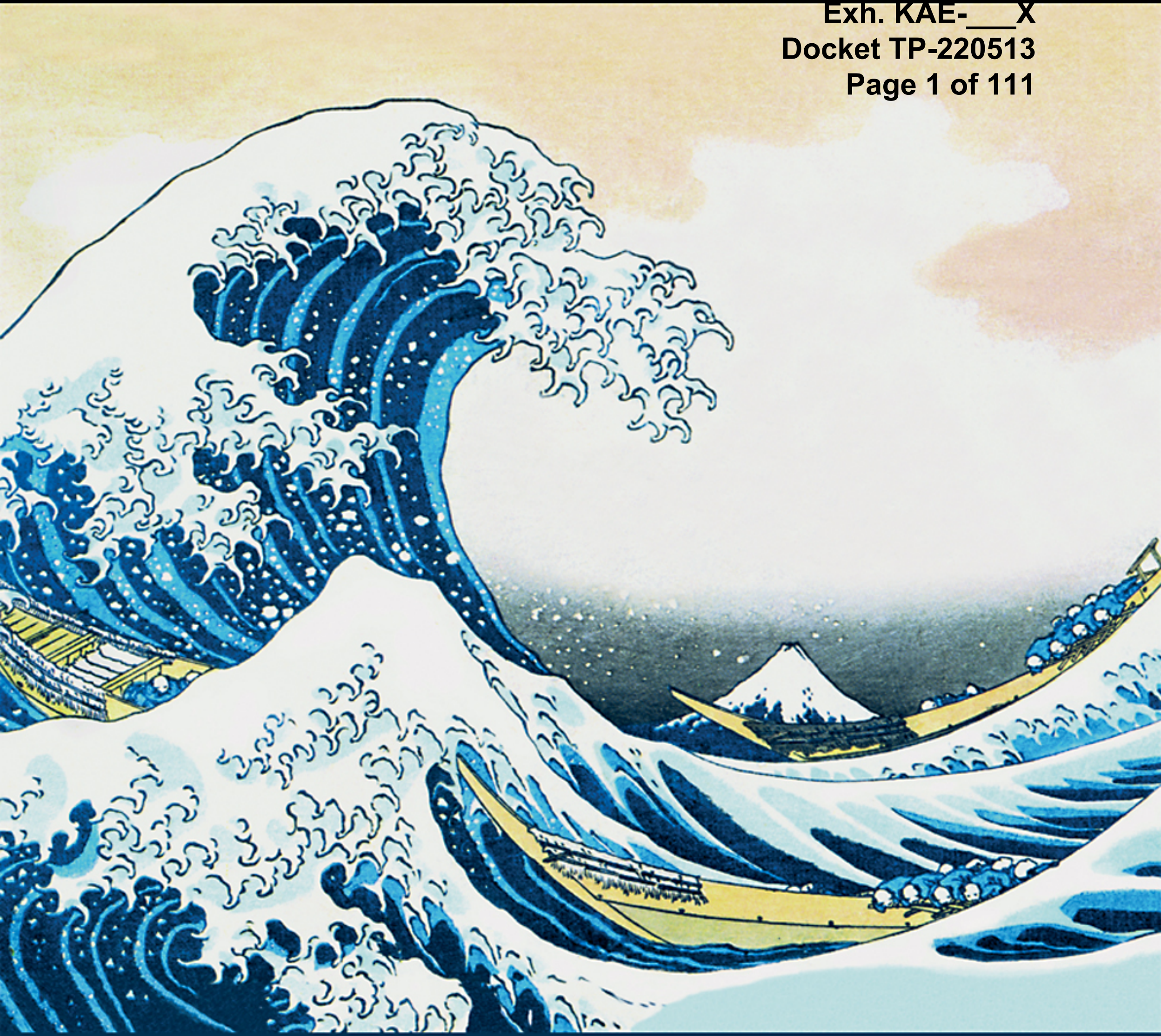

Maritime Economics

3rd edition

Martin Stopford

MARITIME ECONOMICS

Winner of the Chojeong Book Prize 2005 for 'making a significant contribution to the development of maritime transport academically and practically'

'In its breadth, this book is a tour de force and anyone who reads it cannot but be better informed about the shipping world'

Lloyds List, 17th December 1997

For 5,000 years shipping has served the world economy and today it provides a sophisticated transport service to every part of the globe. Yet despite its economic complexity, shipping retains much of the competitive cut and thrust of the 'perfect' market of classical economics. This blend of sophisticated logistics and larger than life entrepreneurs makes it a unique case study of classical economics in a modern setting.

The enlarged and substantially rewritten *Maritime Economics* uses historical and theoretical analysis as the framework for a practical explanation of how shipping works today. Whilst retaining the structure of the second edition, its scope is widened to include:

- lessons from 5,000 years of commercial shipping history;
- shipping cycles back to 1741, with a year by year commentary;
- updated chapters on markets, shipping costs, accounts, ship finance and a new chapter on the return on capital;
- new chapters on the geography of sea trade, trade theory and specialized cargoes;
- updated chapters on the merchant fleet shipbuilding, recycling and the regulatory regime;
- a much revised chapter on the challenges and pitfalls of forecasting.

With over 800 pages, 200 illustrations, maps, technical drawings and tables, *Maritime Economics* is the shipping industry's most comprehensive text and reference source, whilst remaining, as one reviewer put it, 'a very readable book'.

Martin Stopford has enjoyed a distinguished career in the shipping industry as Director of Business Development with British Shipbuilders, Global Shipping Economist with the Chase Manhattan Bank N.A., Chief Executive of Lloyds Maritime Information Services, Managing Director of Clarkson Research Services and an executive Director of Clarksons PLC. He lectures regularly at Cambridge Academy of Transport and is a Visiting Professor at Cass Business School, Dalian Maritime University and Copenhagen Business School.

MARITIME ECONOMICS

Third edition

Martin Stopford

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Preface to the Third Edition

The third edition of *Maritime Economics*, like the previous editions, aims to explain how the shipping market is organized and answer some practical questions about how it works. Why do countries trade by sea? How is sea transport organized? How are prices and freight rates determined? How are ships financed? Are there market cycles? What returns do shipping companies make? How can a shipping company survive depressions? What influences ship design? And, of course, is it possible to make reliable forecasts?

Much has changed in the twenty years since the first edition was published in 1988. Then the industry was struggling out of a deep recession and the second edition, which appeared in 1997, was written in a more prosperous but still disappointing market. However the third edition, on which work started in 2002, coincided with one of the great booms in the industry's history. These contrasting decades provided a unique opportunity to study shipping in feast and famine and I hope the substantially revised third edition has benefited from the insights it provided.

This edition retains the structure of its predecessors, but there are many changes and additions. A major innovation is the chapter on the economic history of the maritime business. Introducing an economics book with history is risky, but shipping has five thousand years of documented commercial history. If you've got it, why not flaunt it? There is a certain comfort in knowing that others have navigated the same seas many times before and there a lesson to learn. Maritime history surges forward with all the momentum of a VLCC, flattening anything in its path, so shipping investors in their commercial sailboats must keep a sharp lookout for the 'secular trend', as well as more immediate, but less threatening, shipping market cycles.

The analysis of shipping cycles now extends back to 1741 and the markets chapter includes an expanded section on derivatives which are more widely used than a decade ago. The theoretical supply demand analysis has been updated to introduce vertical mobility of the supply curve. A new chapter tackles the tricky issue of the return on capital in shipping, focussing on the microeconomics of the industry and introducing the 'risky asset pricing' (RAP) model. There is also a new chapter on the geography of maritime trade which deals with the physical world in which shipping operates and another on specialised shipping. The other chapters have all been updated, extended and revised where appropriate.

Maritime Economics: third edition now has seventeen chapters, the contents of which are summarized in the next section.

In producing the three editions I am grateful for the help from many people. For the first and second editions I would like to repeat my thanks to Efthimios Mitropoulos, now Secretary-General of the International Maritime Organization, Professor Costas Grammenos, Pro-Vice Chancellor of City University, London, the late Peter Douglas of Chase Manhattan Bank, Professor Harry Benford of Michigan University, Professor Rigas Doganis, Professor Michael Tamvakis of CASS Business School, the Rt Hon. Gerald Cooper, Dr John Doviak of Cambridge Academy of Transport, Professor Henk Molenaar, Mona Kristiansen of Leif Hoegh & Company, Captain Philip J. Wood, Sir Graham Day, Alan Adams of Shell International Marine, Richard Hext, CEO of Pacific Basin Shipping Ltd, Rogan McLellan, Mark Page Director of Drewry Shipping Consultants, Professor Mary Brooks of Dalhousie University, Bob Crawley, Betsy Nelson, Merrick Raynor, Jonathan Tully, Robert Bennett, John Ferguson and Paul Stott. All provided comments, suggestions and insights from which the present volume benefits.

For help with the third edition my thanks are due to Professor Peter B. Marlow, Rawi Nair, and Kiki Mitroussi of Cardiff University, Bill Ebersold, now retired from MARAD, Alan Jamieson, Peter Stokes of Lazards, Jeremy Penn, Chief Executive of the Baltic Exchange, Tony Mason, Secretary General of the International Chamber of Shipping, Richard Greiner, Partner of Moore Stephens, Rogan McLellan, Captain Robert W. Sinclair, Sabine Knapp of IMO, Niels G. Stolt-Nielsen, Sean Day, Chairman of Teekay Shipping Corporation, Susan Cooke, Finance Director of Global Ship Lease, Jean Richards, Director of Quantum Shipping Services, Trevor Crowe and Cliff Tyler, Directors of Clarkson Research Services Ltd, Nick Wood and Tom White of Clarksons newbuilding desk, Bob Knight and Alex Williams of Clarksons Tanker Division, Nick Collins of Clarksons Dry Cargo Division, Alan Ginsberg, CFO of Eagle Bulk Shipping, John Westwood of Douglas-Westwood Ltd, Dorthe Bork and her colleagues at Odense Steel Shipyard, Jarle Hammer of Fearnleys, Professor Roar Adland of Clarksons Fund Management, Dr Peter Swift, MD of Intertanko, Professor Knick Harley of Oxford University, Professor Alan Winter of the University of Sussex,, Hamid Seddighi of the University of Sunderland and Erik Bastiensen. Also I would like to thank Randy Young of the US Office of Naval Intelligence (ONI) for his help and enthusiasm in extending the freight cycle statistics back to 1741, my brother John Stopford for many thoughtful discussions and my editor at Routledge, Rob Langham.

Finally, finishing this much enlarged book was a daunting task and I owe special thanks to Tony Gray of Lloyds List, Professor Ian Buxton of Newcastle University and Charlie Norse of Massachusetts Maritime Academy for their encouragement, time, knowledge and advice.

Martin Stopford,
London, 2008

Synopsis

PART 1 INTRODUCTION TO SHIPPING

Part 1 addresses the questions of where shipping has come from and where it is now.

Chapter 1: Sea Transport and the Global Economy

Shipping plays a central part in the global economy, and its well-documented history, stretching back for 5,000 years, gives maritime economists a unique perspective on the way the industry's economic mechanisms and institutions have evolved. We find that today's trading world has evolved over many centuries and history demonstrates the regional center of sea trade is constantly on the move – we call its path the 'Westline'. By examining the trade of the Atlantic and Pacific Oceans we can see where the 'Westline' is today.

Chapter 2: The Economic Organization of the Shipping Market

We give an overview of the market covering the transport system, the demand for sea transport, the merchant fleet, how transport is provided, the role of ports, shipping company organization and political influences.

PART 2 SHIPPING MARKET ECONOMICS

Part 2 sets out the macroeconomic structure of the shipping market to show the role of market cycles, the forces that drive them, and the commercial environment in which the industry operates.

Chapter 3: Shipping Market Cycles

Shipping market cycles dominate the industry's economic thinking. A discussion of the characteristics of shipping cycles leads on to a review of how experts have explained the shipping cycle. The 22 cycles since 1741 are identified from statistical series and contemporary market reports. A brief account is provided of each cycle, drawing attention to the economic mechanism which drove the market up or down and the underlying secular trend. The chapter ends with some thoughts on the return on capital in shipping and the prediction of shipping cycles.

Chapter 4: Supply, Demand and Freight Rates

We now take a more detailed look at the economic model of the shipping market which underlies the cyclical nature of the business. The model consists of three components: supply, demand and the freight rate mechanism. The first half of the chapter discusses the ten key variables which influence the supply and demand functions for the shipping industry. The second half examines how freight rates link supply and demand. Emphasis is placed on market dynamics.

Chapter 5: The Four Shipping Markets

In this chapter we review how the markets actually work. Shipping business is conducted through four related markets dealing in different commodities, freight, secondhand ships, new ships and ships for demolition. We discuss the practicalities of each market and the dynamics of how they are connected by cashflow. As cash flows in and out of shipowners' balance sheets it influences their behaviour in these markets.

PART 3 SHIPPING COMPANY ECONOMICS

Turning to microeconomics, we discuss the practical issues facing a firm. How are shipping costs and revenues structured? How are ships financed? How does the industry make a commercial return on investment?

Chapter 6: Costs, Revenue and Financial Performance

This chapter discusses the costs and revenues of operating merchant ships. Costs are divided into voyage costs and operating costs. Capital costs are also discussed, though the main review of financing is contained in the next chapter. The final section focuses on company accounts, including the income statement, balance sheet and cashflow statement. We finish with a discussion of cashflow analysis.

Chapter 7: Financing Ships and Shipping Companies

Finance is the most important item in the shipowner's cashflow budget. The chapter starts with a review of the many ways ships have been financed in the past, followed by a brief explanation of the world capital markets, showing where the money comes from. Finally the chapter discusses the four main ways of financing ships: equity, debt, newbuilding finance, and leasing.

Chapter 8: Risk, Return and Shipping Company Economics

Shipping has a history of offering very mediocre returns over long periods, interspersed by bursts of profitability. This chapter examines the shipping company investment model and applies the theory of the firm to shipping companies, to establish what determines return on investment in shipping and how the shipping industry prices risk.

PART 4 SEABORNE TRADE AND TRANSPORT SYSTEMS

We turn our attention to cargo and the transport systems which carry it. We begin with the geographical framework of trade, moving on to trade theory and the economic forces that govern trade. Then we examine how the shipping industry transports cargo today, focusing on the three main segments: bulk shipping, specialized shipping and liner shipping.

Chapter 9: The Geography of Maritime Trade

The shipping industry adds value by exploiting arbitrages between global markets, and there is a physical dimension to shipping economics, so we must be aware of the geography of maritime trade. This chapter examines the physical world within which this trade takes place, covering the oceans, distances, transit times and the maritime trading network. It concludes with a review of the trade of each of the major economic regions.

Chapter 10: The Theory of Maritime Trade

Shipping depends on trade, so we must understand why countries trade and why trading patterns change. We start with a short summary of trade theory, identifying the various explanations for trade. This is followed by a discussion of the supply–demand model used to analyse natural resource based commodity trades. Turning to the actual sea trade of 105 countries, we review the evidence for a relationship between trade and land area, population natural resources and economic activity. Finally, we review the 'trade development cycle' and the relationship between sea trade and economic development.

Chapter 11: Bulk Cargo and the Economics of Bulk Shipping

The widespread use of bulk transport systems to reduce the cost of shipping raw materials reshaped the global economy in the twentieth century. The first part of the chapter analyses the principles of bulk transport and bulk handling. It covers the transport system, the transport characteristics of commodities and the development of transport systems for bulk handling. This is followed by a brief account of the various commodities shipped in bulk, their economic characteristics and the transport systems employed.

Chapter 12: The Transport of Specialized Cargoes

In this chapter we study the shipping segments which have been developed to transport those cargoes which can benefit from specialized transport systems. The chapter covers chemicals, liquefied gas, refrigerated cargo, unit labour cargoes, and passenger shipping.

Chapter 13: The Economics of Liner Shipping

Containerization of liner services was one of the great commercial innovations of the twentieth century. Faster transport and lower costs have made it possible for businesses to source materials and market their products almost anywhere in the world. This chapter discusses the organization of the liner system, the characteristics of demand and the way the liner business deals with the complex economic framework within which it operates.

PART 5 THE MERCHANT FLEET AND TRANSPORT SUPPLY

Part 5 is concerned with three key aspects of the supply of merchant ships: the fleet of vessels; shipbuilding and demolition; and the regulatory framework which influences the cost of operating ships and the conditions under which ships can be traded.

Chapter 14: The Ships that Supply the Transport

In this chapter we discuss the design of merchant ships. The aim is to focus on the way designs have evolved to meet technical and economic objectives. The chapter starts from the three objectives of ship design: efficient cargo containment, operational efficiency and cost. There follows a discussion of each of the main categories of ship design: liner vessels, liquid bulk, dry bulk, specialist bulk, and service vessels.

Chapter 15: The Economics of Merchant Shipbuilding and Scrapping

The shipbuilding and ship scrapping industries play a central part in the shipping market model. This chapter starts with a regional review of the location of shipbuilding capacity. This is followed by a discussion of shipping market cycles in production and prices. A section on the economic principles is followed by a discussion of the technology of the business. Finally there is a section on ship scrapping.

Chapter 16: The Regulation of the Maritime Industry

This chapter examines the impact of regulation on shipping economics. We identify three key regulatory institutions: the classification societies, the flag states and the coastal states. Each plays a part in making the rules which govern the economic activities of shipowners. The classification societies, through the authority of the ‘class certificate’, supervise the technical safety of the merchant ships. The flag states make the laws which govern the technical and commercial activities of shipowners registered with them. Finally, the coastal states police the ‘good conduct’ of ships in their waters, notably on environmental issues.

PART 6: FORECASTING AND PLANNING

Decision makers need to decide what is the best thing to do, and that means analysis and forecasting (though the two are different). Part 6 consists of a single chapter which examines the use of maritime economics to answer these questions.

Chapter 17: Maritime Forecasting and Market Research

The 'forecasting paradox' is that businessmen do not really expect forecasts to be correct, yet they continue to use them. There are two different types of 'forecasts' used in the shipping industry: market forecasts and market research. Market forecasts cover the market in general, whilst market research applies to a specific decision. Different techniques are discussed covering each type of study. We conclude with a review of common forecasting errors.

Appendix A: An Introduction to Shipping Market Modelling

Appendix B: Tonnage Measurement and Conversion Factors

Appendix C: Maritime Economics Freight Index, 1741–2007

Abbreviations

ACF	annual cashflow analysis
AG	Arabian Gulf
bt	billion tons
btm	billion ton miles
BTX	benzene, toluene, xylene
cgrt	compensated gross registered tonnage
COA	contract of affreightment
cgt	compensated gross tonnage
dwt	deadweight tonnage
EEC	European Economic Community
FEFC	Far East Freight Conference
FFA	forward freight agreement
FPC	forest products carrier
GATT	General Agreement on Tariffs and Trade
GDP	gross domestic product
GNP	gross national product
GRI	general rate increase
grt	gross registered tonnage
gt	gross tonnage
IACS	International Association of Classification Societies
ILO	International Labour Organization
IMCO	Inter-governmental Maritime Consultative Organization
IMO	International Maritime Organization
IPO	initial public offering
IRR	internal rate of return
ISO	International Organization for Standardization

ITF	International Transport Workers' Organization
LCM	lateral cargo mobility
LNG	liquefied natural gas
LOA	length overall
lo-lo	lift on, lift off
LPG	liquefied petroleum gas
MCR	maximum continuous rating
m.dwt	million tons deadweight
MPP	multi-purpose
mt	million tons
MTBE	methyl tert-butyl ether
NPV	net present value
OBO	oil/bulk/ore carrier
OECD	Organization for Economic Co-operation and Development
OPEC	Organization of Petroleum Exporting Countries
P&I	protection and indemnity-
PCC	pure car carrier
PCTC	pure car and truck carrier
PSD	parcel size distribution function
RFR	required freight rate
ROI	return on investment
ro-ro	roll on, roll off
SDR	Special Drawing Right
TEU	twenty-foot equivalent unit
tm	ton mile
ULCC	ultra large crude carrier
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
VCF	voyage cashflow analysis
VLCC	very large crude carrier
WS	Worldscale

Fifty Essential Shipping Terms

(See also Box 5.1 in Chapter 5 for a glossary of essential chartering terms.)

1. **Aframax**. Tanker carrying around 0.5 million barrels of oil, but usually applied to any tanker of 80,000–120,000 dwt (name derived from old AFRA chartering range).
2. **Auxiliary engines**. Small diesel engines on the ship used to drive alternators providing electrical power. They generally burn diesel oil. Ships generally have between three and five, depending on electricity requirements.
3. **Ballast**. Sea water pumped into carefully located ballast tanks, or cargo spaces, when the ship is not carrying cargo, to lower the ship in the water so that the propeller is sufficiently submerged to perform efficiently.
4. **Berth**. Designated area of quayside where a ship comes alongside to load or discharge cargo.
5. **Bulk carrier**. Single-deck ship which carries dry cargoes such as ore, coal, sugar or cereals. Smaller vessels may have their own cranes, whilst larger sizes rely on shore based equipment.
6. **Bare boat charter**. Similar to a lease. The vessel is chartered to a third party who to all intents and purposes owns it for the period of the charter, provides the crew, pays operating costs (including maintenance) and voyage costs (bunkers, port dues, canal transit dues, etc.), and directs its operations.
7. **Bunkers**. Fuel oil burned in ship's main engine (auxiliaries use diesel)
8. **Capesize**. Bulk carrier too wide to transit the Panama Canal. Usually over 100,000 tonnes deadweight, but size increases over time, currently 170,000–180,000 dwt.

9. **Charterer**. Person or company who hires a ship from a shipowner for a period of time (time charter) or who reserves the entire cargo space for a single voyage (voyage charter).
10. **Classification society**. Organization, such as Lloyd's Register, which sets standards for ship construction; supervises standards during construction; and inspects the hull and machinery of a ship classed with the society at regular intervals, awarding the 'class certificate' required to obtain hull insurance. A ship with a current certificate is 'in class'.
11. **Container**. Standard box of length 20 or 40 ft, width 8 ft and height 8 ft 6 in. High cube containers are 9 ft 6 in. high, and container-ships are usually designed to carry some of these.
12. **Container-ship**. Ship designed to carry containers, with cell guides in the holds into which the containers are lowered. Containers carried on deck are lashed and secured.
13. **Compensated gross ton (cgt)**. Measure of shipbuilding output based on the gross tonnage of the ship multiplied by a cgt coefficient reflecting its work content (see Appendix B).
14. **Deadweight (dwt)**. The weight a ship can carry when loaded to its marks, including cargo, fuel, fresh water, stores and crew.
15. **Freeboard**. Vertical distance between waterline and top of hull.
16. **Freight rate**. Amount of money paid to a shipowner or shipping line for the carriage of each unit of cargo (lonne, cubic metre or container load) between named ports.
17. **Freight alt kinds (FAK)**. The standard rate charged per container, regardless of what commodity it is carrying, e.g. FAK rate of $1500 per TEU.
18. **FEU**. Forty-foot container (see TEU).
19. **Gas tanker**. Ship capable of carrying liquid gas at sub-zero temperatures. Cargo is kept cold by pressure, insulation, and/or refrigeration of 'boil-off gas' which is returned to the cargo tanks (see Chapter 14).
20. **Gross ton (gt)**. Internal measurement of the ship's open spaces. Now calculated from a formula set out in the IMO Tonnage Convention.
21. **Handy bulker**. Bulk carrier at the smaller end of the range of sizes associated with this type of ship, typically up to 30,000–35,000 tonnes deadweight. Most have their own cargo-handling gear.
22. **ice class 1A**. Ship certified to transit ice of 0.8 m thickness.
23. **IMO**. International Maritime Organization, the UN agency which is responsible for maritime regulations.
24. **Lay-up**. This describes a ship that has been taken out of service because freight rates are too low to cover its operating and maintenance costs Not a well-defined condition, it often just means that the ship has not moved for, say, 3 months.

25. **Lashing**. Used with twist-locks to stop containers moving in heavy seas. Lashing wires may be secured, for example, from the top corners of the first tier and bottom corners of the second tier.

26. **LIBOR**. London Inter-bank Offered Rate, the interest rate at which banks raise funds on the eurodollar market.

27. **Lightweight (light displacement tonnage, lwt)**. Weight of a ship's hull, machinery, equipment and spares. This is the basis on which ships are usually sold for scrap, e.g. $200 per lwt.

28. **MARPOL**. International Convention for the Prevention of Pollution from Ships (see Chapter 16).

29. **Off-hire**. Time, usually measured in days, during which charter hire payments are suspended because the vessel is not available to trade, for example because of a breakdown or routine repair time.

30. **Operating costs (OPEX)**. Expenses involved in the day-to-day running of the ship and incurred whatever trade the ship is engaged in. These include crew wages and expenses, victuailing, stores, spares, repairs and maintenance, lubricants, and insurance.

31. **P&l club**. Mutual society which provides third party insurance to shipowner members.

32. **Panamax**. Bulk carrier which can transit Panama Canal where the lock width of 32.5 m is the limiting factor. Vessels of 60,000–75,000 tonnes deadweight fall into this category. 'Panamax' is also used to refer to tankers of 60,000–70,000 deadweight.

33. **Reefer**. Insulated cargo ship for carrying refrigerated food, either frozen or chilled.

34. **Reefer container**. Insulated container for carrying refrigerated cargo. Some have integral electric refrigeration plant run from a plug on the ship or shore facility. Others receive cold air from central refrigeration unit on ship.

35. **Seller's commission**. Fee or commission payable by a seller of a vessel to the broker(s) who has secured her sale.

36. **Service agreement**. Agreement between container line and shipper to provide freight transport on specified terms.

37. **Shipbroker**. Individual with current market knowledge who acts as intermediary between buyers and sellers in return for a percentage commission on the transaction. There are several types of these – for example, chartering brokers deal with cargo; sale and purchase brokers buy and sell ships; newbuilding brokers place contracts for new ships.

38. **SOLAS**. Safety of Life at Sea Convention. Important convention setting out the safety regulations with which all merchant ships must comply (see Chapter 16).

39. **Special survey**. Mandatory examination of the ship's hull and machinery carried out every five years, or on a rolling basis, by the classification society with which the vessel is classed.

40. **Spot rate**. Negotiated rate per unit (tonne, cubic metre, etc.) of cargo paid to the shipowner to carry specific cargo between two ports, say US Gulf to Japan. Voyage costs are paid by the shipowner.

41. **String (of container-ships)**. The number of container-ships needed to maintain a regular service on a specific route ('loop'). For example, a string of four ships is needed to run a transatlantic loop.

42. **Suezmax**. Tanker able to transit Suez Canal fully loaded; carries about 1 million barrels of oil. Tankers of 120,000–200,000 dwt are grouped into this category.

43. **Tanker**. Ship designed for the carriage of liquid in bulk with cargo space consisting of several tanks. Tankers carry a wide variety of products, including crude oil, refined products, liquid gas and wine. Parcel tankers have a separate pump and cargo lining for each tank so that many cargo parcels can be carried separately in the ship.

44. **TEU**. Twenty-foot equivalent unit (a 40 ft container is 2 TEU).

45. **Time charter**. A transportation contract under which the charterer has the use of the vessel for a specific period. A fixed daily or monthly payment is made for the hire of the vessel, for example $20,000 per day. Under this arrangement, the owner manages the day-to-day running of the ships, and pays the operating and capital costs. The charterer pays fuel, port charges, loading/discharging fees and other cargo-related costs, and directs the ship operations.

46. **Time charter equivalent**. The spot freight rate (e.g. $20 per tonne for a 40,000 tonne cargo) converted into a daily hire rate for the voyage (e.g. $20,000 per day) by deducting voyage costs from the gross freight and dividing by the days on the voyage, including necessary ballast time.

47. **Tonne**. Metric ton, equivalent to 1,000 kilograms or 2,240 lbs.

48. **Twist-lock**. Devices used to join and lock containers to those above and below them by clamping the adjacent corner castings together. 'Cones' fit into apertures in the corner castings and turn to lock them in place. Used with lashing wires and bars.

49. **VLCC**. Very large crude carrier, generally carries about 2 million barrels of oil, but all tankers over 200,000 dwt are grouped into this category.

50. **Voyage costs**. The cost of fuel, port expenses and canal costs which are specific to the voyage. On a voyage charter where the ports are specified they are generally included in the negotiated spot rate and paid by the shipowner. On a time charter where the ports are not known in advance they are paid by the charterer.

