a broad review of the management studies in this field. The systems approach, which emphasises both the subsystems (internal) in the organisation and the interaction of the organisation with its environment (external) is clarified and found applicable to determine the main measures of effectiveness in seaports.

Then, the organisational change concept; the types, theories about change, and the methods of change are defined. The relationship between the organisational change and effectiveness concepts are stated. The port organisations as value-added systems, their relations and integrations with the supply chain and the turbulence in their environments are explained. The importance of adaptability to the changing conditions is clarified.

As effectiveness cannot be achieved without adapting to the changes in the environment, a model concerning ports “as complex adaptive systems” has been developed including the effects of changes in logistics and transport systems, supply chain system and global production and trade system to the port system.

Finally, with combining the change and effectiveness concepts in port management “an organisational change and effectiveness model for ports” is developed. The four basic steps in the model are respectively: external drivers for change as determinants; port system model as the organisation system; methods of change as the intervention strategy used in the change process; and finally, the major port effectiveness measures.

2. Systems Theory in Management

All organisations function:

1. within the value patterns of cultural environment in which they are embedded;
2. within the political structure or pattern of legal norms and statues that define their formal legitimacy and limit their activities;
3. within the economic environment of competitive markets and competitive sources of input such as labor force and materials;
4. within the informational and technological environment;
5. within the natural and physical environment of geography, natural resources and climate.

In other words, organisations exist and adapt to five environments – the cultural, the political, the economic, the technological and the ecological (Katz and Kahn, 1978). Emery and Trist (1965) described the four general dimensions of environment as stability/turbulence, uniformity/diversity, clustered/random, scarcity/munificence. Systems Theory paradigm is being used extensively in the investigation of relationships between subsystems within organisations and in studying the environmental interfaces (Kast and Rosenzweig, 1972).

From a systems theory perspective, an organisation is a social system which, in its interaction with its environment, activates at least four systemic processes:

1. inputs of various types of resources;
2. transformations of resources with the aid of social and/or technical mechanism;
3. outputs which are transmitted to other systems; and
4. feedback effects whether negative or positive (Evan, 1976).

The term “systems approach” is applied to

1. the formulation of systems and subsystems;
2. the relating of changes in any part of the system to total performance; and
3. the use of a developing body of knowledge related to the functioning and measurement of various types of systems (Fox, 1974).

According to Optner (1968) a “system” is defined as some ongoing process of a set of elements, each of which are functionally and operationally united in the achievement of an objective. Cleland and King (1975) defines a “system” as an organised or complex whole, an assemblage or combination of things and parts forming a complex and a unitary whole. According to the systems theory, a “system” is an organised, unitary whole composed of two or more independent parts, components or subsystems and delineated by identifiable boundaries from its environmental supra-system. According to Kast and Rosenzweig (1979) an organisation’s subsystem – an interdependent component with some relationship in an organisation – is composed of goals and values, technical, psychosocial, structural and managerial subsystems. The social structure of the organisation is previously defined by Etzioni (1960) as: “the organisations are the systems of coordinated activities of more than one actor.”

The five basic considerations about the definition of the systems are (Churchman, 1979):

- the total system objectives and the performance measures of the whole system;
- the system's environment;
- the resources of the system;
- the components of the system, their activities, goals and measures of performance; and
- the management of the system.

The system concept includes two different definitions according to their interactions with the environment: the closed and open systems. The closed system has rigid, impenetrable boundaries, whereas the open system has permeable boundaries between itself and a broader supra-system. The boundaries set the domain of the organisation’s activities (Berrien, 1976).

The derivation of the general systems theory relevant to formal human work organisations has the name open systems theory. The central propositions of this theory are concerned with system boundaries, differentiation and integration of the subsystems that are parts of the focal system, input–transformation–output processes, boundary transactions and system maintenance processes (Seashore, 1983).

Open systems theory emphasises the close relationship between a structure and its supporting environment. The other major emphasis is on throughput: the processing of production inputs to yield some outcome that is then used by an outside group or system. According to Katz and Kahn (1978) open systems have 10 main characteristics including importation of energy, the throughput, the output, systems as cycles of events, negative entropy, information input, negative feedback and the coding process, the steady state and dynamic homeostasis, differentiation, integration and coordination and equifinality. As organisations are open systems, Jackson (2000) proposes that the

primary subsystems of an organisation are mainly: the goal, technical, human and managerial subsystems.

The interaction of the organisation with its internal resources to the changing environment refers that they are open systems which places a great deal of emphasis on flexibility and external focus, and would stress flexibility and readiness (as means) and growth, resource acquisition, and external support (as ends) (Quinn and Rohrbaugh, 1983). Open systems emphasises the distinctiveness of the organisation as an identifiable social structure or entity, and it emphasises the interdependency processes that relate the organisation to its environment (Yuchtman and Seashore, 1967). The "organisations-as-open systems" approach looks at all the subsystems, their interrelationships, and the interactions between the subsystems (and the organisation as a whole) and the environment (Jackson, 2000).

In the socio-technical systems approach, the goals and values, as well as the technical, structural, psycho-social and managerial subsystems are shown as the integral parts of the overall organisation (Kast and Rosenzweig, 1972). Social organisations are flagrantly open systems in that the input of energies and the conversion of output into further energetic input consist of transactions between the organisation and its environment. Every surviving system must provide some output acceptable usually to a collateral or supra-system (Berrien, 1976). Two basic criteria for identifying social systems and determining their functions are (1) tracing the pattern of energy exchange or activity of people as it results in some output, and (2) ascertaining how the output is translated into energy that reactivates the pattern (Katz and Kahn, 1978).

In a social system, the organisational boundaries are not easily definable and are determined primarily by the function and activities of the organisation (Berrien, 1976). A reason for the indefiniteness of the boundaries in a social organisation is the rapidly changing conditions in its environment and the continuous interaction between the environment and organisation. Organisations do not exist in a static world. The surrounding environment is in a constant state of flux, and a rigid technical system, even if protected by excellent support structures. Organisations develop adaptive structures whose function is to gather advance information about trends in the environment, carry out research on internal productive processes, and plan for future developments (Katz and Kahn, 1978). These complex adaptive systems are open systems in intimate interchange with an environment characterised by a great deal of shifting variety and its constraints (Buckley, 1968). Morel and Ramanujam (1999) state that organisations are routinely viewed as dynamic systems of adaptation and evolution, which contain multiple parts that interact with one another and the environment.

Another approach to measure the complex dynamics systems has been conceived and developed in the late 1950s in Massachusetts Institute of Technology by Jay Forrester and his team. The advent of System Dynamics (SD) is generally considered to be the publication of Forrester's pioneering book, "Industrial Dynamics" in 1961 (Santos *et al.*, 2002). Sterman (2000) used system dynamics modelling for the analysis of policy and strategy, with a focus on business and public policy applications. System Dynamics has its origins in control engineering and management; the approach uses a perspective based on information feedback and delays to understand the dynamic behaviour of complex physical, biological, and social systems (Angerhofer and Angelides, 2000). It focuses on the structure and behavior of systems composed of interacting feedback loops. The objective of this approach is to capture the dynamic interaction of different system variables and to analyse their impact on policy

decisions over a long-term horizon (Sachan *et al.*, 2005).

System Dynamics is widely used in business and management fields and related to our study is a method that portrays the process of organisational change. Many studies have been published about the application of system dynamics methodology to the process of change in organisations (Frechette and Spital, 1991; Samuel and Jacobsen, 1997). SD is also used in supply chain management (Angerhofer and Angelides, 2000; Kumar and Yamaoka, 2007) and in maritime transport concepts (Engelen *et al*., 2006).

3. Organisational Effectiveness and Systems Approach

Organisations are constructed to be the most effective and efficient social units. The actual effectiveness of a specific organisation is determined by the degree to which it realises its goals. There is some further ambiguity between the terms efficiency and effectiveness. Efficiency defines how well the processes of the organisation perform (Jumara, 2005) and the efficiency of an organisation is measured by the amount of resources used to produce a unit of output (Etzioni, 1964). Efficiency is an economic index of the ratio of measured inputs to measured outputs (Cummings, 1983). Effectiveness is a term related with the outputs and goals of an organisation; however efficiency describes the optimal use of current resources (Hirsch, 1975). Katz and Kahn (1966) linked effectiveness explicitly to an external referent, and efficiency to internal activities more easily controlled by the organisation and state that efficiency is a criterion of the internal life of the organisation, especially the economic and technical aspects (Katz and Kahn, 1978). However, the effectiveness is the aggregation of opportunities provided to the members of the unit (in the case of the organisational level, it is the opportunities provided by organisational membership to the individual). For an organisation to be effective, a subsystem must be concerned with showing that performance meets the standards that external and internal constituencies (e.g. resource suppliers and customers) monitor (Cummings, 1983).

In some studies of organisational effectiveness (Gibson *et al.*, 1973; Webb, 1974), efficiency is used as a criterion for the measurement of effectiveness of an organisation. Cunningham (1977) defines efficiency from the organisational and systems perspective and states that efficiency is an indication of the organisation's ability to use its resources in responding to the most important subsystem needs. However, Sproles (2001) states that effectiveness is the domain of the end user who wishes to know if the system is able to meet a need (Sayareh, 2007).

Barnard (1938) reasoned that organisations are "co-operative systems." His definition of organisational effectiveness is couched in terms of the process of cooperation. Organisational effectiveness is the accomplishment of the recognised objectives of the cooperative action. However, organisational efficiency is defined as follows: the efficiency of a cooperative system is the resultant of the efficiencies of the individuals furnishing the constituent efforts, that is, as viewed them (Barnard, 1938). Effectiveness and efficiency are achieved through the interactions among people as managed by both the formal (studied by traditional theory) and informal (studied by human relations theory) structures of the enterprise (Jackson, 2000).

In the management discipline many researchers studied the relationship between the organisational effectiveness and the environment of the organisations (Etzioni, 1960; Yuchtman and Seashore, 1967; Osborne and Hunt, 1974; Hirsch, 1975). According to Yuchtman and Seashore (1967) most existing

definitions of organisational effectiveness have been formulated, implicitly or explicitly, in terms of a relation between the organisation and its environment. A study of effectiveness has to include an analysis of the environmental conditions and of the organisation's orientation to them (Etzioni, 1960). Hirsch (1975); Lawrence and Lorsch (1967) and Negandhi and Reimann (1973) are all concerned with the interrelationships between organisational structure and environment, which prompts them to measure organisational effectiveness.

Katz and Kahn (1966) proposed defining organisational effectiveness as "the maximisation of return to the organisation by all means." Georgopoulos and Tannenbaum (1957) concur with this statement and explicate that the definition of organisational effectiveness must encompass two aspects: the objectives of organisations (the ends); and the means through which they sustain themselves and attain their objectives. Robbins (1990) also states that organisational effectiveness must consider both means (process) and ends (outcomes).

Organisational effectiveness may be typified as being mutable (composed of different criteria at different life stages), comprehensive (including a multiplicity of dimensions), divergent (relating to different constituencies), transpositive (altering relevant criteria when different levels of analysis are used), and complex (having non-parsimonious relationships among dimensions) (Cameron, 1978).

3.1 Approaches to organisational effectiveness

The widely studied and practiced organisational effectiveness models include the goal attainment approach (Etzioni, 1960), the systems resource approach (Yuchtman and Seashore, 1967), the internal process approach (Bennis, 1966; Steers, 1977; Pfeffer, 1977; Nadler and Tushman, 1980), the human relations approach (Argyris, 1964; Ahmed, 1999), the multiple/strategic constituencies approach (Pfeffer and Salancik, 1978; Connolly *et al.*, 1980; Jobson and Schneck, 1982; Keeley, 1984; Tsui, 1987; Zammuto, 1984; Ehreth, 1988), the competing values approach (Quinn and Rohrbaugh, 1983; Shilbury and Moore, 2006) and the ineffectiveness approach (Henri, 2004).

- The *goal attainment approach* views effectiveness in terms of internal organisational objectives and performance (Molnar and Rogers, 1976) and organisations as purposeful and coordinated agents (Georgopoulos and Tannenbaum, 1971). Keeley (1978) proposes two variants of the goal models: official and operative goal models.
- The *internal process approach* focuses on the internal functions of the organisation and stability and efficiency remain two of the criteria of such effectiveness (Heffron, 1989).
- The *human relations approach* focuses on the people and upholds the satisfaction of employees' needs as the most important end (Argyris, 1964).
- The *strategic constituencies approach* proposes that an effective organisation is one that satisfies the demands of those constituencies in its environment from whom it requires support for its continued existence (Robbins, 1990).
- The *competing values approach* constitutes a synthesis and an extension of the other organisational effectiveness models (Pfeffer and Salancik, 1978; Quinn and Rohrbaugh, 1983).
- The *ineffectiveness approach's* basic assumption is that it is easier, more accurate, more consensual and more beneficial to identify problems and faults (ineffectiveness) than criteria of competencies (effectiveness) (Henri, 2004).
- The *system approach* views organisations as open systems, which work in close relationship

with the environment (Yuchtman and Seashore, 1967; Molnar and Rogers, 1976; Ahmed, 1999).

A review of organisational effectiveness literature between the years 1949–2009 shows that there are many different approaches to the effectiveness concept in organisations. Table 1 encompasses 58 publications, composed of books, book chapters and important articles in leading academic journals in business and management fields. Many of the authors wrote in the early stages of the organisational effectiveness concept and are the pioneer theorists in this field (Etzioni, 1960; Yuchtman and Seashore, 1967; Pfeffer and Salancik, 1978). The approaches to the concept changed and developed through the years. Some alternative models which were generally the enhanced versions of the main approaches mentioned above were developed and applied to different types of organisations in recent years (Ridley and Mendoza, 1993; Herman and Renz, 1998; Ahmed, 1999; Henri, 2004).

The systems approach to organisational effectiveness is a widely studied model as can be seen from Table 1. Seventeen (29%) of the authors used the principles of this approach in explaining and measuring effectiveness. The goal-attainment and multiple constituency approaches are both discussed in 10 publications, where competing values approach is embraced by five authors and internal process approach just by four.

3.2 Systems approach to organisational effectiveness

The concept of organisational effectiveness is ordinarily used to refer to goal attainment (Georgopoulos and Tannenbaum, 1957). But, according to Etzioni (1960) the system model is theoretically more powerful and avoids certain value judgments than the goal model of organisational effectiveness.

According to Yuchtman and Seashore (1967) an adequate conceptualisation of organisational effectiveness cannot be formulated unless factors of organisation–environment

Table 1: Organisational effectiveness approaches

Year	Author	Model
1949	Selznick	Systems–resource approach
1952	Bass	Participant–satisfaction approach
1957	Georgopoulos and Tannenbaum	Systems–resource approach
1960	Etzioni (1964)	Goal attainment approach
1961	Perrow	Goal attainment approach
1962	Georgopolous and Mann	Goal attainment approach
1964	Argyris	Human resource approach
1966	Bennis	Internal processes approach
1966	Katz and Kahn	Systems–resource approach
1967	Mahoney	Systems–resource approach
1967	Yuchtman and Seasore	Systems–resource approach
1968	Friedlander and Pickle	Goal attainment approach
1972	Gibb	Systems approach
1972	Hall (1977, 1978, 1982)	Goal attainment approach
1972	Price	Goal attainment approach
1972	Mott	Goal attainment approach
1973	Negandhi and Reimann	Systems–resource approach
1975	Child	Contingency approach
1975	Pennings	Structural–contingency approach
1976	Aldrich	Systems–resource approach
1976	Evan	Systems approach
1976	Kilmann and Herden	Systems approach
1976	Steers (1977)	Internal processes approach
1976	Stewart	Systems approach
1977	Campbell	Goal attainment approach
1977	Hannan and Freeman	Systems approach
1977	Pennings and Goodman	Alternative approach (Goal+Constituency)
1977	Pfeffer	Internal processes approach
1977	Scott	Goal attainment approach
1977	Weick	Novel approach
1978	Cunningham (1977)	Systems–resource approach

Table 1: (Continued)

Year	Author	Model
1978	Keeley	Multiple constituency approach (Social–Justice)
1978	Pfeffer and Salancik	Multiple constituency approach
1980	Bluedorn	Goal attainment approach
1980	Connolly, Conlon and Deutsch	Multiple constituency approach
1980	Miles	Systems approach
1980	Nadler and Tushman	Internal processes approach
1981	Rohrbaugh	Competing values approach
1981	Quinn and Rohrbaugh	Competing values approach
1982	Jobson and Schneck	Multiple constituency approach
1982	Miles and Cameron	Legitimacy approach
1983	Gaertner and Ramnarayan	Organisation's account model
1983	Quinn and Cameron	Life cycle approach
1983	Quinn and Rohrbaugh	Competing values approach
1983	Schneider	Systems approach (interactionist perspective)
1984	Cameron (1978, 1980, 1981, 1986)	Multiple constituency approach
1984	Keeley	Multiple constituency approach
1987	Tsui (1990)	Multiple constituency approach
1984	Zammuto	Multiple constituency approach
1988	Ehreth	Multiple constituency approach
1988	Pasmore	Systems–resource approach
1993	Ridley and Mendoza	Systems–organisation–consultation approach
1998	Herman and Renz	Multiple constituency approach (Social constructivist perspective)
1998	Lysons, Hatherly and Mitchell	Competing values approach
1999	Ahmed	Human relations approach
2004	Henri	Ineffectiveness approach
2004	Muczyk	Systems approach
2006	Shilbury and Moore	Competing values approach

Source: The authors

relationships are incorporated into its framework. However, both the goal and functional approaches cannot give an adequate consideration to the conceptual problem of the relations between the organisation and its environment.

Gaertner and Ramnarayan (1983) categorise organisational effectiveness approaches according to two dimensions: focus of definition (process/structure or outcome) and intended use concepts (general or organisation-specific). The systems approach is located in the intersection of process/structure and general concept. This refers that systems approach is not only related with the outputs and goals of the organisation, but also the process/structure and means (resources) used in this process are the main concerns in this approach. This approach takes the environment and the whole system into consideration, not just the organisation itself.

In the systems approach of the organisational effectiveness the starting point is not the goal itself, but a working model of a social unit which is capable of achieving a goal (Etzioni, 1960) which focuses on behavior conceived as continuous processes of exchange and competition over scarce and valued resources rather than focusing on goals only (Yuchtman and Seashore, 1967). Unlike a goal, it is a model of a multi-functional unit.

Georgopoulos and Tannenbaum (1957) define organisational effectiveness from the systems perspective as: “Organisational effectiveness is the extent to which an organisation as a social system, given certain resources and means, fulfills its objectives without incapacitating its means and resources and without placing undue strain upon its members.”

The systems resource model defines the organisation as a network of interrelated subsystems. The outputs of one subsystem may become the inputs of another subsystem; the organisational system functions effectively to the degree that its subsystems are in harmony and are coordinated to work together (Cunningham, 1977). Universally required resources are mainly, personnel, physical facility, technology and money as a liquid resource (Yuchtman and Seashore, 1967).

In the systems resource model, the interdependence between the organisation and its environment takes the form of input–output transactions. Three phases of the systems model are: the importation of resources, their use (including allocation and processing) and their exportation in some output form that aids further input (Yuchtman and Seashore, 1967).

According to Cunningham (1977) an organisation, in order to survive, must satisfy some basic needs: (1) acquiring resources; (2) interpreting the real properties of the external environment; (3) production of outputs; (4) maintenance of internal activities; (5) coordination of relationships between subsystems; (6) responding to feedback; (7) evaluating the effect of its decision; and (8) accomplishing goals.

However there are some limitations of the systems approach to organisational effectiveness. The three most important shortcomings of this approach relate to the fact that measurements for all of a systems needs are difficult to develop (Cunningham, 1977), the debate that whether means really matter (Robbins, 1990) and are more expensive for the researcher (Etzioni, 1960).

The systems approach looks at factors such as relations with the environment to assure continued receipt of inputs and favourable acceptance of outputs, flexibility of response to environmental changes, the efficiency with which the organisation transforms inputs to outputs, the clarity of internal communications, the level of conflict among groups and the degree of employee job satisfaction (Robbins, 1990).

General systems theory with its biological orientation would appear to have an evolutionary view of system effectiveness. The living system which best adapts to its environment prospers and survives. But, this is not the case in social organisations. According to Kast and Rosenzweig (1972) the questions of organisational effectiveness must be concerned with at least three levels of analysis: the level of the environment, the level of the social organisation as a system, and the level of the subsystems (human participants) within the organisation Emery and Trist (1959) stress that the primary task of managing an enterprise as a whole is to relate the total organisational system to its environment, and not just internal regulation. The basic organisations-as-systems prescription remains: if an organisation is not functioning effectively, examine its subsystems to see that they are meeting its needs to ensure it is well adjusted to its environment (Jackson, 2000).

3.3 Measures of organisational effectiveness

Evaluating the overall effectiveness of an organisation is one of the most difficult problems in organisation theory. There is still a lack of consensus as to measure what constitutes a useful and valid set of effectiveness. According to Steers (1975) this is because effectiveness is an abstract idea rather

than a concrete phenomenon. Quinn and Rohrbaugh (1983) concur with this idea and state that effectiveness is not a concept but a construct. Henri (2004) agrees and states that there is a serious ambiguity and confusion surrounding the construct of effectiveness.

Steers (1975) states that researchers face many problems in the measurement of organisational effectiveness. The ambiguity of the construct "effectiveness", the transitory nature of the many effectiveness criteria, the conflicts that can emerge between these criteria, the difficulty to measure them and the inapplicability of the same criteria to different situations and organisations are the main problems in the measurement of organisational effectiveness.

The criteria of an effective organisation can be classified into two categories: (a) tangible or inorganic criteria; and (b) intangible or organic criteria. The tangible or inorganic criteria refer to the quantitative measures of an organisation (Sahni, 2000) such as performances in finance, sales, manufacturing, purchasing, and profits.

It is possible to identify two general types of models: (1) *normative,* or prescriptive, models, which attempt to specify those things an organisation must do to become effective; and (2) *descriptive* models, which attempt to summarise the characteristics found in successful organisations (Steers, 1975).

A useful framework for assessing organisational effectiveness suggests four main categories: (1) achieving goals; (2) increasing resourcefulness; (3) satisfying clients; and (4) improving internal processes (Cameron, 1980; Bramley, 1986; Redshaw, 2000).

Yuchtman and Seashore (1967) specify the steps needed for the comparative assessment of organisational effectiveness: (1) to provide a taxonomy of resources; (2) to identify the different types of resources that are mutually relevant for the organisations under study; and (3) to determine the relative positions of the compared organisations on the basis of information concerning the amount and kinds of resources that are available for the organisation and its efficiency in using these resources to get further resources.

Georgopoulos and Tannenbaum (1957) observed that the common practice of measuring effectiveness by univariate measures, such as productivity or profit, was inconsistent with the broad meaning attached to effectiveness in the organisational literature (Keeley, 1978). Many researchers have studied several possible criteria available in the measurement of organisational effectiveness. A major advantage of the multivariate

Table 2: Organisational effectiveness measures

Study	**Organisational effectiveness measures**
Bass (1952)	Profitability, survival, societal value, organisation's worth
Caplow (1953)	Cohesion, satisfaction, self-maintenance of the members
Buchele (1955)	Initiative, supportive programmes, leadership, decision making
Georgopoulos and Tannenbaum (1957)	Productivity, flexibility, absence of organisational strain
Bennis (1962)	Adaptability, sense of identity, capacity to test reality
Caplow (1964)	Integration, stability, voluntarism, achievement
Katz and Kahn (1966)	Growth, storage, survival, control over environment
Lawrence and Lorsch (1967)	Integration, differentiation
Pickle and Friedlander (1967)	Satisfaction, employee satisfaction
Yuchtman and Seasore (1967)	Resource acquisition, control over environment
Friedlander and Pickle (1968)	Profitability, employee satisfaction, societal value
Price (1968)	Productivity, conformity, morale, adaptiveness, institutionalisation
Mahoney (1967)	Efficiency, support, planning, initiative, utilisation, reliability
Mahoney and Weitzel (1969)	*General business model:* Productivity–support–utilisation, planning, reliability, initiative. *R&D model:* Reliability, cooperation, development
Schein (1970)	Open communication, flexibility, creativity, psychological commitment
Paine (1971)	Support, planning, integration, goal consensus, goal clarity
Mott (1972)	Productivity, flexibility, adaptability
Campbell (1973)	Productivity, profitability, employee satisfaction, organisational commitment
Duncan (1973)	Goal attainment, integration, adaptation
Gibson *et al.* (1973)	*Short-run:* Production, efficiency, satisfaction *Intermediate:* adaptiveness, development *Long-run:* survival
Negandhi and Reimann (1973)	Growth in sales, net profit. Manpower acquisition, manpower retention, manpower utilisation, employee satisfaction, interpersonal relations, interdepartmental relations

Table 2: (Continued)

Study	Organisational effectiveness measures
Child (1974, 1975)	Profitability, growth
Reimann (1974)	Profitability, employee satisfaction, employee attraction, morale, output quality, customer service, competitor evaluation, growth potential
Webb (1974)	Cohesion, efficiency, adaptability, support
Penning (1975, 1976)	Total production, decline in production, loss due to transactional errors, morale, anxiety
Kilmann and Herden (1976)	Efficiency, member motivation, societal satisfaction, bargaining position in environmental exchange
Stewart (1976)	Adaptability, integration, cohesion, goal attainment
Campbell (1977)	Flexibility/adaptation, productivity, profit, efficiency, job satisfaction, growth, planning and goal setting, morale, conflict/cohesion, communication/information management, stability, quality, motivation, goal consensus, achievement, control, absenteeism, accidents, turnover, internalisation of organisational goals, utilisation of environment, evaluations by external entities, readiness, role and norm congruence, value of human resources, training and development emphasis, managerial interpersonal skills, managerial task skills, participation and shared influence, overall effectiveness
Cameron (1978)	Adaptability, employee satisfaction, support, growth, survival, resource acquisition, satisfaction, communication, development, goal attainment, customer satisfaction, community interaction, organisational health
Glisson and Martin (1980)	Productivity, efficiency
Angle and Perry (1981)	Organisational commitment
Bhargava and Sinha (1992)	Organisational commitment, interpersonal conflict, supportive programmes, production
Ridley and Mendoza (1993)	Adaptability, efficiency, flexibility, survival, sensitivity, maximisation of return, environmental contribution, transformation, advantageous transactions, boundary permeability
Herman and Renz (1998)	Board governance, financial management, fund raising, program delivery, community collaboration, public relations, government relations, voluntarism, human resource management
Jackson (1999)	Organisational structure, voluntarism, internal communication, management experience, political impact, board of directors, involvement

(*Continued*)

Table 2: (Continued)

Study	Organisational effectiveness measures
Parhizgari and Gilbert (2004)	Organisational commitment, supportive programmes, Organisational structure, customer oriented behavior, importance of the mission, working conditions, pay and benefits, operational efficacy, positive supervisory practices
Sayareh and Lewarn (2006)	Adaptability, productivity, profitability, efficiency, growth, planning, communication/information management, stability, output quality, customer satisfaction, leadership, human resource management, professionalism
Shilbury and Moore (2006)	Productivity, flexibility, planning, resource acquisition, stability, member motivation, availability of information, professional support, volunteer support, work harmony

Source: Steers (1975) and the authors.

models is their comprehensive nature, subsuming several variables under one unifying framework. Unfortunately, this advantage can simultaneously represent a major weakness where such criteria are in conflict with one another (Steers, 1975).