The history of freight cycles is an economic struggle between the big modern ships and earlier generations of smaller ships with outdated technology. Usually the combination of small size, which reduces revenue, and increasing maintenance cost makes the ship uneconomic when it reaches 20 or 25 years old, forcing it from the market. However, when the size of ships stops growing, as happened in the tanker market during the 1980s and 1990s, the economic advantage of the modern ships becomes less clearly defined, extending the economic life of ships.[1]

6.3 THE COST OF RUNNING SHIPS

The costs discussed in the previous section illustrate the general principles involved, but in practice all costs are variable, depending on external developments such as changes in oil prices and the way the ship's owner manages and finances the business. To understand ship investment economics we must look in much greater detail at the structure of costs. Figure 6.4 summarizes the key points we will consider. Each box in the diagram lists a major cost category, the variables which determine its value, and the percentage cost for a 10-year-old ship. In the remainder of this section we examine how the four main cost groups – operating costs (14%), periodic maintenance (4%), voyage costs (40%) and capital costs (42%) – are built up to determine an overall financial performance of the ship. Taken together these costs determine the cost of sea transport and they are extremely volatile, as is evident from the trends in fuel, capital and other costs shown in Figure 6.5. Between 1965 and 2007 the ship cost

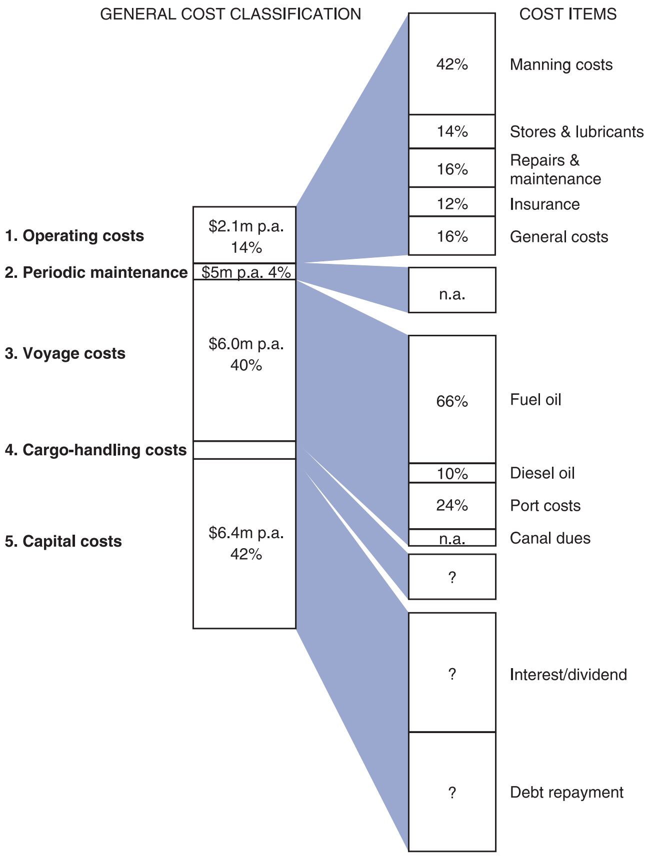

Figure 6.4
Analysis of the major costs of running a bulk carrier
Source: Compiled by Martin Stopford from various sources
Note: This analysis is for a 10-year-old Capesize bulk carrier under the Liberian flag at 2005 prices. Relative costs depend on many factors that change over time, so this is just a rough guide.

index increased by 5.5% per year, compared with 4.6% for the US consumer price index. However, the ship cost index was far more volatile, driven by the wild swings in fuel and capital costs which together account for close to two–thirds of the total.

Operating costs

Operating costs, the first item in Figure 6.4, are the ongoing expenses connected with the day-to-day running of the vessel (excluding fuel, which is included in voyage costs), together with an allowance for day-to-day repairs and maintenance (but not major dry dockings, which are dealt with separately). They account for about 14% of total costs. The principal components of operating costs are:

$$OC_{tm} = M_{tm} + ST_{tm} + MN_{tm} + I_{tm} + AD_{tm} \tag{6.2}$$

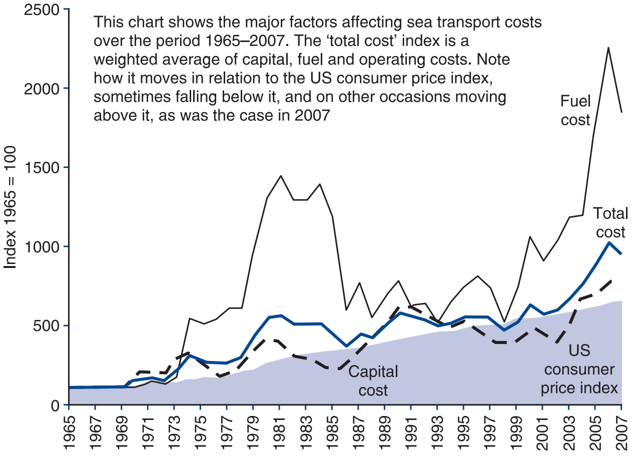

Figure 6.5
Inflation in shipping costs, 1965–2007
Source: Fuel costs based on marine bunker price 380 cSt, Rotterdam; capital costs based on Aframax tanker newbuilding price (in $); other costs based on US consumer price index

where *M* is manning cost, *ST* represents stores, *MN* is routine repair and maintenance, *I* is insurance and *AD* administration.

An example of the operating cost structure of a Capesize bulk carrier is shown in Table 6.2, subdivided into these categories. In summary, the operating cost structure depends on the size and nationality of the crew, maintenance policy and the age and insured value of the ship, and the administrative efficiency of the owner. Table 6.2 shows the relative importance of each of these components in operating costs and compares them for ships of three different ages, 5, 10 and 20 years.

CREW COSTS

Crew costs include all direct and indirect charges incurred by the crewing of the vessel, including basic salaries and wages, social insurance, pensions, victuals and repatriation expenses. The level of manning costs for a particular ship is determined by two factors, the size of the crew and the employment policies adopted by the owner and the ship's flag state. Manning costs may account for up to half of operating costs, depending on the size of the ship.

Table 6.2 Operating costs of Capesize bulk carriers by age ($000 per annum)

Age of ship	5 Years	10 Years	20 Years	% Total Average
Crew cost				
Crew wages	544	639	688	30%
Travel, insurance etc	73	82	85	4%
Victualling	46	54	64	3%
Total	743	871	956	41%
%	32%	31%	26%	
Stores & Consumables				
General stores	129	144	129	6%
Lubricants	148	148	219	8%
Total	277	292	348	15%
%	12%	11%	9%	
Maintenance & Repairs				
Maintenance	90	169	10	4%
Spares	74	169	181	7%
Total	164	338	393	14%
%	9%	15%	13%	
Insurance				
Hull & machinery & war risks	133	148	303	9%
P&I	63	94	120	4%
Total	196	243	423	14%
%	32%	32%	44%	
General Costs				
Registration Costs	17	17	17	1%
Management Fees	255	223	255	12%
Sundries	57	57	57	3%
Total	330	298	330	15%
%	14%	11%	9%	
Total per annum	1,710	2,041	2,450	100%
Daily Costs (365 days)	4,685	5,591	6,712	100%

Source: Ten-year old ship, Moore Stephens, V Ships; 5- and 20-year-old ship costs estimated from various sources

The minimum number of crew on a merchant ship is usually set by the regulations of the flag state. However, it also depends on commercial factors such as the degree of automation of mechanical operations, particularly the engine room, catering and cargo handling; the skill of the crew; and the amount of on-board maintenance undertaken. Automation and reliable monitoring systems have played an important part in reducing crew numbers.[2] It is now common practice for the engine room to be unmanned at night, and various other systems have been introduced such as remote control ballast, single-man bunkering, rationalized catering and improved communications which remove the need for a radio officer. As a result crew numbers declined from about 40–50 in the early 1950s to an average of 28 in the early 1980s. Current levels of technology on modern ships allow a basic crew of 17 in a deep-sea vessel, while experimental vessels have been operated with a crew of 10. Under some flags manning scales govern the numbers of personnel required on the various types and sizes of vessels, and any reductions must be agreed between the shipowners' organization and the seamen's unions.

An idea of the basic manning cost in 2005 is provided in Table 6.2. The figure for annual crew wages of $544,000 for a 5-year-old ship covers direct wages and employment-related costs. An additional $119,000 per annum is required to cover travel; manning and support; medical insurance and victualling; and the basic management costs that apply to crewing – crew selection, rotation, making travel arrangements, purchase of victuals and ship supplies. In total these add 16% to the crew cost for a 5-year-old ship.

Table 6.3 Crew costs on 160,000 dwt bulk carrier, 2007 ($ per month)

Rank	Note	Basic	Consolidated Allowances	Bonus (officers)	Provident Fund[b]	Totals[c] 2007	1993	% ch
Master	India	1,967	3,933	300	35	6,235	3,644	171%
Chief officer[a]		1,294	3,206	200	35	4,735	3,025	157%
2nd officer		1,077	1,773	—	35	2,885	2,338	123%
3rd officer		1,030	1,320	—	35	2,385	1,650	145%
Radio officer		radio officer no longer required in 2007					1,650	0%
Chief engineer		1,760	3,990	300	35	6,085	3,575	170%
1st asst engr	2nd eng.	1,294	3,206	200	35	4,735	3,025	157%
2nd asst engr	3rd eng.	1,077	1,773	—	35	2,885	2,338	123%
Bosun	Philippines	670	649	—	182	1,501	1,521	99%
5AB		558	542	—	171	6,353	6,479	98%
3 oiler		558	542	—	171	3,812	3,888	98%
Cook/std	chief cook	670	649	—	182	1,501	1,596	94%
Std	2nd cook	558	542	—	171	1,271	1,296	98%
Messman		426	378	—	158	962	1,071	90%
Total crew number modern ship: 20						45,344	37,094	122%
Additional crew for 10-year-old ship								
3rd asst engr	India	1,030	1,320	—	35	2,385	1,650	145%
Electrician	Elec. off.	1,077	1,823	—	35	2,935	2,338	126%
AB	Philippines	558	542	—	171	1,271	1,296	98%
1 oiler		558	542	—	171	1,271	1,296	98%
Total crew number 10-year-old ship: 24						53,205	43,673	122%
Additional crew for 20-year-old ship								
2 ordinary seamen	Philippines	426	378	—	158	1,925	2,142	90%
1 oiler		558	542	—	171	1,271	1,071	119%
1 messman		426	378	—	158	962	1,071	90%
Total crew number 20-year-old ship: 28						57,362	47,956	120%
		Annual crew cost for 20-year-old ship				688,344	575,475	120%

Notes

[a]Senior Officer based on 5 yr senority & Junior Officers 3 yrs seniority.

[b]Includes social costs

[c]1993 data from Stopford (1997, Table 5.3)

Source: V Ships

A more detailed breakdown of the crewing arrangements of three Capesize bulk carriers, one 5 years old, one 10 years old and one 20 years old, is provided in Table 6.3. The modern vessel has a crew of, comprising the master, four officers, three engineers, a bosun, eight seamen and three catering staff. The 10-year-old ship, where the maintenance workload is beginning to increase, might require a crew of 24, while a 20-year-old ship might have a crew of 28. The extra crew includes an additional engineer, an electrician, four seamen and one messman. They are needed to handle the repair and maintenance workload which is a continuous cycle on an old ship and can be carried out more cheaply at sea while the ship continues to trade. The total annual cost is $688,344 per year for the 20-year-old ship, a 20% increase on the costs in 1993.

The wages paid to the crews of merchant ships have always been controversial. The International Transport Workers' Federation (ITF) lays down minimum basic monthly rates of pay for all ranks, as well as paid leave, as part of its world-wide and Far East wage scale, but these are not universally accepted. There are, in fact, wide disparities in the rates of pay received by crews of different nationalities. The nationality of the crew is often governed by national statute of the country of registration and under some flags shipowners are prevented from employing non-nationals on their vessels. The cost per crew member may be 50% higher for a vessel registered under a European flag than for a comparable vessel 'flagged out' to one of the countries of open registration such as Liberia, Panama and Singapore, where employment regulations are less stringent. As the practice of flagging out became more widely accepted the cost differentials narrowed and quality became as much an issue as cost.

These costs are certainly not standards. Shipowners have far more opportunity than land-based businesses to determine manning costs by operating under a flag that allows the use of a low-wage crew and by shopping around the world for the cheapest crews available. Exchange rates will be an important factor here if wages are paid in a currency other than the one in which revenue is earned. Although shipping is a dollar-based business, shipping companies typically find themselves handling cashflows in many different currencies.

STORES AND CONSUMABLES

Another significant cost of operating a vessel, accounting for about 15% of operating costs, is expenditure on consumable supplies. These fall into two categories, as listed in Table 6.2: General stores including cabin stores and the various domestic items used on board ship; and lubricating oil which is a major cost (most modern vessels have diesel engines and may consume several hundred litres of lube oil a day while at sea).

REPAIRS AND MAINTENANCE

Routine maintenance, which accounts for 14% of operating costs, covers the routine repairs needed to maintain the vessel to the standard required by company policy, its classification society and the charterers of the vessel who choose to inspect it (it does not include periodic dry docking which is not generally considered an operating expense and is dealt with under 'periodic maintenance' below). Broadly speaking, maintenance covers the cost of routine maintenance, including breakdowns and spares:

- *Routine maintenance*. Includes maintaining the main engine and auxiliary equipment, painting the superstructure and carrying out steel renewal in those holds and cargo tanks which can be safely accessed while the ship is at sea. As with any capital equipment, the maintenance costs of merchant ships tend to increase with age.
- *Breakdowns*. Mechanical failure may result in additional costs outside those covered by routine maintenance. Work of this type is often taken by ship repair yards on 'open order' and is therefore likely to be expensive. Additional costs are incurred owing to loss of trading time.
- *Spares*. Replacement parts for the engine, auxiliaries and other on-board machinery.

The typical maintenance costs for a Capesize bulk carrier listed in Table 6.2 cover visits to repair yards, plus the cost of riding crews and work carried out on board. All items of maintenance costs increase substantially with age, and a 20-year-old vessel may incur twice the costs of a more modern one. Expenditure on spare parts and replacement equipment is also likely to increase with age.

INSURANCE

Typically insurance accounts for 14% of operating costs, though this is a cost item which is likely to vary from ship to ship. Two-thirds of the cost is to insure the hull and machinery, which protects the owner of the vessel against physical loss or damage, and the other third is third party insurance, which provides cover against third party liabilities such as injury or death of crew members, passengers or third parties, pilferage or damage to cargo, collision damage, pollution and other matters that cannot be covered in the open insurance market. Additional voluntary insurance may be taken out to cover against war risks, strikes and loss of earnings.

Hull and machinery insurance is obtained from a marine insurance company or through a broker who will use a policy backed by underwriters in one of the insurance markets. Two important contributory factors in determining the level of hull and machinery insurance are the owner's claims record and the claimed value of the vessel. Ship values fluctuate with the freight market and the age and condition of the vessel.

The third party insurance required by shipowners falls under four headings: P&I cover, which is generally obtained through a club; collision liability cover; war P&I cover; and the provision of certificates of financial responsibility required to trade into the United States.

The P&I clubs, of which there are 13, are mutual insurance societies which settle third party claims for their members. They investigate claims on behalf of their shipowner members, provide advice during any negotiations or legal dispute over the claim and hold reserve funds to settle the claims on their members' behalf. This reserve is replenished through a subscription (known as the 'call') from members which varies, depending on the level of claims settled. The subscription for an individual member depends on the company's claims record and other factors such as the intended trading area, the cargo to be carried, the flag of registry and the nationality of the crew. Since settlement takes time, there may be a supplementary call on members and members changing clubs generally pay a 'release call' to settle their outstanding liabilities with the old club and an 'advance call' to the new club.

Because of the potential size of third party claims, the P&I clubs reinsure their exposure to very large claims. In 2005 individual clubs had a maximum liability exposure of $5 million. A pool of clubs covered larger claims of $5–$20 million, and claims of $20 million to a maximum of $4.25 billion were reinsured in the insurance market. The P&I clubs also obtain credit ratings from the rating agencies, which assist in marketing their services to members. Unlike other forms of insurance, P&I cover cannot be assigned to a mortgagee, though a comfort letter may be obtained. It is also subject to retrospective cancellation, for example if the club member goes bankrupt.

GENERAL COSTS

A registration fee is paid to the flag state, the size of which depends on the flag. In Table 6.2 a fee of $17,000 per annum for a single ship is included under general costs.

Included within the annual operating budget for the ship is a charge to recover shore-based administrative and management charges, communications, owners' port charges, and miscellaneous costs. The overheads cover liaison with port agents and general supervision. The level of these charges depends on the type of operation. For a small tramping company operating two or three ships they may be minimal, whereas a large liner company will carry a substantial administrative overhead. With improved communications, many of these functions can now be undertaken by shipboard personnel in tramping companies. It is also an increasingly common practice for day-to-day management to be subcontracted to specialists for a predetermined fee.

Periodic maintenance

Periodic maintenance, the second major cost item in Figure 6.4, involves a cash payment to cover the cost of interim dry docking and special surveys. It accounts for about 4% of costs, though this depends on the age and condition of the ship. To maintain a ship in class for insurance purposes, it must undergo regular surveys with a dry docking every 2 years and a special survey every 4 years to determine its seaworthiness. At the special survey the vessel is dry-docked, all machinery is inspected and the thickness of the steel in certain areas of the hull is measured and compared with acceptable standards. These measurements become more extensive with age and all defects must be remedied before a certificate of seaworthiness is issued. In older ships these surveys often necessitate considerable expense, for example in replacing steelwork that, owing to corrosion, no longer meets the required thickness standards. In addition, dry docking allows marine growth, which reduces the operating efficiency of the hull, to be removed.

Table 6.4 Standard Capesize, lifetime periodic maintenance costs (1993 dollar prices)

	Age of ship 0–5	6–10	11–15	16–20	
Time out of service (days)	20	23	40	40	
Time in drydock (days)	10	14	23	18	Total
Cost Items (USD)					
Dry-dock charges	62,000	68,000	81,500	74,000	285,500
Port charges, tugs, agency	70,000	73,300	92,000	92,000	327,300
General services	80,000	92,000	160,000	160,000	492,000
Hull blast, clean & painting	102,800	128,800	183,600	99,000	514,200
All dry-dock paint	164,100	175,500	207,000	194,100	740,700
All steel replacement	70,000	350,000	1,190,000	840,000	2,450,000
Cargo spaces	22,200	64,200	126,000	150,000	362,400
Ballast spaces	36,400	23,200	26,000	47,400	133,000
Hatch covers & deck fittings	28,000	56,320	60,560	60,560	205,440
Main engine and propulsion	46,000	42,000	48,000	48,000	184,000
Auxiliaries	27,000	34,000	134,000	44,000	239,000
Piping & valves	18,000	37,000	50,000	34,000	139,000
Navigation & communications	9,000	11,000	11,000	11,000	42,000
Accommodation	6,000	8,000	7,000	7,000	28,000
Surveys & surveyors	70,000	78,500	113,000	108,000	369,500
Miscellaneous	100,000	100,000	100,000	100,000	400,000
Spare parts & subcontractors	70,000	100,000	100,000	120,000	390,000
Owner's attendance	23,800	25,600	35,800	35,800	121,000
Estimated total	1,005,300	1,467,420	2,725,460	2,224,860	7,423,040
Averaged annual cost	201,060	293,484	545,092	444,972	
Averaged daily cost	551	804	1,493	1,219	

Source: Clarkson Research, Capesize Quality Survey (1993)

Table 6.4 shows how the periodic maintenance schedule for a Capesize bulk carrier evolves as the vessel ages. The sums shown cover the cost of both the interim dry dockings and the special surveys.[3] Eighteen cost areas are covered, some of which, such as the cost of using the dry dock ($62,000) vary only slightly with age, whilst others, such as steel replacement and work on the hatch covers, increase very sharply as the ship gets older. In this example the periodic cost increases from $1 million for the two surveys in the first five years to $2.7 million in the 11–15-year period. Naturally this depends on the ship. The average daily cost increases from $551 per day to $1493 per day. Owners who operate preventive maintenance policies may incur lower costs, while for ships in poor condition the costs may be much higher.

Voyage costs

We now turn to voyage costs, the third cost item in Figure 6.4, which accounts for 40% of the total costs. These are the variable costs incurred in undertaking a particular voyage. The main items are fuel costs, port dues, tugs, pilotage and canal charges:

$$VC_{tm} = FC_{tm} + PD_{tm} + TP_{tm} + CD_{tm} \quad (6.3)$$

where *VC* represents voyage costs, *FC* is the fuel costs for main engines and auxiliaries, *PD* port and light dues, *TP* tugs and pilotage, and *CD* is canal dues.

FUEL COSTS

Fuel oil is the single most important item in voyage costs, accounting for 47% of the total. In the early 1970s when oil prices were low, less attention was paid to fuel costs in ship design and many large vessels were fitted with turbines, since the benefits of higher power output and lower maintenance costs outweighed their high fuel consumption. However, when oil prices rose during the 1970s, the whole balance of costs changed. During the period 1970–85, fuel prices increased by 950% (Figure 6.5). Leaving aside changes in the fuel efficiency of vessels, this meant that, if fuel accounted for about 13% of total ship costs in 1970, by 1985 it had increased to 34%, more than any other individual item. As a result, resources were poured into designing more fuel-efficient ships and operating practices were adjusted, so that bunker consumption by the shipping industry fell sharply. In 1986 the price of bunkers fell and the level of interest in this aspect of ship design reduced, but in 2,000 bunker prices started to increase again (see Figure 6.5) and the importance of fuel costs increased.

The shipping industry's response to these extreme changes in bunker prices provides a good example of how the design of ships responds to changes in costs. Although shipping companies cannot control fuel prices, they have some influence on the level of fuel consumption. Like any other piece of complex machinery, the fuel a ship burns depends on its design and the care with which it is operated. To appreciate the opportunities for improving the fuel efficiency of ships it is necessary to understand how energy is used in the ship. Take, for example, a typical Panamax bulk carrier, illustrated in Figure 6.6. At a speed of 14 knots it consumes 30 tons of bunker oil and 2 tons of diesel oil in a day. Approximately 27% of this energy is lost in cooling the engine, 30% is lost as exhaust emission,

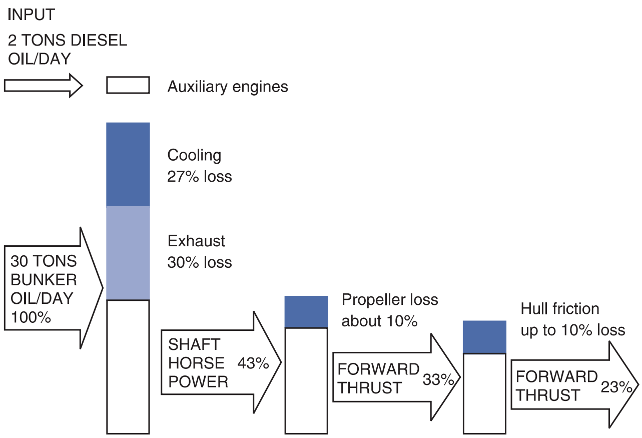

Figure 6.6
Energy losses in typical 1990s built Panamax bulk carrier, 14 knots design speed
Source: Compiled by Martin Stopford from various sources

10% is lost at the propeller, and hull friction accounts for an additional 10%. Only a residual 23% of the energy consumed is actually applied to propelling the vessel through the waves. Whilst this is a simplified view of a complex process, it identifies the areas where technical improvements can, and have, been made – the main engine, the hull and the propeller. The extent of the improvement can be judged from the fact that ships built in the 1970s typically consumed 10 tons per day more fuel than ships built in later years to achieve the same speed.

The design of the main engine is the single most important influence on fuel consumption. Following the 1973 oil price rises, and particularly since 1979, there were major improvements in the thermal efficiency of marine diesel engines. Between 1979 and 1983 the efficiency of energy conversion in slow-speed marine diesel engines improved from about 150 grams per brake horsepower per hour to around 127 grams per brake horsepower per hour. In addition to lower fuel consumption, engine operating speeds were reduced to below 100 rpm, making it possible to use more efficient large-diameter, slow-speed propellers without installing a gear box. The ability to burn low-quality fuel was also improved. In some cases the fuel savings achieved were quite spectacular. Diesel-powered 300,000 dwt VLCCs built in 2005 consumed 68 tons of bunkers a day at 15 knots, compared with fuel consumption of 130–150 tons per day by turbine-powered vessels built in the 1970s.

It is also possible to improve the fuel efficiency of a ship by fitting auxiliary equipment. One method is to install waste heat systems, which use some of the heat from the exhaust of the main engines to power a boiler that drives the auxiliary engines when the main engine is running, thus saving diesel oil. An alternative method is to use generators driven direct from the main engine while the vessel is at sea. This means that auxiliary power is obtained from the more efficient main engine rather than a small auxiliary engine burning expensive diesel fuel.

In operation, the ship's fuel consumption depends on its hull condition and the speed at which it is operated. When a ship is designed, naval architects optimize the hull and power plant to a prescribed design speed which may be, for example, 15 knots for a bulk carrier or 18 knots for a small container ship. Operation of the vessel at lower speeds results in fuel savings because of the reduced water resistance, which, according to the 'cube rule', will be approximately proportional to the cube of the proportional reduction in speed:

$$F = F^{*}\left(\frac{S}{S^{*}}\right)^{a} \tag{6.4}$$

where F is the actual fuel consumption (tons/day), S the actual speed, F^* the design fuel consumption, and S^* the design speed. The exponent a has a value of about 3 for diesel engines and about 2 for steam turbines. It follows from the cube rule that the level of fuel consumption is very sensitive to speed. For example, for a Panamax bulk carrier a reduction in the operating speed of 16 knots to 11 knots results in a two-thirds saving in the tonnage of fuel burnt per day, as shown in Table 6.5.

For any given speed, fuel consumption depends on hull design and hull smoothness. According to work carried out by British Maritime Technology, a reduction in hull roughness from 300 micrometres to 50 micrometers can save 13% on the fuel bill. Between dry docking, marine growth on the hull of the ship increases its water resistance, reducing the achievable speed by 2 or 3 knots in extreme cases. Even with regular dry docking, as the ship ages its hull becomes less smooth as the hull has been scraped and repainted many times. Self-polishing coatings and anti-fouling, which release a poison to kill marine growth and reduce hull fouling between dry dockings, are now widely used but are expensive to apply and have a limited life.

Table 6.5 How speed affects fuel consumption for a panamax bulk carrier

Speed knots	Main engine fuel consumption tons/day
16	44
15	36
14	30
13	24
12	19
11	14

As a result of these factors there can be a wide disparity between the fuel consumption of vessels of a similar size and speed. For example, the fuel consumption of two Panamax bulk carriers operating at the same speed could differ by 20–30% depending on age, machinery and hull condition. Obviously the cost importance of this difference in efficiency depends on the price of fuel.

PORT CHARGES

Port-related charges represent a major component in voyage costs and include various fees levied against the vessel and/or cargo for the use of the facilities and services provided by the port. Charging practices vary considerably from one area to another, but, broadly speaking, they fall into two components – port dues and service charges. Port dues are levied on the vessel for the general use of port facilities, including docking and wharfage charges, and the provision of the basic port infrastructure. The actual charges may be calculated in four different ways, based on: the volume of cargo; the weight of cargo; the gross registered tonnage of the vessel; or the net registered tonnage of the vessel. The service charge covers the various services that the vessel uses in port, including pilotage, towage and cargo handling.

The actual level of port costs depends on the pricing policy of the port authority, the size of the vessel, the time spent in port and the type of cargo loaded or discharged. For example, the typical port cost for a Panamax bulk carrier loading 70,000 tonnes of coal in Australia in 2007 and discharging in Europe would be about $147,000, roughly $2 per tonne. By convention, the allocation of port charges differs for different types of charter. Under a voyage charter, all port dues and charges related to the vessel are charged to the shipowner, while all charges on the cargo are generally paid for by the charterers, except for cargo-handling charges, which are generally agreed under the charter terms. Under a trip charter or time charter, all port charges are carried by the charterer.

CANAL DUES

The main canal dues payable are for transiting the Suez and Panama canals. The toll structure of the Suez Canal is complicated since it is based on two little-known units of measurement, the Suez Canal net ton and Special Drawing Rights (SDRs). Tariffs are calculated in terms of these. The Suez Canal net tonnage of a vessel is a measurement based on late nineteenth-century rules that were intended to represent the revenue-earning capacity of a vessel. It broadly corresponds to the cargo-carrying space below deck, though it is not directly comparable to the more normal measurement of cargo capacity (net tonnage).

The Suez Canal net tonnage of a vessel is calculated either by the classification society or by an official trade organization which issues a Suez Canal Special Tonnage Certificate. For vessels wishing to transit the canal that do not have a certificate, the calculation is provisionally done by adding together the gross and net tonnage, dividing by two and adding 10%. Tariffs are then calculated on the basis of SDRs per Suez net ton. SDRs were chosen as the currency unit in an attempt to avoid losses owing to fluctuations in exchange rates, as their value is linked to a number of major national currencies. Suez Canal toll charges per Suez net ton vary for different types and sizes of ships. For the Panama Canal a flat rate charge per Panama Canal net ton is used (see Chapter 8 for more details on the Suez and Panama canals).