As an extension of Table 1, Table 2 lists the studies and the major organisational effectiveness criteria used in these studies. The studies cover the articles, book chapters and books in this field. By the review of many theoretical and empirical publications on organisational effectiveness concept, just 38 of them prominently state the effectiveness measures that should be used or are used in their studies. A total of 107 effectiveness measures are derived from these studies. The frequencies of occurrence of these criteria are measured. As a criterion of effectiveness, adaptability has the maximum frequency with 11; however flexibility which has a very close meaning with adaptability has a frequency of 6. Many studies use these measures interchangeably. Therefore, the adaptability and flexibility concepts can be combined and used as a single criterion. According to the results, the other important measures of effectiveness and their frequencies are productivity (10), profitability (8), efficiency (8), employee satisfaction (7), support (6), growth (6), planning (6), survival (5), integration (5), resource acquisition (4), morale (4), organisational commitment (4), cohesion (4), satisfaction (4), communication (4) and stability (4).

The main effectiveness criteria are the tangible measures such as productivity, profitability and efficiency whose measurements are easier than the intangible measures. The intangible measures are related to the human resources of the organisation like satisfaction, morale, commitment and cohesion. These are related to the internal processes of the organisation where the tangible measures have an external focus and are directly related to its goals. When we look at the results, it is obvious that the criteria used in systems approach to measure the organisational effectiveness are adaptability/flexibility, support, growth and resource acquisition (Quinn and Rohrbaugh, 1983) have high frequencies and are widely used in the assessment of organisational effectiveness.

4. A Systems Model of Organisational Effectiveness at Ports

In port business literature, there have been many studies relating to port performance and efficiency (Monie, 1987; Tongzon, 1995; De Langen, 2001; Tongzon, 2001; De and Ghosh, 2003; Paixao and Marlow, 2003b; Bichou and Gray, 2004; Barros and Athanassiou, 2004; Lam 2005; Wang and Cullinane, 2006; Wang *et al.*, 2006; De Langen *et al.*, 2006; Owino *et al.*, 2006; Panayides and Song, 2006; Beresford and Pettit, 2007; Brooks and Pallis, 2007; Wang *et al.*, 2007). De Langen *et al*. (2006) lists the name and definitions of the major port performance indicators in their study. However there are only a few approaches considering the effectiveness of seaport organisations (Sayareh and Lewarn, 2006; Sayareh, 2007).

The difference between the measures of effectiveness and performance is that a measure of effectiveness is a standard against which we judge how well we achieved what we intended or wanted to achieve; a measure of performance is the measure of what was achieved (Sproles, 2000). It can be referred that measures of effectiveness are representative of certain properties of the solution and they are concerned with the outcomes (external view) of a solution (Sproles, 2002).

As mentioned above there are not many studies about the effectiveness concept in port management, however some studies use port success or port competitiveness terms that can be used in place of the term effectiveness. Table 3 lists some port studies that mention the measures a port should achieve to be successful or, in other words, effective. Within these studies only Sayareh and Lewarn's, 2006 study uses the term "port effectiveness".

As discussed earlier, multiple criteria should be used for assessing the organisational effectiveness

of seaports. It is because of the complexity and dynamism in the structure (sub-systems) and environment of the port systems. A system model of organisatinoal effectiveness is a model of a multi-functional unit, considering the inputs that are needed for the process/transformation and the outputs that may become the inputs of another following subsystem. Where the seaports are the major parts of the supply chain system and have a complex structure containing many different interdependent units, the systems approach to organisational effectiveness is used as the model (Karatas and Cerit, 2008). This approach has three basic elements which are inputs or resources that are needed for a process/subsystem, the process itself and the outputs or outcomes of these processes.

In the systems approach to organisational effectiveness it is recognised that no organisation can reach overall effectiveness if one or more subsystems are performing inadequately. Therefore the subsystems in a seaport organisation should be identified to reach and assess the whole effectiveness of the system.

Since the seaports are multi-functional and multi-faceted organisations with complex structures, they encompass many functions in their systems. These functions or subsystems can also be regarded as the processes or transformations in the ports. Every function needs certain inputs where some subsystems have common inputs used to form outputs. The outputs of each function and the coherence and harmony between these functions directly affect the effectiveness of the port system.

The systems model of seaport effectiveness covers 11 port sub-systems which are mainly the port engineering facilities (port infrastructure, superstructure, equipment repair and maintenance); port operations (cargo handling, pilotage and towage and

Table 3: Port success/effectiveness measures

Notteboom and Winkelmans (2001)	Flexibility to adapt quickly to changing opportunities, Integral approach to logistics issues in transport chains
Paixao and Marlow (2003)	Agility, leanness
Bichou and Gray (2004)	Logistics and supply chain approach
Song and Yeo (2004)	Customer orientation
Park and De (2004)	Productivity, profitability, marketability, overall efficiency
Sayareh and Lewarn (2006)	Adaptability, productivity, profitability, efficiency, growth, planning, communication/information management, stability, output quality, customer satisfaction, leadership, human resource management, professionalism
Baltazar and Brooks (2007)	Fit between strategy, structure and environment
Notteboom (2007)	Reliability and flexibility in services, transparency in port governance, external coordination and control, planning and concession policy approach, customer orientation, information management and communication, logistics orientation, community support and strong environmental record
Brooks and Pallis (2008)	Effective using the strategies, structures, and task environment to meet the mission and stated goals
Song and Panayides (2008)	Price, quality, reliability, customisation, responsiveness

Source: The authors

services to ships); logistical and industrial aspects (value-added services, distribution parks, manufacturing facilities); social issues (port labour, interaction with the city and nation); economic and financial issues (economic impact to the region, creation of employment, arrangement of port tariffs, profit, finance of investments, employee expenditures); political and legal issues (customs,

immigration); environmental issues (marine pollution); safety and security issues; marketing issues (customer relations); human resources (relations with employees, motivation, training); and finally, organisational and managerial issues (organisation structure, leadership, strategic planning).

The effectiveness measures that are also applicable to port organisations are categorised as outputs under the port sub-systems according to the relevancy with each sub-system. The major effectiveness measures for each port process are listed in Table 4.

All these facets or different interdependent units of the port system intersect at one point, at the port management function which reflects the overall effectiveness of the seaport organisation.

Table 4: Measures of port effectiveness in systems approach

Port process	Output (measure of effectiveness)
Port engineering	• Resource acquisition
Port operations	• Efficiency • Productivity • Output quality
Logistics and industrial facilities	• Value generation
ICT	• Innovation • Adaptability • Information management and communication
Economic and financial issues	• Profitability • Organisation's worth
Social and environmental issues	• Survival
Political and legal issues	• Autonomy
Safety and security	• Compliance (conformity)
Human resources	• Human resource quality • Professionalism • Leadership
Marketing	• Customer satisfaction • External support
Port organisation and management	• Goal attainment • Flexibility • Cohesion • Growth • Stability • Planning

Source: Karatas and Cerit (2008)

5. Organisational Change Concept

Representative descriptions of change vary with the level of analysis (Ford and Ford, 1994). At the most general level, change is a phenomenon of time. It is the way people talk about the event in which something appears to become, or turn into, something else, where the something else is seen as a result or outcome (Weick and Quinn, 1999).

There is no single accepted definition of organisational change. This is perhaps not surprising given the wide diversity of change experienced by organisations and individuals. Porras and Silvers (1991) define organisational change as the "process by which organisations move their present state to some future state to increase effectiveness" (Jumara, 2005). From the perspective of organisational development, change is a set of behavioural science-based theories, values, strategies, and techniques aimed at the planned change of the organisational work setting for the purpose of enhancing individual development and improving organisational performance, through the alteration of organisational members on-the-job behaviour (Porras and Robertson, 1992). Hitt *et al.* (1998) state that organisational change is closely connected to the technology explosion phenomenon – particularly with respect to information and telecommunication technologies, also to the resulting globalisation of

economic activities through free trade and movement of products and capital and, to a lesser but accelerating extent, of human resources (Prastacos *et al.*, 2002).

5.1 Theories of change

In the 1950s, social psychologist Kurt Lewin developed a theory of social change. According to his theory, successful change requires unfreezing the status quo, moving to a new state and refreezing the change to make it permanent (Robbins, 1990). Some researchers have put together more complete models of understanding change, Hinings and Greenwood's (1988) model of change dynamics, Pettigrew's (1985) process/content/context model, and Burnes (2004) change management framework are all in this category (Bamford and Daniel, 2005). Kanter *et al*. (1992) claimed that change is both "ubiquitous and multidirectional" and thus Lewin's model does not come close to the level of complexity needed to address the phenomenon of organisational change (Hatch, 1997). Kanter *et al*. (1992) defined organisations as a "bundle of activities" and claim that change itself occurs at three levels of analysis specified by organisation theory – environment (macroevolutionary forces for change), organisation (microevolutionary forces for change) and individual (political forces for change). In symbolic– interpretive theory, the changes are more normative in nature and the entire system is a political and socially constructed reality rather than the economic and technological reality of the modernist perspective (Hatch, 1997).

Van de Ven and Poole (1995) identify four process theories of organisational change and development according to the unit and mode of change: *life-cycle, evolutionary, dialectical* and *teleological* (Gebhart, 2004). According to their meta-theoretical scheme; the life-cycle model depicts a prescribed change within an entity, the teleological model contains a constructive change within an entity. However, in evolutionary model and dialectical models, change takes place in multiple entities, but modes of change differ as being prescribed and constructive respectively. Van de Ven and Poole (2005) developed a typology of four approaches to study organisational change. They looked organisational change according to ontological and epistemological aspects including two approaches: variance and process approaches to organisational change.

5.2 Types of change

From the literature of organisational change and development there would appear to be two main approaches to change: planned and emergent. Robbins (2000) defines planned change as "the deliberate design and implementation of a structural innovation, a new policy or goal, or a change in operating philosophy, climate and style". The major difference between planned and emergent change is that, in emergent change, the emphasis is on "bottom-up" action rather than "top-down" control as is the case in planned change. Dawson (1994), as a proponent of emergent rather than planned change, claims that change must be linked to developments in markets, work organisation, systems of management control and the shifting nature of organisational boundaries and relationships (Bamford and Daniel, 2005). For the proponents of emergent change, it is the uncertainty of the environment that makes planned change inappropriate and emergent change more pertinent. This point is emphasised by Strickland (1998), who draws on systems theory to emphasise the way that organisations are separate from, but connected to, their environment (Bamford and Daniel, 2005).

Weick and Quinn (1999) see change as a genre of organisational analysis and point out two types of change: *episodic* and *continuous*. *Episodic change* is used to group together organisational changes

that tend to be infrequent, discontinuous, and intentional. However, in *continuous change*, organisations are emergent and self-organising, and change is constant, evolving, and cumulative. Robbins (2000) discusses how change can be measured by two categories: *evolutionary* and *revolutionary* change. *Evolutionary change* is gradual, incremental and specifically focused. *Revolutionary change* is sudden, drastic and organisation-wide (Jumara, 2005). Sherman *et al.* (2006) see the notion from open-systems theory and define evolutionary change, long-run change, as change related with the system's driving forces as well as the relative adaptability of the parts of that system.

5.3 Sources of change

Organisational changes have their sources either from outside the organisation or from within. According to Connor and Lake (1994), among external sources are *social changes* concerning beliefs, values, attitudes and opinions; *political/legal changes* including the liberalisa tion, deregulation, regulation and laws; *changes in economic conditions* and *technological developments* directly affecting the macro and micro environment of organisations. Internal sources of changes, originating primarily from inside organisations, are mainly professional associations, new organisational goals and excess organisational resources (Connor and Lake, 1994). However, Hannan and Freeman (1977) state that internal limitations are capital and personnel expenditures, constraints in information processing, costs of upsetting the political equilibrium, history and tradition. External constraints are legal barriers, fiscal limitations, and costs of securing legitimacy and political support from external forces. Robbins (1990) states that changes in strategy, size, technology, environment, or power can be the probable sources of structural change.

5.4 Objects and methods of change

Objects of change can be classified into four categories. These are mainly, changes in individual task behaviours; organisational processes; strategic direction of the organisation; and organisational culture (Connor and Lake, 1994). They refer the methods of change as "*technological*" which are mostly related to the operations and processes of an organisation, "*structural*" related to the functions, roles and relationships in the organisation, "*managerial*" covering administrative actions, and finally "*people*" which is directly related to the human resources of an organisation.

6. Approaches to Change and Effectiveness

Morel and Ramanujam (1999) state that organisations are routinely viewed as dynamic systems of adaptation and evolution containing multiple parts which interact with one another and the environment. The interaction of the organisation with its internal resources to the changing environment refers that they are open systems which places a great deal of emphasis on flexibility and external focus, and would stress flexibility and readiness (as means) and growth, resource acquisition, and external support (as ends) (Quinn and Rohrbaugh, 1983).

The primary relationship between change and effectiveness comes from the definition of the term "effectiveness". Effectiveness means efficiency plus adaptability, where efficiency comprises achieving existing objectives with acceptable use of resources. The effective organisation is both efficient and able to modify its goals as circumstances change (Carnall, 2003). Argyris (1964) focuses on three core activities of an effective organisation: achieving objectives, maintaining the internal system and adapting to the external environment.

The systems approach, a dynamic model of change, covers both the organisational change and

effectiveness concepts in management. The systems approach to organisational effectiveness, which is a model of multi-functional unit, the interdependence between the organisation and its environment takes the form of input–output transactions (Yuchtman and Seashore, 1967). This approach views the organisation as a unified system composed of interrelated units and forming part of larger external environment (Harvey and Brown, 1996).

Harvey and Brown (1996) state that an organisation can be viewed as a socio-technical open system interacting with its environment consisting of five primary components such as; *structural, technical, psychosocial(cultural), goals and values* and *managerial subsystems.* Any change in the environment of the organisation has a different effect on these subsystems and total systems effectiveness can be only achieved by the interaction of these units.

An organisation's *technologies, processes* and *structures* must be well suited to each other and to the organisation's *environment* to sustain organisational effectiveness and survival (Huber and Glick, 1993). According to Carnall (2003), effective or high performing organisations emphasise the following nine characteristics: concern for the future, concern to develop human resources, focus on product/service being provided, orientation to the technologies in use, concern for quality, excellence and competence, orientation to customers, the community and shareholders, constant adaptation of reward systems and corporate values, focus on the basis of "making and selling" and finally, openness to new ideas. Harvey and Brown (1996) state that the changing organisation of the twenty-first century has five main characteristics: *customer orientation, quality conscious, being responsive to innovation and change, adding value to human resources* and *having more autonomous units.* Prastacos *et al.* (2002) argue that to address the continuously increasing challenges and to successfully manage change, organisations needs to be *innovative* and *flexible.* According to their model regarding the objectives for managing change in the new competitive landscape; organisations should change their strategies from duplicated mediocrity to virtual world, from formal rigor to ad hoc support, from sequenced steps to produce to systemic flows for value, from people as workforce to people as competitive force. When we look at the characteristics needed to achieve effectiveness in organisations, we'll see every variable of a "systems model of organisational effectiveness at seaports" in Karatas and Cerit (2008) as the main effectiveness measures for ports.

7. Change and Effectiveness in Seaport Systems

Port organisations experience dynamism and turbulence in their environments because of the effects of the driving forces like globalisation, technological advances and changes in the expectations of the players in the supply chains. Ansoff and McDonnell (1990) and Rosen (1995) assess the level of environmental turbulence with the two measures of "changeability" and "predictability", both of which have two elements, where complexity and novelty are the elements of changeability, and rapidity of change and visibility of the future are the two elements of predictability (Ferch and Roe, 1998). When we look at turbulence in the port environment, we can see that there has been a rapid change in the maritime and related industries such as ship building, the secondhand market, the freight market, trade volumes and routes–these all have an effect on ports and their environments.

The unexpected changes and complexity in the market are explained by Paixao and Marlow (2003b) as: (1) the significance of ports to the international economic environment; (2) the increasing levels of competition that ports have been facing for the last couple of years; (3) the impossibility of competing

on costs alone but focusing on quality of service; (4) the globalisation phenomenon; (5) the important organisational, technological, and commercial evolution that is taking place in the transport sector; and (6) the introduction of fast communication systems.

Due to the effect of globalisation and higher demand for products and services, shipping companies formed alliances and mergers and acquisitions to reduce the transport costs by sharing costs and risks. These resulted in increasing vessel sizes to benefit from economies of scale and widening the operational areas to benefit from economies of scope. Global port operators, having foreseen these events, are already repositioning their container terminals through joint ventures, port terminals concessions, or to meet this increase in vessel size (Paixo and Marlow, 2003a). The changes in the network structure by the increase of vessel sizes forced the ports to compete globally rather than regionally. The rapid increase in the port competition have pressures on ports to improve the quality of the traditional port services, implementing differentiation strategy by providing more specialised, value-added services and delivering door-to-door transport solutions. These forces change the role of ports from being places providing loading and discharging operations to intermodal terminals in the supply chain systems that add value to the port users and final customers. The integration of the supply chain actors and the introduction of seamless transport systems using state of the art technology force ports to be more flexible to respond the parties in the supply chain and adapt to the changing conditions in the uncertain environment of port business.

As ports are the main links in the supply chain adding value to the whole system, the structural changes in the supply chain and logistics force ports to adapt to the changing conditions in the turbulent environment of transport industry. Most shipping lines are expanding their scope to include terminal operations and hinterland transportation to lower the cost burden of door-to-door transport (Notteboom and Winkelmans, 2001). These changes in the transport industry have direct effects on port structure. Dedicated terminals are an example for this situation.

Both the horizontal and vertical integration in the transport industry result in a concentration of power of port customers and the increase of the bargaining power of the customers over port managements. These emphasise the importance of "*customer satisfaction*" in the port industry. In the new competitive landscape, the port authorities have such roles to effectively manage the port organisation to sustain the competitive position in the changing environment of the port industry. These are: concentrating on value added logistics; development of information and communication systems to enhance the integration of the supply chain actors; and port networking by strategic cooperation with other ports (Notteboom and Winkelmans, 2001).

Paixao and Marlow (2003a) suggest that a new logistics approach, agility should be adopted by port organisations to cope with the uncertainty and the complexity in the port environment. According to Notteboom and Winkelmans (2001) in the port industry key elements in obtaining a competitive advantage are: (1) flexibility to adapt quickly to changing opportunities; and (2) an integral approach to logistics issues in transport chains. Robinson (2006) suggests that there is a critical need to understand that fundamental restructuring in port landside operations is a function of two key issues – pervasive value migration in landside operations and progressive strategy decay as ports struggle to redefine themselves.

UNCTAD (1992) and then Beresford *et al.* (2004) classify the seaports according to the evolutions of different aspects in the port organisations. The changes faced in the type of main cargo, attitude and

strategy of port development, port activities, organisation structure, production characteristics and the decisive factors in the port systems were analysed on a timeline. These practices vary significantly from generation to generation. While the first generation ports are labour intensive, the second-generation ports seem to be more capital intensive and the decisive factor in third-generation ports are technology and know how. Logistics chain and value added aspects of port organisations become important in third-generation ports. However, according to Paixao and Marlow (2003b) the two main characteristics of fourth generation ports are leanness and agility which means more specialisation in services and flexibility to respond to the changes in the port environment, respectively. Port generations stated by UNCTAD (1992) prove the validity of "evolutionary change" concept in the port industry. We define the ports as open systems, having inputs, processes and outputs and interacting with their internal resources to the changing environment. Open-system theory of management, define the evolutionary change, long-run change, as change related with the system's driving forces as well as the relative adaptability of the parts of that system. This means that the adaptation of port organisational structure to the external driving forces sourcing from the changing conditions in the environment provide the effective functioning of the port systems, with its input, sub-systems and outputs.

As effectiveness cannot be achieved without adapting to the changes in the environment, a model concerning ports "as complex adaptive systems" has been developed. Figure 1 depicts the port system with indefinite organisational boundaries and the supra-systems of ports which are mainly logistics and transport systems, supply chain system and global production and trade system. The interaction between the supra-systems and the effects on ports are shown in the figure. The changes and developments in each system directly or indirectly affect the port organisation. Many numbers of variables influence the complexity of the port environment and the rapidity of change assesses how fast the environmental changes in relation to the ports' response time are.

The major shareholders in the port system and their places in the port system are also given because they are the main parties affecting the performance of the port organisation. The shifts in their role have important effects on the port system. The structural changes – the vertical and horizontal integration – of the shipping lines and other parties in the supply chain increase the bargaining power of port customers and force ports to be more competitive. Evolving structure of liner shipping networks, increasingly complex network structures have pressures on ports to compete globally rather than locally.

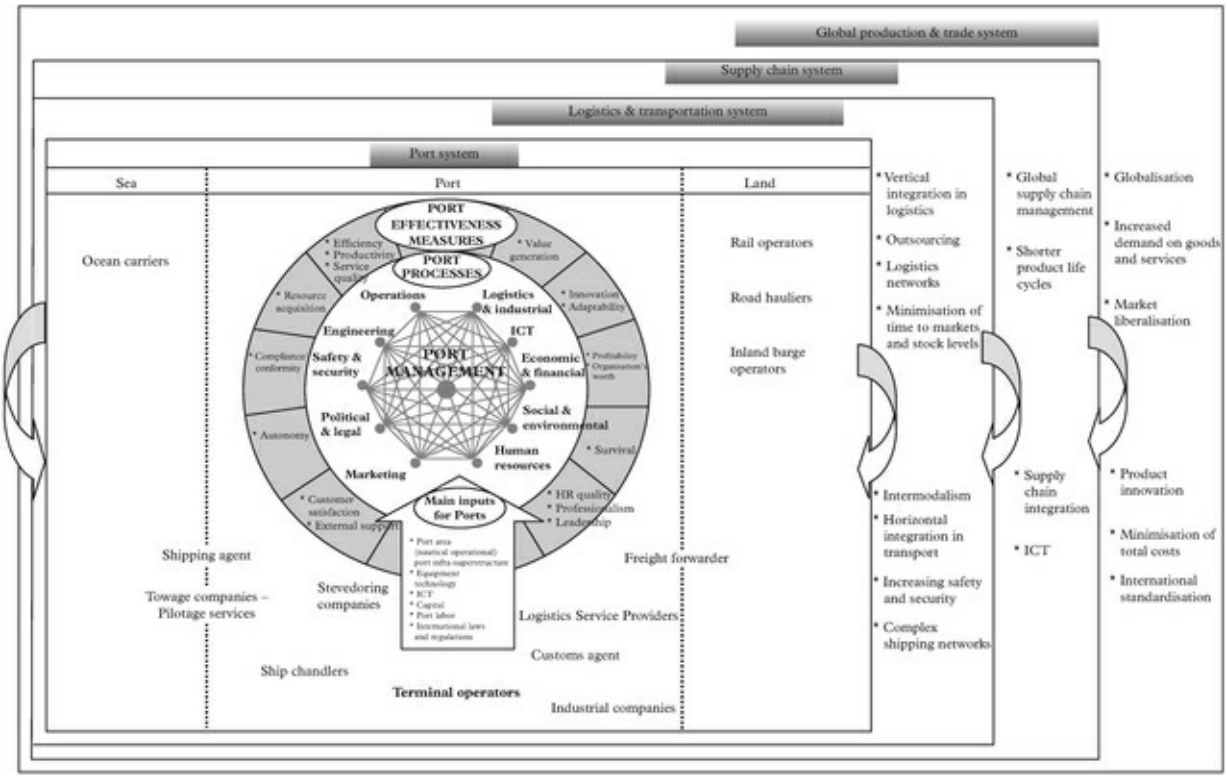

Figure 1: Ports as complex adaptive systems: an effectiveness model

Source: Karatas, Cetin and Cerit (2009a)

In the inner side of the port system, the internal networks of port processes are shown. The inputs that are needed approximately for all the subsystems are mainly port labor/personnel, physical facility (port infrastructure, superstructure), technology and money/capital. All port processes that transform the inputs into outputs that are stated in Table 4 are interrelated with the one another where the port management is in the center of all the port sub-systems and coordinates the port organisation. Every port process has its own effectiveness measures related with its function and domain. The effective functioning and the integration of all sub-systems is a must for achieving the organisational effectiveness in a port system. Therefore every port sub-system should attain the objectives/effectiveness measures that are stated in the figure.

8. An Organisational Change and Effectiveness Model for Seaports

It is a necessity for ports as adaptive systems in new competitive landscape to adapt their strategies, structures and processes to the changes in the turbulent environment to achieve effectiveness and sustain competitive position in the industry. “Organisational change and effectiveness model for seaports” is a model developed by Karatas Cetin and Cerit (2009b) displaying the effectiveness of seaports by systems approach. Four stages constituting the determinants of change, model of the organisation that needs to change because of the pressures of external factors, the methods of change to be used and finally the results or objectives of the change process are depicted in Figure 2.

8.1 Determinants — External drivers of change

Paixao and Marlow (2003a) state that ports having been surrounded by environmental turbulence face many external drivers forcing them to change. In the model, the external drivers for change are classified into two groups; macro- and micro-external environmental factors. The macro-external environmental factors covering *international* (globalisation effect, increase of the international demand on goods and services, market liberalisation and privatisation); *economical* (economic

welfare of the countries, the tendency to minimise the costs), *technological* (faster product innovation due to increased speed-to-market demand, technological change and diffusion of technological knowledge, advanced ICT systems); *social-cultural* (changing societal concern) and *political-legal* (new regulatory policies and/or government regulations, national and international policies to promote sustainable transport, increased safety and security levels) factors are the main remote determinants affecting the trade markets, transport and logistics industries and the port business industry in the scope of derived demand.

However, micro-external environmental factors including customers, competitors, suppliers, distribution, substitute modes and community which are also regarded as industry environment have more direct effects on ports. De Langen and van der Lugt (2007) summarise the relevant changes in the port industry in the recent years under three categories; trade and manufacturing, transport and logistics. The structural changes – the vertical and horizontal integration – of the shipping lines and other parties in the supply chain increase the bargaining power of port customers and force ports to be more competitive. Evolving structure of liner shipping networks, increasingly complex network structures have pressures on ports to compete globally rather than

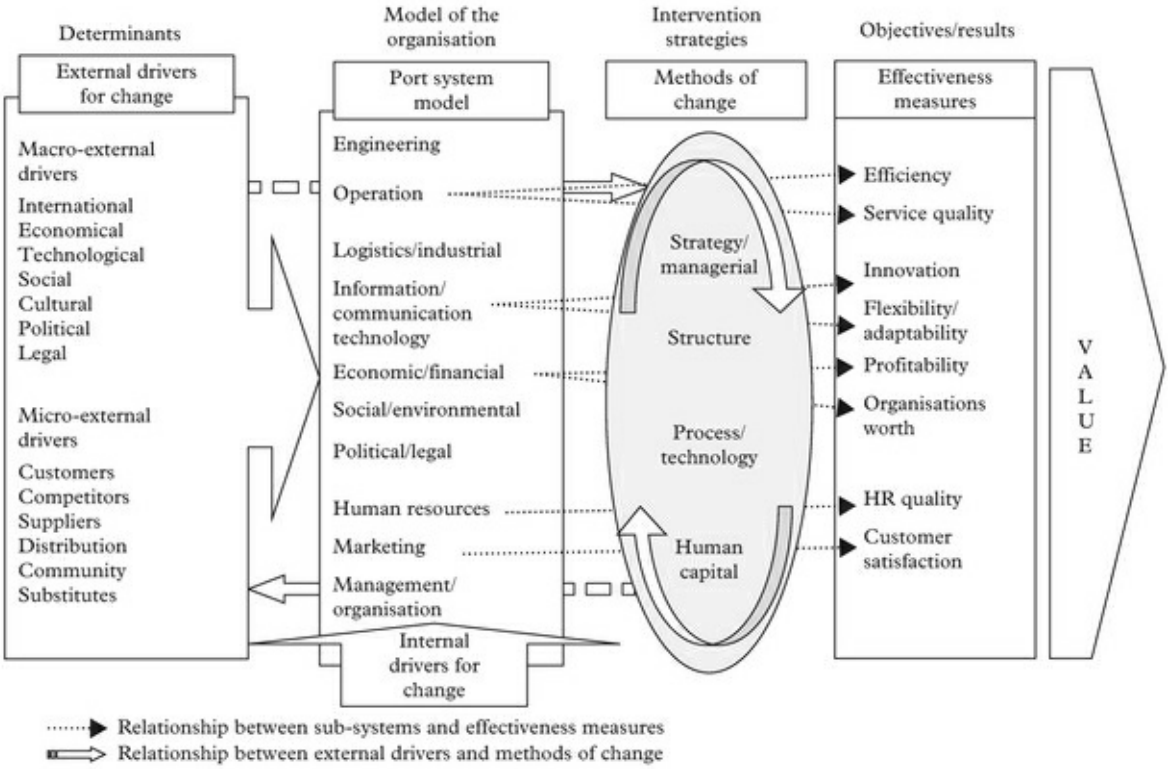

Figure 2: An organisational change and effectiveness model for seaports
Source: Karatas, Cetin and Cerit (2009b)

locally. The changing structure of transport and logistics, the increasing importance of logistics networks and outsourcing activities, the value added logistics concept can be regarded as a distribution factor forcing ports to adapt to the changing conditions. The forces from local stakeholders to improve the safety and security standards of the ports (Gilman, 2003) and from port community to change the structure towards flexibility and transparency (Slack and Fremont, 2005) are the other micro-external environmental drivers of change. These many numbers of variables influence the complexity of the port environment and the rapidity of change assesses how fast the environmental changes in relation to the ports' response time are.

8.2 Model of the organisation — Port system model

The sub-systems or processes in the port organisation are taken from the previous model developed by Karatas and Cerit (2008) and named as *Port System Model* covering engineering, operations, logistics/industrial, social/environmental, economic/financial, political/legal, information and communication technology, human resources, marketing, management and organisation. All these sub-systems are interrelated with each other and in total form the port system.

8.3 Intervention strategies — Methods of change

Connor and Lake (1994) refer the methods of change as "*technological"* which are mostly related with the operations and processes of an organisation, "*structural"* related with the functions, roles and relationships in the organisation, "*managerial"* covering the administrative actions and finally "*people"* which is directly related with the human resources of an organisation. In the rapidly changing environment of port business, in some cases the methods of change should be used together however in other cases a small change in the technology or people factors may be sufficient to initiate change. The dimension and importance of the change is determinative. However, there should be a perfect fit between the changes implemented in strategy, structure, people and processes. The relationship between the external drivers of change and the methods of change is also shown in Figure 2.

Strategy/Managerial: Strategy refers to the central action that decision-makers in the firm implement to: (a) help the firm to achieve a better fit with its environment; (b) match the firm resource base with market opportunities; and (c) achieve a competitive advantage by creating value for its customers (Sherman *et al*., 2006). According to Baltazar and Brooks (2007) two dimensions of strategy are particularly relevant to ports concerned with economic performance: product and market scope and competitive emphasis. Baltazar and Brooks (2007) state that in the port devolution process, effectiveness-oriented configurations are characterised by high levels of environmental uncertainty, a broad product–market scope or a differentiation approach in delivering products and services. The important measure for port performance is the fit between strategy, structure and environment. Customer orientation and satisfaction as one of the most important effectiveness measures for ports should be situated in the centre of the strategies of a port management.

Structure: An organisation's structure is a pattern of relationships that govern the performance of organisational roles. The structural method of change typically involves creating new roles, new work units or new reporting relationships (Connor and Lake, 1994). Effecting a change by structural means can involve any of the following dimensions: complexity, formalisation, centralisation and coordination. An organisation's ability to respond, adapt, innovate to change depends on the extent on to which it has built coordinating, decentralised decision making, less formalised and highly differentiated (complex) mechanisms into its system.

The environmental diversity, actual differentiation and actual integration levels factors defined by Lorsch (1970), are high in the port industry. This means, the integrative devices in the port organisation design should cover teams, roles, departments, hierarchy, plan and procedures to achieve effectiveness. The structural change through effectiveness in the port organisations can be achieved by coordination and integration between the horizontally and vertically differentiated systems, decentralised decision making and low formalisation that covers general guidelines not rules to guide people in the performance of their work. Lean, flexible, non-bureaucratic and result oriented port

organisations can achieve effectiveness by providing collaboration with virtual networks.

Process/Technology: Processes must be seen as something that involve the procedures, the tasks, the schedules, the mechanisms, the activities and the routines by which port services are delivered to the customers (Payne, 1993). In other words, a process is an activity or a group of activities that together are inputs to be processed and whose output is the development of a value-added product which enriches the customer (Berry *et al.*, 1999). In the port processes that are explained before, first need to adapt to the changes is innovation and integration of all the processes. The agility concept, the rapid response to the market is directly related with the use of information and communication technologies in the port operations and also through the supply chain. The usage of state of the art technology accelerates the port operations, decrease costs, provides time and space utilisation and integrates the port with the final customer through networks. The efficiency and productivity of port operations are the results of the use of proper physical and information technologies at ports. Knowledge management, the creation, storage, transfer and usage of corporate knowledge, together with the use of information communication technologies is an important part of the value streaming processes in the port industry.

Human Capital: Port labour is one of the most important inputs for the port processes. Quality of port labour is a direct determinant for a port's success. Port training and education programs, managerial development methods, motivation, safe working conditions, personnel policies and practices designed to help employees excel and develop quality work life can be various methods of change in the human capital for the port business. The labour policy of a port should be "people as a competitive force" rather than workforce.

8.4 Objectives, results — effectiveness measures

Effectiveness measures relate to how well the firm or agency uses its strategies, structures, and task environment to meet its mission and stated goals (Brooks and Pallis, 2008). The effectiveness measures for ports are derived from the results of the delphi study that can be found in Karatas Cetin and Cerit (2009b). Eight of the 24 effectiveness measures are chosen from the experts as the most important ones. The relation between the port sub-systems and the effectiveness measures is shown in Figure 2.

8.5 Value

The final outcome of the model is the value generated to the port customers, the community, the stakeholders, the industry and the region/country.

9. Conclusion

Seaports, as the interface points between land and sea and central links in the supply chain can also be considered as value added organisations. They are the most important subsystems of the whole supply chain traditionally acting as an interface between land and sea transport systems, but also as logistics and trade centers providing distribution facilities, multimodal transport opportunities and industrial activities. Seaports are now not just the places providing cargo handling operations but much more than this.

Seaports need to identify the changes in the market before they occur, by capturing the latest data about the market, intensity and direction of the cargo demands and by tracking regulations, technological advancements and needs of the port users. They need to adapt to the unexpected changes

in the environment to maintain their competitiveness in the market. However, efficiency and performance measurements alone cannot provide a competitive position to the port organisations. There is a broader term that should be assessed to generate value-added to the port users and meet the rapidly changing expectations in the market "the overall organisational effectiveness".

This study focuses on two topical concepts in port business industry: change and effectiveness. Change as its nature is a frequently studied subject in port literature. However, the relation between these two concepts has not been searched in great detail before. The study makes contributions on the literature on measures of effectiveness that should be used to assess the ports' organisational effectiveness. These set of measures for the ports are primarily: productivity, efficiency, service quality, innovation, adaptability/flexibility, information and communication management, profitability, organisation's worth, human resource quality and customer satisfaction. These measures can be regarded as the objectives that should be achieved or in a more optimistic manner the outcomes of the port organisation. However, it is sufficient to determine the basic effectiveness criteria but the way to achieve this in a change process should also be explained.

The organisational change and effectiveness model shows the four stages in the change process. First of all, the determinants of change are needed to be determined because the source of the change and the method of the change to be used are directly related. The external drivers of change for ports are stated in the model. Then the organisation should be analysed since every organisation is unique in its nature. Here, the port organisation is defined as an open system including different sub systems as port operations, marketing, logistics, etc. where each of the sub-system is interrelated with the other, forming the port system model holistically. The port system needs different method of change to achieve effectiveness. These methods are classified under four headings: strategy, structure, process and human capital. Efficient usage of these methods provides the effectiveness in the port organisation. The value generated as an outcome of the model reach the customers, community, the region and the country.

This model is an initial stage of the studies that will continue in change and effectiveness concepts in port business. Further research should be conducted by broader ana lysis of the organisational change concept in the ports of the real world. The strategies used in managing change in different port organisations should be analysed and compared, empirically.

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References

Ahmed, S. (1999): "The emerging measure of effectiveness for human resource management: An exploratory study with performance appraisal", *The Journal of Management Development*, 18(6), 543–556.

Aldrich, H. (1976): "Resource dependence and interorganisational relations: Relations between local employment service offices and social services sector organisations", *Administration and Society*, 8, 419–453.

Angerhofer, B.J. and Angelides, M.C. (2000): "System dynamics modelling in supply chain management: research review" in Joines, J.A., Barton, R.R., Kang, K. and Fishwick, P.A. (eds.) *Proceedings of the 2000 Winter Simulation Conference*, 342–351.

Angle, H.L. and Perry, J.L. (1981): “An empirical assessment of organisational commitment and organisational effectiveness”, *Administrative Science Quarterly*, 26(1), 1–14.

Ansoff, H.I. and McDonnell, E.J. (1990): *Implanting Strategic Management* (2nd edn) (London, Prentice Hall).

Argyris, C. (1964): *Integrating the Individual and the Organisation* (New Y ork, Wiley).

Baltazar, R. and Brooks, M.R. (2007): “Port governance, devolution and the matching framework: a configuration theory approach, port governance and port performance”, *Research in Transportation Economics*, 17, 379–403.

Bamford, D. and Daniel, S. (2005): “A case study of change management effectiveness within the NHS”, *Journal of Change Management*, 5(4), 391–406.

Barnard, Chester I. (1938): *The Functions of the Executive* (Cambridge, MA, Harvard University Press).

Barros, C.P. and Athanassiou, M. (2004): “Efficiency in European seaports with DEA: evidence from Greece and Portugal”, *Maritime Economics and Logistics*, 6(2), 122–140.

Bass, R.M. (1952): “Ultimate criteria of organisational worth”, *Personnel Psychology*, 3(5), 157–173.

Bennis, W.G. (1962): “Toward a ‘truly’ scientific management: the concept of organisational health”, *General Systems Yearbook*, 7, 269–282.

Bennis, W.G. (1966): *Changing Organisations* (New Y ork, McGraw-Hill).

Beresford, A., Gardner, B.M., Pettit, S., Naniopoulos, A. and Wooldridge, C.F. (2004): “The UNCTAD and WORKPORT models of port development: evolution or revolution?”, *Maritime Policy and Management*, 31(2), 93–107.

Beresford, A. and Pettit, S. (2007): An assessment of long term United Kingdom port performance: A Regional Perspective, *Proceedings of International Association of Maritime Economists (IAME) Annual Conference*, Athens, Greece, 04–06 July 2007.

Berrien, F. K. (1976): “A general systems approach to organisations”, in Marvin D. Dunnette (ed.) *Handbook of Industrial and Organisational Psychology* (Chicago, IL, Rand McNally College Publishing Company).

Bhargava, S. and Sinha, B. (1992): “Predictions of organisational effectiveness as a function of type of organisational structure”, *Journal of Social Psychology*, 132, 223–232.

Bichou, K. and Gray, R. (2004): “A logistics and supply chain management approach to port performance measurement”, *Maritime Policy and Management*, 31(1), 47–67.

Bichou, K. and Gray, R. (2005): “A critical review of conventional terminology for classifying seaports”, *Transportation Research – Part A*, 39, 75–92.

Bluedorn, A.C. (1980): “Cutting the gordian now: A critique of the effectiveness tradition in organisation research”, *Sociology and Social Research*, 64, 477–496.

Brooks, M. and Pallis, A. (2007): “Linking port performance and post-devolution port governance models”, *Proceedings of International Association of Maritime Economists (IAME) Annual Conference*, Athens, Greece, 04–06 July 2007.

Brooks, M.R. and Pallis, A.A. (2008): “Assessing port governance models: process and performance components”, *Maritime Policy and Management*, 35(4): 411–432.

Bramley, P. (1986): *Evaluation of Training – A Practical Guide*, British Association for Commercial

and Industrial Education, London.
Buchele, R.B. (1953): “Company character and the effectiveness of personnel management”, *Personnel*, 31, 289–302.
Buckley, W . (1968): *Modern Systems Research for the Behavioral Scientist* (Chicago, Aldine Publishing Company).
Burnes, B. (2004): *Managing Change: A Strategic Approach to Organisational Dynamics* (4th edn.) (London, Financial Times/Prentice Hall).
Campbell, J.P. (1973): *Research Into the Nature of Organisational Effectiveness. An Endangered Species?* Working paper, University of Minnesota.
Cameron, K. and Whetten, D.A. (1983): “Organisational Effectiveness: One Model or Several?” in Cameron, K. and Whetten, D.A. (eds.) *Organisational Effectiveness: A Comparison of Multiple Models* (New York, Academic Press, Inc.) pp. 1–24.
Cameron, K. (1978): “Measuring organisational effectiveness in institutions of higher education”, *Administrative Science Quarterly*, 23(4), 604–632.
Cameron, K. (1980): “Critical questions in assessing organisational effectiveness”, *Organisational Dynamics*, Autumn.
Cameron, K. (1981): “Domains of organisational effectiveness in colleges and universities”, *Academy of Management Journal*, 24(1), 25–47.
Cameron, K. (1984): “An empirical investigation of the multiple constituency model of organisational effectiveness”, Working paper (Boulder, CO, National Center for Higher Education Management Systems).
Cameron, K. (1986): “A study of organisational effectiveness and its predictors”, *Management Science*, 32(1), 87–112.
Caplow, T. (1953): “The criteria of organisational success”, *Social forces*, 32(1), 1–9.
Carbone, V. and Martino, M.D. (2003): “The changing role of ports in supply-chain management: an empirical analysis”, *Maritime Policy and Management* 30(4), 305–320.
Carnall, C.A. (2003): *Managing Change in Organisations* (4th edn.) (Harlow, Pearson Education).
Child, J. (1974): “Managerial and organisational factors associated with company performan – Part I”, *Journal of Management Studies*, 11(3), 175–189.
Child, J. (1975): “Managerial and organisational factors associated with company performance – Part II, A Contingency Analysis”, *Journal of Management Studies*, 12(1), 12–27.
Churchman, C.W. (1979): *The Systems Approach*, (2nd edn.) (New York, Laurel).
Cleland, D.I. and King, W.R. (1975): *Systems Analysis and Project Management* (US, McGraw Hill Book Company).
Connolly, T., Conlon, E. and Deutsch, S.J. (1980): “Organisational effectiveness: a multiple-constituency approach”, *Academy of Management Review*, 5(2), 211–217.
Connor, P.E. and Lake, L.K. (1994): *Managing Organisational Change* (2nd edn.) (Westport, Praeger Publishers).
Cummings, L.L. (1983): “Organisational effectiveness and organisational behavior: a critical perspective”, in Kim S. Cameron and David A. Whetten (eds.),
Organisational Effectiveness: A Comparison of Multiple Models (US: Academic Press Inc.) pp. 187–203.

Cunningham, J.B. (1977): “Approaches to the evaluation of organisational effectiveness”, *The Academy of Management Review*, 2(3), 463–474.

Cunningham, J.B. (1978): “A system-resource approach for evaluating organisational effectiveness”, *Human Relations*, 31(7), 631–656.

Dawson, P. (1994): *Organisational Change: A Processual Approach* (London, Paul Chapman).

De Langen, P. (2001): “The performance of seaport clusters”, *The 9th World Conference on Transportation Research*, Seoul, South Korea, 22–27 July 2001.

De Langen, P., Nijdam, M. and Horst, M. (2006): New indicators to measure port performance, *Proceedings of International Association of Maritime Economists (IAME) Annual Conference*, Melbourne, Australia, 12–14 July 2006.

De Langen, P. and van der Lugt, L.M. (2007): “Governance structures of port authorities in the Netherlands, devolution, port governance and port performance”, *Research in Transportation Economics*, 17, 109–137.

De, P. and Ghosh, B. (2003): “Causality between performance and traffic: an investigation with Indian ports”, *Maritime Policy and Management*, 30(1), 5–27.

Duncan, R.B. (1973): “Multiple decision-making structures in adapting to environmental uncertainty: the impact on organisational effectiveness”, *Human Relations*, 26, 273–291.

Ehreth, J. (1988): “A competitive constituency model of organisational effectiveness and its application in the health industry”, *Academy of Management Annual Meeting*, Anaheim, CA.

Emery, F.E. and Trist, E.L. (1959): Socio-Technical Systems, *Sixth Annual International Meeting of the Institute of Management Sciences*, Paris, France, September.

Emery, F.E. and Trist, E.L. (1965): “The causal texture of organisational environments”. *Human Relations*, 18, 21–32.

Engelen, S., Meersman, H. and Van de Voorde, E. (2006): “Using system dynamics in maritime economics: an endogenous decision model for shipowners in the dry bulk sector”, *Maritime Policy and Management*, 33(2), 141–158.

Etzioni, A. (1960): “Two approaches to organisational analysis: a critique and suggestion”, *Administrative Science Quarterly*, 5(2), 257–258.

Etzioni, A. (1964): *Modern Organisations* (Prentice-Hall, New Jersey, Englewood Cliffs).

Evan, W.M. (1976): “Organisation theory and organisational effectiveness: a preliminary analysis”, in Spray, S.L. (ed.) *Organisational Effectiveness: Theory Utilisation Research* (United States, Kent State University Press) pp. 15–28.

Ferch, S. and Roe, M. (1998): *Strategic Management in East European Ports*, Plymouth Studies in Contemporary Shipping (2nd edn.) (England, Ashgate Publishing).

Ford, J.D. and Ford, L.W. (1994): “Logics of identity, contradiction, and attraction in change”, *Academy of Management Review*, 19, 756–785.

Forrester, J.W. (1961): *Industrial Dynamics* (Portland, OR, Productivity Press Inc.).

Fox, W.M. (1974): “The systems approach to organisational effectiveness”, *Advanced Management Journal*, April.

Frechette, H. and Spital, F. (1991): “A model of organisational change”, *Proceedings of the 9th International System Dynamics Conference*, 209–218.

Friedlander, F. and Pickle, H. (1968): "Components of effectiveness in small organisations", *Administrative Science Quarterly,* 13(3), 289–304.

Gaertner, G.H. and Ramnarayan, S. (1983): "Organisational effectiveness: an alternative perspective", *The Academy of Management Review,* 8(1), 97–107.

Gebhart, G.F. (2004): *Creating the Market Oriented Firm: A Longitudinal Qualitative Study on Organisational Transformations*, PhD Dissertation on Marketing, Northwestern University, Evanston, Illinois, USA.

Georgopolous, B.S. and Mann, F.C. (1962): *The Community General Hospital* (New York, Macmillan).

Georgopoulos, B. and Tannenbaum, A. (1957): "A study of organisational effectiveness", *American Sociological Review*, 22(5), 534–540.

Georgopoulos, B. and Tannenbaum, A. (1971): "A study of organisational effectiveness", in Ghorpade, J. (ed.), *Assessment of Organisational Effectiveness: Issues, Analysis, and Readings* (Pacific Palisades, CA, Goodyear) pp.177–188.

Gibb, B. (1972): *Organisational effectiveness: An open-systems perspective* (Michigan, Ann Arbor, Department of Psychology).

Gibson, J.L., Ivancevich, J.M. and Donnelly, J.H. (1973): *Organisations: Structure, Process, Behavior* (Dallas, BPI).

Gilman, S. (2003): "Sustainability and national policy in UK port development", *Maritime Policy and Management*, 30(4), 275–291.

Glisson, C. and Martin, P.Y. (1980): "Productivity and efficiency in human service organisations as related to structure, size and age", *Academy of Management Journal*, 23(1), 21–37.

Hall, R.H. (1977): *Organisations: Structure and Process* (Englewood Cliffs, NJ, Prentice-Hall).

Hall, R.H. (1978): Conceptual, methodological, and moral issues in the study of organisational effectiveness, *Working Paper*, Department of Sociology, SUNY-Albany. Albany.

Hall, R.H. (1980): "Effectiveness theory and organisational effectiveness", *Journal of Applied Behavioral Science,* 16, 536–545.

Hannan, M.T. and Freeman, J. (1977): "The population ecology of organisations", *The American Journal of Sociology*, 82(5), 929–964.

Harvey, D. and Brown, D.R. (1996): *An Experiental Approach to Organisation Development* (5th edn.) (New Jersey, Prentice Hall).

Hatch, M.J. (1997): *Organisation Theory: Modern Symbolic and Postmodern Perspectives* (New York, Oxford University Press).

Heffron, F. (1989): *Organisational Theory and Public Organisations. The Political Connection* (Englewood Cliffs, NJ, Prentice Hall).

Henri, J.F. (2004): "Performance measurement and organisational effectiveness: Bridging the gap", *Managerial Finance,* 30(6), 93–123.

Herman, R.D. and Renz, D.O. (1998): "Nonprofit organisational effectiveness: contrasts between especially effective and less effective organisations", *Nonprofit Management and Leadership*, 9(1), 23–38.