Cargo-handling costs

Finally, we come to cargo–handling costs, the fourth major cost item in Figure 6.4. The cost of loading and discharging cargo represents a significant component in the total cost equation, and one to which considerable attention has been paid by shipowners, particularly in the liner business. Cargo-handling costs are given by the sum of loading costs, discharging costs and an allowance for the cost of any claims that may arise:

$$CHC_{tm} = L_{tm} + DIS_{tm} + CL_{tm} \tag{6.5}$$

where CHC is cargo-handling costs, L is cargo loading charges, DIS is cargo discharge costs, and CL is cargo claims.

The level of these costs may be reduced by investment in improved ship design – to facilitate rapid cargo handling, along with advanced shipboard cargo-handling gear. For example, a forest products carrier with open holds and four cranes per hold can achieve faster and more economical cargo handling than a conventional bulk carrier relying on shore-based cranes.

6.4 THE CAPITAL COST OF THE SHIP

The fifth component in the cost equation for our 'typical' ship in Figure 6.4 is its capital cost. This accounts for 42% of total costs, but in economic terms it has a very another these very different solutions increase the value added by the yard, but there is no simple formula for increasing productivity to offset high wage rates. Each shipyard must find its own solution.

Currency movements and competitiveness

Although currency movements seem far removed from the shipyard, they are the single most important factor in determining shipbuilding cost competitiveness. Since the world economy moved to floating exchange rates after the breakdown of the Bretton Woods system in 1971, shipbuilders have faced a major problem with exchange rates. Unit costs vary proportionately with the exchange rate, and given the volatility of exchange rates during the 1980s and 1990s this is clearly a very major factor in determining shipbuilding cost competitiveness.

An example illustrates the point. A shipyard was negotiating the sale of a small bulk carrier. The yard's cost was £10 million and the $/£ exchange rate was 1.40, so the best price they could offer was $14 million. Unfortunately the owner would not pay more than $10 million, so to win the order the shipyard needed to cut its price by 30%. Since bought-in materials accounted for 60% of the shipyard cost, that was not possible, but while the negotiation dragged on over a period of six months the exchange rate fell to 1.06. At this exchange rate the shipyard could offer a price of $10 million and the contract was signed. Although such large currency movements are uncommon, it demonstrates just how vulnerable shipyards are to exchange rate fluctuations.

As we pull all of these factors together we build up a picture of how the competitive structure of the world shipbuilding industry really operates. At one extreme there are shipyards with low productivity but wages so low that man-hours hardly matter. They can undercut all comers. At the other end there are the high-productivity yards with even higher wage costs, which are slowly going out of business. This happened to the Swedish shipyards in the early 1980s, despite the fact that they had the highest productivity in the world. Between lie a whole range of shipyards with different combinations of wage costs and productivity. Washing over the whole industry are the waves of exchange rate movements that can sweep shipyards up and down the competitiveness league table in a matter of months. All of this combines to make shipbuilding a tough business that requires great management skill. Despite all these problems, or perhaps because of them, shipbuilders are some of the most tenacious businessmen in the maritime industry.

15.7 THE SHIP RECYCLING INDUSTRY

Compared with shipbuilding, shipbreaking (sometimes referred to as 'demolition' or 'recycling') is a rough business. The ships are sold at a negotiated price per lightweight ton (see Section 5.7 for a discussion of the commercial process). Shipbreakers mainly rely on manual labour to dismantle ships in whatever facilities are available, often a suitable beach. Although it is possible to increase productivity by using mechanized shipbreaking methods, these are capital-intensive and the investment has not generally been thought economic, given the volatility and small margins in the shipbreaking business.

The process of non-mechanized shipbreaking falls into three stages. At the preparatory stage, the owner of the vessel should undertake various operations including stopping up all intake apertures; pumping out all bilge water; blocking off intakes and valves; and removing all non-metal objects together with potentially explosive materials. If the vessel is a tanker it must be cleared of potentially dangerous gases. This work is often subcontracted.

The next stage is to beach the ship and remove large metal structures such as masts, pipes, superstructure, deck equipment, main engine, ancillary equipment of machinery room, decks, platforms, transverse bulkheads, propeller shafts, propeller shaft bearings, upper hull sections, bow and stern end sections. The remainder of the ship is then hauled by winches or lifted on to dry land by means of slipways, ramps or dry docks and cut into large sections. In some of the less sophisticated shipbreaking operations the vessel is simply winched on to the beach. Although this process can be undertaken satisfactorily on a beach or alongside a quay, the availability of a dry dock is a considerable advantage in terms of efficiency, safety and control of spillages.

Pumps, auxiliary engines and other equipment are removed and sold. Finally, the panels and sections obtained from the ship are cut into smaller pieces as required, using manually operated propane cutters. The scrap is then assembled for transport to its ultimate destination.

The market for scrap products

Ships provide very high-quality steel scrap, especially tankers which have large flat panels. Sometimes the scrap is simply heated and rerolled into reinforcing rods for sale to the construction industry. Rerolled steel is also ideal for sewage projects, metal roads and agricultural needs. Smaller pieces are melted down. Much of the shipbreaking industry is located in the Far East and Indian subcontinent where there is a sizeable market for reprocessed steel products of this type. In the advanced countries of Europe, scrap is generally completely melted down to make fresh steel.

Although the scrap steel provides most of the value of the ship, the most lucrative return comes from the equipment and the 2% of non-ferrous items. Diesel engines, generators, deck cranes, compasses, clocks and furniture can also be resold. Again, the market for such equipment is stronger in Asian countries than in the developed countries, where technical standards are more demanding, the costs of refurbishing are higher and there is less demand for the second-hand equipment reclaimed from the ship.

Who scraps ships?

For these reasons most shipbreaking occurs in low-wage countries in Asia where shipbreakers have a local market for their product and cheap labour to dismantle the ships.

Table 15.5 Shipbreaking, by country, (1985–2005)

	1986		1991		1995		2005	
	GT	%	GT	%	GT	%	GT	%
Taiwan	7,773	38	48	2	–	0	0	
China	4,567	23	172	7	754	9	200	3%
South Korea	2,658	13	8	0	3	0	0	
Pakistan	861	4	445	19	1,670	20	0	
Japan	770	4	81	3	146	2	0	
India	636	3	695	29	2,809	33	1000	16%
Spain	581	3	13	1	40	0	0	
Turkey	418	2	77	3	207	2	0	
Italy	311	2	8	0	1	0	0	
Bangladesh	268	1	512	22	2,539	30	4600	75%
Others	1,444	7	306	13	354	4	300	5%
Total	20,287	100	2,365	100	8,523	100	6,100	100%

Source: Lloyd's Register of Shipping

This is a relatively mobile industry. Table 15.5 shows that during the recession in the mid-1980s when scrapping was very high, almost three-quarters of the shipbreaking industry was located in Taiwan, China and South Korea. Ten years later Taiwan and South Korea had left the industry. China's market share had fallen to 9% and India, Bangladesh and Pakistan had taken over as market leaders. By 2005, when the shipping industry was booming and demolition had fallen to 6.1 million gt, Bangladesh dominated the industry.

The explanation is that this very basic industry gravitates towards countries with low labour costs. Taiwan's development as a shipbreaker illustrates the point. The shipbreaking business got started with the dismantling of ships damaged during the Second World War and expanded rapidly after import controls were lifted in 1965. Encouraged by the government to meet rising domestic scrap demand and benefiting from a purpose-built site and from plentiful cheap labour, the industry established itself as the world's leading shipbreaker, with highly efficient facilities. Demolition took place in two state-owned sites at the deep-water port of Kaohsiung, using specially built berths and dockside cranes. The ships to be demolished were moored two abreast along the quayside and systematically dismantled, with a breaking cycle of 30–40 days. With each decade the working conditions improved.[20] As the economy grew and labour costs increased, shipbreaking became less attractive and in the early 1990s Taiwan closed the demolition yards and replaced them with a container terminal. South Korea was a more recent entrant to the Far East scrapping business, but the story is much the same. In the 1980s South Korea was the third biggest shipbreaker with a 13% market share, mainly carried out in two demolition yards owned by Hyundai. As wages rose in the late 1980s and the shipbuilding industry expanded, the demolition yards were closed.

The People's Republic of China entered the ship demolition market in the early 1980s and rapidly became the world's second largest buyer of ships for scrap. There was a considerable domestic demand for steel products and, in fact, the China Steel Corporation was already importing a considerable amount of scrap steel from Taiwan. Although China continued to operate demolition yards in the 1990s, the scale of the business was restricted by government regulations controlling currency for the purchase of ships and strict environmental regulations, and China's market share fell from 23% in 1986 to 9% in 1995 and 3% in 2005.

In 2005 the main ship demolition sites were located in Pakistan, India and Bangladesh (Table 15.5), though the level of activity varies with the volume of ships available to scrap. Pakistan's main site is at Gadani Beach, with up to 100 scrapping plots, each plot covering 2500 square yards. Gadani Beach has no electricity supply or water mains and only a few plots have electric generators. Ship demolition takes place at the most basic level. Ships are driven on to the beach where an army of workers dismantle them. During busy periods, up to 15,000 labourers are employed breaking up the ships with the aid of very little mechanization. Much of the scrap material is moved manually, with the assistance of king-post trucks, blocks and pulleys, but the more profitable plots have now moved into mechanization and are using fork-lift trucks and mobile hydraulic cranes. Alang in India's Gujerat State was opened in 1983 and has 170 ship breakers along the 10 km of coastline on the west coast of the Gulf of Cambay. Strong tides and gently sloping beaches allow ships to be beached under their own motors or by tugs. The workers have access to them at low tide. There were 50,000 workers on this site in the 1990s but by 2006 that had shrunk to between 5,000 and 10,000. The Bangladeshi ship recycling yards are located near the port of Chittagong, and are the nation's main source of steel. Rerolling mills in Chittagong and Dhaka produce over 1 million tons of reinforcing rods for the construction industry.

Little shipbreaking is carried out in western Europe, owing to high labour costs and the lack of a ready market for recycled material. There are also various difficulties associated with health and safety legislation and environmental protection, both of which are more prominent than in the countries scrapping ships in Asia. The only European country of any significance in breaking activity in the recent past is Turkey. There are, however, a number of small shipbreaking companies scattered around the UK and continental Europe, mainly with 10–100 employees, specializing in breaking warships, fishing vessels and other high-value vessels.

Several features of the shipbreaking industry have recently raised concerns over the release of polluting materials such as heavy fuel oil and the effect of hazardous substances such as asbestos on workers. The IMO is currently developing a convention providing global ship recycling regulations for international shipping.

The regulation of shipbreaking

Much of the ship dismantling nowadays takes place on tidal beaches and under primitive conditions and this presents society and policy-makers with a dilemma. On the positive side, the industry provides thousands of jobs for migrant workers and recycles valuable materials, including steel, other scrap metal and equipment which can be refurbished. However, the conditions in which this is done mean that workers employed in the industry face high accident rates and health risks from the dismantling of ships containing many hazardous materials, including asbestos, polychlorinated biphenyls, tributyl, tin and large quantities of oils and oil sludge. Protection for the environment is also a problem, with the pollution of coastal areas.

Work is ongoing, involving inter-agency cooperation between the ILO, IMO and the Secretariat of the Basel Convention, to establish mandatory requirements at a global level to ensure an efficient and effective solution to the problem of ship recycling. The IMO has adopted Guidelines on Ship Recycling and a new IMO Convention on ship recycling will include regulations for the design, construction, operation and preparation of ships so as to facilitate safe and environmentally sound recycling, without compromising the safety and operational efficiency of ships; the operation of ship recycling facilities in a safe and environmentally sound manner; and the establishment of an appropriate enforcement mechanism for ship recycling.

15.8 SUMMARY

In this chapter we have discussed the international shipbuilding and scrapping industries. Although shipbuilders face the same market volatility as their customers, the shipowners, it is a very different business with large fixed overheads and many employees.

Our review of the regional structure of world shipbuilding showed a clear regional pattern. During the first half of the twentieth century the industry was dominated by Europe, then in the second half the focus moved to Asia, with Japan leading the way, followed by South Korea which took over the dominant position at the beginning of the twenty-first century, by which time China was making a bid for market leadership, with a number of smaller Asian countries also entering the market.

This process of regional change was driven by a succession of shipbuilding market cycles, first generating growth which allowed new entrants to win market share, and then recessions during which the less efficient shipyards were forced out of the business. There were 12 of these cycles during the period 1901–2007, with an average length of 9.5 years. The cycles are driven by the interaction of supply and demand and coordinated by price movements. The shipbuilding supply function reflects differences in international cost competitiveness and typically has a J shape, whilst the demand curve is more difficult to define but is generally thought to be relatively inelastic. Movements in the demand curve result in changes in ship prices, which in turn move the supply curve to the left (reducing supply when prices are low) or the right (increasing supply when prices are high).

Shipbuilding production is an assembly process involving 10 steps. However, the competitiveness of the shipyard does not just depend on how efficiently it assembles the ship. Wage rates, the cost and availability of good-quality materials, and, most importantly, the exchange rate all play a part. Labour costs and productivity vary enormously from one country to another.

Finally, we discussed the shipbreaking industry, a very different industry from shipbuilding. Although ideally demolition takes place in a dry dock, gently sloping sandy beaches are often used. The industry at the beginning of the twenty-first century was mainly located in areas with plentiful cheap labour and a market for the steel and equipment recovered from the ship. India, Pakistan and currently Bangladesh undertake most of the ship demolition. Regulation governing health and safety in the recycling yards and the construction of ships from recyclable materials is increasing.

In conclusion, shipbuilding and demolition are fascinating industries, in some ways very close to shipping, and in others very different. Their global location is constantly shifting and this, combined with fixed capacity and a volatile market, makes it a tough business. But the shipbuilders, who are tough people themselves, do not seem to mind that, and as long as there is seaborne trade and salt water, they will remain a distinctive and essential part of the maritime business.

16 The Regulation of the Maritime Industry

Whosoever commands the sea commands the trade; whosoever commands the trade of the world commands the riches of the world and consequently the world itself.

(*Judicious and Select Essays and Observations by the Renowned and Learned Knight Sir Walter Raleigh, upon the First Invention of Shipping*, H. Moseley, 1650)

16.1 HOW REGULATIONS AFFECT MARITIME ECONOMICS

Shipowners, like most businessmen, find that regulation often conflicts with their efforts to earn a reasonable return on their investment. When Samuel Plimsoll first started his campaign against the notorious 'coffin ships' in the 1870s, British shipowners argued that the imposition of load lines would put them at an unfair competitive advantage. Fayle, writing in the 1930s, observed that:

> In their efforts to raise both the standard of safety and the standard of working conditions afloat, the Board of Trade frequently found themselves, during the last quarter of the nineteenth century, at loggerheads with the shipowners. They were accused of cramping the development of the industry by laying down hard-and-fast rules which in effect punished the whole of the industry for the sins of a small minority, and hampering British shipping in international competition, by imposing restrictions from which foreign ships were free, even in British ports.[1]

The same, sometimes legitimate, resistance to regulation is found in most industries, but the world's oceans provide the shipping industry with an unrivalled opportunity to bypass the clutches of regulators and gain an economic advantage. The goal of maritime regulators is to close the net and ensure that shipping companies operate within the same standards of safety and environmental responsibility which apply on land. As a result, in the last 50 years the regulatory regime has played a significant part in the economics of the shipping market.

It would, however, be wrong to think that the regulatory process is only concerned with pursuing villains. A few regulations are made in response to particular incidents.

The *Titanic*, the *Torrey Canyon*, the *Herald of Free Enterprise*, the *Exxon Valdez*, the *Erica* and the *Prestige* all provoked a public outcry which led to new regulations. But these are the exceptions. Over the last century the shipping industry and the maritime states have gradually evolved a regulatory system covering all aspects of the shipping business. Ship design, maintenance standards, crewing costs, employment conditions, operating systems, company overheads, taxation, oil pollution liability, environmental emissions and cartels are all subject to regulation in one way or another. However, the emphasis changes and during the last decade the environment, emissions by ships, ballast water, and ship recycling have all received more attention. Needless to say, all of this has economic consequences and a knowledge of maritime regulation is an essential part of the maritime economist's toolkit.

16.2 OVERVIEW OF THE REGULATORY SYSTEM

The aim of this chapter is to discuss the international regulatory system and the legal and political issues that have influenced, and in some cases dominated, the maritime scene since the mid-1960s. The chapter seeks to answer three questions: *Who* regulates shipping and commerce? *What* do they regulate? *How* do regulations affect shipping economics?

The first step is to identify the regulators more precisely. In an ideal world there would be a supreme legislative body which makes a single set of international laws, with an international court that tries cases and an enforcement agency. Reality does not live up to this ideal, and some experts doubt whether what passes for international law is really 'law' at all.[2] There is an International Court of Justice, but its rulings on shipping matters are purely advisory. We should not be surprised at this state of affairs. Each of the 166 countries with an interest in shipping has its own priorities. Gaining agreement on a body of international law, far less approving an international executive to enforce the laws, is hardly likely to succeed.

Maritime regulation is currently organized through the more pragmatic system set out in Figure 16.1. The difficult task of coordinating the many interests and gaining agreement to a consistent body of maritime law falls to the United Nations. The United Nations Convention on the Law of the Sea (UNCLOS 1982) sets the broad framework, whilst the task of developing and maintaining workable regulations within this framework is delegated to two UN agencies, the IMO and ILO. The IMO is responsible for regulations on ship safely, pollution and security and the ILO is responsible for the laws governing the people on board ships. These two organizations produce 'conventions' which become law when they are enacted by each maritime state.[3] The enactment of the maritime conventions is in some cases patchy because not all the 166 states sign up to some conventions, but the major ones such as SOLAS and MARPOL (see Table 16.5 below) have been made law by every significant flag state.

Each maritime state has two different roles, first as a 'flag state' and second as a 'coastal state' (see centre of Figure 16.1). As a 'flag state' it makes and enforces laws governing ships registered under its flag. For example, as a flag state Greece is legally

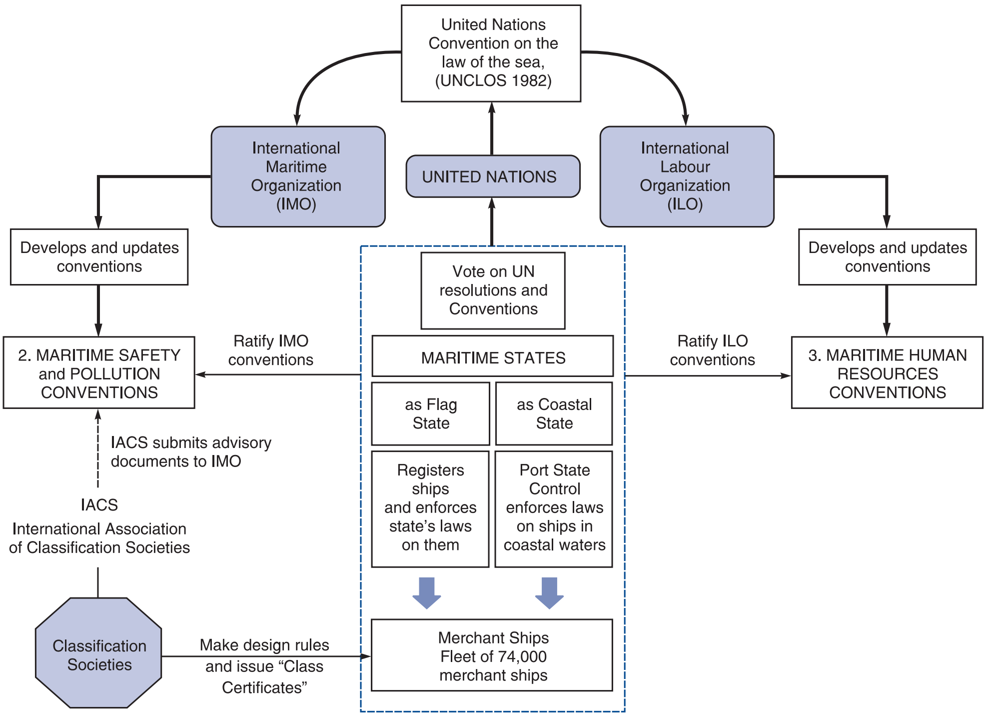

Figure 16.1
The maritime regulatory system showing the role of the 166 maritime states
Source: Martin Stopford 2007

responsible for ships flying the Greek flag, wherever they are in the world, whilst as a coastal state it enforces maritime laws on ships in Greek territorial waters. This is known as 'port state control'. Generally the laws maritime states enforce comply with maritime conventions, but not always. For example when the USA passed the Oil Pollution Act (1990), a law designed to phase out single-hull tankers in US waters, there was no maritime convention on this issue.

The other major 'players' in the regulatory process are the classification societies. Most major maritime nations have their own classification society and they are, in effect, the technical advisers to the maritime regulators. Over the last decade their role as recognized organizations (ROs) has increased and they assist the regulators in making and implementing maritime laws with a technical, human or environmental focus. In addition, they develop technical standards in their own right and award the classification certificate which is required by insurance underwriters. They are paid for these services, but have no legal powers of enforcement beyond withdrawing their services.

In summary, the regulatory system discussed in this chapter involves six principal participants in the regulatory process:

- The *classification societies*: the shipping industry's own system for regulating the technical and operational standard of ships. The classification societies make rules

for ship construction and maintenance and issue a classification certificate to reflect compliance.
- The *United Nations*, which sets the broad framework of maritime law.
- The *flag states*. The primary legal authority governing the activities of merchant ships is the state in which the ship is registered, the flag state. By custom this state is responsible for regulating all aspects of the commercial and operational performance of the ship. International laws are developed by the participation of flag states in treaties or conventions.
- The *coastal states*. A ship is also subject to the laws of the coastal state in whose waters it is trading. The extent of each state's territorial waters and the scope of regulation vary from one country to another.
- The *IMO*, the UN agency responsible for safety, the environment and security.
- The *ILO*, responsible for regulations governing people on board ship.

In the following sections we will consider each of these regulatory regimes.

16.3 THE CLASSIFICATION SOCIETIES

The shipping industry's own regulatory system arose from the efforts of insurers to establish that the vessels for which they were writing insurance were sound. In the mid-eighteenth century they formed the first classification society and during the intervening period their activities have become so closely involved with the regulatory activities of governments that it is often difficult for laymen to understand the difference between the two. In this section we will focus on the role of classification societies and explain why they were set up, how they have evolved, the functions they undertake today and their impact on maritime regulation.

Origin of the classification societies

Like many other shipping institutions, the classification societies are the product of their past, so knowing something of their history helps to explain the current structure. Lloyd's Register of Shipping, the first classification society, can trace its origins back to Lloyd's Coffee House in the early 1700s. The proprietor, Edward Lloyd, presumably in an effort to attract clients, started to circulate lists giving details of vessels which might appear for insurance.[4] The next step came in 1764 when a committee of London insurers and insurance brokers compiled a book containing details of ships that might require insurance. When published the book was known as *Lloyd's Register*. This register classified ships according to their quality, listing a grade 'conferred on the ship by the Committee's appointed surveyors'.[5] The condition of the hull was classified A, E, I, O or U, according to the excellence of its construction and its adjudged continuing soundness (or otherwise). Equipment was graded G, M or B – good, middling or bad. Any ship classified AG was thus as sound as it could be, whilst one rated UB was obviously a bad risk from the underwriter's point of view. In time, G, M and B were replaced by 1, 2 or 3.[6]

The 'green book', as it was known, was compiled by insurers for the sole use of members of the society and contained details of 15,000 ships. All went well until the 1797–8 register introduced a new grading system which based the ship's class on its river of build, favouring ships built on the Thames. This was disputed by many shipowners, and in 1799 a rival register was published, the *New Register Book of Shipping*, known as the 'red book'. A period of punitive competition followed, bringing both registers close to bankruptcy. In 1834 the differences were settled and a new society was set up to produce a shipping register which was acceptable to all sections of the industry. The new publication was Lloyd's *Register of British & Foreign Shipping* and its governing body had 24 members, eight each from the merchants, the shipowners, and the underwriters. This made it representative of the shipping industry as a whole.[7]

The new society had 63 surveyors and a system of regular inspection for ships was instituted. The main function continued to be the production of a register grading ships, but a new classification system was introduced. Under this system, ships that had not passed a prescribed age and had been kept in the highest state of repair were classed A; ships which, though not fit for carrying dry cargo, were considered perfectly safe for carrying cargoes not damaged by the sea were classed E; and ships unsuitable for dry cargo, but fit for short voyages (not out of Europe) were classed I. The condition of the anchor cables and stores when satisfactory was indicated by 1 and when unsatisfactory by 2. This system gave rise to the familiar expression 'A1 condition'. In the first five years 15,000 vessels were surveyed and 'classed'.

As the class movement developed in the nineteenth century, the role of classification societies changed. At first the main job was to grade ships. As time passed they started to set the standards to which ships should be built and maintained. Blake comments:

> As its authority grew, the Committee took upon itself something like disciplinary powers. Any new vessel for which an A1 classification was sought must undergo *a survey under construction*, which meant in effect that its progress was closely inspected at least three times while the hull was still on the stocks.

A1 became a requirement rather than a grade in a scale.

Technical committees were set up to write rule books setting the precise standards to which merchant ships should be built and maintained. These rules set the standards and the society policed them through their network of ship surveyors.

Other classification societies were set up in the nineteenth century. The American Bureau of Shipping (ABS) has its origins in the American Ship Masters Association which was organized in 1860 and incorporated in 1862 through an Act of Legislature of the State of New York. Like Lloyd's Register of Shipping it is a non-profit making organization with general management vested in the membership comprising individuals prominent in the marine and offshore industries and related fields. Most class societies today are managed by a Board drawn from all parts of the maritime industry – shipbuilders, shipowners, insurers, etc. Although underwriters still participate in general management through membership of these boards, the classification societies can no longer be seen as acting exclusively for the insurers.

The classification societies today

There are currently more than 50 classification societies operating world-wide, some large and prominent, others small and obscure. The list of the ten larger societies and the number of cargo ships they class, shown in Table 16.1, gives a rough idea of the relative prominence of the various institutions. These are all well-known names in shipping circles and together they cover over 90% of the cargo and passenger fleet (note that these numbers do not include the many small non-cargo-carrying vessels which the societies also class).

Today the main job of the classification societies is to 'enhance the safety of life and property at sea by securing high technical standards of design, manufacture, construction and maintenance of mercantile and non-mercantile shipping'. The classification certificate remains the mainstay of their authority. A shipowner must class his vessel to obtain insurance, and in some instances a government may require a ship to be classed. However, the significance of the classification certificate extends beyond insurance. It is the industry standard for establishing that a vessel is properly constructed and in good condition.

In addition to their role as regulators, the major classification societies also represent the largest single concentration of technical expertise available to the shipping industry. For example, Lloyd's Register, the largest classification society, has over 5,400 people, of whom half are qualified engineers, operating from 240 offices in 80 countries world-wide. They class ships against their own rules (around 6600 ships annually),

Table 16.1 The major classification societies, November 2006

		Fleet classed		Average ship	
		Number	Million gt	Thousand gt	Age
IACS members					
Nippon Kaiji Kyokei	NK	6,494	142.9	22.0	12.8
Lloyd's Register (LR)	LR	6,190	125.8	20.3	18.4
American Bureau of Shipping	ABS	6,292	103.2	16.4	19.6
Det Norske Veritas	DNV	4,010	102.0	25.4	16.5
Germanischer Lloyd	GL	4,712	54.9	11.7	16.5
Bureau Veritas	BV	4,877	46.6	9.5	18.9
Korean Register	KR	1,648	21.9	13.3	17.4
China Classification Society	CCS	1,897	21.6	11.4	19.4
Russian Register	RS	3,174	12.5	3.9	25.2
Registro Italiano	RINA	1,345	12.0	9.0	23.8
Others					
Indian Register		352	1.5	4.2	17.6
11 Others (under 1,000 ships)		1,819	5.3	54.6	24.8
Total		42,810	650.2	15.2	0

Note: The statistics cover only vessels included in Clarkson Registers carry out statutory certification against international conventions, codes and protocols, and offer a range of quality assurance, engineering and consultancy services. In 2007, ABS and its affiliated companies had a global staff of more than 3,000 people, primarily surveyors, engineers and professionals in the areas of risk assessment and mitigation. ABS maintains offices or is represented in more than 80 countries. To put this into perspective, the IMO has a permanent staff of about 300 and many important bulk shipping companies have fewer than 100 shore-based staff. In these circumstances it is easy to see why, in addition to the classification role, the class societies have a major role as technical advisers to shipowners and undertake technical inspection work on behalf of governments. Since government regulations cover much of the same ground as classification rules, this sometimes leads to confusion over the role of the classification societies and government regulators.