Hinings, C.R. and Greenwood, R. (1988): *The Dynamics of Strategic Change* (Oxford, Basil

Blackwell).
Hirsch, P.M. (1975): “Organisational effectiveness and the institutional environment”, *Administrative Science Quarterly*, 20(3), 327–344.
Hitt, M.A., Keats, B. and DeMarie, S.M. (1998): “Navigating in the new competitive landscape: building strategic flexibility and competitive advantage in the 21st century”. *Academy of Management Executive*, 12(4), 22–42.
Huber, G.P. and Glick, W.H. (1993): *Organisational Change and Redesign: Ideas and Insights for Improving Performance* (New York, Oxford University Press).
Jackson, B. (1999): Perceptions of Organisational Effectiveness in Community and Member Based Nonprofit Organisations, Doctoral dissertation, University of La Verne, 1999. ProQuest Digital Dissertations, AAT9918843.
Jackson, M. (2000): *Systems Approaches to Management* (Secaucus, NJ, Kluwer Academic Publishers).
Jobson, J.D. and Schneck, R. (1982): “Constituent view of organisational effectiveness: Evidence from police organisations”, *Academy of Management Journal*, 25(1), 25–46.
Jumara, J. (2005): *A Case Study of the Influence of Organisational Theory on Organisational Change*, PhD Dissertation in Economics and Social Science, University of Missouri, Kansas City.
Kanter, R.M., Stein, B. A. and Jick, T.D. (1992): *The Challenge of Organisational Change: How Companies Experience It and Leaders Guide It* (New York, Free Press).
Karatas, C. and Cerit, A.G. (2008): Organisational effectiveness at seaports according to the systems approach, *Proceedings of International Association of Maritime Economists (IAME) 2008 Annual Conference*, Dalian-China, 2–4 April, 2008.
Karatas, Cetin, C. and Cerit, A.G. (2009a): *Organisational effectiveness at seaports: a systems approach*, World Conference on Transport Research Society (WCTRS) – Special Interest Group on Maritime Transport and Ports (SIG 2), *International Conference Critical Issues in the Port and Maritime Sector*, Antwerp, Belgium, 7–8 May 2009.
Karatas, Cetin, C. and Cerit, A.G. (2009b) Organisational change at seaports: impact on effectiveness, *Proceedings of International Association of Maritime Economists (IAME) 2009 Annual Conference*, Copenhagen, Denmark, 24–26 June 2009.
Kast, F.E. and Rosenzweig, J.E. (1972): “General systems theory: Applications for organisation and management”, *The Academy of Management Journal*, 15(4), 447–465.
Kast, F.E. and Rosenzweig, J.E. (1979): *Organisation and Management: A Systems and Contingency Approach* (3rd edn.) (New York, McGraw Hill).
Katz, D. and Kahn, R.L. (1966): *The Social Psychology of Organisations* (New York, John Wiley and Sons).
Katz, D. and Kahn, R.L. (1978): *The Social Psychology of Organisations* (2nd edn.) (John Wiley & Sons, Canada).
Keeley, M. (1978): “A social-justice approach to organisational evaluation”, *Administrative Science Quarterly*, 23(2), 272–292.
Keeley, M.A. (1984): “Impartiality and participant-interest theories of organisational effectiveness”, *Administrative Science Quarterly*, 29(1), 1–25.
Kilmann, R.H. and Herden, R.P. (1976): “Towards a systemic methodology for evaluating the impact

of interventions on organisational effectiveness", *The Academy of Management Review*, 1(3), 87–98.
Kumar, S. and Yamaoka, T. (2007): "System dynamics study of the Japanese automotive industry closed loop supply chain", *Journal of Manufacturing Technology Management*, 18(2), 115–138.
Lam, J. (2005): "Major shipping dynamics influencing container port performance", *Proceedings of International Association of Maritime Economists (IAME) Annual Conference, Cyprus*, 23–25 June 2005.
Lawrence, P.R. and Lorsch, J.W. (1967): *Organisation and Environment*. Division of Research, Graduate School of Business Administration, Harvard University: Cambridge, MA.
Lorsch, J.W. (1970): "Introduction to the Structural Design of Organisations", in Dalton, G.W., Lawrence, P.R. and Lorsch, J.W. (eds.) *Organisational Structure and Design* (Homewood, Richard D. Irwin) 13.
Lysons, A., Hatherly, D. and Mitchell, D.A. (1998): "Comparison of measures of organisational effectiveness in UK higher education", *Higher Education*, 36(1), 1–19.
Mahoney, T.A. (1967): "Managerial perceptions of organisational effectiveness", *Management Science*, 14(2), 76–91.
Mahoney, T.A. and Weitzel, W. (1969): "Managerial models of organisational effectiveness", *Administrative Science Quarterly*, 14, 357–365.
Miles, R.H. (1980): *Macro-Organisational Behavior* (Glenview, Scott, Foresman).
Miles, R.H. and Cameron, K.S. (1982): *Coffin Nails and Corporate Strategies* (Englewood Cliffs, NJ, Prentice-Hall).
Molnar, J.J. and Rogers, D.L. (1976): "Organisational effectiveness: An empirical comparison of the goal and system resource approaches", *The Sociological Quarterly*, 17, 401–413.
Monie, D.G. (1987): Measuring and evaluating port performance and productivity, UNCTAD Monographs on Port Management, available at www.unctad.org/en/docs/ship4946_en.pdf.
Morel, B. and Ramanujam, R. (1999): "Through the looking glass of complexity; The dynamics of organisation as adaptive and evolving systems", *Organisation Science*, 10(3), 278–293.
Mott, P.E. (1972): *The Characteristics of Effective Organisations* (New York, Harper & Row).
Muczyk, J.P. (2004): "A systems approach to organisational effectiveness: the alignment of critical organisational dimensions with selected business/competitive strategies", *Journal of Comparative International Management*, 7(1).
Nadler, D.A. and Tushman, M.L. (1980): "A congruence model for organisational assessment", in Lawler, E., Nadler, D. and Cammann, C. (eds.) *Organisational Assessment: Perspectives on the Measurement of Organisational Behavior and the Quality of W orking Life* (New York, Wiley) pp. 261–278.
Negandhi, A.R. and Reimann, B.C. (1973): "Task environment, decentralisation and organisational effectiveness", *Human Relations*, 26, 203–214.
Notteboom, T.E. (2007): "Strategic challenges to container ports in a changing market environment", in *Devolution, Port Governance and Port Peformance, Research in Transportation Economics*, 17, 29–52.
Notteboom, T.E. and Winkelmans, W. (2001): "Structural changes in logistics: how will port

authorities face the challenge?", *Maritime Policy and Management*, 28(1), 71–89.
Optner, S.L. (1968): *Systems Analysis for Business Management* (2nd edn.) (Englewood Cliffs, NJ, Prentice-Hall).
Osborne, R. N. and Hunt, J.G. (1974): "Environment and organisational effectiveness", *Administrative Science Quarterly*, 19(2), 231–246.
Owino, E.L., Wang, T. and Pasukeviciute, I. (2006): Performance measurement in European container terminal industry-an empirical investigation, *Proceedings of International Association of Maritime Economists (IAME) Annual Conference*, Melbourne, Australia, 12–14 July 2006.
Paine, F.T. (1971): Assessment model of government organisation effectiveness, unpublished paper, University of Maryland, USA.
Paixao, A.C. and Marlow, P.B. (2003a): "Fourth generation ports – a question of agility?", *International Journal of Physical Distribution and Logistics Management*, 33(4), 355–376.
Paixao, A.C. and Marlow, P.B. (2003b): "Measuring lean ports performance", *International Journal of Transport Management*, 1(4), 189–202.
Panayides, P.M. and Song, D. (2006): "Port supply chain orientation and performance", *Proceedings of International Association of Maritime Economists (IAME) Annual Conference*, Melbourne, Australia, 12–14 July 2006.
Parhizgari, A.M. and Gilbert, G.R. (2004): "Measures of organisational effectiveness: private and public sector performance", *Omega: The International Journal of Management Science*, 32: 221–229.
Park, R. and De, P. (2004): "An alternative approach to efficiency measurement of seaports", *Maritime Economics and Logistics*, 6(1), 53–69.
Pasmore, W.A. (1988): *Designing Effective Organisations: The Socio-technical System Perspective* (New York, Wiley and Sons).
Payne, A. (1993): *The Essence of Services Marketing* (Hemel Hempstead, Prentice-Hall Europe).
Pennings, J.M. (1975): "The relevance of the structural-contingency model for organisational effectiveness", *Administrative Science Quarterly*, 20(3), 393–410.
Pennings, J.M. (1976): "Dimensions of organisational influence and their effectiveness correlates", *Administrative Science Quarterly*, 21(4), 688–699.
Pennings, J.M. and Goodman, P.S. (1977): "Toward a workable framework", in Goodman, S., Pennings, J.M. and Associates (eds.) *New Perspectives on Organisational Effectiveness* (San Francisco, Josey-Bass) pp. 146–184.
Perrow, C. (1961): "The analysis of goals in complex organisations", *American Sociological Review*, 26(6), 854–865.
Pettigrew, A. (1985): *The Awakening Giant: Continuity and Change at ICI* (Oxford, Blackwell).
Pfeffer, J. (1977): "Usefulness of the concept", in Goodman, P.S. and Pennings, J.M. (eds.), *New Perspectives on Organisational Effectiveness* (San Francisco, Jossey-Bass) pp. 132–143.
Pfeffer, J. and Salancik, G.R. (1978): *External Control of Organisations* (New York, Harper & Row).
Porras J.I. and Silvers, R.C. (1991): Organisation development and transformation, *Annual. Review of Psychology*, 42, 51–78.
Porras J.I. and Robertson, P.J. (1992): "Organisational development: theory, practice, research", in Dunnette, M.D. and Hough, L.M. (eds.), *Handbook of Organisational Psychology* (Palo Alto, CA,

Consult. Psychol. Press) pp. 719–822.
Prastacos, G., Derquist, K., Spanos, Y. and Wassenhove, L. (2002): "An integrated framework for managing change in the new competitive landscape", *European Management Journal*, 20(1), 55–71.
Price, James, L. (1972): "The study of organisational effectiveness", *Sociological Quarterly*, 13, 3–15.
Quinn, R.E. and Rohrbaugh, J. (1983): "A spatial model of effectiveness criteria: towards a competing values approach to organisational analysis", *Management Science*, 29(3), 363–377.
Quinn, R.E. and Cameron, K. (1983): "Organisational life cycles and shifting criteria of effectiveness: some preliminary evidence", *Management Science*, 29(1), 33–51.
Quinn, R.E. and Rohrbaugh, J. (1981): "A competing values approach to organisational effectiveness", *Public Productivity Review*, 5, 122–140.
Redshaw, B. (2000): "Evaluating organisational effectiveness", *Industrial and Commercial Training*, 32(7), 245–248.
Reimann, B.C. (1974): "Dimensions of structure in effective organisations: some empirical evidence", *The Academy of Management Journal*, 17(4), 693–708.
Ridley, C.R. and Mendoza, D.W. (1993): "Putting organisational effectiveness into practice: the preeminent consultation task", *Journal of Counseling and Development*, 72, 168–177.
Robbins, S. (1990): *Organisation Theory: Structure, Design and Applications* (3rd ed.) (USA, Prentice-Hall International Editions).
Robinson, R. (2006): "Port-oriented landside logistics in Australian ports: a strategic framework", *Maritime Economics and Logistics*, 8(1), 40–59.
Rohrbaugh, J. (1981): "Operationalizing the competing values approach", *Public Productivity Review*, 5, 141–159.
Rosen, R. (1995): *Strategic Management* (London, Pitman).
Sachan, A., Sahay, B.S. and Sharma, D. (2005): "Developing Indian grain supply chain cost model: a system dynamics approach", *International Journal of Productivity and Performance Management*, 54(3), 187–205.
Sahni, A. (2000): "Characteristics of an effective hospital as an organisation", *Health Administrator*, 9–10 (1–2), 1–3.
Samuel, Y. and Jacobsen, C. (1997): "A system dynamics model of planned organisational change", *Computational and mathematical Organisation Theory*, 3(3), 151–171.
Santos, S.P., Belton, V.B. and Howick, S. (2002): "Adding value to performance measurement by using system dynamics and multicriteria analysis", *International Journal of Operations & Production Management*, 22(11), 1246–1272.
Sayareh, J. and Lewarn, B. (2006): "Efficient supply chains through effective seaport organisations", *Proceedings of International Association of Maritime Economists (IAME) Annual Conference*, Melbourne, Australia, 12–14 July 2006.
Sayareh, J. (2007): "Benefits of regular organisational effectiveness (OE) assessment in seaport organisations", *Proceedings of International Association of Maritime Economists (IAME) Annual Conference*, Athens, Greece, 4–6 July 2007.
Schneider, B. (1983): "An interactionist perspective on organisational effectiveness", in Cameron, K.

and Whetten, D.A. (eds.) *Organisational Effectiveness: A Comparison of Multiple Models* (New York, Academic Press, Inc.), pp. 27–54.
Seashore, S.E. (1983): "A framework for an integrated model of organisational effectiveness", Cameron, Kim S. and Whetten, David A. (eds.) *Organisational Effectiveness: A Comparison of Multiple Models* (USA, Academic Press Inc) pp. 55–70.
Selznick, P. (1949): *TVA and the Grass Roots* (Berkeley, California, University of California Press).
Sherman, H., Rowley, D.J. and Armandi, B.R. (2006): *Strategic Management: An Organisation Change Approach* (Oxford, University Press of America).
Shilbury, S. and Moore, K.A. (2006): "A study of organisational effectiveness for national Olympic sporting organisations", *nonprofit and voluntary sector Quarterly*, 35(1), 5–38.
Slack, B. and Fremont, A. (2005): "Transformation of port terminal operations: From the local to the global", *Transport Reviews*, 25(1), 117–130.
Song, D. and Panayides, P.M. (2008): "Global supply chain and port/terminal: integration and competitiveness", *Maritime Policy and Management*, 35(1), 73–87.
Song, D. and Yeo, K. (2004): "A competitive analysis of Chinese container ports using the analytic hierarchy process", *Maritime Economics and Logistics*, 6(1), 34–52.
Steers, R.M. (1975): "Problems in the measurement of the organisational effectiveness", *Administrative Science Quarterly*, 20(4), 546–558.
Steers, R.M. (1976): "When is an organisation effective? A process approach to understanding effectiveness", *Organisational Dynamics*, 5, 50–63.
Steers, R.M. (1977): *Organisational Effectiveness: A Behavioral View* (Santa Monica, CA, Goodyear).
Sproles, N. (2000): "Coming to grips with measures of effectiveness", *System Engineering*, 3(1), 50–58.
Sproles, N. (2002): "The difficult problem of establishing measures of effectiveness for command and control: A systems engineering perspective", *System Engineering: The Journal of the International Council on Systems Engineering*, 4(2), 145–155.
Sterman, J.D. (2000): *Business Dynamics: Systems Thinking and Modelling for a Complex Wo r l d* (New York, McGraw Hill).
Stewart, J.H. (1976): "Factors accounting for goal effectiveness: a longitudinal study", in Spray, S.L. (ed.) *Organisational Effectiveness: Theory-Utilisation-Research* (Kent State University Press) pp. 109–121.
Strickland, F. (1998): *The Dynamics of Change: Insights into Organisational Transition from the Natural World* (London, Routledge).
Tongzon, J.L. (1995): "Determinants of port performance and efficiency", *Transportation Research – Part A*, 29(3), 245–252.
Tongzon, J.L. (2001): "Efficiency measurement of selected Australian and other international ports using data envelopment analysis", *Transportation Research – Part A*, 35(2), 107–122.
Tsui, A.S. (1987): "Defining the activities and effectiveness of the human resource department: A multiple constituency approach", *Human Resource Management*, 26(1), 35–69.
Tsui, A.S. (1990): "A multiple-constituency model of effectiveness: an empirical examination at the human", *Administrative Science Quarterly*, 35(3), 458–483.
UNCTAD (United Nations Conference on Trade and Transport) (1992): *Port Marketing and the Third*

Generation Port (Geneva, TD/B C.4/AC.7/14, UNCTAD).
Van de Ven, A. and Poole, M.S. (1995): "Explaining development and change in organisations", *The Academy of Management Review*, 20(3), 510–540.
Van de Ven, A. and Poole, M.S. (2005): "Alternative approaches for studying organisational change", *Organisation Studies*, 26(9), 1377–1404.
Wang, T. and Cullinane, K. (2006): "The efficiency of European container terminals and implications for supply chain management", *Maritime Economics and Logistics*, 8(1), 82–99.
Wang, T., Li, Y. and Wu, X. (2007): "The efficiency and organisation of port-oriented international supply chains", *Proceedings of International Association of Maritime Economists (IAME) Annual Conference*, Athens, Greece, 4–6 July 2007.
Wang, T., Xie, X. and Yang, Z. (2006): Container terminal efficiency – a context-dependent data envelopment analysis approach, *Proceedings of International Association of Maritime Economists (IAME) Annual Conference*, Melbourne, Australia, 12–14 July 2006.
Webb, R.J. (1974): "Organisational effectiveness and the voluntary organisation", *Academy of Management Journal*, 17(4), 663–677.
Weick, K.E. (1977): "Re-punctuating the problem", in Goodman, P.S. and Pennings, J.M. (eds.), *New Perspectives on Organisational Effectiveness* (San Francisco, Jossey Bass) pp. 193–225.
Weick, K.E. and Quinn, R.E. (1999): "Organisational change and development", *Annual Review of Psychology* (50), 361–386.
Yuchtman, E. and Seashore, E.S. (1967): "A system resource approach to organisational effectiveness", *American Sociological Review*, 32(6), 891–903.
Zammuto, R.F. (1984): "A comparison of multiple constituency models of organisational effectiveness", *Academy of Management Review*, 9, 606–616.

Chapter 33

The Economics of Motorways of the Sea: Re-Defining Maritime Transport Infrastructure

*Alfred J. Baird**

1. Introduction

When referring to maritime transport infrastructure, very often the focus is on ports (Haralambides, 2002; Verhoeven, 2009). Defining (or rather re-defining) maritime transport infrastructure is an important outcome of this chapter, in particular setting out how this relates specifically to the ship or seaway.

Ships and ports are considered also in the context of modal shift; that is, transferring freight from road to sea, or the so-called "Motorways of the Sea" (MoS). Reviewing MoS policy and developments in the context of comparable road and rail infrastructure allows for new insights about the reality of maritime transport infrastructure.

Whilst there is universal acknowledgement that *roadways* and *railways* are indeed transport infrastructure platforms, there appears to be rather more uncertainty about what constitutes the *seaway* platform. To argue that maritime transport infrastructure is simply the port (i.e. the node) seems inadequate when talking at the same time about roadway and railway infrastructure platforms along a given corridor which may be several hundred kilometres or more in length.

This chapter briefly considers the general policy approach to developing MoS in Europe and the influence this has had in helping to re-appraise our understanding of maritime transport relative to land transport modes. This is followed with an analysis of modal shift MoS examples, emphasising some of the challenges faced, which tend to relate to market realities determined by policy approaches and influenced by traditional definitions of transport infrastructure. Thereafter the discussion centres on developing, explaining and justifying the need to re-define our understanding of the term *maritime transport infrastructure*.

2. Motorways of the Sea Policy

In Europe, governments at EU and Member State levels are now working to facilitate MoS services leading to large-scale modal shift. According to the European Commission, the sea represents the only real solution to tackle road freight traffic growth in Europe, hence the inclusion of MoS projects in the Trans-European Transport Network (TEN-T) (Commission of the European Communities, 2004). Whilst such motives are indeed honourable, the appreciation of what exactly constitutes seaway infrastructure still requires careful consideration, more especially in view of economic distortions resulting from ongoing public financing of land transport infrastructure generally.

The TEN-T of MoS is intended to recreate the road and rail network on the water, by concentrating flows of freight in viable, regular searoutes. TEN-T MoS project sare expected to improve port facilities and infrastructure, as well as electronic logistics management systems, safety and security and administrative and customs procedures, as well as access routes for year-round navigability. The policy and funding emphasis, therefore, is largely aimed at ports and transport access to ports.

The EU Van Miert High-Level Group, during its deliberations on extending Europe's TEN-T network, nevertheless decided that MoS were "Floating Infrastructure" (Commission of the European Communities, 2004). This corresponded with ideas put forward by GIE (2007), albeit the latter went further by highlighting the need for public financing of the "boat infrastructure" in the specific context of integrating waterborne transport into the Trans-European Networks. Clearly there is a recognition here that the 'boat' needs to be taken into account.

Such views were supported through the findings of the SUTRANET project funded by the EU Interreg IIIB North Sea Programme (SUTRANET, 2007). Both GIE and SUTRANET findings consider the role of the port as being that of (merely) a transport node, and certainly not a seaway or MoS. In this regard, defining a seaport as maritime transport infrastructure seems to be totally insufficient.

EU funding is aimed at counteracting ongoing transport market distortions favouring land transport modes, and Member States themselves are also requested to do more in this area. The various EU TEN-T MoS initiatives are intended to facilitate new developments through current limited financial intervention. Some success is also occurring with the EU Marco Polo Programme which aims to support MoS service start-ups, albeit over a limited period of three–four years. However, the bulk of investment in MoS projects is expected to be provided by private transport operators.

At the same time, public funding of roadway and railway infrastructure is set to continue at high levels for the foreseeable future, which will lead to ongoing challenges for MoS start-ups. The key question here is – why should there be limited short-term support for maritime transport when large-scale public sector funding for roadway and railway infrastructure continues?

EU Member States have been requested to co-finance MoS initiatives themselves as well and under the new EU TEN-T MoS policy this is now allowable. In addition to international services between states, MoS services could also comprise domestic/coastal routes within states. Where road transport does not pay its full cost of using road infrastructure (as in the UK) then the need for MoS support is found to be greater (UK Marine Motorways Study, 2002).

In Italy, the EcoBonus MoS incentive scheme is perhaps the most advanced modal shift initiative so far within the EU. This provides for state support of €240 million over three years towards MoS services, with some 30 MoS routes qualifying, and allowing for a 20–30% fare rebate to truckers to help equalise costs with road transport.

Another MoS scheme for routes between France and Spain has been implemented rather differently. In this instance a tender process was developed for an Atlantic Spain–France MoS service, based on an agreement between both countries, and supervised by the EC. In this MoS scheme the ports have been selected by bidders themselves, not by the state. Subsidy is considered as start-up aid to support operations (over three or five years) with the criteria of evaluation for bids being:

- 30% for traffic shifted from road (min 100,000 lorries);
- 30% for the quality of the proposition;
- 35% the economic and financial performance; and
- 5%: for other factors.

Clearly, the development of MoS initiatives in Europe is still at an early stage. The EC and Member States are also at a formative stage of really understanding what MoS is, and how it fits into the wider transport policy context. Implementation of different MoS funding schemes by individual Member

States results in non-standardisation and could lead to confusion amongst service providers. Conversely, those States not implementing any MoS scheme at all may be unlikely to gain the modal shift benefits from the start-up of MoS services.

This implies that there needs to be a better understanding of what is meant by the term “maritime transport infrastructure”, or MoS, as well as a shift towards some standardisation on attractive and easy to use/implement MoS funding methods and incentives which take full account of subsidies applying to alternative land transport modes.

3. Modal Shift and Motorways of the Sea (Mos)

New MoS modal shift transport services have developed in a number of countries over recent years. Italy has been at the forefront of European MoS developments over the last 15 years or so. MoS in the modern sense arguably began when state-owned Finmare introduced the innovative Viamare service in 1991. That service employed five three-deck Ro-Ro ships each capable of carrying well over 100 trailers plus 50 drivers, to provide a daily link between two dedicated out-of-town terminals at Voltri (Genoa) and Termini Imerese (near Palermo). While the Viamare “Autostrade del Mare” experiment was not without its difficulties (Baird, 1997), the initiative demonstrated for the first time in Europe what could be achieved in terms of road-to-sea modal shift on a large scale.

Since then ship design and efficiency has continued to improve and today the right ships are available now to do the job of modal shift very effectively. Existing Ro-Ro and Ro-Pax (i.e. freight plus limited passenger capacity) vessels offer fast speed (22 knots or more), coupled with high payload, and high reliability (Figure 1). Although ships of 2,000 lane metres (i.e. around 150 trailer capacity) have become something of a standard size for many MoS services, far larger ships are now in service offering 4,000 lane metres, and new ships of over 5,000 lane metres will be delivered by 2010.

Such vast ship sizes means that seaway economies of scale are un-matched by other transport modes. On the roadway, a single trailer is the norm, while on rail, even where rail systems can accept trailers on railcars (many railway systems are unable to carry

Figure 1: ‘Standard’ type 2,300 lane metre/400 passenger 24-knot Ro-Pax
Source: courtesy of Norfolk Line

trailers due to gauge/tunnel/width constraints), the maximum number of units carried tends to be under 50.

Other strengths of the Ro-Ro/Ro-Pax MoS option include (SUTRANET, 2007):

- the ability of vessels to carry temperature-controlled units and unaccompanied or accompanied vehicles, with drivers using the ferry trip as a statutory rest break;
- reduced wear and tear of trucks and trailers, less vehicle maintenance costs, and lower insurance; and
- lower fuel costs and avoidance of road tolls and weekend bans on truck movement by road.

In this regard the Ro-Ro or Ro-Pax ferry/MoS functions in a complementary fashion to the long-distance trucking sector. In cost terms, whilst size/scale benefits give the MoS a basic unit cost-per-km advantage over road, other factors such as ongoing state subsidy for roadways and railways, plus Ro-Ro terminal handling charges (the latter not applicable in the case of road transport), and local road haulage tend to limit the overall benefit of MoS in terms of total costs. Previous research suggests that the sea leg of MoS services may actually represent less than half the total door-door cost of a trailer movement by MoS (Baird, 2008). The other half or more comprises terminal handling costs plus local road haulage costs at the beginning and end of a trip.

Nevertheless, a number of MoS routes have been successfully developed over the last 10 years or so, each achieving success in freight modal shift from road to sea transport (see Table 1) . The examples presented in Table 1 help illustrate the complex reality and challenges surrounding development of new MoS services (or seaways).

Table 1: Selected motorway of the sea routes/trailer volumes

MoS route	Operator	Date started	Trailers (2006)
Barcelona–Genoa	GNV	1997	40,000
Civitavecchia–Barcelona	Grimaldi Lines	2004	41,000
Genoa–Palermo	GNV; Tirrenia; Strade-Blu	1991	100,000
Naples–Catania	TTT Lines	2001	57,000
Salerno–Messina	Caronte & Tourist	2003	71,500
Toulon–Civitavecchia	Grimaldi & LD Lines	2005	9,700
Belfast–Birkenhead	Norfolk Line	1996	143,000
Rosyth–Zeebrugge	Superfast Ferries	2002	40,000
Kiel–Klaipeda	DFDS	1997	50,000
Ancona–Igoum-Patras	Superfast Ferries	1995	90,000
Trieste–Istanbul	UN Ro Ro	1995	112,000

Source: ShipPaxStatistics

For example, the 1990s Balkans conflict coupled with poor road quality/access and problematic border crossings initially helped the UN Ro-Ro and Superfast Ferries services to develop. Illustrating MoS complementarity with trucking, UN Ro-Ro was itself established and owned by Turkish road transport operators (Torbianelli, 2000).

In Italy, road tolls and weekend bans on freight transport by road have played a major part in helping to move freight from road to sea. Moreover, where a sea route offers a distance advantage over an alternative roadway (e.g. Genoa–Palermo, Genoa–Barcelona), this is also an important factor favouring MoS.

In all of these examples the application of modern ship technology, and in particular the use of modern, fast-conventional Ro-Ro/Ro-Pax ferries offering high payloads and attractive transit times, has had a large part to play in the success of MoS services competing against parallel roadways.

However, in instances where roads are still provided and maintained by the state more or less free

to truckers (i.e. no road tolls), the alternative private sector provided seaway is not so readily a viable proposition. Indeed, although it can be demonstrated that Ro-Ro/Ro-Pax ferry MoS solutions can work successfully in a number of different circumstances, policymakers need to exert care when developing or facilitating initiatives. In the absence of a level playing field it remains difficult for the private sector alone to take the risk of starting up a MoS service.

4. Redefining Maritime Transport Infrastructure

Researchers, policymakers and commercial actors generally consider "maritime transport infrastructure" to be the port (e.g. Haralambides, 2002; IMPRINT-NET, 2007). Thus the understood position across the three main surface transport modes is that the principal surface transport infrastructure includes:

- road infrastructure;
- rail infrastructure; and
- port (i.e. maritime) infrastructure.

On the European Continent, at least, port infrastructure receives considerable public sector investment, and ports there are treated more or less in the same way from a public investment perspective as roads and railways (Baird, 2004).

However, ports are also regarded as "nodal points along a transport chain" (UNCTAD, 1992). This implies that ports themselves are not the transport chain; ports act as an interface, or in other words, as points of transfer between transport modes.

Indeed, the paramount good a port must provide to facilitate its wide range of services is not sea, but *land* (Haralambides, 2002). Although it is correct to say that ports depend on sea transport, they are also highly dependent on land transport, (e.g. road, rail, pipeline, and in some cases inland waterways). The ship in this sense is only one of many different transport vehicles that serve, and are served by, a port.

If roadway and railway infrastructures, the latter extending hundreds if not thousands of kilometres, both represent a transport platform between points, it is evident that a port does not offer the same comparable good (or anything close to it). A transport platform (or transport "way") must consist of more than just a port/node, which merely acts as a static interface between modes.

It has been suggested that EU ports will play an important role in the development of MoS services (Psaraftis, 2005). Such a perspective further implies that MoS is more than just simply ports. If ports, being nodes, are not the "transport platform" or "way", then the *seaway* (or MoS) must represent the platform. And if the port is not seaway or MoS infrastructure, then that raises another question, namely – what is seaway/MoS infrastructure?

Whereas state entities generally provide, finance, and maintain roadway and railway infrastructure, and in many countries ports as well, this is not the case with the seaway. The port is evidently not the seaway, because it is a transport node, so in that sense port infrastructure is not in any way comparable to roadway and railway infrastructure, the latter offering a transport platform over long distances.

This is the point at which any contention that maritime transport infrastructure consists only of the port becomes particularly weak and unconvincing (Figure 2) . Consequently, maritime transport infrastructure (the seaway) has to be a good deal more than the port.

Installation of any transport infrastructure platform provides for territorial continuity (GIE, 2007).

This implies that, once transport infrastructure is in place, there is the capacity for unhindered movement of persons and goods across the Earth's surface. Once created, road and rail infrastructure offers this potential. But the sea on its own does not.

For the sea there is also a need to create a basic transport platform (i.e. a seaway platform), that is comparable in a functional sense to roadway and railway. As an illustration, if a truck or a train was placed onto the sea, in its natural state, neither would move anywhere other than where wind or tide might take them (Figure 3 illustrates this and the need for a seaway platform). Therefore, in the absence of a seaway platform (i.e. maritime transport infrastructure) sea transport cannot occur (SUTRANET, 2007). In other words, sea transport cannot function without a platform, which would

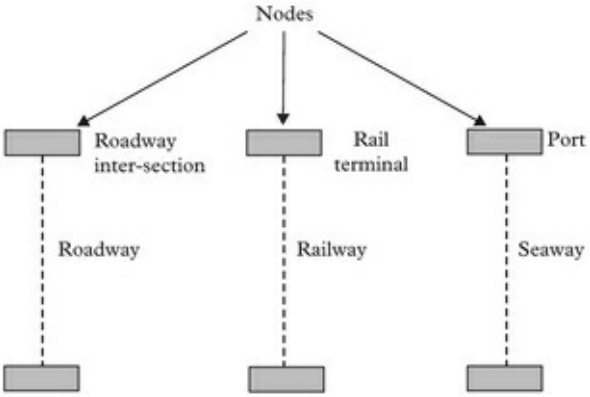

Figure 2: Ports are nodes, not seaway transport infrastructure platforms comparable with roadway and railway platforms

Figure 3: The seaway transport platform (i.e. maritime transport infrastructure) is the deck of a ship, without which the "seaway" does not exist

Source: author

comprise, in effect, maritime transport infrastructure, with the purpose of ensuring territorial continuity.

Transport infrastructure comprises any kind of works and structures that establishes the platform of a means of transport (GIE, 2007). In this regard it can be argued that the seaway/MoS platform, if it is not the sea, must therefore be the deck of a ship. This is already in part recognised at EU level, reflecting the statement by the van Miert EC High-Level Group on TEN-T that a boat/ship is a "floating structure" (Commission of the European Communities, 2002); however the full policy implications of this (*vis-a-vis* road and rail) have not yet been thought through. In other words, the boat has yet to be termed "maritime transport infrastructure" or considered as such from a policy and funding perspective.

The floating structure (i.e. the ship) comprises both the infrastructure and the platform of waterborne transport. This notion of the boat as floating infrastructure has therefore now taken root. The need to better support MoS services has raised calls (e.g. in France (GIE, 2007)) for the financing of the "boat infrastructure" by public authorities (i.e. up to 30% of the ship value). This estimate more or less equates to the cost of a ships' basic hull (or cargo platform), leaving the costs of propulsion machinery, accommodation and navigation/bridge systems etc. for the market/operator to provide. This approach would go some way to help equalise the effect of subsidies applying to road and rail infrastructures, thereby levelling the playing field between sea and land transport.

Ports, and indeed navigation aids (e.g. port access channels, lights etc) may be considered as auxiliary to waterborne transport infrastructure, which is composed fundamentally of the floating infrastructure of boats/ships'. But ports are not the (sea) transport infrastructure platform necessary to convey goods over long distances, and cannot function in any way comparable to parallel alternative road/rail platforms covering long distances.

The ship, albeit mobile, must therefore be acknowledged as what it is – *maritime transport infrastructure*. The ship might also be termed the *seaway platform.* Irrespective of the terminology used, the ship, which is maritime transport infrastructure, must be considered as comparable to roadway and railway transport infrastructure in providing for territorial continuity. Transport policies need to be revised in order to reflect this.

5. Conclusions

Despite policies tending to favour land transport infrastructure, ongoing MoS developments have helped signal the need for a new definition of maritime transport infrastructure. This new definition elevates the seaway in relation to the port, the latter being simply a node.

The theory explained and presented here states that the maritime transport infrastructure platform (i.e. the *seaway*) is the deck of a ship. The port is not a seaway platform; the seaway platform and therefore directly comparable transport infrastructure to roadway and railway infrastructure is the ship. It is the ship that provides for territorial continuity (not the port).

MoS experience has shown that more efficient Ro-Ro and Ro-Pax ship technology in particular has helped facilitate effective MoS solutions in an effort to overcome road transport problems and associated externalities resulting from increasing land transport usage. However, it is still the case that incentives are needed to further develop the seaway in order to alleviate market distortions in favour of land transport and facilitate change.

EU and Member State MoS/maritime transport policies will require appropriate adjustment to more adequately reflect the new definition of maritime transport infrastructure outlined here. Respecting the new definition of maritime transport infrastructure should enable policy-makers to develop and implement policies and initiatives that ensure seaway transport infrastructure receives appropriate consideration relative to other surface transport modes.

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References

Baird, A.J. (1997): "Coastal ro-ro freight ferry services: an alternative to trunk road haulage in the UK?", *Journal of Transport Logistics*, Vol. 1, No. 2, 85–152.

Baird, A.J. (2004): "Public goods and the public financing of major European seaports", *Journal of Maritime Policy & Management*, Vol. 31, No. 4, 1–17.

Baird, A.J. (2007): "The economics of motorways of the sea", *Journal of Maritime Policy & Management*, Vol. 34, No. 4, 287–310.

Baird, A.J. (2008): "Re-defining seaway infrastructure: impacts for ports, modal shift and MoS policy", in Musso, E. and Ghiara, H. (eds.) *Ports and Regional Economies* (Milan, McGraw-Hill) p. 71–80.

Commission of the European Communities (2004): *Motorways of the Sea, Implementation through Article 12a TEN-T*. Consultation document D(2004) (Brussels: 30 July 2004, Directorate G, CEC).

GIE (2007): *Transport and Territorial Continuity: Intergrating Waterborne Transport into the Trans-European Networks* (Les Pieux, France, Groupement d'Interet Economique).

Haralambides, H.E. (2002): "Competition, excess capacity, and the pricing of port infrastructures", *International Journal of Maritime Economics*, Vol. 4, 323–347.

IMPRINT-NET (2007): *IMPRINT-NET Project*, EC 6th Framework Programme. www.imprint-net-org

Psaraftis, H.N. (2005): "EU ports policy: where do we go from here?", *Maritime Economics and Logistics*, No. 7, 73–82.

Sutranet (2007): *Sustainable Transport Networks for Research and Development – SUTRANET*. Project funded by the EU Interreg IIIB North Sea Programme. University of Aalborg & Partners. www.sutranet.org

Torbianelli, V.A. (2000): "When the road controls the sea: a case study of Ro-Ro transport in the Mediterranean", *Maritime Policy & Management*, Vol. 27, No. 4, 375–389.

UK Marine Motorways (2002): *UK Marine Motoways Study*, for Engineering and Physical Sciences Research Council (EPSRC) and UK Department for Transport (DfT) (Edinburgh, TRI-Napier University).

UNCTAD (1992) *Port marketing and the challenges of the third generation port*. TD/B/C.4/ AC.7/14 (New York, United Nations).

Verhoeven, P. (2009): "European ports policy: meeting contemporary governance challenges", *Maritime Policy & Management*, Vol. 26, No. 1, 79–101.

Part Eleven

Aspects of International Logistics

Chapter 34

International Logistics Strategy and Modal Choice

*Kunio Miyashita**

1. Introduction

The container shipping mode of transportation has in large part cooperated with, but has also competed against, the air transportation mode. The concepts of both total distribution costs and the opportunity cost support a division of labour by the two modes (air and sea) and explain the existence of a competitive grey zone. However, traditional theory is not sufficient to explain a recent trend towards air-oriented cargo flows. The modal choice problem is not in the sole domain of the transport field, but has a new dynamic dimension, which involves integration with both logistics strategy and the supply chain management of shippers. This chapter brings insight into the traditional economic phenomenon of modal choice and its innovative research frontiers related with the logistics strategy.[1]

The interaction between the shipping and air modes of transportation has been dominated by a trend towards air-oriented transport,[2] if observed from the point of view of the value of trade volumes. Needless to say, in terms of total volume as measured by weight-tonne, sea shipments are responsible for more than 99% of total international physical distribution. Hence, the shipping industry plays a core status role in the international transport industry. However, in terms of value of the goods shipped, the share of industrial goods transported by air has increased significantly.[3]

Traditionally, the principle of total cost based on the difference in the service quality between the two modes of transportation has explained modal choice.[4] This view is important even today. However, a point has been reached where it has become necessary for a new analytical angle based on logistics theory to be combined with the aforementioned traditional argument. In other words, there is a need for a greater level of entrepreneurial spirit in the shipping industry, especially in relation to container shipping and air transportation, which supports the logistics activities of the shipper. In this chapter, we discuss a hypothesis in which structural change in both shipping and air transportation modes will be derived according to the international logistics strategy of shippers. The core problem of modal choice will be closely related to a shippers' logistics strategy, under which international direct investment, the product cycle and the stability of international transactions will generate a rational causal relationship with modal choice. In accordance with a shipper's logistics strategy, international physical distribution markets will be composed of both sea and air-based logistics systems. Both of these types of system will either compete or cooperate, so that the modal choice problem of transport is gradually absorbed into the logistics system.

2. Competition and Cooperation of Container Shipping and Air Transportation

2.1 Total distribution cost as the criterion of modal choice

The higher the value of a good is, the faster the speed of the transport mode being selected will be. This is the reason why inventory costs will fluctuate in proportion to both the price of goods and the transportation period. Hence, it is preferable to transport high value goods by the speedier air-based

mode to reduce the transportation period (inventory period), if the saving rate of the inventory cost is higher than the increased rate in the transportation cost. The sum of these two costs is referred to as the total distribution cost. In this case, the total distribution costs relating to high value goods will be decreased if a high-speed mode is utilised. The establishment of the concept of total distribution cost is very important in terms of determining modal choice between container shipping and air transportation. It is the concept of distribution costs that has led to the transport of high value goods by air since the 1960s.

According to the concept of total distribution costs, the value of a good is negatively correlated with the transport period. As is commonly known, if we select the transport period as the measure of the horizontal axis and total distribution costs as the measure of the vertical axis, a downward convex total distribution curve can be generated. On the contrary, if we select the value of the good instead of the transport period as the measure of the horizontal axis, an upward convex total distribution curve will be generated as shown in Figure 1.

In Figure 1, the total distribution cost curve for container shipping intersects with the cost curve for air transportation at the value of the product *e*. If the value of the product is greater (more expensive) than *e*, it will be advantageous to transport a particular product by air, and vice versa. Hence, it can be hypothesised that a division of labour between the two modes can be confirmed at *e*. In addition, the higher the value of the product, the higher the opportunity cost will be for products transported by container shipping. If a seasonal product, such as a currently fashionable good, is transported by the sea mode, large scale, temporary opportunity costs will be generated. In this case, the opportunity cost will increase in a greater proportion to the value of product as indicated by curve ②. If we add opportunity costs to the total distribution cost of container shipping, a new interactive point (intersection) indicating the total distribution costs of air transport can be realized at/, which is located to the left of the existing point *e*.

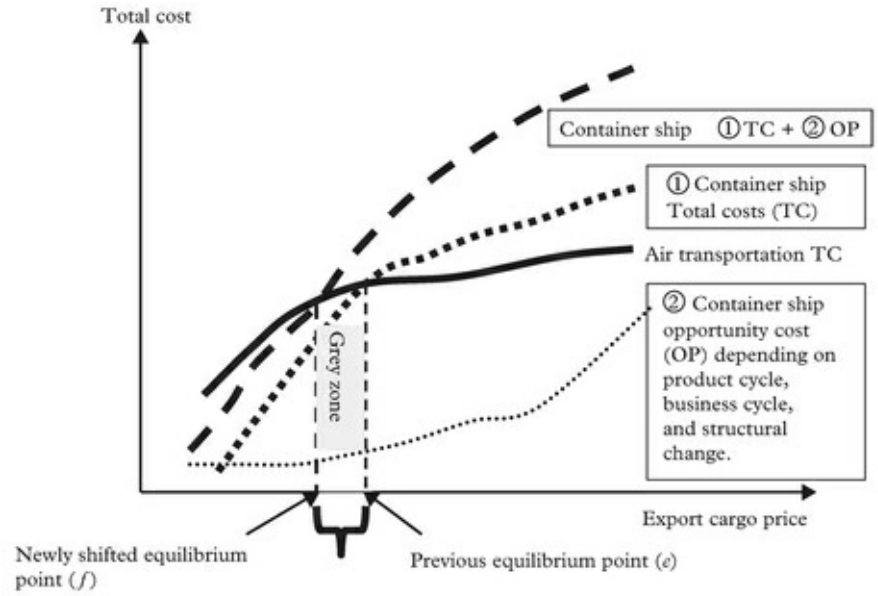

Figure 1: Competitive grey zone between container shipping and air transportation

Thus, it is possible to discriminate between three kinds of value ranges for a particular product:

a. Shipment by container is the logical modal choice if the value range of a particular product is lower than *f*;
b. Air transportation is the logical modal choice if the value range of a particular product is

greater than *f*; and

c. A value range between *e* and *f* indicates a 'grey zone', where modal choice is extremely competitive.

The relationship in terms of modal choice between container shipping and air transportation is in principle complementary but if it is considered from a total distribution cost point of view, it will be competitive.

2.2 Turning point in modal choice

Recent Japanese export trade volume data in Figure 2 shows that between 1980 and 1992 existed a parallel relationship between the export share of goods transported by container shipping and the share of goods transported by air transportation.

The share of goods shipped by air transportation increased steadily as new markets were exploited, while container shipping continued to maintain its share of the conventional liner shipping business. However, after reaching a plateau in 1992, container shipping gradually began to lose share relating to export transport. Since 1992, modal share has fluctuated in a downward direction. In 1992, container shipping was responsible for 52% of all export shipments. By 1998, this share had decreased to 47%.

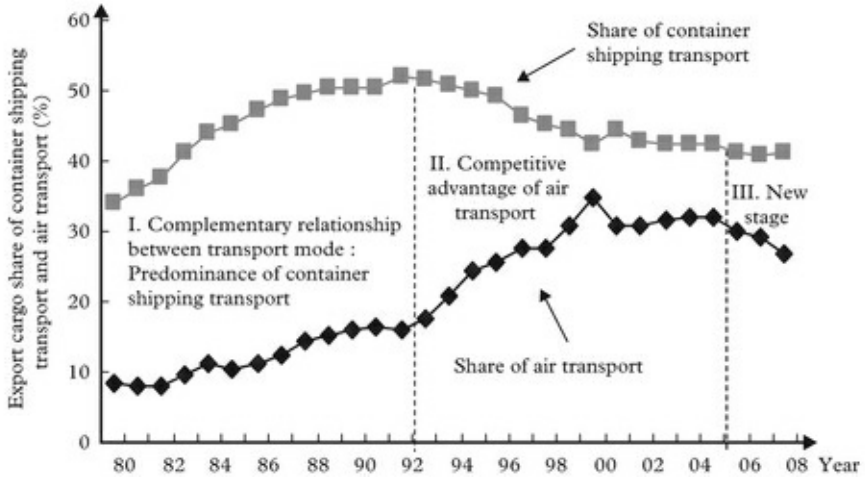

Figure 2: Development of trade by air in Japan: competitive and complementary relationship with container shipping

Source: Ministry of Finance Japan

On the contrary, in 1992, the modal share for air transportation was 18%. This had increased to 29% by 1998.

Thus, it appears that 1992 can be considered to be the turning point in share fluctuation between the two modes in the case of exports from Japan. It should be noted that it is the shipper who has changed the international physical distribution strategy. In addition, the modal choice problem has structurally changed since 1992 in Japan. Generally speaking, it is necessary to generate a different model of modal choice for the period before 1990 as opposed to model considered representative of the 1990s.[5]

2.3 Modal choice model prior to 1990

Before 1990, the principle of total distribution costs dominated the modal choice behaviour of shippers. Following, the principal and complementary relationship between two modes will be determined. As shown in Figure 1, opportunity costs will generate a competitive grey zone. In this case, it can be hypothesised that while air transport service is not a superior good, a container shipping service cannot be considered to be an inferior good. If this is indeed the case, the question of which type of modal service will be preferred by shippers remains to be answered, especially if the income

(revenue, profit) of a shipper determines modal choice.

Accordingly, the modal choice activity function will be noted as follows.

$$(ETA_i / ETS_i) = f((TCA_i / TCS_i); GDP_i; OPC_i; TAS_i) \quad (1)$$

where:

ETA = value of export trade volumes by air transportation,

ETS = value of export trade volumes by container shipping,

Table 1: Conditions of the signs in equation (1)

Causality / Main determinant factors	Complementary causality	Substitution causality	Estimated result
Total distribution cost ratio of air transport to container shipping	Positive	Negative	0.433[a]
GDP of export country	Negative*	Positive**	−1.077[b]
Opportunity cost of container shipping	Positive	Positive	1.996[b]
Preference for freighter	Positive	Positive	0.599[c]

Note: *Air transport services are neither superior goods nor inferior ones.
**Air transport service is the superior goods.
Statistical Indicator of Estimated Result: RB2 = 0.733, SE = 0.127, DW = 1.58. Constant = 2.063. Estimated Period: 1963–83. RB2 denotes the coefficient of determination adjusted by the degree of freedom, SE the standard error of estimate, and DW the Durbin-Watson Statistics. a, b and c show the t-statistics and the significance level at 5%, 10% and 20% levels respectively.

TCA = total distribution costs by air transport,

TCC = total distribution costs by container shipping,

GDP = gross domestic product of export country,

OPC = opportunity cost of container shipping,

TAS = preference by shippers for freighter, and

i = specific time point.

The data for the variables ETA, ETS, GDP and TAS are readily available in each of the countries under study. An approximation of total distribution costs can be determined hypothetically by calculating the reciprocal of freight share as measured by *commodity price/freight rate*. This type of approximation is only available if the ratio of container freight rate in container cargo price is constant or in other words its technological progress is comparatively stable[6].

In equation (1), the dependent variable (the ratio of trade volumes between air transportation and container shipping) will fluctuate in a reverse direction as compared to the ratio of the total distribution cost between the two modes, if their respective transport services are both substitutive and competitive. In this case, the sign of the ratio representing total distribution costs will be negative. However, if the trade volume ratio fluctuates in the same direction as the total distribution cost ratio, both transport modes will possess a complementary relationship. In this case, the sign of the total distribution cost ratio will be positive as per our hypothesis.

Next, we assume that as the GDP of an export country increases, its trade volume ratio will increase. Thus, the sign of the GDP ratio will be positive. In this case, an increase in the GDP of a particular country will lead to an increase in air transport volumes, which represents the numerator in the trade volume ratio. Hence, air transportation service can be classified as a superior good with container shipping service representing an inferior good. On the contrary if the sign of GDP ratio is negative, air transportation service can be classified as neither a superior or inferior good.

In general, the opportunity cost of container shipping will have a positive sign, because the total distribution cost of air transportation will lead to cost advantages over container shipping. The preference by shippers for freighter will likely increase the share of trade volume flows by the air transportation mode, so it can be assumed that its sign will be positive.

For Japan, the signs of the variables in equation (1) and the estimated results of the equation are summarised in Table 1. Equation (1) is specified in the logarithmic form and is estimated by the least square method.

The estimated results with respect to the sign of the coefficient indicate a complementary relationship between air transport and container shipping. The coefficients of both the total distribution cost ratio of air transport to container shipping and the GDP of the export country (Japan) are statistically significant and demonstrate a complementary causality. At the same time, the basic relationship is influenced by both the opportunity cost of container shipping and the preference for the shipper to freighter, which leads to the existence of a competitive zone, which we refer to as a grey zone.

2.4 Increases in substitution causality in the 1990s

Next, we expand the estimated period to cover the years 1980–1996. In the 1990s, in addition to the total distribution cost ratio of air transport to container shipping, the function of the logistics network is also a determinant factor. Such network effects, as represented by foreign direct investment, will absorb the traditional function of opportunity cost, income and preference on a shipper's modal choice behaviour. Direct investment will determine the shipper's international logistics strategy to the extent that the existing simple modal choice mechanism will no longer be appropriate due to the structural change in the network effects. The function is thus adjusted as follows:

$$(\mathrm{ETA}i / \mathrm{ETS}i) = f((\mathrm{TCA}i / \mathrm{TCS}i); \mathrm{DIU}i; \mathrm{DIE}i; \mathrm{DIA}i) \qquad (2)$$

where:

DIU = direct Japanese investment in the US

DIE = direct Japanese investment in the EU and

DIS = direct Japanese investment in Asia.

Equation (2) is specified in the logarithmic form and is estimated by least square method as in equation (1). The estimated results are detailed in Table 2.

Table 2: The effect of total cost and networking on modal choice

Total distribution cost ratio of sea and air	Direct investment in US	Direct investment in EU	Direct investment in Asia
0.307b	–0.078	–0.228a	0.688a

Note: RB2 = 0.962, SE = 0.05, DW = 2.12. Constant = –4.69.
Estimated Period = 1980–1996. a = 1%, b = 5%.

The estimated results of the total distribution cost ratio as detailed in Table 3 suggest a fundamental complementary relationship between air transportation and shipping. However, the effects of direct investment on modal choice vary considerably. The sign representing the coefficient of direct investment in Asia is positive, indicating that the shipper regards air transport as the superior good. In the Asian region, the substitutive nature of air and sea services are clearly indicated. However, direct investment in the EU strongly indicates the complementary nature of the services. Finally, the

coefficient representing direct investment in the US is not statistically significant. Thus, the network function as related to air transportation and shipping services is neither complementary nor substitutive. In the Pacific region, the effect of service quality on modal choice is neutral.

It is important to keep in mind that the estimation period of equation (2) includes data for the 1980s. During that period, the competitive zone was limited to the aforementioned grey zone. Hence, the estimated results of equation (2) do not necessarily reflect the characteristics of a shipper's logistics strategy and its network operations. However, it is possible to recognise a trend towards the utilisation of an air-based logistics system in the global economy. In particular, it is necessary to consider closely the economic circumstances behind the investment behavioural patterns of the three regions. For example, why is it possible to discriminate between modal choice behaviors in the three regions? The answer is that the modal choice in a specific region will be affected by a logistics strategy, which is based on the competitive advantage of a specific product. In next section, we try to access this problem.