Although the major societies do not distribute profits, they depend on selling their services to cover their costs and are subject to commercial pressures. As self-funding organizations, their survival depends on maintaining a sufficiently large fee-paying membership to recover their costs. There is, therefore, intense competition between classification societies to attract members, leaving them in the tricky position of competing for the business of shipowners on whom they will often have to impose financial penalties as a result of their regulatory inspections.

The regulatory activities of the classification societies

The role of the class societies today has two fundamental aspects, developing rules and implementing them.

Developing rules includes both new initiatives and the continuous updating of existing rules to reflect changes in marine technology and conventions. Procedures vary, but most societies develop their rules through a committee structure, involving experts from various scientific disciplines and technical activities including naval architects, marine engineers, underwriters, owners, builders, operators, materials manufacturers, machinery fabricators and individuals in other related fields. This process takes into account the activities of IMO and IACS unified requirements.

The second stage involves applying the rules to practical shipbuilding and shipping activities. This is a four-step procedure:

1. *Technical plan review*. The plans of new ships are submitted to the classification society for inspection to ensure that the structural details in the design conform to the society's rules. If the plans are found satisfactory they are passed and construction can proceed. Sometimes modifications are required, or explanations required on certain points. Alternatively, the society may be asked by the shipyard to help out in developing the design.
2. *Surveys during construction* to verify that the approved plans are implemented, good workmanship practices are employed and rules are followed. This includes the testing of materials and major components such as engines, forgings and boilers.

3. *Classification certificate*. On satisfactory completion of the vessel the class is assigned and a certificate of classification is issued.
4. *Periodic surveys* for the maintenance of class. Merchant ships are required to undergo a scheme of surveys while in service to verify their acceptability for classification. The ship's classification society carries out these inspections and keeps records which, for example, a prospective buyer of the ship may ask to inspect.

The classification procedures for existing ships are, in general terms, agreed by IACS for its members and associates. The regulations typically require a hull and machinery annual survey, a hull and machinery special survey every 5 years, a dry-docking survey every 2½ years, a tail shaft inspection every five years, and a boiler survey every 2½ years. The hull and machinery survey is very demanding, involving detailed inspection and measurement of the hull.

As the ship grows older, the scope of this inspection widens to cover those areas of the ship which are known to be most vulnerable to ageing. For example, as oil tankers grow older the area of the deck plates subject to tests for corrosion increases. To avoid the lengthy time out of service, the classification societies allow owners to opt for a *continuous survey* consisting of a programme of rolling inspections covering one-fifth of the ship each year.

As more governments have become involved in flag state regulation over the last 30 years, the activities of classification societies as government representatives has increased. The most common authorizations are in connection with tonnage measurement and load lines, SOLAS, MARPOL and IMO set standards on the transportation of dangerous goods. In carrying out statutory work, the classification society applies the standards relevant to the country of registry.

Finally, it is worth mentioning the vetting inspections carried out by charterers of ships, particularly corporations in the oil and steel industries.

The International Association of Classification Societies

Over the last thirty years classification societies have been under pressure from shipowners and regulators to standardize their rules. Non-standard rules mean design work classed by one society may not be acceptable to another, causing unnecessary cost and inconvenience. For regulators legislating on the technical standards of ship construction, particularly through the IMO, the lack of a common standard complicates their job. To address this problem, in 1968 the International Association of Classification Societies was set up. Its ten members are listed in Table 16.1 and account for about 90% of world classification activity. The IACS has two main aims: to introduce uniformity into the rules developed by class societies and to act as the interface between class societies. A related function is to collaborate with outside organizations and in particular IMO. In 1969 IMO granted IACS 'consultative status'. The fact that it is the only non-governmental organization with observer status at the IMO neatly illustrates the position of the classification societies as intermediaries between the commercial shipping industry and governments.

Over the last 30 years IACS has developed more than 160 sets of unified requirements. These relate to many factors, of which a few are minimum longitudinal strength, loading guidance information, and the use of steel grades for various hull members. However, a significant step forward came in December 2005 when the IACS Council adopted Common Structural Rules for tankers and bulk carriers. For the first time this integrated the rule-making activities of the societies into a single design standard. The Common Structural Rules were implemented on 1 April 2006.

16.4 THE LAW OF THE SEA

Why the law of the sea matters

Since maritime law is made and enforced by nation states, the next task is to examine the legal framework which determines the rights and responsibilities of nations for their ocean-going merchant ships. There are two obvious questions. First, which nation's law applies to a ship? Second, what legal rights do other nations have over that ship as it moves about the world? The answers were not developed overnight, they were evolved over the centuries as a set of customary rules known as the *law of the sea*.

The law of the sea: flag state versus coastal state

The debate over the legal responsibility for ships stretches back to the days when naval power was the deciding factor. A country's navy protected the ships flying its flag and this established the principle, which survives today, of flag state responsibility. However, coastal states also had a claim over ships visiting their ports or sailing in their coastal waters, if only because they could sink them with their cannons if they did not behave. Indeed, early writers suggested that the distance controlled by shore-based cannons should be the criterion for determining the extent of the coastal seas. In a world of rapidly growing commerce, agreeing the rights of the flag and coastal states has become a major issue. Can a country ban alcohol on board foreign ships in its territorial waters? If it considers a foreign ship unsafe, has it the right to detain it? The answers to these questions, in so far as there are answers, are to be found in the UN Convention on the Law of the Sea (UNCLOS 1982), the culmination of three Conferences on the Law of the Sea, referred to as UNCLOS I (1958), UNCLOS II (1960) and UNCLOS III (1973).

The process of developing these conventions started in 1958 when the United Nations called the UNCLOS I. Eighty-six states attended. The aim was to define the fundamental issues of the ownership of the sea, the right of passage through it and the ownership of the sea bed. The latter issue was becoming increasingly important as offshore oilfields started to be developed. Four conventions were eventually finalized, dealing with the Territorial Sea and Contiguous Zone, the High Seas, the Continental Shelf, and Conservation of Fisheries.

A second conference, UNCLOS II, was called in 1960 to follow up on some items not agreed in UNCLOS I. In the 1960s the growing awareness of the mineral wealth on the sea bed placed new significance on the law of the sea, and in 1970 the United Nations convened a third conference to produce a comprehensive Convention on the Law of the Sea. Work started in 1973 (UNCLOS III), attended by 150 states. With so many participants, discussion was extended. It was not until 1982 that the UNCLOS 1982 was finally adopted, to enter into force 12 months after it had been ratified by 60 states. It finally came into force on 16 November 1994, at last providing a 'comprehensive framework for the regulation of all ocean space … the limits of national jurisdiction over ocean space, access to the seas, navigation, protection and preservation of the marine environment'.[8]

As far as the flag of registration is concerned, UNCLOS 1982 endorses the right of any state to register ships, provided there is a 'genuine link' between the ship and the state. Since the flag state can define the nature of this link, in practice it can register any ship it chooses. Once registered, the ship becomes part of the state for legal purposes. The flag state has primary legal responsibility for the ship in terms of regulating safety, labour laws and on commercial matters. However the coastal state also has limited legal rights over any ship sailing in its waters.

The rights of the coastal states are defined by dividing the sea into the 'zones' shown in Figure 16.2, each of which is treated differently from a legal point of view: the

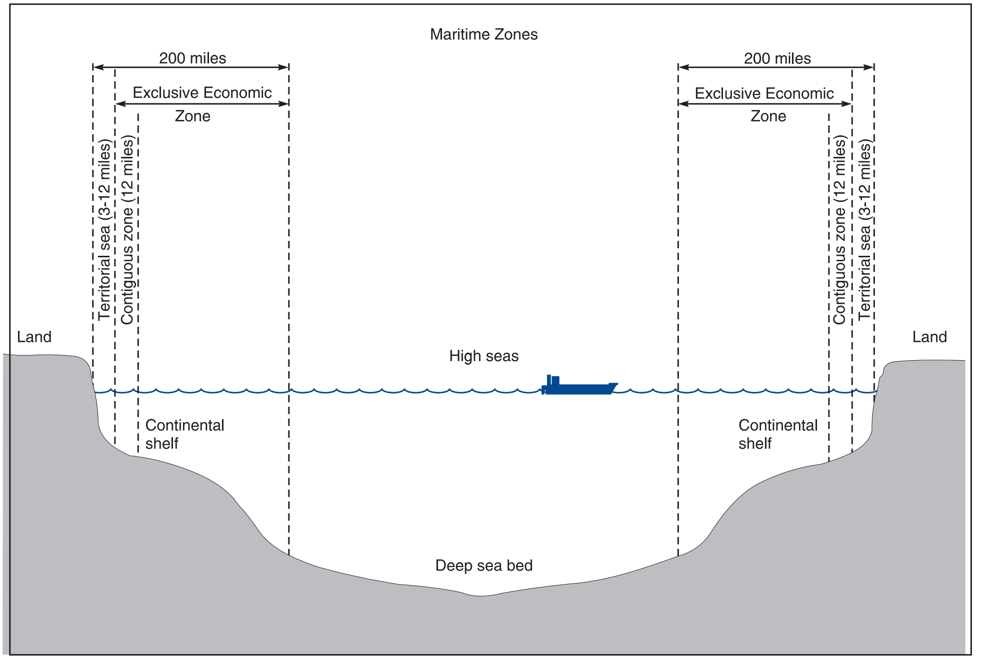

Figure 16.2
Maritime zones
Source: Martin Stopford 2007

BOX 16.1 MARITIME ZONES RECOGNIZED BY THE UN CONVENTION ON THE LAW OF THE SEA 1982

The territorial sea

This is the strip of water closest to the shore. UNCLOS recognizes a maximum width of 12 nautical miles, but in practice countries use many different limits, as can be seen in Table 16.2. Three miles is the smallest limit, 12 miles the most common, while 200 miles is the furthest. Ships have the right of innocent passage through territorial waters. Coastal states only have the right to enforce their own laws relating to specific topics listed in Article 21 such as safe navigation and pollution. They are entitled to enforce international laws.

The contiguous zone

This is a strip of water to the seaward of the territorial sea. It has its origins in the eighteenth-century 'Hovering Acts' enacted by Great Britain against foreign smuggling ships hovering within distances of up to 8 leagues (i.e. 24 miles) from the shore. Coastal states have limited powers to enforce customs, fiscal, sanitary and immigration laws.

The exclusive economic zone

The exclusive economic zone (EEZ) is a belt of sea extending up to 200 miles from the baseline (i.e. the legally defined shoreline). It is mainly concerned with the ownership of economic resources such as fisheries and minerals. Within this zone third parties enjoy freedom of navigation and the laying of cables and pipelines. From a shipping viewpoint the EEZ is more like the high seas. However, the exception concerns pollution. Article 56 confers on the coastal state 'jurisdiction as provided for in the relevant provisions of this convention with regard to the protection and preservation of the marine environment'. The 'relevant provisions' relate to the dumping of waste and other forms of pollution from vessels. This gives the coastal state the right to enforce oil pollution regulations in the EEZ, a matter of major economic importance for shipowners.

The high seas

The high seas are 'all parts of the sea that are not included in the exclusive economic zone, in the territorial sea or the internal waters of a state'. In this area vessels flying a particular flag may proceed without interference from other vessels. This convention establishes the basis on which nationality can be granted to a merchant ship and the legal status of that ship. Article 91 of the 1982 Convention on the High Seas states that:

> Each state shall fix the conditions for the grant of its nationality to ships, for the registration of ships in its territory, and for the right to fly its flag. Ships have the nationality of the state whose flag they are entitled to fly. There must exist a genuine link between the state and the ship.

This paragraph was unchanged from the 1958 Convention and was the end-product of a heated debate about whether countries such as Liberia and Panama had the right to establish open registries. Since the Convention does not define what constitutes a 'genuine link' between state and ship, it was left to each state to define this link for itself.

territorial sea (the strip closest to land); the contiguous zone; and the exclusive economic zone. The fourth zone is the high seas, which nobody owns. None of the zones are precisely defined. Although the 1982 Convention fixes the limit to the territorial sea at 12 miles, Table 16.2 shows that many different limits are in use. The most common is 12 miles, but a few countries have adopted much more extensive limits. The contiguous zone and the exclusive economic zone are mainly of interest to shipowners because pollution control and prevention rights are granted to the coastal states in these areas. These zones are briefly defined in Box 16.1.

Table 16.2 Limits of the territorial sea

Distance miles	Number countries
3	20
4	2
6	4
12	81
15	1
20	1
30	2
35	1
50	4
70	1
100	1
150	1
200	13
None	5
Total	137

Source: Churchill and Lowe, (1983, Appendix)

16.5 THE REGULATORY ROLE OF THE FLAG STATE

Economic implications of flag state regulation

In recent years the flag state issue has been crucial for maritime economics because it provided shipowners with a way of reducing their costs. When a ship is registered in a particular country (the flag state), the ship and its owner must comply with its laws. The unique feature of shipping is that because the ship moves around the world anyway, it is easy to change legal jurisdiction. For a shipowner there are four principal consequences of choosing to register a ship in one state rather than another:

1. *Tax, company law and financial law*. A company that registers a ship in a particular country is subject to that country's commercial laws. These laws will determine the company's liability to pay tax and may impose regulations in such areas as company organization, auditing of accounts, employment of staff and limitation of liability. All of these affect the economics of the business.
2. *Compliance with maritime safety conventions*. The ship is subject to any safety regulations the state has laid down for the construction and operation of ships. Registration under a flag that has ratified and rigidly enforces the 1974 Safety of Life at Sea (SOLAS) Convention means complying with these standards. Conversely, registration under a flag state that has not ratified SOLAS, or does not have the means to enforce it, allows shipowners to set their own standards on equipment and maintenance (but they are still subject to port state regulation).

3. *Crewing and terms of employment*. The company is subject to flag state regulations concerning the selection of crew, their terms of employment and working conditions. Some flag states, for example, insist on the employment of nationals.
4. *Naval protection and political acceptability*. Another reason for adopting a flag is to benefit from the protection and acceptability of the flag state. Although less important today, there were examples during the war between Iran and Iraq in the 1980s when shipowners changed to the US flag to gain the protection of US naval forces in the Gulf.

Any of these factors may be sufficient to motivate shipowners to seek a commercial advantage by changing their flag of registry. Table 16.3 shows that this has a long history, and one that gathered momentum during the twentieth century as taxation and regulation came to play an increasing part in the shipowner's commercial operations. This naturally raises the question whether a shipowner is free to change his flag. To answer this question we must look at how ships are registered. In some countries the shipowner is subject to the same legal regime as any other business, while in others special legislation is introduced covering merchant shipping companies.

Registration procedures

A ship needs a nationality to identify it for legal and commercial purposes, and it is obtained by registering the ship with the administration of a national flag. The way registration works varies from one country to another, but the British regime provides an illustration.

Under the Merchant Shipping Act 1894, British ships must be registered within Her Majesty's dominions (in practice, because of the constraints presented by the legislation of UK Dependent Territories, that registration may have to be in the UK). A peculiarity of British registration is that the ship is registered as 64 shares, at least 33 of which must be owned by a British subject or a company established under the law of some part of Her Majesty's dominions and having its principal place of business in those dominions.[9] Under the UK Companies Acts, any person of any nationality may register and own a company in the United Kingdom, so a national of any country may own a British ship.

Interestingly, there are no legal penalties for failing to register a ship, possibly because it was felt that the practical penalties are such that no legal enforcement is required to provide an additional inducement. A ship registered in the UK can fly the British flag, i.e. the Red Ensign, but is not obliged to do so. Nor is there any legal constraint on a British subject or British companies registering ships outside Britain if they wish to do so. All that is necessary is for the requirements of the recipient register to be met.

There is much variation in the requirements for registration. Some flag states require the ship to be owned by a national. This is the case in Liberia, but nationality is easily established by setting up a Liberian company, which qualifies as a national for the purposes of registration. Panama has no nationality requirements, while the Greek flag falls

Table 16.3 History of ship registration and port state control

Period	Flag of registry	Motivation
16th century	Spanish	English merchants circumvented restrictions limiting non-Spanish vessels from West Indies trade.
17th century	French	English fishermen in Newfoundland used French registry as a means to continue operation in conjunction with British registry fishing boats.
19th century	Norwegian	British trawler owners changed registry to fish off Moray Firth.
Napoleonic War	German	English shipowners changed registry to avoid the French blockade.
	Portuguese	US shipowners in Massachusetts changed registry to avoid capture by the British.
1922	Panamanian	Two ships of United American Lines changed from US registry to avoid laws on serving alcoholic beverages aboard US ships.
1920–1930	Panamanian	US shipowners switched registry to reduce operating costs by employing cheaper shipboard labour.
1930s	Panamanian	Shipowners with German-registered ships switched to Panamanian registry to avoid possible seizure.
1939–1941	Panamanian	With encouragement from the US government, shipowners switched to Panamanian registry to assist the Allies without violating the neutrality laws. European shipowners also switched to Panamanian registry to avoid wartime requisitioning of their vessels.
1946–1949	Panamanian	More than 150 ships sold under the US Merchant Sales Act of 1946 were registered in Panama - as it offered liberal registration and taxation advantages.
1949	Liberian	Low registration fees, absence of Liberian taxes, absence of operating and crewing restrictions made registry economically attractive.
1950–late 1970s	Flags of convenience develop as preferred registration for the independent shipping industry	As registry in USA and other countries became increasingly uneconomical, many countries competed to become ‘flags of convenience’ for ship registrations; only a few succeeded in attracting significant tonnage.
1982–2007	National flags start to enforce regulations on ships in their coastal waters	1982 Paris Memorandum of Understanding in which 14 European states agreed to work together to ensure that ships visiting their ports complied with international conventions on safety and pollution. Others followed.

Source: Cooper (1986)

somewhere between the two, requiring 50% ownership by Greek citizens or legal entities.[10] Dual registration is also possible to deal with situations where, for example, the ship is financed under a different jurisdiction from its legal ownership (dual registration is discussed below).

In 2004 the IMO adopted a scheme for issuing a unique number to each company and registered owner. Its purpose is to assign a permanent number for identification purposes to each company and/or registered owner 'managing ships of 100 gross tonnage and inwards … involved in international voyages'.[11]

Types of registry

Ship registers can be broadly divided into three groups: national registers, international registers and open registers.

- *National registers* treat the shipping company in the same way as any other business registered in the country. Certain special incentives or subsidies may be available but, broadly speaking, the shipping company is subject to the full range of national legislation covering financial, company and employment regulations.
- *International registers* were set up by some national flag administrations to offer their national shipowning companies an alternative to registering under open registries. They treat the shipping company in broadly the same way as an open register, generally charging a fixed tax on the tonnage of the ship (tonnage tax) rather than taxing corporate profits. The aim is to provide a national flag environment which offers shipowners the commercial advantages available under an open register. In 2005 there were eight international registers, of which Singapore, Norwegian International Registry, Hong Kong, Marshall Islands and the Isle of Man were the biggest.
- *Open registers (flags of convenience)* offer shipowners a commercial alternative to registering under their national flag, and they charge a fee for this service. The terms and conditions depend on the policy of the country concerned. The success of an open register depends on attracting international shipowners and gaining the acceptance of the regulatory authorities. In 2005 there were 12 open registries, which are listed in Table 16.4. Panama, Liberia, Bahamas, Malta and Cyprus were the biggest.

The distinction has more to do with how registered ships are treated than access to the flag. Most national registers are open to any shipowner, whatever his nationality, who wishes to apply for registration and satisfies the necessary conditions. For example, the United Kingdom is open to any Greek, Norwegian or Danish shipowner who wishes to register his vessels under the UK flag, provided he satisfies certain requirements.[12] Confronted with a choice of flags under which to register, the shipowner must weigh up the relative advantages and disadvantages of each of the alternatives.

Table 16.4 World merchant fleet by ownership and registration, January 2005

(1)	(2)	(3)	(4)	(5)
Flag state	'000 dwt			
1. NATIONAL REGISTERS				
	Registered			% on home register
	Home	Overseas	Total	
Greece	50,997	104,147	155,144	33%
Japan	12,611	105,051	117,662	11%
Germany	9,033	48,878	57,911	16%
China	27,110	29,702	56,812	48%
United States	10,301	36,037	46,338	22%
Norway	14,344	29,645	43,989	33%
Hong Kong	17,246	23,747	40,993	42%
Republic of Korea	10,371	16,887	27,258	38%
United Kingdom	10,865	14,978	25,843	42%
Singapore	12,424	9,909	22,333	56%
Russian Federation	6,845	10,022	16,867	41%
Denmark	8,376	8,491	16,867	50%
India	11,729	980	12,709	92%
Sweden	1,530	3,889	5,419	28%
Others	70,915	80,963	151,877	47%
Total national registers	274,697	523,326	798,022	
2. INTERNATIONAL REGISTERS				
		Fleet Owned by		% owned by nationals
	Total	Nationals	Foreigners	
Singapore	40,934	12,424	28,510	30%
Norwegian Int. Registry	21,262	12,424	8,838	58%
Hong Kong (China)	43,957	17,246	26,711	39%
Marshall Islands	38,088	10,828	27,260	28%
Isle of Man	12,073	4,700	7,373	39%
Danish Int. Ship Registry	8,859	8,330	529	94%
French Antarctic Territory	5,427	1,769	3,658	33%
Netherlands Antilles	2,132	616	1,516	29%
Total international registers	131,798	55,913	75,885	42%
3. OPEN REGISTERS ('FLAGS OF CONVENIENCE')				
		Fleet Owned by		% owned by nationals
	Total	Nationals	Foreigners	
Panama	177,866	0	177,866	—
Liberia	76,372	0	76,372	—
Bahamas	41,835	0	41,835	—
Malta	30,971	0	30,971	—
Cyprus	31,538	459	31,079	1%
Bermuda	6,206	—	6,206	—
St Vincent & Grenadines	6,857	0	6,857	0
Antigua & Barbuda	8,383	0	8,383	0
Cayman Islands	4,040	0	4,040	0
Luxemburg	794	0	794	0
Vanuatu	2,077	0	2,077	0
Gibraltar	1,281	0	1,281	0
Total open registers	388,220	—	387,761	0%
World total* (sum of col 2)	794,715			

Source: United Nations Review of Maritime Transport, 2005. Section 1 "National Registers" is from Table 16, p. 33; Sections 2 "International Registers" and 3 "Open Registers" are from Table 18 p. 37

* Of which: National registers 35%; International registers 17%; Open registers 48%

The economic role of open registers

The movement towards open registers started in the 1920s, when US shipowners saw registration under the Panamanian flag as a means of avoiding the high tax rates in the United States, while at the same time registering in a country within the stable political orbit of the United States. There was a spate of registrations during this period, but the real growth came after the Second World War when the US government sold off Liberty ships to US owners. Anxious to avoid operating under the American flag, US tax lawyers approached Liberia to set up a ship register designed to attract shipowners to register under that flag on the payment of an annual fee.[13] Shortly afterwards, Panama adapted its laws to attract shipowners from anywhere in the world, and thus the two major international open registers were established.

The use of an open register generally involves payment of an initial registration fee and an annual tonnage tax, which enables the register to cover its costs and make a profit. In return, the register offers a legal and commercial environment tailored to the requirements of a shipowner trading internationally. There are major differences in the way registers approach this task, but in general the areas addressed are:

- *Tax*. There are generally no taxes on profits or fiscal controls. The only tax is the subscription tax per net registered ton.
- *Crewing*. The shipping company is free to recruit internationally. There is no requirement to employ nationals either as officers or crew. However, international conventions dealing with crew standards and training may be enforced, depending on the policy of the register.
- *Company law*. As a rule, the shipping company is given considerable freedom over its corporate activities. For example, ownership of the stock in the company need not be disclosed; shares are often in 'bearer' form, which means that they belong to the person who holds them; liability can be limited to a one-ship company; and the company is not required to produce audited accounts. There are generally few regulations regarding the appointment of directors and the administration of business.

In effect, open registers are businesses and the service offered is determined by the register's maritime laws and the way they are enforced. Supervising safety standards is expensive and during the 1980s recession some open registers paid little attention to this aspect of the business, but this has proved a difficult stance to maintain. To be successful an open register's ships must be acceptable in the ports of the world and to bankers lending against a mortgage on the ship. As the scrutiny of ships by shippers and port authorities has increased it has become more important for open register flags to comply with international conventions, and most open registries, whilst offering shipowners freedom in the areas of taxation and company law, enforce legislation regarding the operational and environmental safety of ships registered under their flag.

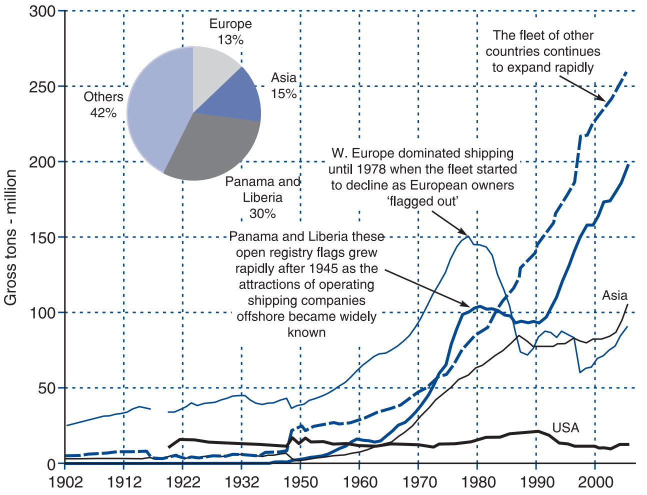

Figure 16.3
World merchant fleet by flag, 1902–2006
Source: Lloyd's Register of Shipping and CRSL

Figure 16.3 shows that by the late 1950s the Panamanian and Liberian fleets had reached 16 million grt and open registers were becoming a major issue for the established shipping states. Inevitably the question was raised whether a country such as Liberia has the right to offer registry to a shipowner who is not a national of that country. This issue was discussed at UNCLOS I in 1958 and put to the test in 1959 when the newly formed Inter-governmental Maritime Consultative Organization (IMCO) met in London and elected its Maritime Safety Committee. The terms of the election of the Committee stated that eight members of the committee should be the largest shipowning nations. Initially the eight nations elected were the USA, UK, Norway, Japan, Italy, the Netherlands, France and West Germany. However, objections were raised that Liberia, which ranked third in world tonnage, and Panama, which ranked eighth, should have been elected instead of France and Germany.

The dispute was submitted to the International Court of Justice for an opinion on whether the election was legal in terms of the 1948 Convention that established the IMCO.[14] It was argued by the European shipowners that for a ship to register in a country there had to be a 'genuine link' between registration and ownership, and that in the case of international open registry flags this link did not exist. Predictably Liberia, Panama, India and the USA took the opposite view. The European argument was not accepted by the Court which by a 9–5 vote held that, by not electing Liberia and Panama to the Maritime Safety Committee, the IMCO assembly had failed to comply with Article 28(a) of the 1948 Convention. As a result, international open registry flags were legitimized in international law.

In a world of high taxation, offshore registration was enormously attractive, and once this facility became available it was widely adopted. Today about half the world merchant fleet is registered under open registers. The principal open registry flags, Panama, Liberia, Bahamas, Malta, Cyprus, and Bermuda, plus half a dozen smaller flags including St Vincent and Antigua, are listed in Table 16.4. The fact that so few ships under these flags are owned by nationals confirms their status as open registries (see Table 16.4.3, column 3). Because in addition to tax concessions open registers allowed freedom in crew selection, in the 1980s and 1990s many large shipping corporations bowed, often reluctantly, to commercial pressures and abandoned their national flag in favour of open registers.

Although open registers acquired a mixed reputation in the 1980s, their success could not be overlooked and several established maritime nations set up their own 'international registry', designed to offer similar conditions and bring shipowners back under the national flag. The eight listed in Table 16.4 show that by 2005 these international registers had been successful in attracting 17% of the world fleet, though the fleet under open registers is considerably bigger and many shipowners in Greece, Japan, and the USA continue to register under their domestic flags. In the meantime the open registers have, in the main, fallen in line with regulatory practice and this form of ownership has become less controversial than it was a decade ago.

Dual registration

In some circumstances it is necessary for a shipowner to register a ship under two flags. For example, the owner may be required to register the ship under his domestic flag, but this flag may not be acceptable to the financing bank, so for mortgage purposes it is registered under a second jurisdiction. The way this works is that the ship is first registered in country A and its owning company then issues a bare boat charter which is registered in country B where it enjoys the same rights, privileges and obligations as any other ship registered under the flag. Obviously this only works if the registration authorities in country B are prepared to accept a bare boat charter, but several flags such as Malta and Cyprus are willing to do so for registration purposes, provided the registers are compatible.[15] Separating ownership from operation in this way can be used, for example, to allow the company to register in country A to maintain the nationality of the ship, whilst using the second register to circumvent restrictive national regulations such as crewing or to gain access to certain ports.