3. Logistics Strategy and Modal Choice

3.1 Determinant factors supporting the shippers' behaviour

From the previous section, it is clear that shippers of Japanese exports base modal choice on the level of direct investment in a particular region. In this section, we attempt to construct a more sophisticated modal choice model, which represents export logistics systems.

The basic determinants of modal choice from the shippers' point of view are the following two factors which are based on the analysis in Section 2 and logistics concepts in general:

a. the total logistics cost ratio of air-based logistics systems to sea-based logistics systems to different destinations from Japan;
b. the level of direct investment by shippers in different regions of the world.

The total logistics cost ratio is the main factor determining basic modal choice between an air-based logistics system and a sea-based logistics system. Carriers such as airlines and container lines act as logistics service providers striving to realise an advantage in terms of reducing total logistics costs. In the current logistics era, forwarders also act as logistics service providers.

Certainly from an historical point of view of the transport service provider, air forwarders have maintained an advantage over air carrier in terms of the network available for cargo booking. In contrast, container-shipping carriers have dominated booking activity for cargo flows over sea borne forwarders. At this stage of development, it is possible to classify both the carrier and forwarder as transportation service providers. Based on their background, it is possible to find different advantages in terms of booking power between the carrier and the forwarder in different markets.

In the transition period, during which the transportation service provider gradually developed into a logistics service provider, shippers have strived to combine successively and cross-functionally value added logistics services with their procurement (physical supply), production support and sales marketing (physical distribution) activity. Based on the Bowersox concept, a logistics system is composed of both a value-added inventory flow as mentioned above and other required information relating to market forecasts, order analysis, production planning, and procurement planning.[7]

During the process of logistics development, the product cycle became shorter and shorter and industrial shippers preferred "speedier" logistics systems. In addition, there was a considerable

increase in foreign investment in global markets at the same time. Currently, debates revolve around where the optimum location for assembly and parts production is. It has become necessary for parts production and assembly to be relocated in a timely fashion, in response to cross-functional logistics system analysis. Courier transport has been developing at a tremendously high growth rate with companies such as FedEx and UPS being representative. These companies have taken advantage of a preferential environment in which information technology has been utilised to exploit a new frontier of logistics system integration amongst different firms. Supply chain management (SCM) responsive strategy has become a common component of logistics systems.[8]

Under a SCM strategy, international express service companies are playing a leading role as an integrated carrier. FedEx utilises an SCM responsive strategy in terms of its integration with Dell Computers, Hewlett Packard, Laura Ashley, Rosh, and American Express.[9] The integrated carrier plays the dual role of the logistics system builder and the logistics operator. Enterprising forwarders also commonly utilise this type of strategy. The role played by the integrated carrier is referred to as third-party logistics (3PL).[10]

International express services as well as enterprising air forwarder services have been developing as part of the package of services provided by the logistics system provider. This has had the effect of increasing the preference for the air mode. If this is indeed the case, it's becomes necessary to select the following (c)–(d) as determinant factors of modal choice.

(c) International air express services.

(d) Enterprising air forwarder services.

These two factors function in the incremental zone of modal choice. Needless to say, there has been a trend towards the greater utilisation of SCM in the development process of logistics. Under a SCM strategy, partnership among SCM members is the key factor leading to sustainability. The international logistics industry should insist on maintaining an equal partnership as a core member of a strategy utilising SCM. As a result, it is necessary to reflect on the level of customer satisfaction amongst member shippers in an SCM responsive logistics system. Under SCM, it is necessary to achieve cooperation amongst the final assembly company and the parts and accessory manufacturing companies. The main issue facing each member of SCM thus becomes the product cycle of the industrial goods manufactured and traded in a specific SCM system.

The product cycle has certainly been the most important factor not only during the period of the transport service provider but also currently with the logistics service provider. The role of the product cycle becomes even more important for the logistics system provider under SCM. Thus, it is necessary to add this factor as a key environmental component of modal choice in international logistics.

(e) At each stage in the logistics system, the product cycle in each region (US, EU and Asia) is distinct from each other.

There are basically five factors determining modal choice for a shipper, which are represented by the circles in Figure 3. The circles with the dotted lines represent the environment factors in tiers 1 and 2, which were detailed previously. The arrow indicates a causal relationship between a basic logistics strategy (tier 1), the different types of providers (tier 2), five theoretical determinant factors circled by solid line (tier 3), their practical proxy variables in quadrangles (tier 4) and modal choice behaviour

(tier 5).

3.2 Modal choice behaviour under global logistics linkage

In tier 4 in Figure 3 total logistics cost is dived into two components, (i.e. space transfer cost (transportation cost) and time transfer cost (inventory cost). Due to the recent rapid changes in technology, it is not appropriate to evaluate total logistics cost by the reciprocal of freight share as measured by *commodity price/freight rate*. In this scheme, the effect of air integrator and forwarder services on logistical modal choice can be grasped by the coefficient dummy variable of time transfer cost since 1993, because 1992 was the turning point for the existing shippers' behaviour.

The most important structural change in the world economy will be the increasing trend of global linkage among Asia, the EU and the US. In Figure 3 the key factors to combine three kinds of district economies with each other, will be the level of investment and the product cycle. First, the Asian economy can be regarded as the operator of investment buffer in the global economy and has the long reach to absorb the impact of direct investment in the EU and the US. The terms of Japan's trade with Asia by air will play a key role in the direct investment behaviour in the global economy. Secondly, the effect of innovational edge of product cycle on modal choice can be observed in US trade, strictly in the terms of Japan's trade with US by air.

Then the modal choice function in Japan trade with US is built up in Table 3, where the rational sign conditions of five independent variables are summarised. In the logistics age it is especially important to avoid the increase in time transfer costs, which tends to induce the trade by air. Originally air trade has the advantage to decreasing inventory costs. It is the reason why two kinds of variables concerned with time transfer cost are positive. On the contrary the change in the space transfer cost brings about the normal demand behaviour, so that its sign will be negative. Product cycle in US represented by the terms of Japan's trade with US by air has a positive sign, whereas the investment buffer function represented by the terms of Japan's trade with Asia by air has a negative sign. The latter two variables function as the factors combining the Japan with Asia, the EU and the US.

The basic model of global economic linkage is grasped by the modal choice behaviour of Japanese shippers' trade with the US. Then their networks extend via the EU trade to Asia as shown in Figure 4. The time lag structure of trade transactions among three districts is assumed to follow the specific lag type of the Shiller model. Certainly

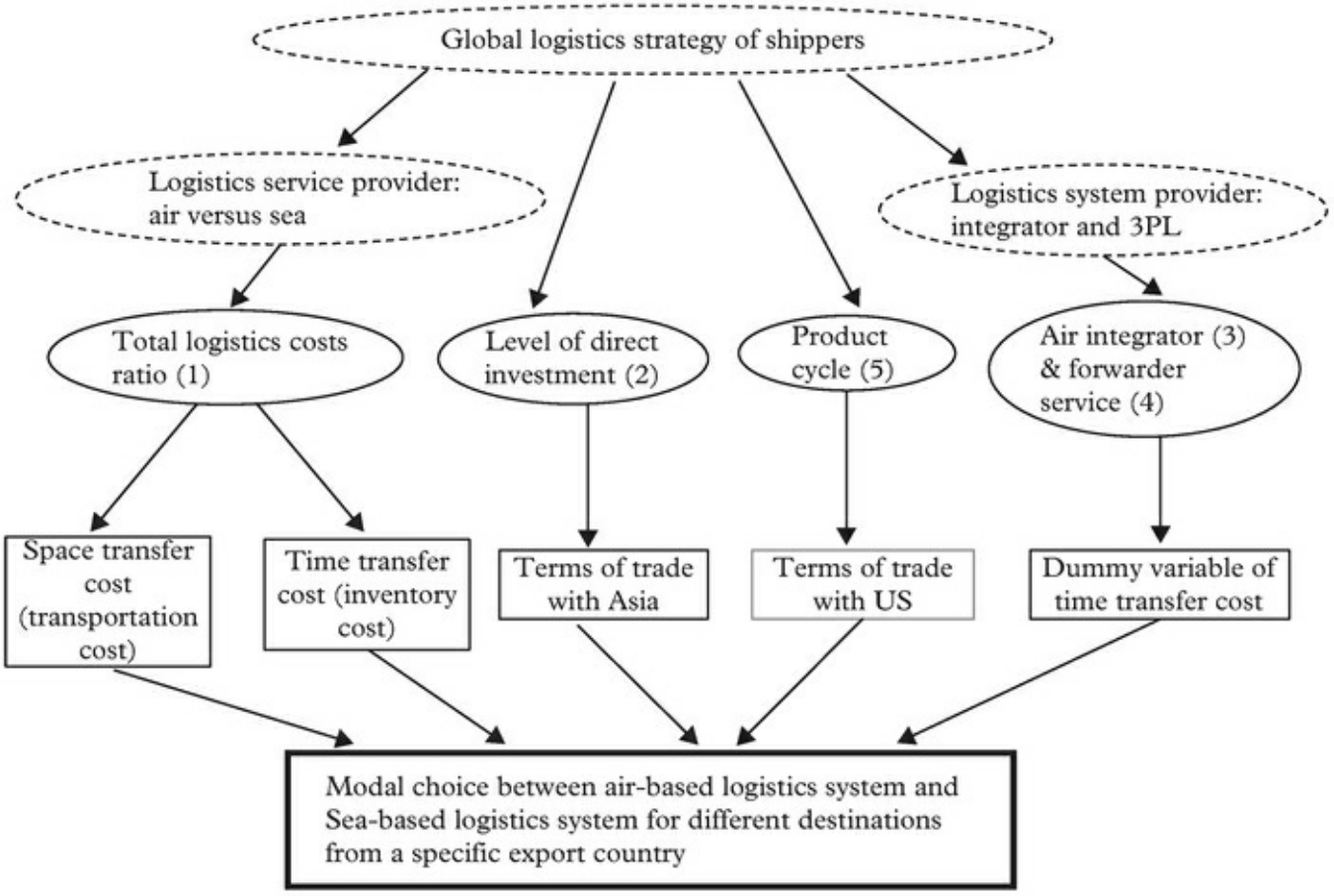

Figure 3: Modal choice flow chart of logistics system – air-based logistics system or sea-based logistics system?

Table 3: Modal choice function in Japan trade with US

Dependent variable	Modal Choice between air-based logistics system and sea-based logistics system for three different destination from specific export country Japan		
Independent proxy variables and their of coefficients	1. Space-transfer cost ratio (transportation cost ratio)	Ratio of air freight rate to container ship freight rate	Negative
	2. Time-transfer cost ratio (inventory cost ratio)	Ratio of air cargo export price to container cargo export price	Positive
	3.Air integrator and forwarder service	Dummy variable of time transfer cost ratio (1993–2004 = 1.0, otherwise: 0)	Positive
	4. Product cycle	Terms of air trade with the US	Positive
	5. Level of direct investment	Terms of air trade with Asia	Negative

Source: Bank of Japan (1980–2005), *Service Price Index for Firm*. Ministry of Economics, Trade and Industry Japan (1980–2008), *Japan Trade Statistics*. Ministry of Land, Infrastructure, Transport and Tourism Japan (1980–2005), *Statistics of Air Cargo exported and Imported by Main Routes*. Ministry of Land, Infrastructure, Transport and Tourism Japan (2001–2004), *Maritime Transport*. Journal of Commerce (1985–2005), *PIERS Data*. Transpacific Conference from Japan to West Coast of USA, *Conference Freight Rate of Specified Cargos*.

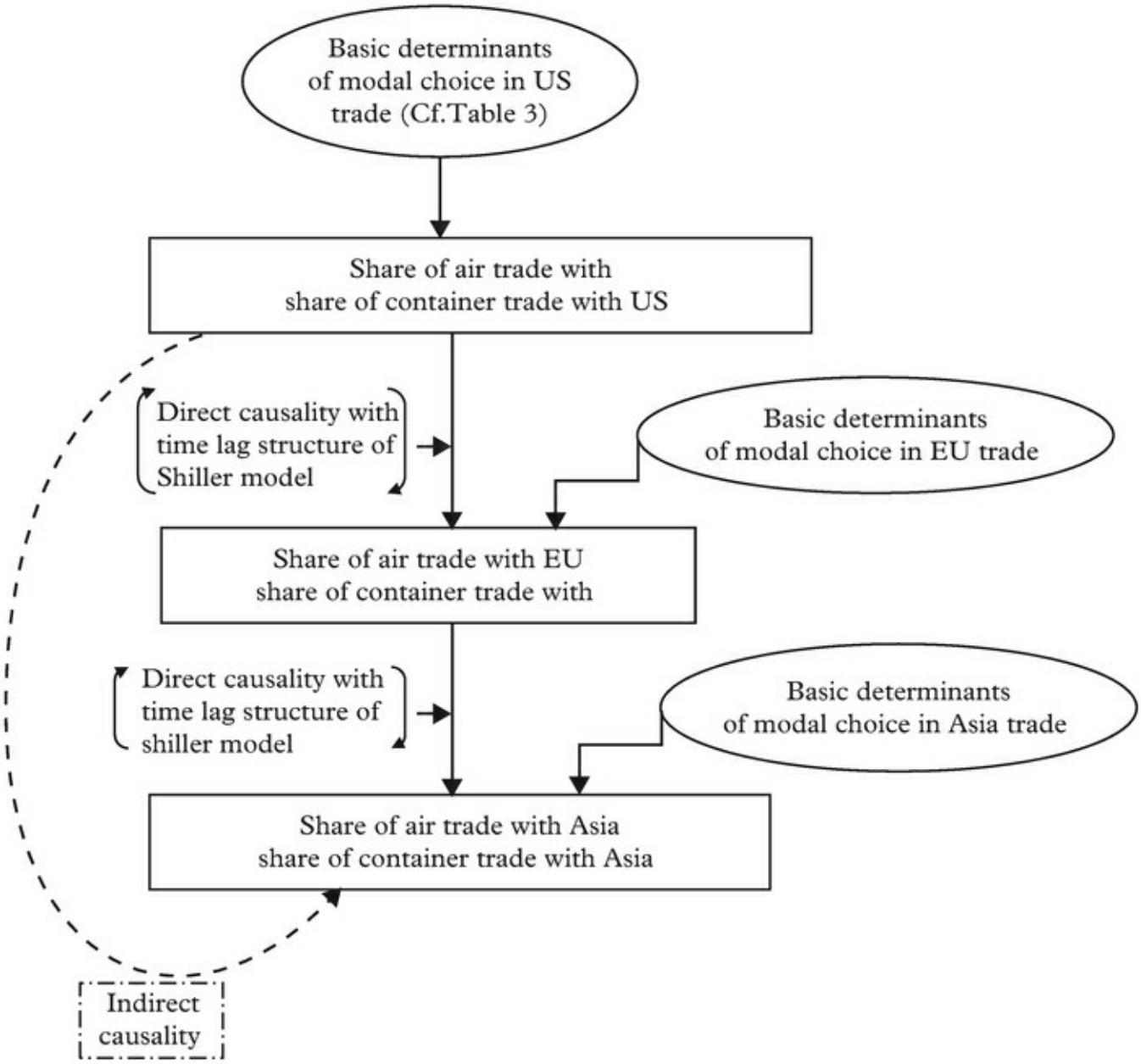

Figure 4: Global linkage of Japanese shippers' modal choice behaviour

the causal relationship of trade between the US and Asia can be recognised. But its effect is not so strong that their relationship stays in the indirect conditions. At present the dominant type of global linkage around Japan is one way causal relationship starting from US trade, through the EU to Asia.

The estimated result of the modal choice behaviour of Japanese shippers in Table 3, followed by the global linkage model of Figure 4 is summarised in Tables 4 and 5. Table 4 shows the estimated function of a Japanese shipper's modal choice behaviour in US export trade. Based on this estimation and the Shiller lag model, we have the estimated function of Japanese shippers' modal choice behaviour in EU export trade in the left column of Table 5. Then, in the right column of Table 5, we can show the estimated result of Japanese shipper's modal choice behavior in Asia export trade.

Then based on the estimated result in Tables 4 and 5, Japanese shippers' long run modal choice elasticity in US, EU and Asia trades can be given as follows in Table 6. In all of three trades the structural change in shippers' modal choice behaviour toward logistics strategy can be demonstrated clearly by positive time-transfer cost-ratio

Table 4: Estimated function of Japanese shipper's modal choice behaviour in US export trade

Determinant factors	Estimated coefficient
Space transfer cost ratio (transportation cost ratio)	− 0.08931[b]
Time transfer cost ratio (inventory cost ratio)	− 0.2491
Dummy variable of time transfer cost ratio (1993–2004 = 1.0, otherwise; 0)	0.3767[a]
Terms of air trade with US (product cycle)	0.3573[c]
Terms of air trade with Asia (direct investment)	− 0.7039[b]

Note: RB2 = 0.897, SE = 0.142, DW = 1.70, Constant = − 1.70.
Estimated period = 1980–2004. a = 1%, b = 5%, c = 10%.

Table 5: Estimated functions of Japanese shippers' modal choice behaviour in EU and Asia export trades

Export trade with EU		Export trade with Asia	
Determinant factors	**Estimated coefficient**	**Determinant factors**	**Estimated coefficient**
Space transfer cost ratio	− 0.1476[a]	Space transfer cost ratio	− 0.3205[b]
Time transfer cost ratio	− 0.3695c	Time transfer cost ratio	− 0.4512[b]
Estimated value of the modal choice function in US export trade in Table 4 (Shiller lag = 0)	0.3877[a]	Estimated value of the modal choice function in EU export trade on the left column in Table 5 (Shiller lag = 0)	0.7376[a]
Ditto (Shiller lag = − 1)	0.2687[a]	Ditto (− 1)	0.4483[a]
Ditto (Shiller lag = − 2)	0.1819[a]	Ditto (− 2)	0.1853[a]
Ditto (Shiller lag = − 3)	0.1518[a]	Ditto (− 3)	− 0.0214[a]
Ditto (Shiller lag = − 4)	0.1615[a]	Cumulative coefficient toal of Shiller lag (0)−(− 3)	1.3498
Cumulative coefficient total of Shiller lag (0)–(− 4)	1.1506		
Constant	− 2.4038	Constant	− 2.8745
RB2; SE; DW	0.979; 0.073; 1.98	RB2, SE, DW	0.964; 0.085; 1.62

Note: Estimated period = 1980–2004. a = 1%, b = 5%, c = 10%.

Table 6: Long run elasticity of Japanese shippers' modal choice behaviour in three main trades

Determinant factors	US trade	EU trade	Asia trade
Space transfer cost ratio (transportation cost ratio)	− 0.08931	− 0.2500	− 0.6580
Time transfer cost ratio in 1980–1992 (inventory cost ratio)	0	− 0.3695	0.8683
Time transfer cost ratio in 1993–2004	0.3767	0.06393	0.1336
Terms of air trade with US (product cycle)	0.3573	0.4111	0.5549
Terms of air trade with Asia (direct investment)	− 0.7039	− 0.8099	− 1.0932

Note: If the t-value of the coefficient concerned is bellower than the level 20%, it is regarded as null value.

elasticity. The traditional space transfer cost ratio elasticity is almost equal to zero, especially in US

trade so that the modal choice behaviour is dominated by shippers' logistics strategies. Also in other two trades time-transfer cost-ratio elasticity in 1993–2004 changes to positive.

The product cycle impact is different among three trades, where US trade has the lowest elasticity despite its higher level of product cycle. The modal choice impact tends to be gradually accumulated and growing as the main trend of logistics strategy.

Terms of air trade with Asia is the proxy variable of the buffer function of global trade. The weaker the trend of air-orientated behaviour, the stronger its buffer function to compensate the decrease in global trade. The negative sign of its elasticity represents the rational response of Asian economy. Its elasticity is largest in three trades to restore the inverse trend of global economy.

Based on our estimated result of Tables 5 and 6, we can depict, in Figure 5, the long-term ripple effect of Japanese shippers' modal choice behaviour in exports to the US. In Asian trade its effect tends to continue for seven years and in the EU for five years.

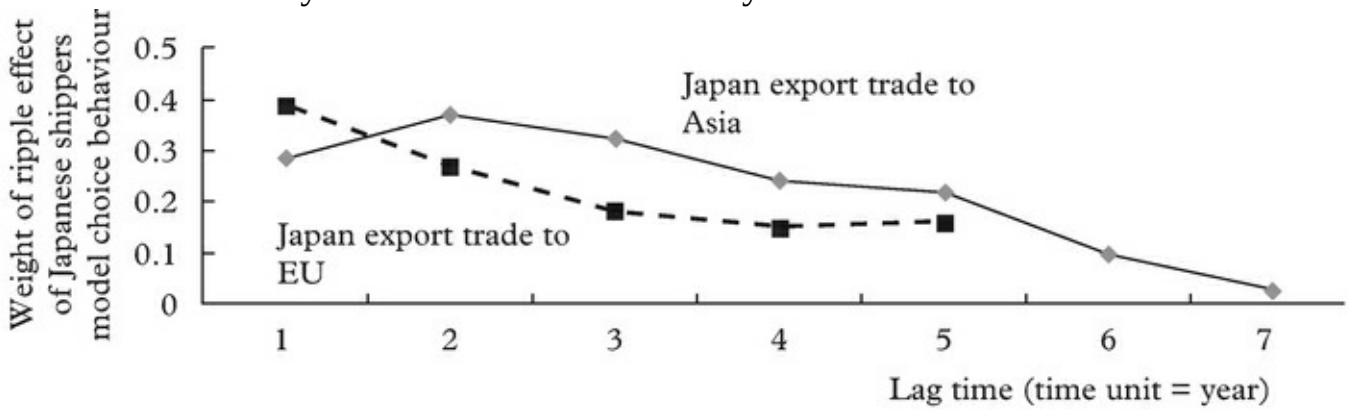

Figure 5: Ripple effect of Japanese shippers' modal choice behaviour in export trade to US

It is the Asian economy that takes the final responsibility to absorb the global economic shock and buffer it.

4. Logistics Cycle and Modal Choice Perspective

4.1 Logistics cycle hypothesis based on product cycle and modal choice

As is well known, product cycle theory as proposed by Raymond Vernon can explain the relationship between investment behaviour and cargo flows between specified countries.[11] Vernon introduced three phases – innovation, maturity and simple standardisation – which occur during the developing stages of the product cycle. Mark Casson then modified Vernon's research slightly and added a new original third stage referred to as standardised differentiation, which falls between the maturity and simple standardised stages.[12] Thus, the Vernon–Casson model depicts the total dynamics of the product cycle as follows.

During the initial stages of the life cycle, innovative products including parts and accessories are manufactured solely in the country of origin and one then exported to other industrial countries. Technical advancements are directed towards reductions in labour costs. These advancements tend to be repeated to keep pace with consumer demand. As information exchanges between the production and sales arms increase, it becomes more conducive to relocate the production centre closer to the market. However, it is too early in the cycle to establish the know-how necessary to utilise this technique. Only a few industrial countries are able to continue such innovative market research, production and marketing in their home countries. Direct investment is restricted to establishing and

expanding sales centres as foreign subsidiaries. As it is only finished goods, which flow between the parent company and the foreign subsidiary, a horizontal physical distribution flow is dominant among industrial countries in the innovative stage.

In the second stage, the transfer of manufacturing technology to foreign subsidiaries located in industrial countries is instigated by the introduction of a technological manual used for manufacturing. In this scenario, the promotion of import–oriented production is increased. Foreign subsidiaries begin to produce and assemble almost all of the necessary parts. The parent company concentrates on producing the key components of the product, in such a way that a vertical type of physical distribution appears among industrial countries. On the contrary, horizontal physical distribution is common between developed and developing countries.

The third stage of the production cycle is referred to as standardised differentiation, where a rational production method is introduced involving the division of labour among foreign subsidiaries. Under the concept of selection and concentration, each subsidiary is ordered to produce specific components if an inherent comparative advantage exists. Such a production system will promote both a refined division of labour as well as lead to a reduction in production costs. New products can be introduced by utilising different combinations of components even though the components themselves are standardised. Such an exchange system of components allows products to remain fresh and maintain differentiation. In this sense, the third stage of the product cycle determines whether or not the cycle will survive over a period of time. As a result, subsidiaries in developing countries and economies are able to produce the general components necessary for assembly, although even in this stage, a limited amount of the key components necessary to produce a given good are manufactured by the parent company. The main flow of physical distribution is horizontal with components moving from developing countries and economies to industrialised countries.

As we move towards the end of the product cycle, goods become perfectly standardised and gradually begin to lose market status. At this stage, new innovative products will begin to appear in the market.

According to product cycle theory, it is possible to construct a modal choice hypothesis pertaining to export shippers in an international logistics system.

1. During the first stage, export shippers prefer to utilise an air-based logistics system. This is due to the highly value-added nature of innovative products, which leads to high inventory costs over time. In order to minimise total logistics costs, the share of this product shipped by air in terms of total product shipped will grow rapidly as opposed to a reduced share for a sea-based logistics system.
2. Next comes the growing stage. At this stage the air-based logistics system is growing more and more, because the new entry of producers to the market increases. Based on this market competition, the price of product concerned is decreasing, so that the share of sea-based logistics system is increasing in comparison with the first stage.
3. At the third stage, as the product's life cycle begins to mature, a sea-based logistics system will be developed in parallel with an air based logistics system. The assembly line is relocated gradually to other developed industrial countries. Exports of both components from the parent company and finished goods from the subsidiary lead to a trade off relationship between air-based and sea-based logistics systems. At this point, the second stage reaches

peak levels.

4. During the fourth stage, the share of product moved by a sea-based logistics system increases to a greater level than the share of product moved by an air-based logistics system. Standardised differentiation promotes the utilisation of a sea-based logistics system for goods moving from emerging countries and economies to countries worldwide. However, the share of the core components shipped from the parent country is decreasing.
5. At some point, a simple standardised product loses market share due to the appearance of new innovative products. In this final stage, the volumes of goods shipped not only by air-based but also by sea based logistics systems will decrease simultaneously.
6. Finally, new innovation product of next generation appears. This stage can be called the potential innovation.

Based on the above hypothesis, it is possible to construct Figure 6, where the vertical axes represents the share of product shipped by an air-based logistics system on a specific export route from a specific country and the horizontal axes the share of the same product shipped by a sea-based logistics system. A logistics cycle with a circular line of the same orientation much like the hand of watch is generated.

4.2 Estimated result of the logistics cycle in Japan export trade and some perspective on the business cycle

In order to generalise this hypothesis, we formulate the share of product shipped by an air-based and sea-based logistics system where:

S = share of products shipped by a sea-based logistics system (%),

A = share of products shipped by an air-based logistics system (%),

i = destination of products shipped from the export country (e.g. 1 = US, 2 = EU, 3 = Asia), and

j = specific year (e.g. j = 1998),

thus,

$$\Sigma S_{i,j} + \Sigma A_{i,j} = 100.$$

By observing the time series path of both $S_{i,j}$ and $A_{i,j}$, it is possible to draw three theoretically generated circular lines based on the three destinations of the goods exported (i).

If we input data for Japanese exports to the US, EU and Asia into the set of $S_{i,j}$ and $A_{i,j}$, it is possible in practice to trace a successive two kind of full circle as shown in Figure 6, which will suggest the modal choice of the logistics systems in each destination between 1983–2004. It is clear that a modal choice hypothesis based on the dynamic product cycle as shown in Figure 6 coincides with the current export logistics systems utilised in Japan. The main characteristic of such a system is the increase in the share of volume being shipped by an air-based logistics system. This tends to cause the central point of the circle to shift in a northwest direction as shown in figure 7.

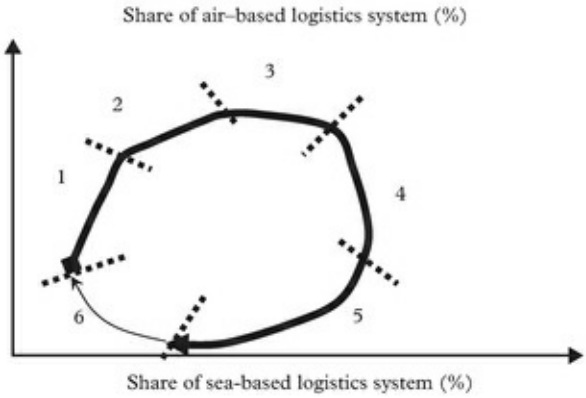

Figure 6: Logistics cycle based on product cycle and modal choice for export trade in a specific destination: hypothetical case

Note: 1 = Innovative stage; 2 = Growing stage; 3 = Maturity stage; 4 = Standardised differentiation stage; 5 = Simple standardisation stage, 6 = Potential innovation stage.

The logistics cycle in Figure 7 represents the long-term economic fluctuation in US economy from the modal choice and product cycle concept. Also it is effective to predict the current economic conditions. Why logistics cycle has been linked with product cycle, depends on the time lag between the air -based logistics system dominant period and the sea-based one. In other word, the current sea-based logistics system is the cumulative result of past air-based logistics system.

As already mentioned, before 1992 the complementary relationship was dominant between sea transportation and air transportation. Since 1993 the air-based logistics system has been the leading strategy supporting the international logistics. So assuming the partial adjustment process of sea-based logistics system before 1992 and the consecutive cumulative role of air-based logistics system in the export trade to the US, EU and Asia following the Shiller lag model, we have the Japanese shippers' sea- based logistics system function in equation (3).

$$SLS_i = f(DES_i^{\star}(1-\lambda)^{\star}SLS_i; \delta^{\star}ALS_i) \qquad (3)$$

where:

SLS = Share of sea-based logistics system,

ALS = Share of air-based logistics system,

DES = Dummy variable representing the dominant effect of sea-based logistics system(1980–1992=1.0, otherwise 0),

λ = Adjustment speed of the share of sea-based log istics system ($0<\lambda<1$ or $\lambda=1$), and

δ = Cumulative Shiller lag distribution on share of air-based logistics system ALS.

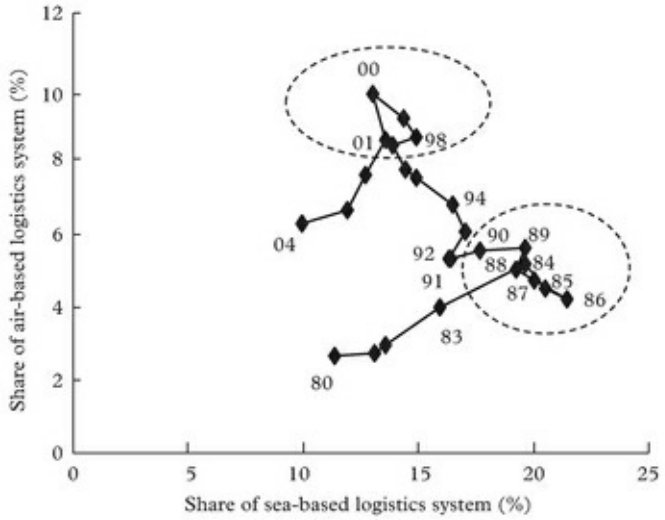

Figure 7: Logistics cycle in the export trade to US (1980–2004)

Table 7: Estimated result of sea-based logistics system in the export trades to the US, the EU and Asia

Determinant factors	US trade	EU trade	Asia trade
(Dummy variable representing the dominant effect of sea-based logistics system)* (Share of sea-based logistics system(– 1)) = 1-λ	0.07327(2.35)[a]	0.09384(2.96)[a]	0.10779(3.10)[a]
Share of air-based logistics system (Shiller lag = – 1)	0.3377(2.27)[b]	0.3240(2.50)[b]	0.7749(3.75)[a]
Share of air-based logistics system (Shiller lag = – 2)	0.2238(2.20)[b]	0.1261(1.68)	0.4774(4.63)[a]
Share of air-based logistics system (Shiller lag = – 3)	0.1130(1.39)	−0.0440(−0.53)	0.2072(2.73)[b]
Share of air-based logistics system (Shiller lag = – 4)	0.0138(0.20)	−0.1899(−2.18)[b]	−0.0117(−0.13)
Share of air-based logistics system (Shiller lag = – 5)	− 0.0731(1.20)	−0.3356(−2.25)[b]	−0.1852(−1.96)[c]
Share of air-based logistics system (Shiller lag = – 6)	−0.1553(−2.83)[b]	–	−0.3308(−2.30)[b]
Share of air-based logistics system (Shiller lag = – 7)	−0.2391(−3.64)[a]	–	–
Share of air-based logistics system (Shiller lag = – 8)	−0.3282(−2.96)[b]	–	–
Cumulative coefficient total of Shiller lag	− 0.107471	− 0.11933	0.9318
Constant	2.6209	2.1042	1.9604
Statistical value	RB2 = 0.8202, SE = 0.065, DW = 2.08	RB2 = 0.6224, SE = 0.13, DW = 1.16	RB2 = 0.7870, SE = 0.113, DW = 0.80

Note: Estimation period = 1980–2004.

Equation (3) is specified in the logarithmic form and is estimated by least square method. The estimated results are detailed in Table 7.

For the period 1980–1993, the adjustment speed(λ) of the share of sea-based logistics system shippers in US trade is 0.92673 (=1–0.07327). In EU trade, λ is 0.90616 and in Asian trade 0.89221. Shippers prefer sea-based logistics system, succeed in the almost perfect adjustment behaviour every year, which demonstrates the sea-based logistics system to be dominant for 1980–1992. But after 1993 the sea-based logistics system tends to suffer only from the share of air based logistics system.

The air-based logistics system continues to give the cumulative effect on the current sea-based logistics system for total estimated period. It is the air-based logistics system that can play

continuously the role of logistics cycle driver in Japan trade. Based on the estimated result in Table 7, the logistics cycle in US trade has the eight years' distributed lag, which represents the eight years' periodicity. The so-called Juglar cycle has the similar cycle operation of with 8–11 years' periodicity based on the fluctuation of investment of firms.[13] The periodicity of cycle in EU trade is five years and in Asian trade six years, which are a little shorter than the Juglar cycle but a longer than the Kitchin inventory cycle with an average of 40 months' periodicity. According to the existing statistical studies of cycle, the logistics cycle in Japan export trade can be regarded to belonging to the Juglar cycle. It means the logistics cycle is generated by the technological revolution, which accompanies the fixed investment of the shipper's firms.

If we can analyse the causality and the distributed lag structure between the logistics cycle and the business cycle more precisely in the long-term, we will be able to use it to predict the turning point of business cycle, because the logistics index tends to be the leading indicator of the manufacturing index. It is necessary to gain insight into the national economy in a specific country in order to understand the business cycle fluctuation from the viewpoint of international logistics cycle. This will be an important topic for further research.

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Endnotes

1. This paper is the revised form of my following article: Miyashita. K. (2002): "International logistics and modal choice", in Grammenos, C.T. (ed.): *The Handbook of Maritime Economics and Business* (London, Informa Professional) Chapter 37.
2. Sletmo, G.K. (1984): *Demand for Air Cargo – An Econometric Approach* (Bergen, Institute for Shipping Research, Norwegian School of Economics and Business Administration) p. 9.
3. Sletmo, G.K. and Williams Jr., E.W. (1981): *Liner Conferences in the Container Age* (New York, Macmillan) pp. 115–118 and 222–223.
4. Miyashita, K. (1994): "On the fusion of international transport markets", *Annals of the Graduate School of Business Administration,* Kobe University, No. 38, pp. 59–75.
5. Miyashita, K. (2009): "Structural change in international advanced logistics", *The Asian Journal of Shipping and Logistics*, 25, 1, 121–138.
6. In the estimation, including the technological innovative period from the second half of 1990s to 2000s, it is necessary to divide the total distribution costs into space-transfer cost (transportation cost) and time-transfer cost (inventory cost). See Figure 3 where the total distribution costs are called the total logistics costs.
7. Bowersox, D.J. and Closs, D.J. (1996): *Logistical Management – The Integrated Supply Chain Process* (New York, McGraw-Hill) pp. 33–40.
8. Reddy, M. and Reddy, S. (2001): *Supply Chains to Virtual Integration* (New York, McGraw-Hill) Ch. 1; Bowersox, D.J., Closs, D.J. and Cooper, B.C. (2007): *Supply Chain Logistics Management* (New York, McGraw-Hill).
9. Taylor, D. (ed.) (1997): *Global Cases in Logistics and Supply Chain Management* (London, International Thompson Business Press); Mangan, J., Lalwani, C. and Butcher, T. (2008): *Global Logistics and Supply Chain Management* (London, John Wiley & Sons), Part Two.

10. OECD (1996): *"Integrated Advanced Logistics for Freight Transport"*, Report Prepared by an OECD Scientific Group (Paris, OECD).
11. Casson, M. (1986): *Multinationals and World Trade* (London, Allen & Unwin) pp. 21–22.
12. Vernon, R. (1966): "International investment and international trade in the product cycle", *Quarterly Journal of Economics*, LXXX, 190–207; Vernon, R. (1979): "The product cycle hypothesis in a new international environment", *Oxford Bulletin of Economics and Statistics*, 41, 262–263.
13. Rostow, W. W. (1992): *Theories of Economic Growth from David Hume to the Present* (Oxford, Oxford University Press) pp 233–248; Punzo, L. F. (2001): *Cycles, Growth and Structural Change* (New York, Routledge) p. 5; Farago, A. (2002): *How to Survive the Recession and the Recovery* (London, Canada, Insomniac Press) pp. 36–41.

Chapter 35

It in Logistics and Maritime Business

Ulla Tapaninen[*], *Lauri Ojala*[†], *and David Menachof*[‡]

1. Introduction

This chapter deals with contemporary information technology (IT) solutions and applications in logistics, and focuses on their usage in maritime business. The chapter discusses some of the underlying reasons for the pervasive use of IT, and exemplifies some existing solutions on various levels in shipping. More specifically, the chapter is organised under the following sections:

a. intra-company systems, applications and uses of IT (operational systems in capacity allocation, tracking and tracing, ERP/ES-based on management level etc.)
b. inter-company systems between business operators (exchange of operational data on cargo, shipments, payments etc. on a system-to-system basis using EDI, XML, etc., and relying either on shared software or dedicated (proprietary) systems)
c. company-public authority exchange of data (such as to/from trade and transport authorities – port agencies, customs, border/coast guard etc.)

The list is not exclusive, for example various public sector systems, either within or between public bodies are left outside the presentation. One should also realise that these categories are simplified, and that many of the systems will have overlap into the other sections, but are classified as to their main section.

The interesting linkages of IT to Vessel Traffic Service or Management Systems (VTS/VTMIS) and Automatic Identification Systems (AIS) of vessels related to IMO's International Convention for the Safety of Life at Sea (SOLAS) convention, to safety at sea, or regional (port) development are beyond the scope of this chapter.[1, 2]

As far as various sectors of maritime business are concerned, liner shipping is perhaps most affected by IT development.[3,4] In liner shipping, the service offered has become a commodity, which is transacted in very high quantities with relatively little negotiation between the parties. The increasing logistics or supply chain management (SCM) needs of shippers also underline the need of efficient information management along the whole supply chain.

In industrial shipping, the number of transactions is typically much smaller than in liner shipping, but the operations often require more negotiation between the trading partners, or parties involved in transport operations. Industrial shipping solutions tend to be dedicated and more long-term arrangements with multiple parties.

The maritime business includes a large number of operators both on the seaside and the landside that are, or that could be, involved. This chapter deals mainly with shipping companies within liner and industrial shipping, and port communities. For IT and information flows in (industrial) bulk shipping, see, e.g. Hull.[5]

Despite the pervasive use of IT and its immense importance in shipping and maritime operations, it has received surprisingly little research coverage in both logistics and supply chain management literature[6,7] as well as in maritime economics literature. For example in journals such as *Maritime*

Policy and Management (MPM) and *Maritime Economics and Logistics* (MEL), only a handful of papers during the past 7–8 years have touched upon the issue, often from the point of view of a specific problem.[8], [9], [10], [11], [12] Perhaps because of the focus of the textbooks and the legacy of their authors, the most recent maritime economics or shipping textbooks do not address the IT issue as a separate section either.[13], [14]

As there seems to be an apparent lack of coverage of the issue, this section attempts to provide a short and updated overview of this topic.[15] The text tries to avoid excessive technical detail and acronyms that are ubiquitous in this field.

2. It in Logistics and Supply Chain Management

SCM enables the coordinated management of material and information flows throughout the chain from your sources to your customers.[16] The US-based Council of Supply Chain Management Professionals (CSCMP) provides the following definition of SCM:

"Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies."[17]

The supply chain is both a network and a system. The network component involves the connections needed in the flow of products and information. The systemic properties are the interdependence of activities, organisations and processes. As one example, transportation transit times influence the amount of inventory held within the system. Generally said, actions in one part of the system affect other parts.[18]

Mentzer[19] defines a supply chain as a set of three or more companies directly linked by one or more of the upstream and downstream flows of products, services, finances and information. To be supply-chain oriented means that the company consciously develops the strategic system approach to enhance the processes and activities involved in managing the various flows in a supply chain. Supply chain management can envisage almost all of the company's main functions, or at least those functions like sales, marketing, R&D and forecasting can be handled within a supply chain context. To sum it up, SCM means a systemic coordination of the traditional business functions within a particular company and across businesses within the chain.

Information is an essential part of logistics and supply chains. The flow of information consists of data that is needed to launch the flows of material and capital and to steer them. Information can be generated in three ways: current information, forecasts and historical information. Some logistics models are based on current information. As an example, vehicle dispatching models need information about today's orders, vehicles available and driver status. Other models are based on forecasts. Historical data is then used to predict future demand, available production capacity, and so on. Some models use actual historical data to calibrate model accuracy. This means that model outputs can be compared to what actually happened to ensure the model is valid.[20]

Enterprise resource planning is one of the most essential functions in a modern manufacturing company and it also has a very strong supply chain implication. The old MRP-originated model, nowadays running at the core of the most sophisticated ERP systems: "What do I need, what do I have,

what do I need to get and when" is right at the backbone of the integrated supply chain. The requirements are taken from a customer or from internal forecasts.[21] This has also had a profound effect on the way in which major companies now operate their global manufacturing and supply chains. "Innovative supply chain management structures are rapidly emerging. These incorporate expanded access to 'e-sources' of supply, which use web-based exchanges and hubs, interactive trading mechanisms and advanced optimisation and matching algorithms to link customers with suppliers for individual transactions."[22] Many industries have embarked on reengineering efforts to improve the efficiency of their supply chains. The goal of these programs is to better match supply with demand so as to reduce the costs of inventory and stockouts, where potential savings are substantial.

One key initiative is information sharing between partners in a supply chain. Sharing sales information has been viewed as a major strategy to counter the so-called "bull-whip effect", which is essentially the phenomenon of demand variability amplification along a supply chain. It can create problems for suppliers, such as grossly inaccurate demand forecasts, low capacity utilisation, excessive inventory, and poor customer service.[23] The result for many companies is an expanded role of global sourcing of supply, and global reach in the search for customers. This, in turn, signifies an increasingly important role for liner shipping companies in making supply chains more efficient. It is this visibility that today's IT systems are able to provide.

Trade and transport operations invariably involve numerous partners both in the public and the private sector, such as banking and insurance agents, in addition to various logistics service providers. Likewise, the trading partners (buyers and sellers or consignors and consignees) evaluate the practicalities often on a case-by-case basis.

3. Intra-Company Information Flows

It is not possible to describe all the possible uses of IT for intra-company information purposes, and many of these intra-company systems integrate with intercompany systems. What we will attempt to do is describe some of the systems in place and highlight the key issues that are related to these systems. It should also be noted that the logistics functions must still take place whether or not there is an IT solution available. For example, before ERP programs, accounting data was still maintained, Bills of Materials were still created, sales orders were still processed, but much less efficiently than today.

Enterprise Resource Planning programmes are the foundation for many firms' IT capabilities. Companies like SAP, J.D. Edwards, PeopleSoft, and Oracle are the major companies in this multi-billion dollar industry. All ERP providers are looking to extend the capabilities of their products by adding additional functionality to their product. The three major functional areas of ERP are: Manufacturing & Logistics, Finance & Accounting, and Human Resources & Payroll (see Table 1). Various environmental calculation systems have become a significant part of present-day accounting systems, reporting e.g. CO_2 emissions, fuel consumption, amounts of waste and waste water.

Jakovljevic[24] identifies some of the key reasons why ERP systems have become so popular and are essential to the modern firm. These are strategic, tactical and technical.

Table 1: Base functions of ERP programmes

Manufacturing and logistics	**Finance and accounting**	**Human resources and payroll**
Operations (production) planning	General ledger	Human resources administration
Engineering	Accounts receivable	Payroll
Shop floor control	Accounts payable	Benefits
Procurement management	Fixed assets	Self-service HR
Order entry and processing	Cash management	
Sales, marketing and after sales	Budgeting	
Warehouse (inventory) management	Treasury management	
Distribution (transportation)		
Management		
Cost control		
Project management	Financial consolidations	
Plant maintenance	Environmental calculation	
Customers service management		
Extended supply chain management		

Strategic reasons:

- enable new business strategies;
- enable globalisation;
- enable growth strategies;
- extend supply/demand chain;
- increase customer responsiveness.

Tactical reasons:

- reduce cost/improve productivity;
- increase flexibility;
- integrate business processes;
- integrate acquisitions;
- standardise business processes;
- improve specific business processes/performances.

Technical reasons:

- standardise system/platform;
- improve quality and visibility of information;
- enhance technology infrastructure to handle the immense amount of data.

Programmes that “plug-in” to ERP systems are gaining in popularity, as enhanced functionality not offered by the base ERP system is required to gain competitive advantage.

Customer Relationship Management (CRM) software is designed to keep track of more than just customer orders. Delivery preferences, and past ordering profiles are among some of the information captured by CRM systems.

In addition to ERP, Electronic Data Interchange (EDI) is a commonly used technique in logistics companies. EDI stands for standardised automated transmission of data between two information systems. An example of the use of EDI is transmission of different documents, such as orders,

invoices and customs documents. With EDI, these are automatically transmitted from the sender company's IT system to the receiving company's information system. The use of EDI is very reasonable when there are large flows of goods and the company's partners are established. The building of EDI connections is expensive and there has to be quite a large number of transactions for the system to pay itself back. These facts make it unprofitable for small and medium-sized enterprises (SMEs) to use EDI.

The versatility of standards can also be considered as a downside of EDI. It is possible that a company is forced to use different kinds of EDI messages with different customers because of the customers' demands. Some logistics companies have begun to use the open standard Extensible Markup Language (XML) aside EDI. XML is an extensible language, because the user can define the mark-up elements. The purpose of XML is to help information systems share structured data, especially through the Internet, to encode documents, and to serialise data. The main difference between these two is that EDI is designed to serve the needs of business, and is a process, whereas XML is a language.[25]

Because of the extensive cost in implementing EDI or XML systems SMEs usually make bookings to transportation companies using the company's own web-based booking systems. The advantage of these systems is a reduction of errors and a decrease in costs, but SMEs may have to book on multiple internet platforms.

After a day of sales orders being generated and shipments organised, companies that have their own delivery fleets must send those vehicles out on the road to deliver to their customers. This is the job of routing and scheduling software, provided by firms such as IBM through ILOG, Radical, ALK Technologies and Paragon. Simple routing and scheduling problems can be solved by Linear Programming (LP) but as the number of constraints grows, the ability to obtain an optimal solution decreases. This is where the complex algorithms used by these specialised programmes come into their own.

In liner shipping companies, where changes of shipping routes are very seldom done, the allocation of vessels on routes is usually done by combining expert knowledge and experience with spreadsheet systems.

In routing problems, the objective is generally to minimise cost subject to constraints such as total travel time, road distance between deliveries, waiting time at each stop, and driver work regulations. Costs are assigned to each type of constraint, and the programme searches for a feasible solution. PCmiler (ALK associates) is just one version of this type of software programme.

Scheduling is a much more complex task, as it must incorporate many more requirements. Routing software generally doesn't check to see if the total quantities you are trying to ship exceed the capacity of the vehicle. Scheduling looks at total capacities and also looks at additional constraints such as delivery time windows.

Many companies working with just-in-time production facilities need strict delivery times. They cannot take delivery early or later than specified periods, and thus a vehicle that could deliver to all the customers in terms of capacity constraints might be unable to deliver those goods within the time parameters set by the customers. The costs and distance travelled using scheduling constraints is generally higher than when routing only issues are required.

ILOG Solver software from IBM allows a user to integrate shipment data from their ERP system by consolidating all the shipments for a given time period, then using the available fleet information along with the information for all of the shipments, to generate a set of shipping plans to assist in the order of deliveries for each vehicle required to meet all of the constraints. If no feasible solution is found, the user is notified, and will have to make management decisions as to which shipments will be unable to be delivered within their time windows, or must attempt to find additional vehicles that enable a feasible solution to be found.

Warehouse Management Systems are another popular "plug-in" adding enhanced capabilities for inventory control. While ERP systems have some ability to keep inventory storage location data, it is not nearly enough for complex warehouse operations. For example, more recent automated warehouses may have Automated Storage and Retrieval Systems (AS/RS).These systems need to know where the inventory is stored, which the ERP system can provide, but the ability to schedule and run the automated forklifts requires additional computing power, provided by WMS. Warehouses today can have the most simple of functions – just keeping the inventory dry but they have also become some of the most IT-intensive aspects of the supply chain.

Because they have been around for so long, one may not think of a barcode as much of an IT solution, but that little printed symbol can help a warehouse run smoothly. At Wal-Mart's distribution centres, automated conveyor belts scan the barcodes on packages, redirecting them to specific conveyor belts assigned to each store's destination.

Radio Frequency Identification (RFID) has come to the markets to "compete" with bar code. Radio identification systems that use short-range radio technique are a rapidly growing area of interest. The system consists of (a) RFID tags that are identified by their unique serial number or with some other certain data; and of (b) one or more RFID readers. The whole system is controlled by an RFID IT system and the company's other IT systems. Many different radio technical solutions and different frequency ranges can be used within RFID systems. RFID technology does not provide real-time data but rather status information. The information is created every time the tag is read and then the status of the delivery is updated. Despite the promising outlook for RFID technology, a number of institutional, organisational, financial and technological issues have so far prevented it from becoming the "killer application" across international supply chains.[26, 27]

Many traditional warehouses that use forklift trucks are being upgraded to use RFID technology to save time and reduce errors. Picking and storage information is sent directly to a screen on the forklift, giving the driver instructions on where to go for their next movement. Once the driver gets to the location, using a handheld scanner, he/she scans the barcode for that location to verify he/she is in the right place, and then picks or stores the correct quantity. Once completed, he/she sends a signal that he/she is ready for the next movement. There is no need to come back to the office to collect the next movement order. The drivers can stay on their forklifts, and are more productive than previously.

In many operations, firms do not have their own fleet to deliver the shipments, so they use commercial carriers. There are now systems that take information for each shipment and, based on the weight/volume, destination, and time constraints, calculate the best carrier to use, and print the specific waybill required for that carrier, thus minimising shipment costs. For example, a firm can choose a national logistics service provider, between a UPS, or DHL to deliver the shipment. Checking

each tariff manually to find the lowest cost would be extremely time consuming for high-volume businesses.

The number of business parties, logistics providers and officials taking part in a trans-ocean transport for each individual shipment is very large. Thus, it is very difficult to control the overall information flow along the route. In order to stay competitive in the global logistics markets, practically all major liner shipping operators now offer extensive door-to-door tracking and tracing services (see e.g. Heaver[28] and the websites of liner shipping operators such as Maersk or APL).

4. Inter-Company Information Flows

The information flows in shipments requiring several modes of transport can be very complicated. Figure 1 shows the standard structure of a multimodal logistics chain, where there are multiple data transfers within one cargo shipment. The interface is critical in relation to customs. Also, the changes in carriers cause critical points of information exchange.