Company structures associated with ship registration

The use of open registers in shipping has given rise to a distinctive structure of company organization designed to protect the 'beneficial owner'. A typical company structure is shown in Figure 16.4. There are four active components:

1. *The beneficial owner*. The ultimate controlling owner who benefits from any profits the ship makes. He may be located in his home country or an international centre such as Geneva or Monaco.

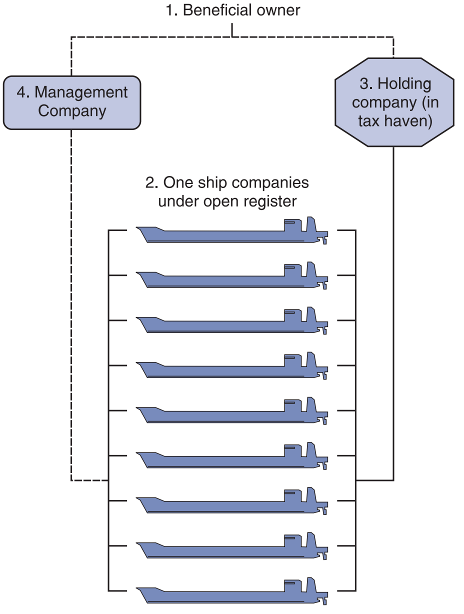

Figure 16.4
Shipping company ownership structure
Source: Martin Stopford, 2007

2. *One-ship company*. A company, usually incorporated in an open registry country, set up for the sole purpose of owning a single ship. It has no other traceable assets. This protects the other assets of the beneficial owner from claims involving the one-ship company.[16]
3. *Holding company*. A holding company is incorporated in a favourable tax jurisdiction for the purpose of owning and operating the ships. The only assets of this company are the shares in each one-ship company. The shares in this company are held by the beneficial owner, which could be a company or an individual.
4. *Management company*. Day-to-day management of the ships is carried out by another company established for this purpose. Usually this company is located in a convenient shipping centre such as London or Hong Kong.

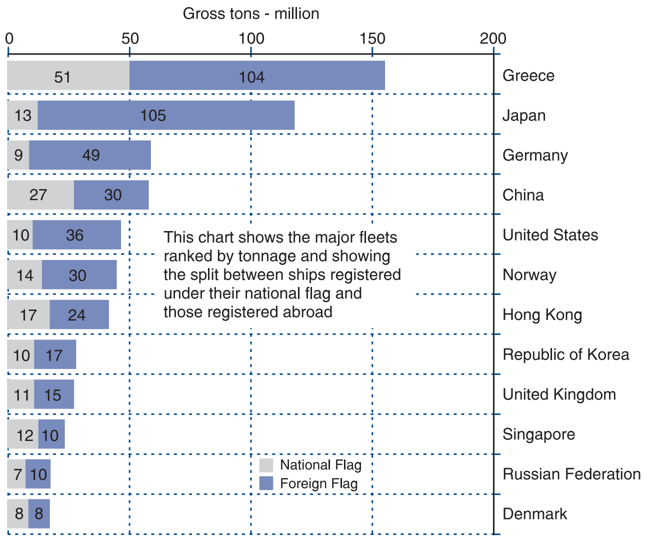

Figure 16.5
National merchant fleets using open registry flags, 2005
Source: Table 16.4

Beneficial ownership of the shipowning, management and holding companies takes the form of bearer shares. This device is used to insulate the beneficial owners of the ships from authorities seeking to establish tax and other liabilities. Its use is not universal and depends on the relative merits of the domestic flag. If we take the largest shipowning nations in 2005, we find that most had some vessels registered under foreign flags (Figure 16.5). For example, Greece, the nation with the biggest merchant fleet, had 67% of the tonnage registered abroad, leaving 33% under the domestic flag, whilst Japanese and US owners, both exceptionally high-cost flags, had had 89% and 78% registered abroad respectively. Germany had over 80% of its fleet flagged out. Norway had 67% flagged out, but many Norwegian owners use the Norwegian International Ship Register (NIS). In 1987 the Norwegian government, concerned about the trend towards flagging out, set up the NIS to give Norwegian owners most of the benefits they would receive under an international flag. Several other countries followed suit and their 'international flags' are listed in Table 16.4, including the Danish International Registry, Singapore, Hong Kong, Marshall Islands (the United States), Isle of Man (UK), French Antarctic Territory, Netherlands Antilles, and Belgium. All of these were established with the specific intention of providing a national alternative for domestic shipowners on commercial terms comparable with those available from open registries. There is a stark contrast between the open registries, which have few nationals using their flag, and the national registers shown at the top of Table 16.4 where most of the registered tonnage belongs to domestic shipowners (though more is flagged out).

16.6 HOW MARITIME LAWS ARE MADE

The role of maritime laws

There are good practical reasons for developing an internationally accepted body of maritime law. It is common sense that if ships are to trade efficiently, the maritime states they trade between should have the same regulations on such matters as safety and the environment. Different rules about, for example, how hazardous cargoes should be stowed or the hull design mean that a ship complying with one country's rules could not trade with another, wasting economic resources. It would also make designing specialized ships more difficult because the designer needs to know precisely where it will trade. But an enforceable body of maritime law must also be seen as just by the various maritime interests involved in carrying world trade, and the institutions which enforce those laws must be accepted as satisfying the same principles of justice.[17] History proves that the shipping industry is too diverse to police autocratically, so the regulatory process must carry the shipping industry as well as the regulators with it.

Persuading maritime states to agree the conventions which are the framework of maritime law will never be easy. The issues dealt with are often controversial, emotional and involve commercial interests, especially those triggered by a particular maritime incident, so developing a workable solution calls for patience and pragmatism. In the nineteenth century, British law was widely used as the framework for national maritime law, providing a common base. More recently, governments of maritime nations have taken more formal steps to standardize maritime law. This is achieved by means of international 'conventions', which are jointly drawn up between maritime states, setting out agreed objectives for legislation on particular issues. Each country can, if it wishes, introduce the measures set out in these conventions into its own national law. All nations that do this (known as signatories to the convention) have the same law on the subject covered by the convention.

The topics covered by maritime law

Today's body of maritime law has evolved gradually. Taking Britain as an example, in the mid-nineteenth century there were few rules and regulations and virtually no construction or safety standards for merchant ships. Many were sent to sea badly built, ill found, grossly overloaded and often over-insured. These 'coffin' ships 'frequently took their unfortunate crews to the bottom of the oceans of the world'.[18] As a result of the agitation for reform from a Member of Parliament called Samuel Plimsoll, the

'Plimsoll Act' became law in 1876 and the Board of Trade was empowered, as the responsible government department, to survey ships, pass them fit for sea, and have them marked with a load line indicating the legal limit to which they could be submerged.

In due course other laws were introduced as they became necessary, and the UK built up a body of maritime law which was specifically geared to tackling the problems that arise when operating an extensive merchant shipping fleet. As other countries developed their own laws they often drew on British practical experience as a basis for drafting their legislation. The first step towards a system of internationally accepted regulations (conventions) came in 1889 when the US government invited 37 states to attend an international marine conference. On the agenda at this conference was a list of problem areas in the maritime industry where it was felt that the standardization of the international regulations would be an advantage, including:

- rules for the prevention of collisions;
- regulations to determine the seaworthiness of vessels;
- draught to which vessels should be restricted when loaded;
- uniform regulations regarding the designation and marking of vessels;
- saving life and properties from shipwrecks;
- necessary qualifications for officers and seamen;
- lanes for steamers and frequented routes;
- night signals for communicating information at sea;
- warnings of approaching storms;
- reporting, marking and removing dangerous wrecks and obstructions to navigation;
- notice of dangers to navigation;
- the uniform system of buoys and beacons;
- the establishment of a permanent international maritime commission.[19]

In fact the conference succeeded in dealing with only the first item on the agenda, but the full agenda neatly illustrates the areas that were thought to be important and that were addressed by subsequent international conferences and conventions. But the most important outcome was to set the pattern for the present system under which maritime laws are developed by consensus between maritime states.

Procedures for making maritime conventions

The conventions which form the building blocks of maritime law are not laws; they are internationally agreed 'templates' which maritime states use as a base for enacting their national maritime legislation. This does not guarantee that every country will have exactly the same maritime law since some modify it and others do not even sign up. But it helps to avoid badly thought-out and inconsistent maritime legislation and on important issues such as safety, most maritime countries now have the same maritime law. The procedure for making or changing a maritime convention involves four steps, which are broadly summarized in Box 16.2.

BOX 16.2 FOUR STEPS IN MAKING A MARITIME CONVENTION

Step 1: *Consultation and drafting convention*. The issue requiring legislation is identified by interested governments and a conference is called to discuss it, at which written submissions from various interested states and parties are discussed. If there is enough support the agency (e.g. IMO or ILO) drafts and circulates to member states a convention setting out in detail the proposed regulation or an amendment or annex to an existing regulation.

Step 2: *Adoption of draft convention*. The conference is reconvened to consider the draft regulation, and when agreement has been reached on the text, it is adopted by the conference. The discussion serves the dual purpose of showing whether or not there is a consensus that the regulation is required and, if so, refining the form it should take.

Step 3: *Signature*. The convention is 'opened for signature' by the governments; by signing, each state indicates its intention to ratify the convention by making it legally binding in its own country.

Step 4: *Ratification*. Each signatory country ratifies the convention by introducing it into its own domestic legislation so that it becomes part of the law of the country or dominions, and the convention comes into force when the required number of states (usually two-thirds) have completed this process – the precise conditions of entry into force form part of the original adoption of the convention. Once the necessary conditions have been met, the convention has the force of law in those countries that have ratified it. It does not apply in countries where it has not been ratified and any legal cases must be tried under the prevailing national law.

An example of this process is provided by UNCLOS 1982 discussed in section 16.4. This was instigated by UN General Assembly Resolution 2749, which noted the 'political and economic realities' of the preceding decade and 'the fact that many of the present State Members of the United Nations did not take part in the previous United Nations Conferences on the law of the sea'. It called for a new conference on the law of the sea. The conference was convened in 1973, and discussions continued until 30 April 1982 when the draft convention was adopted by vote (130 in favour, 4 against, with 17 abstentions). The convention was opened for signature in Montego Bay, Jamaica, on 10 December 1982. On the first day signatures from 117 states were appended. In addition, one ratification was deposited.

Considerable time and effort is required to organize conferences, draft conventions and resolve differences and misunderstandings. This work is carried out by the IMO and the ILO. Each deals with a particular range of maritime affairs, as detailed in the following sections.

16.7 THE INTERNATIONAL MARITIME ORGANIZATION

History and organization of IMO

The IMCO came into operation in 1958, with responsibility for adopting legislation on matters relating to maritime safety and pollution prevention on a world-wide basis and acting as the custodian of a number of related international conventions. Subsequently, in 1982, the IMCO changed its name to the International Maritime Organization (IMO). It has been responsible for developing a large number of conventions, ranging from the Convention for the Safety of Life at Sea (SOLAS) to conventions on tonnage measurement and oil pollution.

The IMO has 166 member states and two associate members. Its governing body is the Assembly, which meets every two years. In between Assembly sessions a Council, consisting of 32 member states elected by the Assembly, acts as the governing body. The technical and legal work is carried out by five committees:

- The *Maritime Safety Committee* deals with a whole range of issues concerning safety at sea. Sub-committees deal with a wide range of issues which cover safety of navigation; radio communications and life-saving; search and rescue; standards of training and watch keeping; ship design and equipment; life-saving appliances; fire protection; stability and load lines; fishing vessel safety; carriage of dangerous goods, solid cargoes and containers; carriage of bulk liquids and gases; and flag state implementation.
- The *Marine Environment Protection Committee* deals with all issues relating to pollution, particularly oil.
- The *Technical Co-operation Committee* handles the technical cooperation programme which is designed to help governments implement the technical measures adopted by the organization.
- The *Legal Committee* is responsible for considering any legal matters within the scope of the organization.
- The *Facilitation Committee* is concerned with easing the flow of international maritime traffic by reducing the formalities and simplifying the documentation required of ships when entering or leaving ports or terminals.

To support these committees the IMO has a secretariat of about 300 staff located in London.

In its early years the IMO developed a comprehensive body of maritime conventions, codes and recommendations which could be implemented by member governments. The 16 most important conventions are listed in Table 16.5 along with a brief summary of their scope and the percentage of world tonnage which has ratified each one. Its most important convention, SOLAS, is now accepted by countries whose combined merchant fleets represent 98.8% of the world total. Although the initial emphasis was on drafting conventions, since the 1980s the focus has changed. By then the IMO had developed a comprehensive series of measures covering safety, pollution

Table 16.5 Major IMO conventions relating to maritime safety and pollution prevention for merchant shipping

No.		Instrument	Entry into force Date	% fleet
1	SOLAS	International Convention for the Safety of Life at Sea, 1974* as amended, and its Protocols (1978, 1988)	25/05/80	99
2	SAR	International Convention on Maritime Search and Rescue, 1979	22/06/85	52
3	INTERVENTION	International Convention relating to Intervention on the High Seas in Cases of Oil Pollution Casualties, 1969, and its Protocol (1973)	06/05/75	73
4	MARPOL	International Convention for the Prevention of Pollution from Ships, 1973, and its Protocol (1978) Annex I (2 Oct. 1983); Annex II (6 April 1987) Annex III (1 July 1992); IV; Annex V (31 Dec. 1988)	02/10/83	98
5	CSC	International Convention for Safe Containers (1972)	06/07/77	62
6	OPRC	International Convention on Oil Pollution Preparedness, Response and Co-operation, 1990	13/05/95	65
7	LC	Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 as amended, and its Protocol (1996)	30/08/75	69
8	COLREG	Convention on the International Regulations for Preventing Collisions at Sea, 1972, as amended	15/07/77	98
9	FAL	Convention on Facilitation of International Maritime Traffic, 1965, as amended	05/03/67	69
10	STCW	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended	28/04/84	99
11	SUA	Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation, 1988, and its Protocol (1988)	01/03/92	92
12	LL	International Convention on Load Lines, 1966, as amended, and its Protocol (1988)	21/07/68	99
13	TONNAGE	International Convention on Tonnage Measurement of Ships, 1969	18/07/82	99
14	CSC	International Convention for Safe Containers, 1972 as amended	06/09/77	62
15	SALVAGE	International Convention on Salvage, 1989	14/07/96	38
16	ISM Code	Management Code for the Safe Operation of Ships and Pollution Prevention	01/12/09	

Status as at October 2006

Source: International Maritime Organization (London)

prevention, liability and compensation. It was recognized that legislation is of little value unless it is enforced so, in 1981, the Assembly adopted Resolution A500(XII) which redirected activity towards the effective implementation of the conventions. This resolution was reaffirmed for the 1990s and 'implementation' has become the major objective of IMO.[20] To promote the task the Maritime Safety Committee established a flag state implementation subcommittee.

The coverage of the conventions is briefly described in the following paragraphs.

The Safety of Life at Sea Convention (SOLAS)

The first conference organized by the IMO in 1960 adopted the International Convention for the Safety of Life at Sea 1960, which came into force in 1965 and covered a wide range of measures designed to improve the safety of shipping. This important convention has 12 chapters dealing with:

Chapter I – General Provisions
Chapter II:1 Construction: subdivision and stability, machinery and electrical installations
Chapter II:2 – Fire protection, fire detection and fire extinction
Chapter III – Life-saving appliances and arrangements
Chapter IV – Radio communications
Chapter V – Safety of navigation
Chapter VI – Carriage of cargoes
Chapter VII – Carriage of dangerous goods
Chapter VIII – Nuclear ships
Chapter IX – Management for the safe operation of ships
Chapter X – Safety measures for high-speed craft
Chapter XI:1 – Special measures to enhance maritime safety
Chapter XI:2 – Special measures to enhance maritime security
Chapter XII – Additional safety measures for bulk carriers.

SOLAS was updated in 1974 and now incorporates an amendment procedure whereby the convention can be updated to take account of changes in the shipping environment without the major procedure of calling a conference. The 1974 SOLAS Convention entered into force on 25 May 1980, and by October 2006 had been ratified by states representing 99% of the registered merchant fleet. A protocol relating to the Convention in 1978 entered into force on 1 May 1981.

With the growing recognition that loss of life at sea and environmental pollution are influenced by the way companies manage their fleets, in the 1990s the IMO took steps to regulate the standards of management in the shipping industry. At the SOLAS Conference held in May 1994, the International Safety Management (ISM) Code was formally incorporated into Chapter IX of the SOLAS regulations. The Code requires shipping companies to develop, implement and maintain a safety management system which includes:

- a company safety and environmental protection policy;
- written procedures to ensure safe operation of ships and protection of the environment;
- defined levels of authority and lines of communication shore and shipboard personnel;

- procedures for reporting accidents and non-conformities (i.e. errors which occur);
- procedures to prepare for and respond to emergency situations.

The ISM Code became mandatory for tankers, bulk carriers and passenger ships over 500 gross tons on 1 July 1998 and for most other ships trading internationally on 1 July 2002. Approximately 12,000 ships had to comply by the first deadline and the second phase of implementation brought in another 13,000 ships.[21] Previously safety regulations had tended to focus on the physical rather than the managerial aspects of the shipping business, so the ISM Code represented a new direction in maritime regulation. Inevitably it raised many new problems over the implementation and policing of such a complex system.

Collision avoidance at sea

Collisions are a common cause of accidents at sea. Measures to prevent these occurring were included in an Annex to the 1960 Safety of Life at Sea Convention, but in 1972 IMO adopted the Convention on the International Regulations for Preventing Collisions at Sea (COLREG). Included in this convention were regulations to introduce traffic separation schemes in congested parts of the world. These 'rules of the road' have substantially reduced the number of collisions between ships.[22]

Ships' load lines

The problem of dangerously overloading ships encountered in the nineteenth century was referred to earlier in the chapter. In 1930 an International Convention on Load Lines was adopted, setting out standard load lines for different types of vessels under different conditions. A new updated convention was adopted in 1966 and came into force in 1968.

Convention on Tonnage Measurement of Ships, 1969

Although this might seem an obscure subject for an international convention, it is one of great interest to shipowners because ports, canals and other organizations fix their charges on the basis of the ship's tonnage. This created an incentive to manipulate the design of ships in such a way as to reduce the ship's tonnage while still allowing it to carry the same amount of cargo. Occasionally this was at the expense of the vessel's stability and safety.

In 1969 the first International Convention on Tonnage Measurement was adopted. It proved to be so complex and so controversial that it required 25 states with not less than 65% of the world's gross merchant tonnage to ratify it before it became law. The required number of acceptances was not achieved until 1980 and the Convention came into force in 1982. The Convention established new procedures for computing the gross and net tonnages of a vessel and for the allocation of an IMO number to each ship, so that vessels could be uniquely identified.

Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), 1978

The aim of this Convention was to introduce internationally acceptable minimum standards for the training and certification of officers and crew members. It came into force in 1984. Amendments in 1995 complemented the ISM Code initiative by establishing verifiable standards, structured training and shipboard familiarization.

International Convention for the Prevention of Pollution from Ships

This convention, knowns as MARPOL, is the main international convention covering the prevention and minimization of pollution of the marine environment by ships from operational or accidental causes. It is a combination of two treaties adopted in 1973 and 1978 and updated by amendments through the years. It currently has six technical annexes which set out the detail of the regulations:

Annex I: Regulations for the Prevention of Pollution by Oil
Annex II: Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk, including a list of 250 regulated substances
Annex III: Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form (shipped in drums, etc.)
Annex IV: Prevention of Pollution by Sewage from Ships
Annex V: Prevention of Pollution by Garbage from Ships
Annex VI: Prevention of Air Pollution from Ships.

As the volume of oil shipped by sea increased in the 1950s and 1960s, regulations on marine pollution were needed. A conference to discuss the matter was held in London in 1952 and this resulted in the 1954 Convention for the Prevention of Pollution of the Sea by Oil (OILPOL). The main problem addressed by this convention was the uncontrolled discharge of oily ballast water. At the time tankers generally carried ballast water in their cargo tanks and discharged it outside the loading port. Because the ballast water contained small amounts of crude oil, it polluted the sea and beaches in these areas. To prevent this pollution OILPOL established ‘prohibited zones’ extending at least 50 miles from the nearest land. These regulations were progressively updated during the next 20 years.

During the 1960s, it became evident that there was a need for a wider-ranging convention on marine pollution, and in 1973 MAPROL was adopted. This convention applies to all forms of marine pollution except land-generated waste and deals with such matters as: the definition of violations; certificates and special rules on the inspection of ships; enforcement; and reports on incidents involving harmful substances. It required all tankers to have slop tanks and be fitted with oil discharge and monitoring equipment, whilst new oil tankers over 70,000 dwt must be fitted with segregated ballast tanks large enough to hold all ballast water for normal voyages – oil tanks could only be used for water ballast in extreme weather. At the next international conference on tanker safety and pollution prevention in 1978 additional measures were added in the form of a

Protocol to the 1973 Convention. The lower limit for tankers to be fitted with segregated ballast tanks was reduced from 70,000 dwt to 20,000 dwt and existing tankers were required to fit crude oil washing equipment.

Following a number of major oil pollution incidents, in particular the *Exxon Valdes*, in the early 1990s attention turned to tanker regulations to reduce the risk of oil spills resulting from tanker collisions and groundings. A new Annex I to MARPOL (73/78) was drafted, introducing two new regulations designed to reduce oil spills of this type. Regulation 13F required new tankers ordered after 6 July 1993 to have double hulls built to specified design parameters including a requirement that vessels over 30,000 dwt have a two-metre space between the cargo tanks and the hull. Regulation 13G created two age 'hurdles' for existing single hull tankers. As a defensive measure, at 25 years 30% of the side or the bottom area must be allocated to cargo-free tanks; and at 30 years all tankers must comply with Regulation 13F by fitting a double hull. The Annex was adopted on 1 July 1992.

Two major oil pollution incidents in European waters, the *Erika* in 1999 and the *Prestige* in 2002, resulted in the IMO Marine Environmental Protection Committee making further amendments to Annex 1 of MARPOL 73/78.

Firstly, the phasing-out of single hull tankers was accelerated. Under a revised Regulation 13G of Annex I of MARPOL, which entered into force in April 2005, the final phasing-out date for Category 1 tankers (pre-MARPOL tankers) was brought forward from 2005 to 2007. The final phasing-out date for Category 2 and 3 tankers (MARPOL tankers and smaller tankers) was brought forward from 2015 to 2010, though they were permitted to trade beyond the anniversary date of their delivery in 2010 at the discretion of port state administrations (double-bottomed and double-sided vessels were allowed to trade to 25 years or 2015). This was controversial because some single hull tankers would only be 15–20 years old in 2010. Secondly, it adopted the Conditional Assessment Scheme requiring a more detailed inspection of Category 2 (non-MARPOL compliant) and Category 3 (MARPOL compliant) single-hull tankers. Thirdly, a new Regulation 13H prohibited single hull tankers over 5,000 dwt from carrying heavy grades of oil from 5 April 2006 and smaller tankers of 600–5,000 dwt from 2008. These amendments entered into force on 5 April 2005. Note that in January 2007 the names of the regulations changed – Regulation 13F became Regulation 19, Regulation 13G became Regulation 20, and Regulation 13H became Regulation 21, all in MARPOL Annex 1.

In addition to oil pollution, in the late 1990s the IMO started to focus on the environmental impact of emissions from ships, including air emissions and ballast water. MARPOL Annex VI sets limits on sulphur oxide and nitrogen oxide emissions from ship exhausts and prohibits deliberate emissions of ozone-depleting substances. The annex includes a global cap of 4.5% on the sulphur content of fuel oil by weight and requires IMO to monitor the worldwide average sulphur content of fuel. In 2007 air emissions by ships were at the top of the IMO's agenda and were being studied by a working group on air pollution. Their agenda included nitrogen (NOx) emission limits for new and existing engines; sulphur and fuel oil quality; emission trading; and emissions of volatile organic compounds from tankers. The aim was to propose amendments to existing regulations for implementation in 2008.

16.8 THE INTERNATIONAL LABOUR ORGANIZATION

Since the 1920s the terms and conditions of employment for seafarers have been dealt with by the International Labour Organization (ILO), making it one of the oldest intergovernmental agencies now operating under the United Nations. Its principal concern is with the welfare of the 1.2 million people who work at sea. It was originally set up in 1919. During the twentieth century it developed 32 maritime labour conventions and 25 maritime labour recommendations dealing with working and living conditions at sea, manning, hours of work, pensions, vacation, sick pay and minimum wages.

By the end of the twentieth century the maritime industry and governments were finding this complex body of maritime conventions difficult to ratify and enforce, and it became apparent that the industry needed a more effective system if it was to eliminate substandard ships. In 2001 the international seafarers' and shipowners' organizations presented a joint resolution at ILO calling for 'global standards applicable to the entire industry'. As a result, the ILO was charged with developing 'an instrument to bring together into a consolidated text as much of the existing body of ILO instruments as it proves possible to achieve'. The comprehensive new Maritime Labour Convention for the maritime industry was adopted in 2006 and comes into force after being ratified by 30 ILO member states with a total share of at least 33% of world gross tonnage. By mid-2008 it had been ratified by Liberia, Bermuda and the Marshall Islands and was expected to be in force by August 2011 (this section focusses on the new regulations, but a list of the existing regulations can be found in *Maritime Economics*, second edition, Table 12.6 or on the ILO website).

The 2006 Consolidated Convention aimed to maintain existing maritime labour standards, while giving countries more discretion to establish national laws adapted to local circumstances. It applies to all publicly or privately owned commercial ships, but excludes traditional vessels (e.g. dhows and junks), warships, naval auxiliaries and ships under 200 gross tons in domestic trades. Fishing boats are covered in a separate convention.[23] A 'seafarer' is defined as 'any person who is employed, engaged or works in any capacity on board a ship that is covered by the Convention'. Much of the new convention is devoted to a more structured version of the existing 68 ILO maritime conventions and recommendations, and gives countries flexibility to harmonize the new maritime legislation with national labour laws.

The convention has five 'titles', summarized in Table 16.6, setting minimum standards for seafarers, including conditions of employment, hours of work and rest, accommodation, recreational facilities, food and catering, health protection, medical care, welfare and social security protection. It sets legally binding standards but also incorporates guidelines, a significant departure from traditional ILO conventions. It also introduces procedures to simplify amending the regulations, allowing amendments to come into effect within three to four years from the proposal date.

A major innovation is Title 5, which deals with compliance and enforcement of the regulations. Any ships over 500 gross tons trading internationally must carry a maritime labour certificate and a declaration of maritime labour compliance, setting out the shipowner's plans for ensuring that national regulations are complied with. The ship's

Table 16.6 ILO Consolidated Maritime Labour Regulations, 2006*

Title 1. Minimum requirements for seafarers to work on a ship
- Minimum age
- Medical certificate
- Training and qualifications
- Recruitment and placement

Title 2. Conditions of employment: seafarers' employment
- Wages
- Hours of work and hours of rest; entitlement of leave
- Repatriation
- Seafarer compensation for the ship's loss; manning levels
- Career and skill development and opportunities for seafarers' employment

Title 3. Accommodation, recreational facilities, food and catering
- Accommodation and recreational facilities
- Food and catering

Title 4: Health protection
- Medical care, welfare and social security protection
- Medical care on board ship and ashore
- Shipowner's liability
- Health and safety protection and accident prevention
- Access to shore-based welfare facilities
- Social security

Title 5. Compliance and enforcement

Flag state responsibilities
- General principles
- Authorization of recognized organizations
- Maritime labour certificate and declaration of maritime labour compliance
- Inspection and enforcement; on-board complaint procedures; marine casualties

Port state responsibilities
- Inspections in port
- Onshore seafarer complaint-handling procedures
- Labour-supplying responsibilities

Note: This regulation was adopted in 2006, but is not expected to come into force until 2011 when the necessary ratifications have been achieved

master is responsible for carrying out these plans and keeping records as evidence of compliance. The flag state is responsible for reviewing the plans and their implementation. To encourage compliance by operators and owners, the Convention sets out mechanisms dealing with on-board and onshore complaint procedures; port state inspection; and the flag state's jurisdiction and control over vessels on its register.

16.9 THE REGULATORY ROLE OF THE COASTAL AND PORT STATES

The rights of coastal states over foreign ships

Now we come to the 'coastal states' and the part they play in regulating merchant shipping. UNCLOS 1982 allows coastal states to legislate for the 'good conduct' of ships in their territorial seas, but otherwise not to interfere with them. The Convention lists eight specific areas in which legislation is permitted – the main ones are safety of navigation; protection of navigational aids; preservation of the environment and prevention, reduction and control of pollution; and the prevention of infringement of customs and sanitary laws, etc. However Article 21 of UNCLOS 1982 specifically states that the legislation of coastal states 'shall not apply to the design, construction, manning or equipment of foreign ships, unless they are giving effect to generally accepted international rules or standards'. This is intended to prevent a 'nightmare scenario' in which ships are subject to different construction and crewing standards in different territorial waters. However, it also endorses the coastal state's right to enforce international regulations in its territorial waters, and this gave rise to the port state control movement.

The port state control movement was a response to the growing number of ships registered under flags of convenience, and the recognition that some of these flags were not, for whatever reason, enforcing international maritime regulations. This made the traditional supervisory role of the flag states less reliable than previously and in response the port states started to play an increasingly important part in the regulatory system.

The port state control movement

The port state control movement started in 1978 when eight European states located around the North Sea informally agreed to inspect foreign ships visiting their ports and share information about deficiencies. In 1982 the arrangement was formalized with the signing of the Paris Memorandum of Understanding (MOU) in which 14 European states agreed to work together to ensure that ships visiting their ports comply with international conventions on safety and pollution.

Signatories to the Paris MOU undertake to maintain an effective system of port state control by ensuring that foreign merchant ships calling at their ports comply with the standards laid down in the 'relevant' maritime conventions and their protocols which they define as the Load Lines Convention 1966; SOLAS 1974; MARPOL 1973/78; STCW 1978; COLREG 1972; the International Convention on the Tonnage Measurement of Ships 1969; and the ILO Convention No. 147 Merchant Shipping (Minimum Standards), 1976. Details of the first five conventions can be found in Table 16.5, whilst ILO Convention 147 is concerned with the crew safety, employment and welfare issues dealt with under Titles 1–4 of the new consolidated regulation in Table 16.6. Each participating state undertakes to inspect 25% of the foreign merchant ships entering its ports, basing the number on the average number of port calls during the previous three years. They also agree to work together, to exchange information with other authorities and to notify pilot services and port authorities immediately if they find deficiencies which may prejudice the safety of the ship or pose a threat of harm to the marine environment.

By 2007 the number of signatories to the Paris MOU had increased to 27, stretching from Russia to Canada, and the MOU has been updated regularly. In the meantime additional port state control MOUs have been established in the following areas:

- the Mediterranean MOU (10 participating countries);
- the Tokyo MOU (18 participants);

- the Caribbean MOU (11 participants);
- the Latin American agreement (12 participants);
- the Indian Ocean MOU (11 participants).

The United States controls its own programme.

Port state control inspections

In 1995 the IMO adopted a resolution providing basic guidance on port state control inspections to identify deficiencies in ship, its equipment or its crew should be conducted. The aim was to ensure that the inspections are consistently applied across the world from port to port. These procedures are not mandatory, but many countries have followed them.[24] The range of inspections is now very broad with over 50,000 ships a year being inspected, a significant proportion of the international fleet. For example, the Paris MOU undertakes about 20,000 inspections a year, identifying an average of 3.5 deficiencies per inspection. Ships with serious shortcomings are detained and a small number are banned. Lists of detained ships are published on a website. The Tokyo MOU undertakes a similar number of inspections.

The ships to be inspected are selected from lists of vessels arriving in the port, often using statistical techniques to identify higher-risk vessels. For example, the Paris MOU uses a target factor calculator which takes into account such factors as flag, age and ship type, weighting each characteristic on the basis of previous association with defects.

The inspection has three parts: a general external inspection of the ship on boarding; a check of certificates; and a more thorough 'walk around' to inspect the condition of exposed decks, cargo-handling gear, navigation and radio equipment, life-saving appliances; fire-fighting arrangements; machinery spaces; pollution prevention equipment; and living and working conditions. Under each heading the inspector works through a detailed checklist and notes any deficiencies. A 'deficiency' exists when some aspect of the ship does not comply with the requirements of a convention. If the inspector finds significant deficiencies, a more detailed inspection may be required, and if the ship is considered too unsafe to be allowed to proceed to sea, a detention order will be made. For example, a detention could be ordered under the Load Lines Convention if some structural shortcoming is apparent such as serious pitting in the deck plating; or under MARPOL if the remaining capacity in the slop tank is insufficient for the intended voyage; or under SOLAS if the engine room is not clean, with oily water in the bilges and pipe work installation contaminated by oil.

The US Oil Pollution Act 1990

Pollution is an area in which coastal states are very active. One of the most forthright initiatives in recent years has been the US Oil Pollution Act 1990. This legislation was formulated in response to the public concern following the grounding of the *Exxon Valdez* in the Prince William Sound, Alaska, in March 1989.

The Act applies to oil spills in US inland waters; up to 3 miles offshore; and the 'exclusive economic zone' up to 200 miles to sea from the shoreline. The LOOP

Terminal is not included. It lays down wide-ranging regulations for the handling of oil spills. The 'responsible party', defined as the owner or operator of the tanker, is required to pay for the clean-up, up to a liability limit of $10 million or $1200 per gross ton, whichever is the greater. However, if there has been gross negligence these limits do not apply.

In addition to making shipowners responsible for the cost of pollution incidents, the Act laid down specific requirements for ships operating in US waters. Each ship must carry a certificate of financial responsibility, demonstrating that it has sufficient financial means to pay a claim. There was also a requirement that vessels ordered after 30 June 1990 or delivered after 1 January 1994 should have double hulls and a schedule for phasing out single-hull tankers by 2010. The coastguard is required to evaluate the manning standards of foreign vessels and to ensure that these are at least equivalent to US law. All tankers are required to carry a contingency plan for responding to an oil spill.

This legislation, particularly the requirement for double-hulled tankers, caused great controversy. However, the effect was to focus the attention of the shipping community far more rigorously on the risks associated with oil pollution. In particular, for the first time, shipowners were faced with the possibility of unlimited liability for the cost of any oil spill they are involved in. The high cost of cleaning up after the *Exxon Valdez* spill put a financial dimension on the possible scale of this problem.

16.10 THE REGULATION OF COMPETITION IN SHIPPING

The final regulatory issue we will mention in this chapter is competition. Although the shipping industry is very competitive, parts of the business have a history of collusion, notably the liner business (Chapter 13) and some of the specialist shipping segments (Chapter 12). Even bulk shipping has various pools and cartels. Most countries have some legislation dealing with these issues, but the competition policy of the European Union and the anti-trust legislation in the United States are the two areas we will concentrate on in this section.

Regulatory control of liner cartels, 1869–1983

When liner conferences were set up in the 1870s (see Section 13.10) they immediately came under attack. In 1879 the *China Mail*, a Hong Kong newspaper, set the tone for a debate which lasted a century by describing the China Conference as 'one of the most ill-advised and arbitrary attempts at monopoly which has been seen for many a year'.[25] The first legal challenge came in 1887 when the Mogul Line sought an injunction to stop the Far East Freight Conference, which had seven members, from refusing rebates to shippers using Mogul vessels. The background was that when in 1885 Mogul Line had applied for admission to the conference, it was refused because it did not bear a full share of running regular services during off-peak periods. This led to a rate war and the Conference's Shanghai agents issued a circular warning that shippers who used Mogul ships would forfeit their rebates. Mogul applied for an injunction to stop the Conference refusing the rebates, but it was refused, confirming the legality of the Conference. Some years later, however, a British Royal Commission on Shipping Rings was set up to investigate the rebate system. Its report in 1909 again confirmed that the commercial relationship between shippers and conferences was justified and that the possible abuses of the deferred rebate system should be tolerated in the interests of achieving a strong liner system.[26]

The conference system reached its peak during the 1950s. The prominence which the liner conferences had achieved by this time is demonstrated by the UNCTAD Code of Conduct for Liner Conferences which was initiated at the first UNCTAD Conference in Geneva in 1964 (see Section 12.9). Many of the developing countries which had gained independence during the previous decade had balance of payments problems and were searching for solutions. Sea freight played an important part in the price of the primary exports on which most of them relied. In addition, the freight itself was a drain on their scarce foreign currency reserves. Setting up a national shipping line seemed the obvious solution to both problems. However, the liner conferences were not generally sympathetic and the emerging nations lacked the experience in the liner business to press their case. This led to political action by the 'Group of 77', a pressure group of developing countries within UNCTAD, the result of which was the UNCTAD Code which aimed to give each country the right to participate in liner conferences servicing their trade.

The UNCTAD Code was developed in the 1960s and 1970s and covered four major areas of liner shipping. It provided the right to automatic conference membership for the national shipping lines of the countries served by the conference. A cargo-sharing formula gave national shipping lines equal rights to participate in the volume of traffic generated by their mutual trade, with third parties carrying the residual. For example, under a 40:40:20 cargo-sharing agreement the bilateral traders reserved 40% of the cargo for their national vessels and 'cross traders' carried the remaining 20% of the cargo. Finally, shipping conferences were required to consult shippers over rates, and national lines had the right of consent on all major conference decisions affecting the countries serviced.

The Code took almost 20 years to develop and by the time it came into force in 1983 the liner business had changed out of all recognition. It has never been ratified by the USA and implementing a convention of this complexity, which involved agreeing and measuring trade shares, was too difficult. Despite this, the Code achieved two things. First, it gave rights to the emerging Third World shipping industry at a time when this recognition was needed. Second, it was the first international effort to regulate the extensive, and overly weighty, system of closed conferences. By opening the conferences to new participants, it weakened the tight control which had developed and set the scene for a new regulatory attitude towards the conference system.

US regulation of liner shipping, 1983–2006

From the 1970s onwards the USA became determined to open the newly containerized liner services to market forces and to curb, but not entirely prohibit, the activities of conferences. Under US anti-trust laws, agreements which restrict competition are illegal, but the US Merchant Shipping Act 1984 excluded liner conferences from US anti-trust legislation and allowed inter-modal rate making. However, the legislation placed severe limitations on conference activities, making closed conferences and loyalty rebates illegal. In addition, tariffs fixed by conferences operating into the USA were required to be filed with the Federal Maritime Commission FMC along with all service contracts, and made public. This changed the nature of the conferences operating on the Atlantic and the Pacific, producing the various alliances discussed in Section 13.10. The Ocean Shipping Reform Act which took effect on 1 May, 1999 was another step towards making the liner shipping industry more market-driven. The new law retained the antitrust exemption for the ocean liner industry and still required service contracts to be filed, but allowed their terms to remain confidential. A subsequent study found that as a result most shippers negotiated one-on-one confidential service contracts with individual carriers, instead of negotiating with rate-setting conferences or groups of carriers. In the two years following the regulation the number of these service contracts and amendments increased by 200%.[27]

European Union regulation of shipping competition

European regulations governing competition are set out in Articles 81 and 82 of the Treaty of Rome (1958). Article 81 makes it illegal for companies to cooperate to 'prevent, restrict or distort' competition by fixing prices, manipulating supply or discriminating between parties. Article 82 makes it illegal for a company to use its dominant position to undermine free competition by price fixing, manipulating supply or other abuses. In 1962, Regulation 17 gave the EU powers to enforce these articles but specifically excluded the transport industries, and it was not until 1986 that the EU Regulation 4056/86 set out 'detailed rules for the application of Articles 81 and 82 of the Treaty to maritime transport'. This regulation excluded tramp shipping because prices were 'freely negotiated on a case by case basis in accordance with supply and demand conditions'. Liner shipping was included, but, like most regulators before them, the EU accepted that conferences were in the interest of consumers, providing stability. As a result, the liner companies were given a 'block exemption' from Article 81, permitting them to fix rates, regulate capacity and collude in ways which would otherwise be illegal under the Treaty of Rome (although some shipping companies were fined for fixing prices outside liner conferences).

In 2004 the EU launched an initiative to review this special treatment received by the tramp shipping and liner industries. After consultation with the liner and tramp shipping industries, the EU concluded that:

> no credible consideration has been put forward in response to the consultation to justify why these services would need to benefit from different enforcement rules than those which the council has decided should apply to all sectors. On that basis the intention would be to bring maritime cabotage and tramp vessels services within the scope of the general enforcement rules.[28]

In September 2006, Regulation 4056/86 was repealed. The tramp shipping exemption lapsed on 18 October 2006, facing companies with the possibility that Articles 81 and 82 of the Treaty of Rome might be enforced against shipping pools, of which a number were operating in the tanker, dry bulk and specialist markets.

For the rapidly growing container industry the Commission's discussion paper published in 2005 argued that

> even if conferences were to provide for pro competitive effects in terms of e.g. price stability, reduced uncertainty about trade conditions, possible more accurate forecasts of supply and demand, reliable and adequate services, this would appear in itself not to be sufficient to conclude that the second condition of Article 81(3) on the treaty is fulfilled, since it has not been established that the net effect on consumers (transport users and end consumers) is at least neutral.[29]

After a lengthy investigation they ruled that price agreement was no longer necessary and that the industry and consumers would benefit from free competition. The repeal of Regulation 4056/86 removed the block exemption with effect from 18 October 2008. From this date all shipping companies operating on routes into and out of Europe cannot operate in conferences that fix price and capacity. This will apply equally to EU and non-EU based carriers. Liner shipping conferences outside of Europe are not affected but are subject to their own anti-trust laws.

EU regulation of tramp shipping pools

For tramp shipping the loss of the exemption from Articles 81 and 82 raised questions about the legality of the pools operated in the tanker and bulk carrier markets. Tramp shipping pools bring together similar vessels under different ownership. They are placed under a single pool manager, though the ships generally continue to be operated and crewed by the owners. The nature of pool agreements in tramp shipping varies widely, but the main principles were discussed in Section 2.9.

Article 81(1) of the Rome Treaty explicitly prohibits price fixing and sharing markets between competitors, unless the pool produces genuine benefits as defined in Article 81(3). In effect, pool members must be able to demonstrate: that their pool produces efficiency gains; that these benefits are passed on to transport users, for example as lower transport costs or new logistic solutions; that there is no less restrictive way of obtaining these efficiencies; and that the pool does not have an unreasonably large market share which inhibits free market competition.

Generally the EU took the view that tramp pool agreements that have very low market shares are unlikely to raise competition problems, provided the agreement does not contain provisions regarding joint price fixing and/or joint marketing or if the participants cannot be considered actual or potential competitors.[30] In September 2007 the EU published draft guidelines setting out the principles that the EU will follow when defining markets and assessing cooperation agreements in the maritime transport services sectors affected by the repeal of Regulation 4056/86.[31]

16.11 SUMMARY

In this chapter we have moved outside the conventional framework of market economics to examine the regulatory system that plays such a vital part in the economics of the shipping industry. We started by identifying three regulatory regimes which operate in the shipping industry: the classification societies, the flag states and the coastal states.

The classification societies are the shipping industry's internal regulatory system. The mainstay of their authority is the classification certificate which is issued when the ship is built and updated by means of regular surveys throughout the life of the ship. Without a class certificate a ship cannot obtain insurance and has little commercial value. But they are also the industry's largest technical resource, and in their role as recognized organizations they play an increasingly important part in the regulation of safety and security.

Flag states make the laws which govern the commercial and civil activities of the merchant ship. Because different countries have different laws, the flag of registration makes a difference. Registers can be subdivided into national registers, which treat shipping companies in the same way as other national industries; open registers (flags of convenience) such as Liberia and Panama, which are set up with the specific objective of earning revenue by offering commercially favourable terms of registration as a service to shipowners; and international registers set up by maritime states to offer their domestic shipowners comparable commercial terms to the open registers. With the increasing globalization of the maritime industry, open registers have become more prominent and half the world merchant fleet is now registered under a foreign flag, which in practice usually means a flag of convenience.

Although each nation makes its own maritime laws, on matters such as safe ship design, collision avoidance, load lines, pollution of the sea and air, tonnage measurement and certificates of competency it would be hopelessly impractical if each country had different laws. Developing a framework of international law which avoids this problem is achieved by means of international conventions. Maritime nations meet to discuss the draft convention, which is finally agreed. Each country then ratifies it and in doing so undertakes to incorporate the terms of the convention into its own national legislation. International conventions drawn up since the mid-1960s cover a wide range of different subjects including the safety of life at sea, load lines, crew training, tonnage measurement, terms and conditions of employment of crew, oil pollution and the conduct of liner conferences. The organizations active in developing these conventions are the International Maritime Organization and International Labour Organization.

Although major conventions such as SOLAS (1974) are ratified by 99% of the eligible countries, others are controversial and some countries choose not to ratify them, or allocate sufficient administrative resources to enforcing them, leaving 'loopholes' in the system.

Shipowners registered in these countries are, in principle, able to operate outside the convention, but they are still subject to a third form of regulation, by the coastal state in whose waters their ship is trading. The Law of the Sea permits coastal states to pass legislation concerning the 'good conduct' of ships in its territorial waters. One important area of legislation is pollution control, notably the US Oil Pollution Act 1990. In addition, since the 1970s there has been a trend towards 'port state control'. The movement started with the Paris MOU under which a group of European states agreed to work together to ensure that ships visiting their ports complied with international conventions on safety and pollution. There are now similar MOUs covering most parts of the world and over 50,000 ships a year are inspected.

Finally, the competitive practices of the shipping industry are also subject to regulation, and the United States and Europe are particularly active in this area. The principal area of concern is the liner conferences which fix prices and capacity levels. During the cargo liner era this was accepted as necessary to provide stable services and pricing, but with the advance of containerization the regulatory authorities are less willing to exempt the liner and tramp shipping industry from anti-trust regulations, and in 2006, for example, the EU made liner conferences and tramp shipping pools subject to its competition laws.

Finally, *Step 6* is the crucial task of presenting the results. Usually a report is prepared with an executive summary for busy decision-makers who do not want to read the whole thing. That does not mean they do not want the detail. The ability to have an independent expert check the methodology is important and a report setting out the detailed research gives credibility to the conclusions. The summary may include a risk analysis. For example, suppose some of the key influences on the market develop unfavourably, what would happen and how would the company be able to react? Suppose, the company buys products tankers but one or more of the growth markets for products imports fails to develop. Would it matter? Is there any action that can be taken now to guard against such an event? This is not easy to carry out but it is a valuable addition to the 'spot prediction' technique.[20] In addition to the written report, a verbal presentation with slides is often provided.

17.6 FREIGHT RATE FORECASTING

Probably the most common requirement is for a forecast of freight rates. Freight rate forecasts are extensively used by banks, shipping companies, civil servants and consultants commissioned to produce commercial studies. There are several market forecasting models commercially available which allow users to enter their own assumptions. Although these models vary enormously in detail, most use a methodology based on forecasting the supply and demand for merchant ships and using the supply–demand balance to draw conclusions about developments in freight rates. This provides a consistent framework for preparing a market forecast of the shipping market and can be developed in appropriate detail to produce projections that are significant for particular purposes. Although forecasts of this type are produced in precise detail they are often wildly inaccurate. Their detail is the result of the way they are produced and not an indication of their accuracy.

The classic maritime supply–demand model

For some purposes a computer model is more useful than a report. All economic forecasts are based on some sort of model, which provides a simplified image of the world we are seeking to forecast, but in this case we are aiming to develop a working model that will successfully reproduce the relationship between the key variables in the segment of the shipping market under investigation, often including prices and freight rates.

The shipping supply–demand model was discussed at length in Chapter 4. We reviewed the key variables and the relationships between them and this model is summarized in Figure 17.3. The main variables 'V' are shown by rectangular boxes and the relationships 'R' which form the links in the model by arrows. The principal demand variables are the world economy, the commodity trades and ship demand, whilst the main supply variables are scrapping, orders, and the merchant fleet. In addition to 'normal' values of these variables there may be wild cards, which are sudden and unexpected changes in

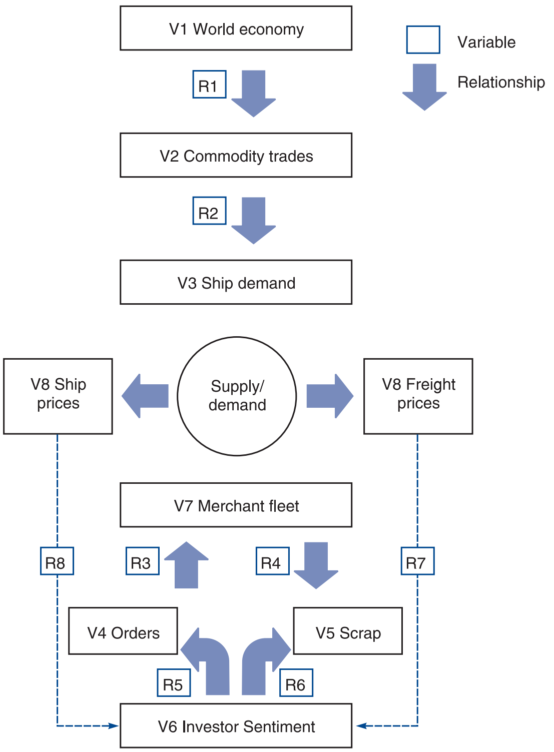

Figure 17.3
Macroeconomic shipping model

any of these key variables (see Section 17.2). The important point about wild cards is that although their timing is unpredictable, their occurrence is not. For example, it is impossible to predict exactly when political disruption will occur in the Middle East, but it has happened seven times over the last 50 years (1952, 1956, 1967, 1973, 1979, 1980 and 2001), so it is likely to happen again at some point. A parallel example is designing a ship to deal with 'super-waves'. The designer does not know when a ship will be hit by one, but if it is likely to happen eventually, the design must be able to cope with it. So timing is not the only issue.

Relationships link the variables together. The key relationships in the macroeconomic model in Figure 17.3, shown by the arrows, are the links between the world economy and commodity trade; commodity trade and ship demand; shipowner investment, orders and scrapping. Finally there is the crucial relationship between the supply–demand balance, freight rates, prices and investor sentiment. This feeds back into the supply side of the model through the relationship between freight rates, prices and investment sentiment shown by the dotted lines. This is one of the most difficult parts of the model. Obviously there are many ways the model can be developed in greater detail. For example, the world economy can be divided into regions or countries, commodity trades can be split into many commodities, each dealing with the industrial sector concerned in detail, and ship demand can be split by cargo type, for example containers, bulk and specialized cargoes. On the supply side, the fleet can be split by ship type and size, and such issues as fleet productivity can be developed in detail. Taken to extremes, the result could be a model with many thousands of equations, though as we will see in what follows, detail does not necessarily make models more accurate.

Five stages in developing a forecasting model

In principle, supply–demand modelling can be applied to any segment of the shipping industry, but success depends on quantifying the variables at a significant level of desegregation, and in practice this is easier for some segments than others. Shipping segments such as crude oil tankers and bulk carriers which operate in well-documented markets are the easiest to model, whilst specialist vessels such as container-ships, vehicle carriers and chemical tankers are more difficult to model as a whole due to the lack of published information and the more complex relationships involved. Having said this, it is often possible to model parts of these complex sectors. The five stages in preparing a model are summarized below:

1. *Design model*. Draw a flow chart of how the model works. This helps to think about the structure and ensures that all possible influences on the dependent variables are considered. What variables are important? Does the model make economic sense?
2. *Define relationships and collect data*. At this stage the structural form of the model is established as a set of related equations. This stage is shown in parallel with data collection in Figure 17.3 because the form of the model will be influenced by data availability – there is no point in specifying equations which cannot be fitted because no statistical information is available. Once the structural equations have been established it is usual to recast the model into reduced form, by algebraic manipulation, to derive a model in which each endogenous variable has a separate equation in terms of exogenous variables. This can help to avoid statistical problems.[21]
3. *Estimate equations and test parameters*. This stage is usually carried out using a computer package which estimates the parameters and automatically provides a range of test statistics. In addition to the correlation coefficient and the 't'-test, various statistics are used to test for particular econometric problems – for example, the Durbin-Watson statistic to identify autocorrelation. The results of these tests will determine whether the equations are useful.
4. *Validate model*. In addition to statistical tests, it is good practice to test the model by carrying out a simulation analysis, ideally using data which was not used to estimate the equations. Following this stage, the model structure is finalized.
5. *Prepare forecast*. To make a forecast of the dependent variables it is necessary to forecast values for the exogenous variables. For example, this might include predictions of industrial production, commodity trade, and ship investment. The study of the appropriate values for the exogenous variables is therefore a vital stage.

Example of a forecasting model

The practical procedure for producing a forecast using the shipping market model SMM described in Appendix A involves working through nine separate stages.

STAGE 1: ECONOMIC ASSUMPTIONS

The first step is to decide what period the forecast is to cover and to discuss what assumptions should be made about the way in which the world economy will develop during this period. Specific requirements of the forecasting model are an assumption about the rate of growth of gross domestic product (GDP) and industrial production in the main economic regions. Deciding which regions to include and in how much detail is a key task. Oil prices may also play an important part, as will views on such issues as political instability, passage through the Suez Canal, etc.

STAGE 2: THE SEABORNE TRADE FORECAST

The next step is to forecast seaborne trade during the period under review. The simplest method is to use a regression model of the following type:

$$ST_t = f(GDP_t) \tag{17.1}$$

where *ST* is seaborne trade and *GDP* is gross domestic product, both in year *t*.

Suppose, for example, we assume that there is a linear relationship between seaborne trade and gross domestic product. The linear equation which represents this model is:

$$ST_t = a + bGDP_t \tag{17.2}$$

This model suggests that the two variables, seaborne trade and gross domestic product move together in a linear way. For example, if industrial production increases by \$1 billion, seaborne trade increases by 100,000 tons; whilst if industrial production increases by \$2 billion, seaborne trade increases by 200,000 tons. The precise nature of the relationship is measured by the two parameters *a* and *b*. Using past data and the linear regression technique we can estimate the value of these parameters. As an example, Figure 17.4(a) shows this model fitted to data for the period 1982–1995 using a linear regression:

$$ST_t = -26.289 + 30.9.\ GDP_t \tag{17.3}$$

What does this model tell us? The estimate for *b* shows us that during the period 1982–1995, for each 1 point increase in the GDP index, seaborne trade increased by 30.9 million tonnes. The 'fit' of the equation is excellent, with a correlation coefficient of 0.99, which means that changes in industrial production 'explain' 99% of the changes in sea trade. If we accept the model, a forecast of seaborne trade can then be made by substituting an assumed value of GDP and calculating the associated level of seaborne trade.

How reliable is this model? One way to test it is by carrying out a simulation analysis. We feed the actual GDP index for the years 1995–2005 into the equation and compare the predicted level of sea trade with the actual trade volume. The comparison of projected with actual trade growth in Figure 17.4(a) shows that the model worked very well. Anyone who used it in 1995 to forecast trade volume would have been correct to within 0.1%. There were a few small divergences along the way, as the dotted line showing the predicted trade shows – the prediction was low in 1997 and high in 2002. But overall the model works very well, and provided the correct assumptions were made about GDP the result would have been very accurate.

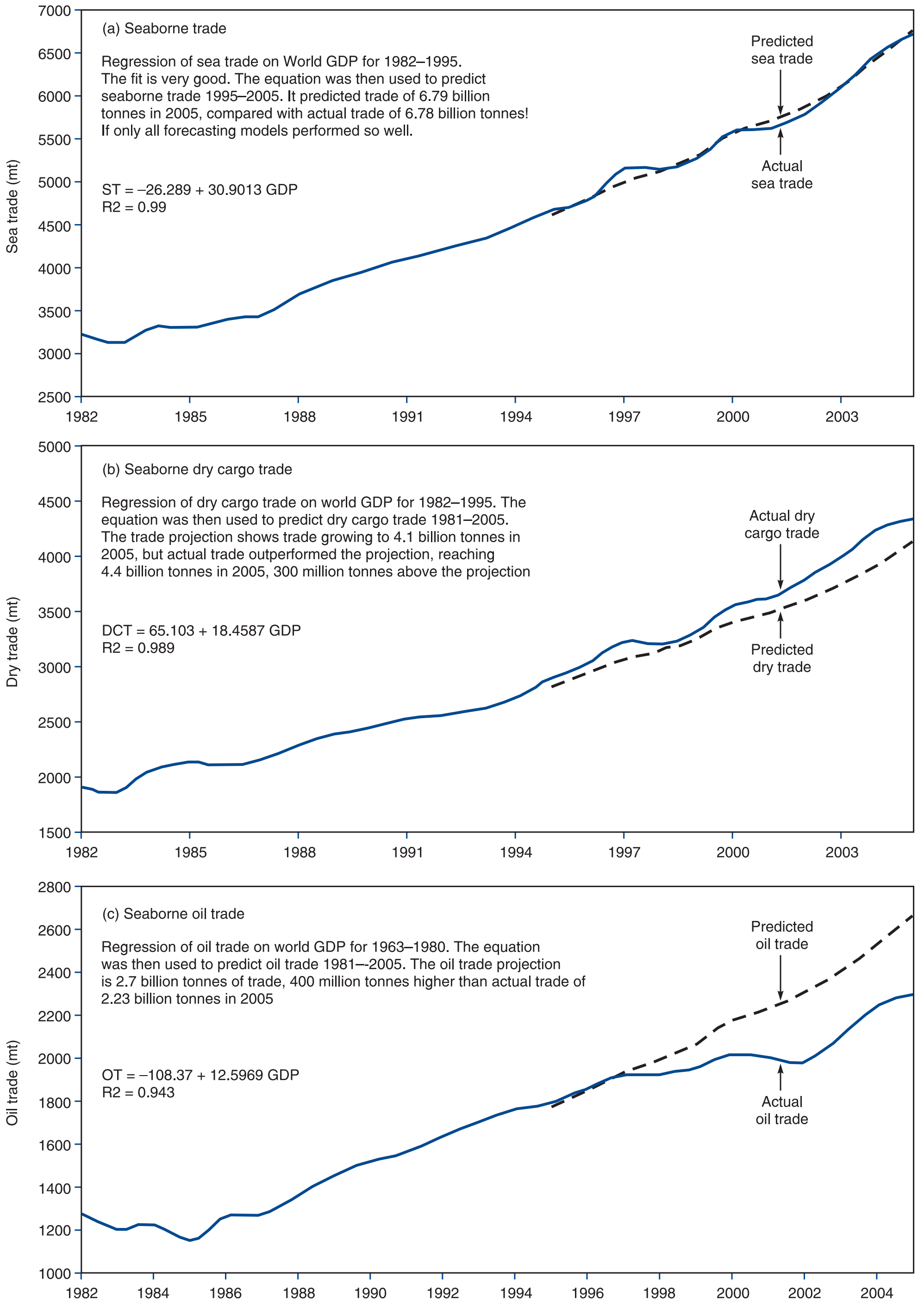

Figure 17.4
Seaborne trade models comparing projections with actual trade growth
Source: World Bank and Fearnleys Annual Review, various editions

The problem with simple models of this type is that we have no way of checking in advance whether the relationship will be valid in future. A more thorough approach, which helps to check out the model, would be to subdivide the trade into separate commodities (crude oil, oil products, iron ore, coal, grain, etc.), and to develop a more detailed model of the type discussed in Section 10.5, for each commodity trade. For example, we might start by splitting seaborne trade into dry cargo and oil and estimating the regression model separately for each commodity, again using data for the period 1982–1995.