Combining physical distribution with electronic information transfer and management, Bowersox and Closs[29] define three main drivers in the development of a logistical system. The first driver is the customer interface. Satisfied customers require easy and rapidly available information regarding their product locations, conditions and transport schedules. Secondly, good information resources reduce warehousing needs and help to provide more “on demand” services. Thirdly, information resources add

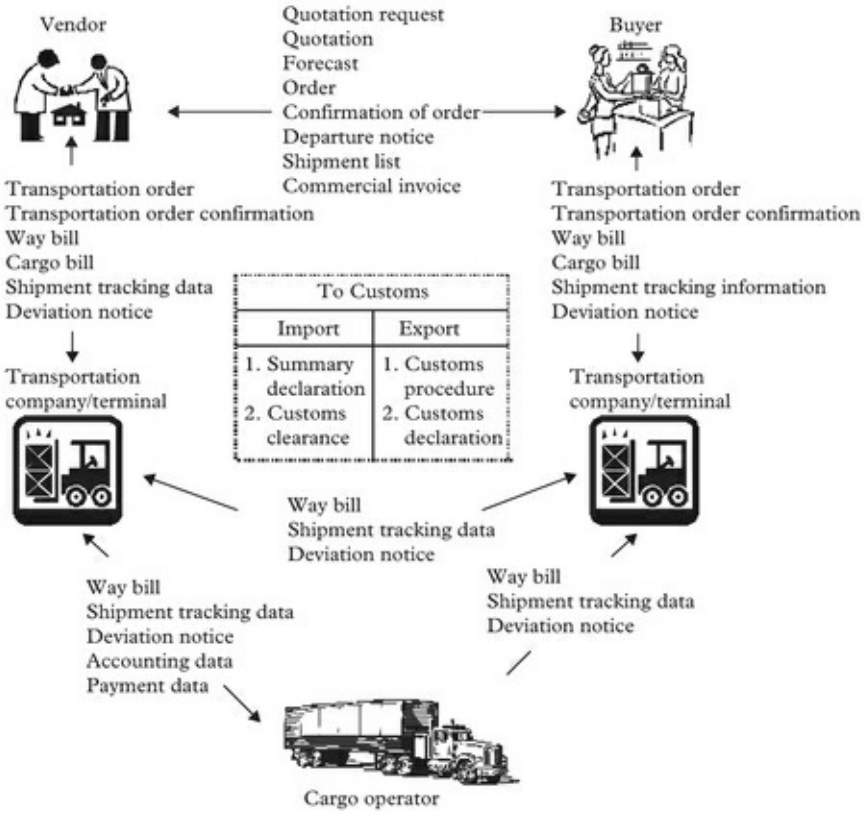

Figure 1: Information transfer needs in a multimodal logistics chain[30]

flexibility to the process and help to adapt to new situations if unforeseen events take place.

There have been many recent developments in inter-company information flows. Supply Chain Event Management (SCEM) software works with companies’ ERP programmes by defining responses to specified events. For example, HighJump Software’s Event Advantage solution promotes proactive customer service and reduces costs by alerting managers and trading partners to supply chain events

and exceptions via e-mail, pager, fax or phone. For example, a delayed shipment could trigger such a response, allowing the customer to take alternative action. By creating better visibility in the supply chain, all parties involved will have earlier notification and will be potentially able to respond before things become critical.

An illustrative example of these initiatives is the Collaborative Planning, Forecasting, and Replenishment (CPFR), which was launched in 1995. The process of implementing CPFR involves sharing information to better provide for end customer requirements. As in any collaborative process, the key is the commitment from the firms involved. Theoretically, CPFR could take place without IT systems, but as the number of Stock

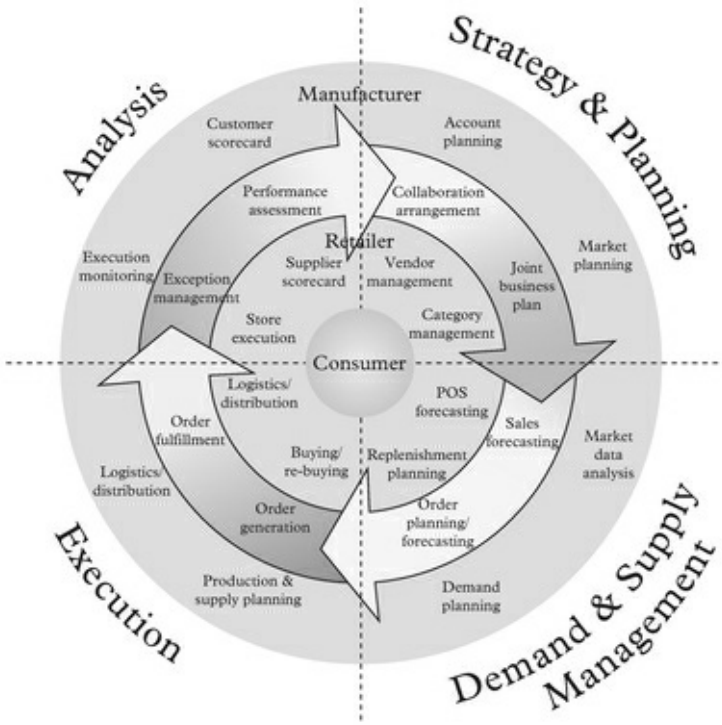

Figure 2: The CPFR® model
Source: www.vics.org/committees/cpfr/
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Keeping Units (SKUs) increases, the ability to track the information manually becomes less manageable. In general, CPFR involves three stages and is summarised in Figure 2.

The Planning Stage, involves an initial front-end agreement regarding what information is going to be shared, how it is to be shared, when, and other details. Then there is a quarterly planning session which looks at the wider strategic issues of the collaboration. The Forecasting Stage involves several steps. In step one, each firm will create a sales forecast for the upcoming period, and once that has been done, the information is centralised. Step two compares the forecasts and identifies any exceptions. The initial agreement might state that if both forecasts differ by more than 20%, this record is flagged as an exception. The third step is for both parties to meet and resolve the exceptions. Typically, one firm will host the database on their computer system and allow the other remote access to their data, using the internet and the appropriate security methods. The Replenishment Stage follows the steps of the Forecasting Stage, but looks at existing inventories along with the forecasts to determine how much to supply for the upcoming period. Once this stage is completed, the actual order is processed and submitted into each firms' ERP system.

The Process then continually repeats itself, with the end goal of enhanced inventory management, resulting in better customer satisfaction. Another example of where intracompany information can be exchanged is by firms using Vendor Managed Inventory (VMI). “VMI has been around for some time, but it is becoming increasingly accessible and relevant now as data communications systems improve.”[30] EPOS (Electronic Point of Sales) data is automatically transferred to the vendor, who will be responsible for replenishment of the stock based on agreed service standards and inventory levels. “The control of his customer delivery and visibility on customer needs, which VMI gives to the vendor, enables him to plan production and supply more reliably.”[31]

Although there is much that can be done electronically, the paperless supply chain is not yet here. One major issue that international logistics faces is documentary requirements by government agencies worldwide. Likewise, people still like the security of a physical document, even though electronic PODs (Proof of Deliveries) are being used by major delivery companies on a regular basis.[32] To be able to increase the efficiency of maritime transportation, the European Union has introduced an e-Maritime policy with the aim of promoting “coherent, transparent, efficient and simplified solutions in support of cooperation, interoperability and consistency between member States, sectors, business and systems involved in the European Transport System”.[33]

The e-Maritime initiative can be divided to following areas:

- Administration Domain Applications, including reporting using Single Windows and eCustoms
- Improved Shipping Operations, including eNavigation, ship reporting, e.g. CO_2 operational index, and VTS-systems
- Improved Port Operations; including Port Community systems, Integration of authorities, e.g. Port@Net, SafeSeaNet
- Integration into logistic chains; including Short Sea Shipping and intermodalism
- and eFreight
- Promote seafaring profession and sea-shipping, including eHealth at sea and improving image of EU shipping.

Although Business to Business (B2B) procurement websites have come and gone, B2B procurement will be, if it is not already, an important tool for many companies. B2B is not new, and was the basis for the use of EDI. It was a direct relationship between one company and its supplier. It was expensive, but for large companies who could afford it, offered competitive advantage over smaller competitors.

Figure 3 identifies the general type of e-procurement concepts. On the vertical scale, the nature of the transaction is measured, while the horizontal looks at the infrastructure and access to the system. Looking at the bottom right quadrant, with open access to the public, and a direct relationship between buyer and seller, general e-commerce is transacted here. As we move to many buyers and sellers getting together, we move to the e-marketplaces, with hubs designed to bring those parties together. Some are private, while others are open to anyone. Conceptually, they are appealing to the buyer, with more choice and enhanced price competition. However, for the seller, the proposition is less than appealing at the moment. Sellers have been staying away as price is the only selling point, and things like reputation and quality are hard to factor in at this point in time.

B2B exchanges come in several general models with vertical and horizontal hubs. Vertical hubs are generally industry/commodity based, attempting to bring together all

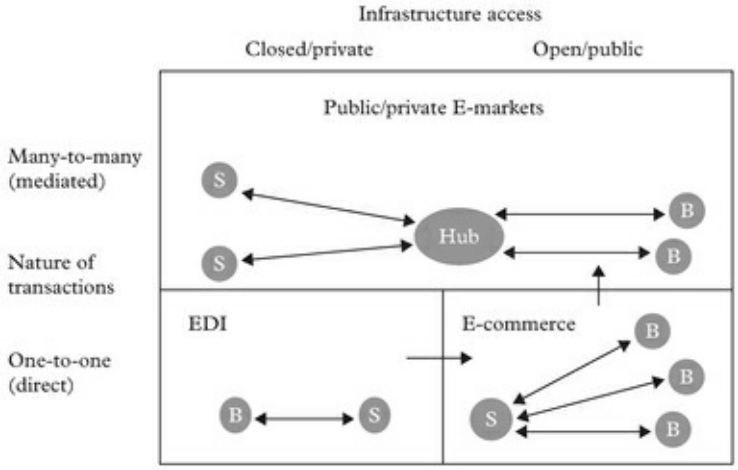

Figure 3: Types of business to business procurement models

players in the steel industry, for example. Other vertical hubs exist in plastics, chemicals, energy, telecoms, and even flowers.

Horizontal hubs attempt to look at specific functions, that are used across industries. Logistics hubs fit into this area. Transcore 3sixty Freight Match is a US-based firm that attempts to match companies excess transport capacity with firms who are looking for capacity. According to Richard Hunt, past-president of the Chartered Institute of Logistics and Transport International, more than 30% of road haulage vehicle miles are run either empty or under capacity. There is significant scope for improved efficiency. Although there is significant consolidation taking place in the industry currently, as firms figure out how to become profitable providing online procurement services, it is evident that the desire for the services are needed. The keys to success in this rapidly developing arena include integration with participating firms' back-end systems (ERP), value creation for all parties, and the critical mass needed to bring the initial fixed costs of these IT investments down to reasonable per transaction costs.

4.1 Illustrative case: Port process[34]

The transportation process requires a large amount of information, in particular when the transport mode is changed. To illustrate the amount of data interaction in one shipment in one position, we look closely at the process in a sea port. In sea ports, the central operating partners are (a) a shipping company; (b) a stevedoring company; (c) a land transport company; (d) port authorities; (e) Customs; (f) a terminal/warehousing operator; and (g) a drayage haulage. Customs and port authorities control the sea transport, they are in charge of safety and security and they take care of collecting taxes and other duties.

The representative of the shipping company agrees with the shipper about the transportation. Based on this agreement, the shipping company reserves a certain quota of the vessel capacity. The shipper starts the transportation by making a booking, usually by EDI or a web-based booking platform. The shipping company informs the stevedoring company about the booking (usually on-line). If there are dangerous cargoes in question, the shipper must apply for permission to carry them from the port authorities and present the necessary information to all parties.

The shipper organises the land transport, and informs the loading port of the arrival of the cargo. The cargo and its details are presented to Customs, who gives permission to load it on the vessel. The

information about the cargo that has arrived on port is also given to the shipping company (usually on-line by combining stevedoring and shipping company's systems) who can control the booking situation. The shipping company decides which cargo is loaded on the vessel and gives loading permission to the stevedore.

The representative of the vessel decides how the cargo is to be located in the cargo hold using specialised software based on stability of the vessel, dangerous cargo rules, etc. This Cargo Plan is given to the stevedoring company usually by on-line systems. When the loading is finished, the stevedore informs the shipping company and Customs about the cargo that was loaded. Based on this list, the shipping company creates a manifest – a list of the cargo on board and delivers it to Customs and port authorities.

Before arrival at the destination port, the representative of the vessel makes an announcement to Customs and port authority (see case Port@Net). The shipping company makes a special declaration of any dangerous cargo. Using this information, the port authority gives permission to unload the dangerous cargo with special requirements. The stevedoring company receives the Cargo Plan and is able to execute the unloading process. After unloading, the stevedoring company reports the unloaded cargo and the manifest can be updated.

The stevedoring company is in charge of the cargo until the permission to deliver the cargo to next partner is received from Customs, the shipping company and the port authorities. When the permission is received, the haulier arranges the land transport and informs the stevedoring company which truck has permission to take the cargo.

5. Company-Public Authority Exchange of Data

Due to the events and aftermath of September 11 2001, the growing pressure from external regulatory sources has made it necessary for maritime industry players to fully integrate the security element into both strategic plans and operational procedures. The 24-hour rule has the most profound effect on maritime IT-systems. Under this rule, detailed information of 14 data elements (e.g. number and quantity of packages, shippers names and Addresses, vessel flag, name and number) on container cargo on board vessels call at, or transiting via US ports must be submitted electronically to US Customs authorities at least 24 hours prior to departing from a foreign port. [35, 36]

Port community systems (PCS) have been developed to assist the rapid flow of information between all of the firms involved in moving goods in/out of a port. Since many of them were developed before clear standards were created, they were generally independent from each other. For example, Port of Charleston has the Orion system, Felixstowe has its own system, and as illustrated below, and Finnish ports use the Port@Net system. (For review of port community systems, see Srour et al. 2007[37]). The general concepts of PCSs are the same, although the systems and interfaces may be different at each port. One of the major benefits is the reduction in time needed to transmit information. For example, a container vessel's load plan may have been upwards of 60 pages, sent by fax or telex. Once received by the port, a computer operator would enter the data into their system, with many chances for errors occurring. These systems eliminate that need for re-keying of data, maintaining the accuracy and integrity of the information.[38]

5.1 Illustrative case: A Finnish port community system: Port@Net

The Port@Net is a national port community system that offers a single administrative desk for all the

declarations required with vessel's arrival and departure to major ports and authorities in Finland.[39] It is used by shipping lines, ship agents, a number of ports, the Customs, and Maritime Administration. It has over 1,000 users in Finland.

The Port@Net extranet application was implemented in year 2000 when it replaced the previous application in use since 1994. The newest version of Port@Net was taken into test use in 2009. As shown at the website of the Finnish Maritime Administration (www.fma.fi), the main users of Port@Net are:

- ship agents (see below);
- customs (check the data);
- port authorities (use the information in invoicing, statistics and dangerous cargo handling);
- maritime authorities (for traffic follow-up and statistics);
- coastguard (for traffic control);
- haulage and stevedoring companies (for vessel time of arrivals).

The procedures for vessels entering or leaving the port are in principle mirror images. For illustration purposes, the procedure for vessels leaving the port are highlighted below in Figure 4. When using the Web interface, the reporting principles similar, but instead of EDIFACT messages, XML-based messages are used.[40]

Before the vessel arrives, information of the vessel and its voyage has to be transferred to the Customs 24 hours before. If this cannot be achieved, the exceptions must be agreed with the Customs office of the port of call.

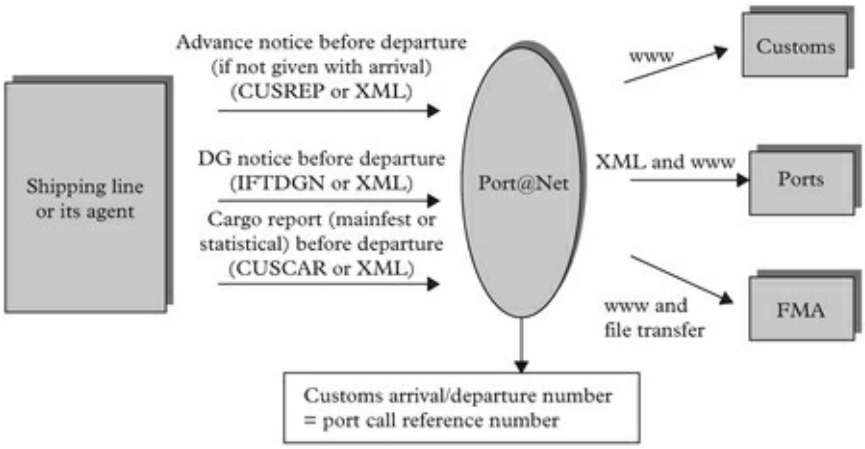

Figure 4: Information flows for arriving ships in Port@Net
Adapted from http://virtual.vtt.fi/virtual/proj6/fits/julkaisut/hanke8/IP_FITS_loppuraportti_020121.pdf

The procedure for the agent if giving cargo report on manifest level is the following:

- before the vessel's arrival the cargo report is transmitted using the CUSCAR message;
- several cargo reports can be sent per one advance notice (supplementary B/L's);
- the cargo report(s) refer to the same Customs' arrival/departure reference number;
- cargo information can be updated or modified before the arrival of the vessel;
- after the vessel has arrived, the agent can send updated cargo reports BUT then the changed information has to be faxed to the local Customs office;
- the agent will fill in the information of the general Customs declaration, sign it, attach a copy of the manifest to it and deliver the papers to the Customs office;

- the Customs office accepts the general declaration and gives permission for discharging;
- the port operator unloads the cargo and delivers the list of discharged cargo to the Customs.

6. Epilogue

Despite the profound change the development of IT has brought about in many fields, including the maritime business, it could be argued that the age of digital networks is only starting to take shape. One of the developments that would profoundly change the international logistics and shipping operations and business is the possibility to track, trace and control individual parcels and shipments wirelessly, and virtually in real time. Many of the technological breakthroughs required for that to happen have already been made, and their cost is likely to approach the level of commercial exploitation fairly soon. This type of technology could even change the nature of maritime business, or at least the liner shipping part of it beyond recognition.

Particularly, while port are so important nodes for information where dozens of operators are in contact with each other when handling a piece of cargo, there is still very many improvements to be realised. It can be assumed that the biggest improvements in future of maritime logistics information handling will be seen in cargo track and trace operations and streamlining the data exchange between various operators in ports.

In the previous edition of this book in 2002, we concluded our chapter 1 by quoting Churchill:[41] "This is not the end. It is not even the beginning of the end. But it is, perhaps, the end of the beginning."

During the years that have passed since, much has happened in the usage and applications of IT systems both in the business and public sector. Still, there is a long way to reach the full potential of IT and mobile technologies in maritime and logistics business and practice. But one might say that the end of the beginning is nigh.

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Endnotes

1. Goulielmos, A. and Tzannatos, E. (1997): "Management information system for the promotion of safety in shipping", *An International Journal of Disaster Prevention and Management*, 6, 4, 252–262.
2. Sletmo, G. (1999): "Port Life Cycles: Policy and Strategy in the Global Economy", *International Journal of Maritime Economics*, 1, 1, 11–38; and Airriess, C.A. (2001): "Regional production, information-communication technology, and the developmental state: the rise of Singapore as a global container hub", *Geoforum*, 32, 2, 235–25.
3. Frankel, E.G. (1999): "The Economics of Total Trans-ocean Supply Chain Management", *International Journal of Maritime Economics*, 1, 1, 61–69.
4. Stopford, M. (2002): "E-commerce implications, opportunities and threats for the maritime business", *International Journal of Transport Management*, 1, 1, 55–67.
5. Hull, B. (2002): "A structure for supply-chain information flows and its application to the Alaskan crude oil supply chain", *Logistics Information Management*, 15, 1, 8–23.
6. Lumsden, K. and Mirzabeiki, V. (2008): "Determining the value of information for different partners in the supply chain", *International Journal of Physical Distribution & Logistics*, 38, 9, 659–673.

7. Kouvelis, P., Chambers, C. and Wand, H. (2006): “Supply Chain Management Research and Production and Operations Management”, Review, Trends and Opportunities, Production and Operations Management, 15, 3, 449–469.
8. Olivo, A., Zuddas, P., di Francesco M. and Manca, A. (2005): “An operational model for empty container management”, *Maritime Economics and Logistics*, 7, 199–222.
9. Roumboutsos, A., Nikitakos, N. and Gritzalis, S. (2005): “Information technology network security risk assessment and management framework for shipping companies”, *Maritime Policy and Management*, 32, 4, 421–432.
10. Yeung, A.C. (2006): “The impact of third-party logistics performance on the logistics and export perfomance of users: An Empirical Study”, *Maritime Economics and Logistics*, 8, 121–139.
11. Lam, S. Y-W. and Yip, T.L. (2008): “The role of geomatics engineering in establishing the marine information system for maritime management”, *Maritime Policy and Management*, 35, 1, 53–60.
12. Vaneslander, T. (2008): “Expansion in cargo handling: geographical and functional issues”, *Maritime Policy and Management*, 35, 2, 193–214.
13. Stopford, M. (2009): *Maritime Economics* (3rd edn.) (London, Routledge).
14. Wijnolst, N. and Wergeland, T. (2009): *Shipping Innovation* (Amsterdam, IOS Press).
15. Ojala, L. and Menachof, D. (2002): “IT in Logistics and Maritime Business”, in Grammenos, C. (ed.) (2002) *The Handbook of Maritime Economics and Business*, (London, Lloyd’s of London Press) pp. 898–913.
16. Boubekri, N. (2001): “Technology enablers for supply chain management”, *Integrated Manufacturing Systems*, Vol. 12, No. 6, 394–399.
17. Council of Supply Chain Management Professionals. See: http://cscmp.org/aboutcscmp/definitions.asp.
18. Schary, P. B. and Skjott-Larsen, T. (2001): *Managing the Global Supply Chain* (2nd edn.) (Copenhagen, Copenhagen Business School Press).
19. Mentzer, John T. (2001): *Supply Chain Management* (London, Sage Publications Inc.).
20. Ratliff, H.D. and Nulty, W.G. (1997): “Logistics composite modelling”, in Artiba, A. and Elmaghraby, S.E (eds.) *The Planning and Scheduling of Production Systems. Methodologies and Applications* (London, Chapman & Hall).
21. Ptak, C. A. and Schragenheim, E. (eds.) (2000): ERP: *Tools, Techniques and Applications for Integrating the Supply Chain* (Florida, St Lucie Press).
22. Agarwal, V. and Cohen, M. (2001): “Long live the revolution: Understanding SCM”, *The Financial Times*, Autumn, pp. 4–5.
23. Lee, Hau L., So, Kut C. and Tang, Christopher S. (2000): “The value of information sharing in a two-level supply chain”, *Management Science*, 46, 5, 626–643.
24. Jakovljevic, P.J. (2000): “Essential ERP – Its Functional Scope”, 10 March, at www.technologyevaluation.com
25. Lysons, K. and Farrington, B. (2006): *Purchasing and Supply Chain Management* (Harlow, Pearson Education Limited).
26. Delen, D., Hardgrave, B.C. and Sharda, R. (2007): “RFID for better supply-chain management

through enhanced information visibility", *Production and Operation Research Management*, 16, 5, 613–624.

27. Dutta, A., Lee, H.L. and Whang, S. (2007): *Production and Operation Research Management*, 16, 5, 646–655.

28. Heaver, T. (2002): "Supply chain and logistics management: implications for liner shipping", in Grammenos, C. (ed.) *The Handbook of Maritime Economics and Business* (London, Lloyd's of London Press), pp. 375–396.

29. Bowersox, D.J. and Closs, D.J. (1996). *Logistical Management: The Integrated Supply Chain Process* (London, McGraw-Hill).

30. Inkinen, T., Tapaninen, U. and Pulli, H. (2009): "Electronic information transfer in the supply chain", *Industrial Management and Data Systems*, 109, 6, 809–824.

31. Wallis, R. (2002): "Elements in value chain design", *Manufacturing and Logistics IT*, April, 35.

32. Packington, R. (2001): "The paperless supply chain? Perhaps not yet", e.logistics, Vol. 1, No. 11, May, 16.

33. European Commission Green Paper "Towards a Future Maritime Policy for the Union"; COM(2006) 275 final, see also EC's Freight Transport Logistics Action Plan; available at: http://ec.europa.eu/transport/logistics/freight_logistics_action_plan/maritime_en.htm

34. Pulli, H., Posti, A. and Tapaninen, U. (2009): TUKKE – Product tracing in portrelated supply chains (in Finnish), Publications from the Centre for Maritime Studies, University of Turku, B 167 (Finland, Turku).

35. Bichou, K., Lai, K-H., Lun, Y.H. V., and Cheng, T.C.E. (2007): "A Quality Management Framework for liner shipping companies to implement the 24-hour advance vessel manifest rule", *Transportation Journal*, 2007, Winter, 5–21.

36. *Reforming the Regulatory Procedures for Import and Export: Guide for Practitioners* (2007): International Finance Corporation, available at: http://rru.worldbank.org/Documents/Toolkits/ReformBookFinal.pdf

37. Srour, F. J., Oosterhout, M., Baalen, P. and Zuidwijk, R. (2007): 'Port Community System Implementation: Lessons Learned from an International Scan.' TRB 2008 Annual Meeting CD-ROM.

38. Garstone, S. (1995): "Electronic Data Interchange (EDI) in port operations", *Logistics Information Management*, 8, 2, 30–33.

39. Based on material of the PortNet community, hosted by the Finnish Maritime Administration.

40. XML = Extensible Mark-Up Language; used for creating internet sites.

41. Referring to Winston Churchill's speech on the Battle of Egypt, 10 November 1942.

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