The result of this analysis for dry cargo is shown in Figure 17.4(b). For the years 1982–95 we estimate the relationship between the tonnage of dry cargo trade each year and world GDP. Once again the fit is excellent, with a regression coefficient of 0.989. However, when we use the equation to project seaborne trade through to 2005 using actual GDP the projection proves to be less accurate. The model predicts seaborne dry cargo trade of 4.1 billion tonnes in 2005, compared with actual trade of 4.4 billion tonnes. Admittedly a 7% error over 10 years is a better result than most economists would dare to hope for, but in real life it is unlikely that the GDP assumptions would be precisely correct and any errors here would be reflected in the projection.

When we extend the exercise to the oil trade the result is even less satisfactory, as can be seen in Figure 17.4(c). Although the model fits quite well during the base period 1982–95, with an R^2 of 0.94, the projection for 2005 is 400 million tonnes too high, an error of 20%. Between 1995 and 2000 the trade hardly grew, then it picked up between 2001 and 2005. There is really no choice but to dig deeper, perhaps by developing a regional oil trade model. During the first half of the projection period Japan and Europe hardly increased imports and a properly specified model of the type discussed in Section 10.5 would incorporate regional analysis to pick up these trends, thus providing a more informed basis for making forecasts

Some of the more sophisticated market forecasting models subdivide trade into many commodities and forecast each commodity trade using a set of equations. In theory more information should lead to a more reliable result. The danger is that it is very time-consuming and can easily generate so much detail that the underlying rationale of the forecast is lost. The key issue is to identify a significant level of detail to work at. Finally, we can note that we got a bit lucky with the total sea trade projection in Figure 17.4(a). The amazingly accurate projection in Figure 17.4(a) was the result of a dry cargo forecast which was 300 million tonnes too low and an oil trade forecast which was 400 million tonnes too high.

STAGE 3: AVERAGE HAUL FORECAST

There are two alternative ways of forecasting average haul. The simple way is to project historic trends in the average haul for each commodity, attempting to identify the factors that might cause the average haul to increase or decrease. In the case of the crude oil trade, for example, an increase in the market share of Middle East oil producers would increase the average haul and vice versa.

Another approach is to analyse the trade matrix for each commodity, and from this to calculate the average haul. This is technically possible and probably worthwhile for some of the larger commodities such as oil, iron ore, coal and grain. For others it is extremely difficult because the information about the trade matrix is difficult to obtain, and the time taken to produce a matrix forecast is disproportionate to the small amount of trade involved. A compromise is to study the average haul of the major commodities in some detail, whilst extrapolating past trends for the remainder of the trade.

STAGE 4: THE SHIP DEMAND FORECAST

As we saw in Chapter 4, ship demand should be measured in ton miles of cargo to be transported. The total requirement for transport is calculated by multiplying seaborne trade by the average haul. Some forecasters take an additional step and calculate the ship requirement in deadweight tons. This presents conceptual problems because the productivity of the fleet is a supply variable – it is the shipowner who decides how fast his ship should travel – but it is easier for users to understand because it can be compared directly with the fleet. Typically the merchant fleet transports about 7.3 tons per deadweight each year and that is a useful rule of thumb for converting tons of cargo into deadweight demand (see stage 6).

STAGE 5: THE MERCHANT FLEET FORECAST

The supply side of the forecast starts by taking the available merchant fleet in the base year, adding the predicted volume of deliveries and subtracting the forecast volume of scrapping, conversions, losses and other removals. Forecasting scrapping and deliveries is complicated because these are behavioural variables. The minute freight rates go up, shipowners stop scrapping and start ordering new ships. For this reason the forecast needs to be made on a dynamic basis, preferably year by year using a computer model that adjusts scrapping and new ordering in line with the overall supply–demand balance.

STAGE 6: SHIP PRODUCTIVITY FORECAST

As we saw in Chapter 4, the productivity of a ship is measured by the number of ton miles of cargo carried per deadweight of merchant shipping capacity per annum. There are two forecasting methods. The simplest is to take a statistical series of the past productivity of the merchant fleet either in tons per deadweight or ton miles per deadweight (see Figure 4.8) and project this forward, taking account of any changes of trend that may be thought appropriate. Since productivity depends on market conditions, the forecast ought to be developed on a dynamic basis that recognizes that when market conditions improve the fleet will speed up and vice versa. A more thorough methodology for building up a forecast of productivity in this way would use an equation like (6.7) in Chapter 6.

STAGE 7: THE SHIPPING SUPPLY FORECAST

The shipping supply is calculated in ton miles by multiplying the available deadweight tonnage of ships by their productivity. By definition, supply must equal demand. If supply is greater than demand, the residual is assumed to be laid up or absorbed by slow steaming; if supply is less than demand, the fleet productivity must be increased.

STAGE 8: THE BALANCE OF SUPPLY AND DEMAND

As we have already stressed, a supply–demand model of this type contains behavioural variables, particularly the scrapping and investment variables. This is the most difficult part of the model. We know that supply must equal demand, and if the forecast level of supply does not match the forecast level of demand, then we must go back through the whole process again and make the adjustments that we believe the market would make in response to financial stimuli such as asset prices, freight rates and market sentiment.

STAGE 9: FREIGHT RATES

Now we come to the heart of the forecast, the level of freight rates which will accompany each level of supply and demand. We discussed the relationship between supply, demand and freight rates in Chapter 4, relating demand to the shipping supply function and showing how prices are established in different time-frames. This is the method which should be used. From a technical viewpoint the most difficult element to model accurately is the J shape of the supply curve. Regression equations relating freight rates to laid-up tonnage do not generally work very well due to the difficulty of finding a functional form which picks up the 'spiky' shape of freight graph. Simulation models offer a more satisfactory solution.

A typical market forecast generally includes predictions of the rate of growth of ship demand, the requirement for newbuilding tonnage and the overall balance of supply and demand. There may also be scenarios of freight rates and prices.

Finally, a word of caution. Analysts who successfully design and use a model of this type will learn an important lesson about the freight market which only becomes obvious when the relationships are quantified. As the market modelled approaches balance, the freight rates become so sensitive to small changes in assumptions that the only way to produce a sensible forecast is to adjust the assumptions until the model predicts a level of freight rates which is determined by the forecaster. That is the nature of the market. When there are two ships and two cargoes freight rates are determined by market sentiment at auction, and economics cannot tell us how the auction will develop. At their best shipping market models are educational in the sense that they help decision-makers to understand in simple graphic terms what could happen, but when it comes to predicting what will actually happen to freight rates they are very blunt instruments.

Sensitivity analysis

Forecasting models can be used to develop sensitivity analyses which explore how much the forecast changes as a result of a small change in one of the assumptions. A 'base case' forecast is first established using a reasonable set of assumptions, then small changes are made to the input assumptions and the resulting changes in the target variable are recorded. For example, the model might be used to explore the impact of lower industrial growth or higher scrapping on projected freight rates and a table compiled showing the change in each exogenous variable and the corresponding change in the target variable.

In theory this technique allows the user of the forecast to understand the sensitivity of the forecast to small changes in assumptions, but in the maritime economy there are many interrelationships which cannot be quantified with sufficient clarity to make this sort of sensitivity analysis totally 'automatic'. A change in the assumption for world industrial growth might reduce trade and trigger a fall in freight rates. However, in the real world lower freight rates may result in higher scrapping, so the market mechanism compensates for the lower growth in subsequent periods. Models are rarely capable of reflecting these behavioural interrelationships automatically and just changing one assumption whilst leaving everything else the same does not necessarily accurately reproduce the way the market mechanism works.

17.7 DEVELOPING A SCENARIO ANALYSIS

A third approach to forecasting is scenario analysis. The problem it deals with is communication between the analyst and the decision-maker. By the end of his market study the forecaster may be an expert, but how does he convey this knowledge to the decision-maker? And how does he take advantage of the decision-maker's own knowledge? Scenario analysis tackles this problem head on by involving the decision makers in the forecasting process. Scenarios are developed in a seminar forum with executives working alongside analysts. This avoids the rigidity of formal models which can oversimplify complex issues and be biased towards quantifiable variables. It also provides a better opportunity to focus on weighing up which issues are likely to be important.

The scenario approach was developed by Herman Kahn in his work for the Rand Corporation in the 1950s. He borrowed the term 'scenario' from the film industry, where the 'scenario' of a film outlines its plot and the mood of each successive scene. Khan's scenarios aimed to deal with the future in the same sort of way. Over the years this approach has been adapted and developed, often by big corporations (though nobody has yet tried producing feature length movies!). One approach is to start with a base-case scenario which takes the current 'plot' and develops it forward into a 'surprise-free' scenario which continues much as the past. From this base, alternative scenarios are developed by systematically discussing the developments which could produce different scenarios. Generally the scenarios are developed in clusters of two or three, normally covering long periods.

A systematic methodology for scenario analysis might consist of phases as follows:

1. A group of analysts manage the analysis and ask the assembled group of experts and managers to name the issues which they feel will be most important in determining how events will develop over the time-scale of the forecast. This can be done by splitting the group into working parties and asking each to report back with a list of issues.
2. Compile a list of 'key' issues based on the responses of the various groups and discuss the significance of each. The aim of this part of the analysis is to establish the facts that will be important in future, for example demographics, geography, political alignments, industrial developments, and resources.
3. Feed the edited list back to the working party and ask them to rank the issues in order of importance, using weights on the scale 1 to 10. Analyse the results and identify the variables on which there is greatest consensus, and those on which there is least agreement.
4. From this base develop a social, technical, economic and political 'no change' scenario, and alternatives in which the most important variables are changed, and prepare a report summarizing the results.

Scenario analysis is a way of encouraging management and staff in large organizations to become more aware of the issues which will be facing the company in future. Because it is based on 'systematic conjecture' it is much easier to range widely, but it requires skill and judgement to narrow down the range of possible trends to the few which are significant.

In conclusion, scenario analysis can be a useful way of defining the long-term business risks and opportunities. However, it is demanding in terms of time, calls for intellectual energy, and the results are difficult to encapsulate and distribute. The risk of a single quantified model forecast is that it ignores key issues. The risk of a scenario analysis is that it becomes so blurred that it is of little value.

17.8 ANALYTICAL TECHNIQUES

We will now briefly review the analytical techniques which are available. Four of the most popular forecasting techniques are summarized in Table 17.2. A brief review of their different capabilities will help to give newcomers to forecasting an idea of what to expect.

- *Opinion surveys* ask people 'in the know' what they expect to happen. Lots of shipping people do this informally, but there are structured methodologies such as the Delphi technique or opinion surveys. This technique is particularly useful for picking up emerging trends that are obvious to specialists but are not apparent from past data. The approach can be formal, using a panel, or informal.

Table 17.2 Overview of five analytical techniques used in shipping

	Analytical technique	Main characteristic
1	Opinion survey	
	Delphi technique	Discussion session in which group of experts make a consensus forecast
	Opinion surveys	Send questionnaire to selection of experts and analyse results
2	Trend analysis	
	Naive	Simple rule e.g. 'no change', or 'if earnings are more than twice OPEX they will fall'
	Trend extrapolation	Fit a trend using one of several methodologies and extrapolate forward
	Smoothing	Smooth out fluctuations to obtain average change, and project this
	Decomposition	Split out trend, seasonality, cyclicality and random fluctuations, and project each separately
	Filters	Forecasts are expressed as a linear combination of past actual values and/or errors
	Autoregressive (ARMA)	Forecasts expressed as a linear combination of past actual values
	Box–Jenkins model	Variant of the ARMA model, with rules to deal with the problem of stability
3	Mathematical model	
	Single regression	Estimated equation with one explanatory variable to predict target variable
	Multiple regression	Estimated equation with more than one independent variable to predict target variable
	Econometric models	System of regression equations to predict target variable
	Supply–demand models	Estimate supply and demand from their component parts and predict change in balance
	Sensitivity analysis	Examine the sensitivity of the forecast to different assumptions
4	Probability analysis	
	Monte Carlo	Probability analysis used to calculate the likelihood of a particular outcome occurring.

- *Trend analysis* identifies trends and cycles in past data series (time series). The naive forecast extrapolates recent trends into the future, a quick approach because there are no tricky exogenous variables to forecast, but it gives no indication of when or why the trend may change. More sophisticated trend analysis analyses the underlying trends, cycles and the unexplained residuals. With one grand gesture the trends and cycles tell us what will happen, but the forecaster still has to decide whether past trends will change.
- *Mathematical models* go a step further and explain trends by quantifying the relationships with other explanatory variables. For example, how much does the oil trade grow if world industrial production increases? By estimating equations which quantify relationships like this we can build a model to predict the oil trade.
- *Probability analysis* uses a completely different approach. Instead of predicting what will happen, probability analysis estimates the chance of a particular outcome occurring. For example, probability analysis might tell the decision-maker that

there is a 20% chance that freight rates will be $20,000 per day next year. This approach only works if you can find a way of calculating probability in numeric terms.

Analysts can approach each of these techniques at several different levels. In all cases there is a quick approach which requires little special skill and yields nearly instant results, and a sophisticated version which is a specialist subject in itself. In this section we will concentrate on the quick forecasting methods and limit the discussion of the sophisticated methods to a review of the general issues involved.

Opinion surveys

Opinion surveys involve canvassing the opinion of other experts. This is a good way of investigating issues that are constantly changing, and this approach is a firm favourite with shipping decision-makers who are constantly on the lookout for insights from experts. For analysts it can be a useful way of finding market intelligence, and opinion surveys approach the task in a structured way designed to provide a balanced appraisal of what experts in the industry think is important. Of course there is no guarantee that the issues identified will be correct, but in an industry driven by sentiment, knowing what others think has its uses (but see the dangers of consensus forecasting in Section 17.9).

Time series analysis

Statistical techniques for analysing time series range from the straightforward to the highly sophisticated. In its simplest form trend extrapolation requires little technical knowledge, while the more sophisticated forms of exponential smoothing are complex, involving advanced mathematical skills.

TREND EXTRAPOLATION

The simplest time series technique is trend extrapolation. A forecast is made by calculating the average growth rate between two points in a time series and extrapolating into the future. That is all there is to it, and it is very handy. When there is no data to build a more complex model, or there are hundreds of target variables to predict, it may be the only option. For example, a forecaster predicting the throughput of container terminals in the Mediterranean may have little choice but to extrapolate trends in the trade on each route, because all he has is a time series of past container lifts and no idea what is in them. Trend extrapolation may be simplistic, but it is better than nothing.

However, it is important to be aware of the pitfalls. A time series may look simple, but often there are several different components at work below the surface. Figure 17.5 illustrates the point. The line A_1A_2 shows the linear trend (T) in the data series; the curve shows the cycle (C) superimposed on the trend; and a small section of a seasonal cycle (S) is also shown. So at any point in time t, the value of variable Y will be a mixture of the trend, the two cycles, plus an error term E to reflect the random disturbances that affect all time series, thus:

$$Y_t = T_t + C_t + S_t + E_t \tag{17.4}$$

In shipping the cycles C_t are the shipping cycles we discussed at length in Chapter 4; the seasonal cycles S_t are found in many trades in agricultural commodities, and especially in oil demand in the Northern Hemisphere; and the trend T_t reflects long-run factors such as the trade development cycle we discussed in Chapter 10.

Because time series mix trends and cycles, extrapolation must be carried out with care. A forecast based on one phase of a cycle, for example between points B_1 and B_2 in Figure 17.5, is highly misleading because it suggests faster growth than the true trend A_1A_2. In fact the cyclical component C_t changes from negative at B_1 to positive at B_2. Just after point B_2 the cycle peaks and turns down, so it would not be correct to extrapolate this trend. This is not just a fanciful example; it is one of the 'bear traps' with which maritime forecasting is littered. The economic world dangles the 'bait' of rapid exponential growth in front of forecasters, who are delighted to predict a positive outlook. After all, that is what their clients usually want to hear. But no sooner have they made their positive forecast than the ground opens under them and they are in the trap. Our discussion of 'stages of growth' in Chapter 9 showed that growth rates often change as economies and industries mature, so the fact that a trade has grown at 6% per annum for 10 years does not really prove anything. Trends change.

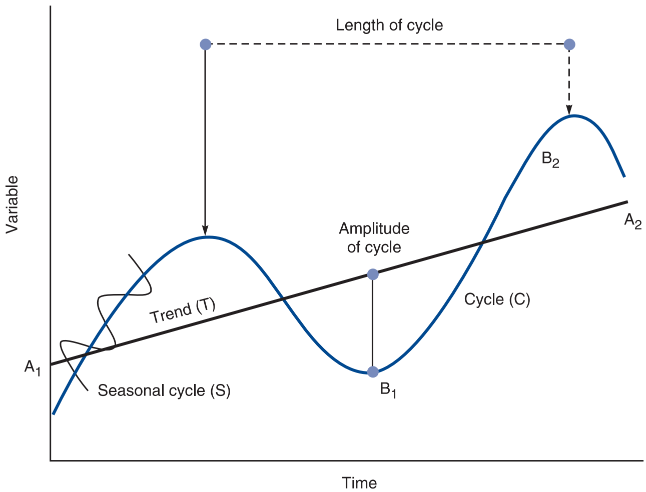

Figure 17.5
Cyclical components in a time series model

In conclusion, trend extrapolation is handy for quick forecasts, but the 'bear trap' awaits forecasters who rely on it for long-term structural forecasts. Remember the second principle of forecasting – there must be a rational explanation for the forecast. Data series must be examined to establish what is driving the growth, including cyclical influences, and, as far as possible, these must be taken into account. Fortunately there are well-established techniques for doing this.

EXAMPLE OF TIME SERIES ANALYSIS

Now we will analyse a time series in a different way, known as 'decomposition analysis'. Figure 17.6 shows a 16-year series for the freight rate for grain from the US Gulf to Japan.

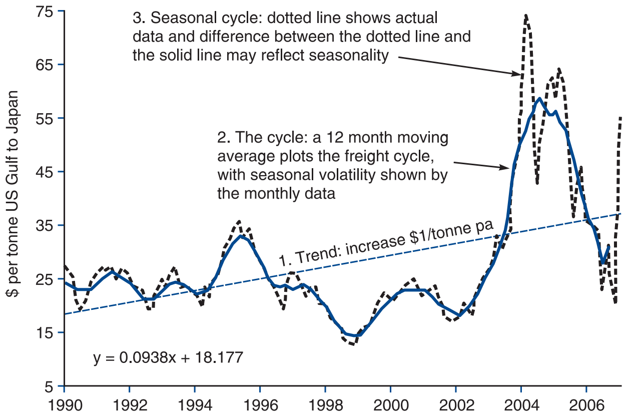

Figure 17.6
Grain freight rates – trend and seasonal volatility
Source: CRSL, monthly grain rates US Gulf to Japan

Brokers watch this series carefully for signs that rates are moving in or out of a cycle. We have three components to think about: the trend; some big cycles which seem to peak in 1995, 2000 and 2004; and what looks like short-term volatility which may turn out to be seasonal.

The starting point is the *trend* shown by the flat dashed line on the chart. It increases from $17 per tonne in 1990 to $36 per tonne in 2007. This trend was fitted by linear regression, which we will discuss below. However, it could easily have been drawn in by hand. It increases at a rate of $1 per tonne each year, so if we extrapolate it we find that in 10 years' time, cycles aside, the grain rates will have increased to around $46 per tonne. That is a very significant forecast for anyone running Panamax bulk carriers used in this trade, since it suggests they will be very profitable over the next decade. Naturally that invites the question 'why'. If we had fitted the trend to a slightly shorter data set of data ending in 2002 the positive slope would have disappeared and the rate would be stuck at around $24 per tonne. So have we found a significant trend caused by, for example, the emergence of China as a major importer and exporter? Or it could just be a cyclical effect caused by bulk carriers having an exceptional cycle between 2003 and 2007. Time series analysis gives trends, but not explanations, and a serious forecaster would not let the matter rest there. Research is needed.

Next we can look for signs of *cycles* which are shown by the 12-month moving average. As already noted, Figure 17.6 shows a cycle which peaks in 1995, falls to a trough in 1999, peaks again in 2000, declines in 2002, then finishes with a spectacular peak in 2004. Unfortunately, there is not very much consistency in these cycles, a conclusion that will not surprise readers of Chapter 3 where we argued that shipping cycles are periodic rather than symmetrical.

Finally, there is the *seasonal cycle*. The usual technique for revealing the seasonal cycle is moving averages. The method is simple. Using a monthly time series, we take a 12-month moving average of the US Gulf–Japan freight rate, centring the average in June (a 'centred' moving average calculates the average freight rate for an equal number of months either side of the target date, so if you start in June, the average would be taken from January to December). The resulting 12-month moving average, shown by the solid line in Figure 17.6, has smoothed out the seasonal fluctuations in the data, and we can see how the actual rate shown by the dotted line fluctuates around the 12-month trend. Computation of a moving average helps to squeeze a little extra information out of the data by a separating the seasonal and the trend components.

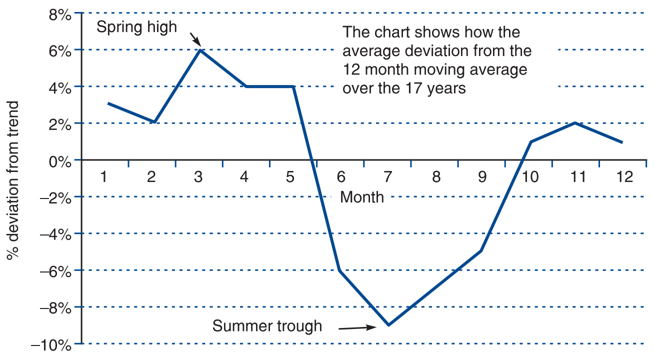

Figure 17.7
Grain trade seasonal cycle, 1990–2007
Source: CRSL, monthly grain rates US Gulf to Japan

The next step is to calculate the seasonal cycle by averaging the deviation from the trend for each calendar month, to produce the pattern shown in Figure 17.7. By the magic of statistical analysis the random fluctuations of the dotted line in Figure 17.6 are transformed into the well-defined seasonal cycle in Figure 17.7. It shows that the US Gulf–Japan rate is above trend for the first five months of the year and then dips below trend during months 6–9, before recovering in months 10, 11 and 12. That is exactly what we would expect. The US grain harvest is ready for Gulf loading in October and shipments build up during the following months, reaching a peak in January. They then slump in the last months of the agricultural year when there is less grain to ship. So the statistical analysis supports a common-sense view of what is likely to happen, and we may choose to accept this for forecasting. The cycle in Figure 17.7 can be used to 'correct' trend forecasts and make allowance for seasonal factors. The dip over the summer is quite significant.

EXPONENTIAL SMOOTHING

This technique is similar to moving averages, but instead of treating each (for example). monthly observation in the same way, a set of weights is used so that the more recent values receive more emphasis than the older ones. This notion of giving more weight to recent information is one that has strong intuitive appeal for managers, and adds credibility to the approach. It is useful for short-term forecasting jobs when there are many target variables.

AUTOREGRESSIVE MOVING AVERAGE

This takes the whole process of time series analysis a step further. Although the underlying approach is the same as for exponential smoothing, a different procedure is used to determine how many of the past observations should be included in the forecast and in determining the weights to be applied to those observations. The most commonly used technique is the procedure developed by Box and Jenkins.[22] They devised a set of rules for identifying the most appropriate model and specifying the weights to be used. This technique assumes that there are patterns buried in the data. It is particularly good for forecasting large numbers of variables when these are elements of cyclical activity. For example, the sales of many retail products are seasonal and large stores handling

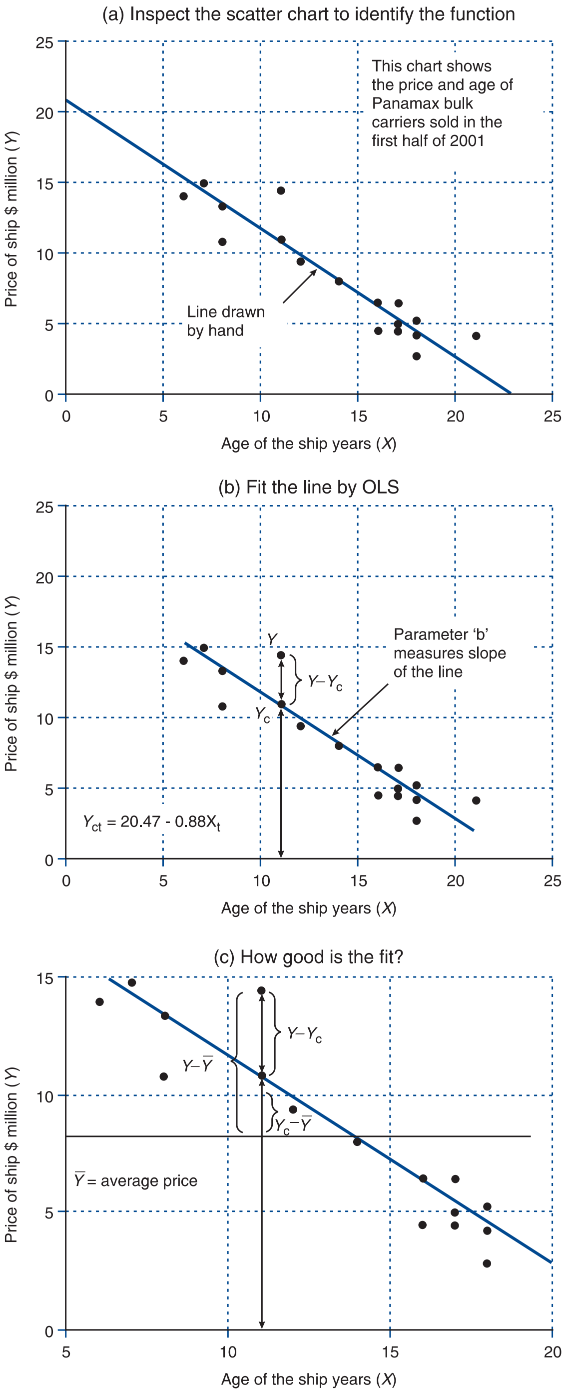

Figure 17.8
Three steps in fitting a regression equation

thousands of product lines often use this technique to predict sales levels for inventory management.

Regression analysis

Regression analysis is a useful statistical technique for modelling the relationship between variables in the shipping market. Spreadsheets make estimating regression equations straightforward and, with so much data available in digital form, regression analysis has suddenly gained a new lease of life. Developing big models has become much easier, but regression can also be used for simple jobs. So it is worth looking carefully at the application of this technique. There are excellent textbooks which discuss the methodology in detail, so here we will only deal with the broad principles.

Regression analysis estimates the average relationship between two or more variables. An example explains how this is done. Suppose you are asked to value a Panamax bulk carrier and have available the data on 21 recent ship sales shown by the dots in Figure 17.8(a) – the price is on the vertical axis and age is on the horizontal axis. The ships range in age from 6 to 21 years, and the prices paid range from \$2.8 million to \$15 million. How do you do it? By fitting a regression equation to the data to estimate the *average* relationship between the dependent variable Y (the sale price) and the independent variable X (the age of the ship when it was sold). Thus we aim to reduce the relationship between Y and X to an equation of the form

$$Y_t = a + bX_t + e_t \tag{17.5}$$

In this equation, which represents a straight line, 'a' and 'b' are parameters (i.e. constants) and e is the error term. The parameter 'a' shows the value of Y when X is zero (i.e. where the line cuts the vertical axis), the parameter b measures the slope of the line (i.e. the change in Y for each unit change in X), and e is the difference between the actual value and the value indicated by the estimated line. This is 'simple regression'. If we have several independent variables it is a 'multiple regression'. The aim is to find the line which fits the data best.

FITTING A REGRESSION EQUATION

The three main steps are set out below and illustrated graphically in Figure 17.8.

Step 1: *What type of function?* The first step is to plot the data on a scatter diagram and examine it to see whether there appears to be a relationship. In this case the data is plotted in a scatter graph shown in Figure 17.8(a), with the price of the ship (Y) on the vertical axis, and the age (X) on the horizontal axis. We seem to have a negative linear relationship, since as the variable X increases, the variable Y declines. The points are scattered about, but there is clearly a relationship. If we draw a line by hand we can see if the relationship makes sense. The line crosses the Y axis at about \$21 million, which is the value of the parameter a, or in economic terms the value of the ship when X (its age) equals zero, that is, the ship is new. It then falls steadily to cross the X axis at about 22.5 years, which is the age of the ship when it has no value. That certainly makes sense. A new Panamax bulk carrier cost about \$22 million in the second half of 2001, and on average Panamax bulk carriers get scrapped at about 25 years old. By fitting a regression equation we can estimate the line that fits the data best.[23]

Step 2: *What Equation?* To fit the equation we use the 'ordinary least squares' (OLS) technique. This method calculates the line that produces the smallest difference between the actual values Y and the calculated value which we refer to as Y_c (see Figure 17.8(b)). The values of these parameters which minimize the squared differences $(Y\text{-}Y_c)^2$ can be found by solving the 'normal equations' for 'a' and 'b'. This can be done using the Regression 'Add-in' provided by most spreadsheet packages. The results are as follows:

$$Y = 20.47 - 0.88X \tag{17.6}$$

In this case the estimated value of a is \$20.47 million and the value of b is –0.88, (see Table 17.3) which means that the value of the ship falls by \$0.88 million a year. That is very close to the line we fitted by eye.

Step 3: *How good is the fit*? Having found the line which fits the data most closely, the third stage is to examine just how close the fit really is. The OLS technique splits

Table 17.3 Example of regression statistics for 2 variable equation
SUMMARY OUTPUT (regression of Panamax price on ship age)

(a) Regression statistics

Number of observations		21	
Multiple R	0.95	Adjusted R^2	0.90
R^2	0.90	Standard error	1.43

(b) Analysis of variances (ANOVA)

Row label	*df*	*SS*	*MS*	*F*	*Significance F*
Regression	1	355.6	355.6	173.3	5E-11
Residual	19	39.0	2.1		
Total	20	394.5			

(c) Parameter estimates and test statistics

Row label	*Coeff-icients*	*Standard error*	*t stat*	*P value*	*Lower 95%*	*Upper 95%*
Intercept	20.47	0.90	22.63	3.3336E-15	18.57	22.36
X variable 1	–0.88	0.07	–13.17	5.3277E-11	–1.02	–0.74

Source: Based on output of regression function produced by popular spreadsheet 'add in'

the variation in Y from its mean into two parts: the part explained by the regression equation, and the 'error' term e which is not explained. This is shown diagrammatically in Figure 17.8(c). From this basic information we can derive three central test statistics, the standard error, the t-test, and the correlation coefficient (R_2) (see Box 17.2 for definitions). These statistics are a quick way of summarizing how good the fit is. The test statistics in Table 17.3 were obtained for the regression of Panamax price on age illustrated in Figure 17.7. The standard error is 1.43, which tells us that on average \$1.43 million variance in the price of a Panamax is not explained by the equation. The t statistic is the value of b divided by its standard error. It should be at least 2 in absolute value. In this case it is –13.2, which is highly significant. Finally, the R_2 is 0.9, which tells us that 90% of the variation in y is explained by the equation. So overall the equation works pretty well.

CALCULATING THE REGRESSION EQUATION

Although it is quite straightforward to calculate the parameters and test statistics using a spreadsheet, it is easier to use a statistical package which automatically calculates the estimated parameters and a table of test results.[24] The example of a standard table shown in Table 17.3 has three parts. Part (a) shows the number of data observations, which in this case is 21, and the regression statistics – the correlation coefficient and the standard error of regression. Part (b) is an analysis of variance (ANOVA) table describing the relationship between Y, Y_c and its mean, as discussed in Figure 17.8. Finally, part (c) shows the coefficients a (the intercept) and b, along with their test statistics.

BOX 17.2 SUMMARY OF TEST STATISTICS

Test 1: Standard error. The standard error of the regression measures how well the curve fits the data by calculating the average dispersion of the Y values around the regression line. It is given by:

$$SER = s_Y = \sqrt{\frac{\Sigma(Y - Y_C)^2}{N - K}}$$

where N is the number of observations and K is the number of parameters estimated.

Test 2: Standard error of the regression coefficient. Although the standard error is an interesting descriptive statistic, it does not in itself test the equation for significance. To do this we need to establish the confidence limits which can be placed on the estimated value of the regression parameters a and b. If we can make the assumption that b is normally distributed, it is possible to estimate its standard error:

$$s_b = \frac{s_y}{\sqrt{\Sigma x^2}}$$

Test 3: The *t*-test. If the independent variable does not contribute significantly to an explanation of the dependent variable we would expect the estimated value of b to equal zero (i.e. X will vary randomly in relation to Y). To test whether b could have come from a population in which the true value was zero we use the t-test. Divide the coefficient by its standard error (s_b)

$$t = \frac{b}{s_b}$$

and look up the resulting ratio in the t-table for N–K degrees of freedom. As a rule of thumb the value of t needs to be at least 2 to pass the test at the 5% significance level. If it is less than 2 the estimated parameter is probably not worth using.

Test 4: The *F* statistic. An alternative test statistic to the t test is the F statistic which is defined as follows:

$$F = \frac{\text{Variance explained}}{\text{Variance unexplained}}$$

Typically F will be a number in the range 1–5, with higher numbers indicating better fit. The statistic is tested by looking up the value of F In a table of critical values for the appropriate degrees of freedom of the numerator and the denominator.

Continued

BOX 17.2—cont'd

Test 5: The coefficient of correlation (R^2). A more general measure of the relationship between two variables is the coefficient of correlation. This statistic shows the average variation in Y from its mean as a proportion of the total variation in Y:

$$R^2 = \frac{\Sigma(Y_c - \bar{Y})}{\Sigma(Y - \bar{Y})}$$

A little reflection will make it clear that the value of R will fall between 0 and 1 (or −1). This makes the statistic particularly easy to interpret, and probably accounts for its popularity. It can, however, be misleading in time series analysis, since the variances are calculated in relation to the mean and two time series which are changing rapidly will invariably give a higher value of R than two time series which are not growing. For this reason the correlation coefficient should be treated with some caution. In multiple regression the correlation coefficient shows the overall fit of the equation, and is a quick test to see how successful additional variables are in explaining variation in Y.

Test 6: The Durbin–Watson statistic. This a test for autocorrelation of the residuals. This statistic should show a value of about 2 and is defined as follows:

$$D = \frac{\Sigma(e_t - e_{t-1})^2}{\Sigma(e_t^2)}$$

D takes values between 0 and 4. Values of D below 2 indicate that the residual values (e) are close together and that there is positive autocorrelation which causes bias in the parameter estimates. Values of D above 2 indicate negative autocorrelation.

We have already discussed Regression statistics. The correlation coefficient R^2 in Table 17.3(a) explains the variation of the dependent variable Y_c from its mean, as a percentage of the total variation. In this case an R^2 of 0.9 tells us that 90% of the variation in Y was explained by variations in X, which is a good result.

The first column of the ANOVA table in Table 17.3(b) shows the row labels; the second shows the degrees of freedom (df) accruing to the sum of squares appearing in the corresponding row; the third states the sum of squares (SS) of the regression and the residual. The bigger SS is for the regression and the smaller the summed square of the residuals the better; the 4th column shows the mean square (MS). The final column shows the value of F, which is the mean square of the regression divided by the mean square of the residual (355.6/2.1), which is a test of goodness of fit and should be looked up in a table of the F distribution for the number of degrees of freedom for the numerator and denominator.

Table 17.3(c) shows the coefficients in the second column and the standard error, the t statistic, p value and the 95% confidence limits. The latter show that we can be 95% certain that the intercept lies in the range 18.57 to 22.36 and the b coefficient lies in the range −1.02 to −0.74. These are useful results.

MULTIPLE REGRESSION ANALYSIS

Regression analysis can be extended by adding more explanatory variables. Continuing with second-hand prices, we can construct a time series model to forecast the price of a five-year-old Aframax tanker using the data shown in Figure 17.9. This time series starts in 1976, showing many fluctuations in the price over the years which the model needs to explain. In Chapter 4 it was argued that two key variables drive second-hand prices, newbuilding prices and earnings. To model this we run a multiple regression analysis using the five-year-old price of an Aframax tanker as the dependent variable (Y) and the newbuilding price (X_1) and one-year time-charter rates (X_2) as the independent (exogenous) variables:

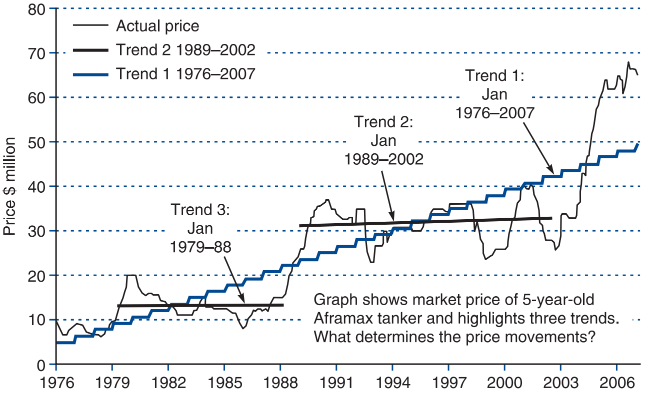

Figure 17.9
Example of time series trend analysis
Source: CRSL 5 year old Aframax price

$$Y_t = a + b_1X_{1t} + b_2X_{2t} \tag{17.7}$$

where Y is the second-hand price, X_1 is measured in millions of dollars and X_2 in thousands of dollars per day. Running this regression produces a high R^2 of 0.92 and significant t test results for all the parameters. The equation we estimate is

$$Y_t = -10.6 + 0.589X_{1t} + 1.1478X_{2t} \tag{17.8}$$

This equation tells us that on average the second-hand price of the ship increases by \$0.589 million for each \$1 million increase in the newbuilding price, and \$1.148 million for each \$1,000 increase in the one-year time charter rates. When we compare the estimated past values shown by the dotted line in Figure 17.10, it is clear that the fit is reasonably close. Throughout the 22-year period the equation explains the main cycles in second-hand prices very well. Its weakness is that it sometimes overestimates the second-hand price at the peak of cycles, and underestimates it at the trough. These are quite significant differences.

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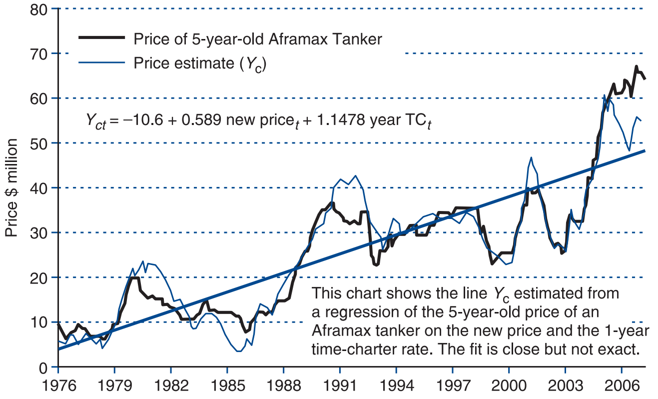

Figure 17.10
Example of time series trend analysis
Source: CRSL and estimate

However, there are two important matters to consider before we risk using this model for forecasting. The first is the specification of the model. We have assumed that new prices influence second-hand prices, and got an equation with a good fit. However, in Chapter 15 we argued that shipbuilding prices are influenced by second-hand prices. So which is it? Unfortunately statistical analysis will not answer this question. It is an economic question which we have to resolve by examining how the economics of the shipbuilding price model really works. In fact in, Section 15.4 we suggested that shipyard prices are determined by the interaction of shipbuilding demand and supply functions and one of the demand variables is the second-hand price – when second-hand ships become too expensive shipowners start to buy new ships. So there is much more that could be done to develop this simplistic model before relying on it too much.

This leads on to another common problem, autocorrelation. Since both time-charter rates and newbuilding prices are influenced by the shipping market cycle, they are likely to be correlated (i.e. they move in the same direction at the same time). When this happens it is possible that the parameters are not estimated accurately in the equation. The Durbin-Watson statistic is used to test for autocorrelation. In this case it shows a very low value of 0.12 (ideally it should be about 2), which indicates significant autocorrelation. The value is small because the value of e_t is often very close to the value of e_{t-1}. This is a matter which should be addressed.

Unfortunately, in this text space prevents us from exploring this type of modelling further, and indeed many practical forecasters would find the degree of analysis carried out here sufficient for their purposes. The model fits the data well enough, and although it may not work perfectly in some circumstances, as long as we are aware of the underlying risks, we might decide to use the equation anyway to predict second-hand prices in future. After all, there is no point in pouring an enormous amount of effort into a statistical analysis when the estimates for the newbuilding prices and time-charter rates which we feed into the model are likely to be wide of the mark!

Hopefully, this brief review has given readers who are not familiar with statistical analysis a sense of the way it can be used for modelling purposes and the precautions which must sensibly be taken. Sometimes regression equations are used as part of a comprehensive model, but often they can be used in a piecemeal way in different parts of a market report. Or maybe just as a ‘rule of thumb’ for making a quick forecast ‘on assumptions' – for example, to project iron ore imports into Japan, or US oil demand. If nothing else, this type of simple analysis illustrates relationships that have existed in the past, and that is bound to be helpful to the decision-maker who is trying to weigh up what might happen in future.

Regression analysis is simple to apply, but a more thoughtful investigation reveals the fundamental problem that the analyst does not know with any certainty the true relationship between variables, and has available only a limited amount of statistical data from which to estimate these relationships. It is all too easy for these estimated relationships to be biased, producing results which are inaccurate and possibly misleading. Econometrics is the branch of economics which deals with these problems and offers a collection of skills and techniques which allow the practising economist to avoid the pitfalls outlined in the previous example. There are also some excellent texts available on econometric modelling,[25] and many excellent articles on this subject in shipping journals.[26]

Probability analysis

We began this chapter by observing that forecasts are bound to be wrong sometimes, and this raises the question of probability. Some future events are reasonably predictable. For example, deliveries of ships next year are quite easy to predict because the orders have already been placed. But other shipping variables such as freight rates and prices are much less predictable, changing dramatically from month to month. Faced with this uncertainty, decision-makers might reasonably ask for an analysis of how predictable or unpredictable events are. That, essentially, is the role of probability analysis.

The basic technique involves taking a sample of data, either a time series or a cross-section, and calculating the number of times a particular event occurs. For example, if the basic data is a time series of tanker freight rates, you calculate how often during the sample period freight rates were above or below a particular level. If VLCC freight rates exceeded \$60,000 per day 10 times in a data series with 100 entries, then on the basis of this sample, you can say there is a 10% chance that freight rates will exceed \$60,000 a day.

As an example, suppose we take a time series of monthly earnings for tankers and bulk carriers, and analyse them into the histograms shown in Figure 17.11. On the horizontal axis this shows monthly earnings divided into \$2,000 per day bands. The vertical axis shows the number of months when earnings fell into each band. For example, there were seven months when tanker earnings fell into the \$10,000–\$12,000 per day band. This frequency distribution gives us a snapshot of the earnings profile of these two market segments, and at a glance it conveys some significant information. Firstly, tankers obviously earned more than bulk carriers. In fact, the average tanker earnings were \$21,800 per day, whilst the average bulk carrier earnings were \$10,900 per day. Secondly, the earnings profile for tankers is much more widely distributed, ranging from \$10,000 per day at the lower end to \$68,000 per day at the upper end. In contrast,

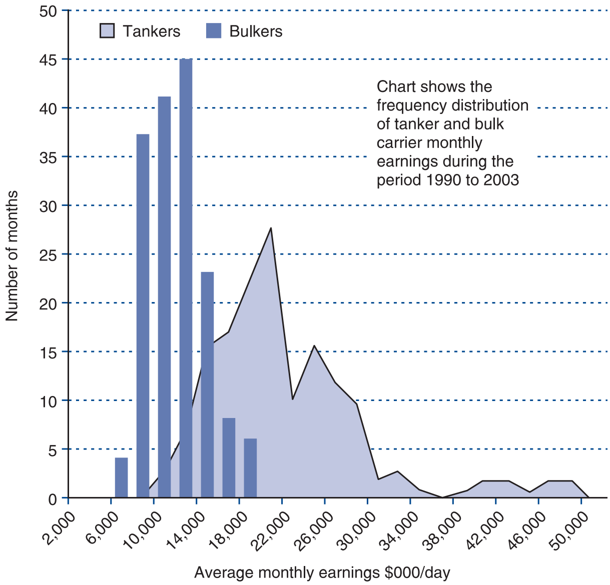

Figure 17.11
Earnings frequency distribution, 1990–2003
Source: CRSL and estimate

the bulk carrier distribution ranges from $4000 per day at the bottom to $18,000 per day at the top. Third, the bulk carrier at distribution is much more compact, with over 40 months in the $10,000–$12,000 per day band, whilst the most heavily populated tanker band has only 28 observations in it.

In fact this data is just a sample, but by using statistical analysis we can calculate the probability of earnings falling within a particular range. For example, if the frequency distribution is normally distributed, the mean and standard deviation can be used to calculate the probability of a particular event occurring. If the break-even earnings of a bulk carrier company are $7,500 per day, we can calculate the probability of earnings falling below that level. The mean bulk carrier earnings are $10,109 per day and the standard deviation is $2,708 per day, so $7,500 per day falls one standard deviation below the mean, which has a 66% chance of occurring. This is fine in theory, but the events of 2003–8 (see Figure 5.7, p. 195) showed that historic probabilities are not always a guide to the future.

This is a simplistic example, but statisticians have developed an extensive body of statistical analysis so that the analysis of probability can be applied to business problems. For example, a shipping banker trying to weigh up the credit risk on a particular loan may know that if the shipowner defaults on his repayments, his main source of collateral is the mortgage on the ship. As the mortgagee, he is entitled to seize the ship and sell it. So he is interested in three questions. First, what is the probability that during the five-year period following the shipowner will default? Second, in the event of a default, what is the probability that the resale value of the ship will equal or exceed the outstanding loan? Third, are there any actions he can take now which will improve the chances of a successful outcome? In such cases probability analysis and more sophisticated uses of it, such as Monte Carlo analysis, can be helpful.

17.9 FORECASTING PROBLEMS

There are many obstacles to producing worthwhile forecasts and it is useful to round off our discussion of forecasting methods with a review of some of the errors that can easily trap the unwary, including behavioural issues, problems with model specification and the difficulties of monitoring results:[27]

Problems with behavioural variables

We will start with a few home truths about our own capabilities. It seems that most of us are programmed to feel overconfident in our ability to make accurate estimates and find it hard to accept that we know so little about the future, preferring to give forecasts that are unrealistically specific.[28] Behavioural economists illustrate this point by asking a group to estimate the value of something they know nothing about (say the length of cable on a VLCC's anchor). Rather than playing safe with a wide range, most participants give a narrow one and miss the right answer. Because we are unwilling to reveal our ignorance by specifying the very wide range, we choose to be precisely wrong rather than vaguely right.[29] The same sort of thing happens with forecasts, and we need to be careful not to be misled. The solution to this problem is to test strategies under a much wider range of forecast scenarios for example by adding 20–25% more downside (or upside) to the extreme cases.

The next problem is *status quo bias*. It is always tempting to forecast that the future will be like the past, even when common sense says that it will not be. When freight rates are high at the top of a cycle we assume that they will always be high, and when low that they will always be low. To make things worse, we often evaluate new developments in the context of the present system and conclude that the new way will not work. This happened to some shipping companies when containerization started to appear in the 1960s. They concluded it would not work because they evaluated it within the framework of the cargo liner system.

The *herding instinct* reinforces status quo bias and is well known in markets, including shipping. When markets are high, there is peer pressure to produce more positive forecasts. Conversely, during recessions forecasts tend to be downgraded. The desire to conform to the behaviour and opinions of others is a fundamental human trait, and when sentiment is pessimistic it is natural to want to fit in. Warren Buffet made the point neatly when he wrote: 'failing conventionally is the route to go; as a group, lemmings may have a rotten image, but no individual lemming ever has received bad press'.[30] This is particularly relevant to shipping cycles. It suggests that forecasters should look to the periphery for innovative ideas and look particularly carefully at counter-cyclical cases.

Finally, we have the issue of *false consensus*. The similarity of forecasts published by several different agencies may give the impression that a particular outcome is likely, but in reality it is often caused by the uncertainty of the agencies as a result of which each keeps an eye on what the other is saying. P.W. Beck, Planning Director for Shell UK Ltd, found that there were few 'uncorrelated estimates' in the work done by so-called independent forecasters.[31] He argued that, uncertain about what to predict, agencies check what other forecasters are saying and follow the consensus. In such cases the fact that all the forecasts are the same is not evidence of a strong case for that particular outcome; it just means nobody is sure what to think.

Problems with model specifications and assumptions

Another obvious danger area lies in developing the framework (or model) and deciding what assumptions to use. The following problems often occur:[32]

- *Incorrect or superficial model specification*. The forecast may analyse and measure only surface factors and ignore important underlying forces. For example, when considering the future of the seaborne coal trade, it is important to take account of new technology which may, for example, change the type or volume of coal used in steel-making.
- *Too much detail*. There is a research rule of thumb that the researcher will identify 80% of the facts in 20% of the time required to obtain 100% of the facts. Put another way, it is easy to spend a long time investigating interesting but unimportant matters and lose sight of the overall objective.
- *Unchallenged preconceptions*. It is all too easy to assume that certain assumptions or relationships are correct and to accept them without question. Careful examination may show that under some circumstances they may be wrong (look how often forecasters have been caught out by oil price changes). Recall Aristotle Onassis's the assumption in 1956, mentioned earlier in this chapter, that Egypt could not reopen the Suez Canal for several years when in fact they reopened it in a few months.
- *Attempting to predict the unpredictable*. Some variables, such as the actions of small groups of people, are intrinsically unpredictable, and to attempt to predict them can create a false sense of security for decision-makers who assume that the forecast has a 'scientific' basis.

The forecaster needs constantly to ask the question: Am I falling into one of these traps?

The problem of monitoring results

When we look at past forecasts, we see just how difficult forecasting really is. Even deciding whether a forecast was right is not as easy as it seems. The problem was neatly summarized in an article reviewing the forecasting record of the UK National Institute of Economics and Social Research over a period of 23 years.[33] The article comments:

> It might be imagined that it must be possible, after a certain time has elapsed, to conclude in an unambiguous way whether a forecast has turned out to be correct or not. Unfortunately, the comparison of forecasts with actual results is not nearly as straightforward as it sounds. The first difficulty is that official statistics often leave a considerable margin of doubt as to how big the increase or decrease in output has been. The three measures of GDP (from expenditure, income and output) often give conflicting readings. Moreover the estimates are frequently revised, so that a forecast which originally appeared wrong may later appear right and vice versa. Another difficulty is that forecasts, which were pre-budget, were

conditional on unchanged policies. Since policies often did change it would be inappropriate to compare the forecasts directly with what actually happened.

Assessing the accuracy of shipping forecasts presents just as many problems. In some cases we find that the forecasts are of ship demand, but there are no published statistics of ship demand with which we can compare the forecasts to judge their accuracy. In others, the statistical database has been so manipulated that it requires a considerable effort to reduce currently available statistics to a form comparable with the forecast.

The difficulty of making accurate comparisons of the predictions with actual events led M. Baranto to comment: 'The analysis of forecasting errors is not a simple process – ironically it is as difficult as making forecasts'.[34] Care is needed to produce forecasts that are capable of being monitored quickly and easily by users.

Objectivity: the problem of escaping from the present

Another challenge facing any forecaster is to escape from the present. An illuminating example of this is provided by a forecast of the British economy in 1984 which was published in the early 1960s. Although this is a long time ago, the study is of particular interest because it was so wide-ranging and explicit in both its assumptions and its predictions. Reviewing the book 20 years later, Prowse draws the following conclusions:[35]

- Some of the basic assumptions that appeared unquestionable at the time have proved to be very wide of the mark. For example, the study contains the passage: 'It has been assumed throughout that no Government in power will permit unemployment to rise above 500,000 (2 per cent of the labour force) for any length of time'. In a similar vein, it assumed that there would be an 'average rise in retail prices of 1–2 per cent per annum'. Neither of these assumptions looked unreasonable in terms of the statistical trends evident in 1964. In fact, by 1984 Britain had unemployment of 10–15% in many areas of the country, while a reduction of the annual inflation rate to 5% per annum was regarded as a major achievement.
- In the area of technological change, the forecasts proved to be equally wide of the mark. Written at a time when the Concorde supersonic liner project was at the development stage, the study anticipated the use of vertical take-off passenger airliners crossing the Atlantic in 1½ hours. As it turned out the airlines, like shipping, preferred economies of scale to cutting-edge technology. In 1984 no new Concordes had been built, and transit times had hardly changed, but 'jumbo jets' had made cheap air travel available on an unprecedented scale. In the motor industry it was the same story. The study anticipated the replacement of the petrol engine by the fuel cell. By 1984 the cars were still basically the same as in the 1960s, but their design had evolved, making them more fuel efficient, better built and relatively cheaper. In all these cases revolution was predicted, but the commercial world chose evolution. Yet some revolutions were overlooked. The potential of computers was recognized in the statement that 'By 1984 the electronic computer will have come into its own', but the study did not anticipate the

revolutionary impact which the microchip revolution has had on almost every area of business.

- Another area where problems arose was in the long-term projections of economic growth. The study predicted that UK productivity would increase by 2½% per annum, and taken together with a 17% rise in the labour force, it was expected that real GDP would double by 1984. As it turned out, the stagnation of demand during the 1970s and the failure of productivity increases to materialize meant that the increase in output was only about one-third during the period.

At the time these forecasts were prepared, inflation was running at 1% and within living memory prices had actually fallen; Concorde was the big technical phenomenon; and the first generation of nuclear power stations had been highly successful. In short, the forecasts seemed reasonable and it is easy to see the problems of following any alternative line of thought. A forecast in the mid-1960s that anticipated inflation rates of 20%, or the virtual stagnation of the nuclear power programme, would have been extremely difficult to justify. The one certainty is that things will change and we must not be surprised by surprises.

17.10 SUMMARY

Francis Bacon, the sixteenth century man of letters, said that 'if a man will begin with certainties, he shall end in doubts; but if he will be content to begin with doubts, he shall end in certainties'. How right he was. We began with doubts about whether it is sensible to make shipping forecasts, and ended with the certainty that many of the issues confronting forecasters are impossible to predict reliably. But that does not mean forecasting is pointless. Since forecasters are only called on to predict things which are unpredictable, they must expect to be wrong (the forecasting paradox). Their task is not to predict precisely, it is to help decision-makers to reduce uncertainty by obtaining and analysing the *right information* about the present and show how that information can help to understand the future.

All forecast analyses should satisfy three simple criteria: they should be *relevant* to the decision for which they are required; they should be *rational* in the sense that the conclusion should be based upon a consistent line of argument; and they should be based upon *research* at a significant level of detail.

We discussed the preparations for the forecast. The first step is to carefully define the decision being made. Decision-makers have very different requirements and forecasts are used for many different purposes, ranging from speculative investments to budgets and product development by shipbuilders. The forecasting time-scale is also important and we identified four different time horizons: momentary, which is concerned with days or even hours; short term, which is concerned with a period of 3–18 months; medium term, which covers a typical shipping cycle of, say 5–10 years; and long term, which spans the life of a merchant ship. Each time-scale requires a different forecasting technique.