2 The Organization of the Shipping Market

Shipping is an exciting business, surrounded by many false beliefs, misconceptions and even taboos … The facts of the matter are straightforward enough and, when stripped of their emotional and sentimental overtones in clinical analysis, are much less titillating than the popular literature and maritime folklore lead one to expect.

(Helmut Sohmen, 'What bankers always wanted to know about shipping but were afraid to ask', address to the Foreign Banks' Representatives Association, Hong Kong, 27 June 1985. Reprinted in *Fairplay*, London, 1 August 1986)

2.1 INTRODUCTION

Our aim in this chapter is to sketch the economic framework of the shipping industry. Like the street map of a city, it will show how the different parts of the maritime business fit together and where shipping fits into the world economy. We will also try to understand exactly what the industry does and identify the economic mechanisms that make the shipping market place operate.

We start by defining the maritime market and reviewing the businesses that are involved in it. This leads on to a discussion of the demand for international transport and its defining characteristics. Who are its customers, what do they really want and what does transport cost? The overview of the demand is completed with a brief survey of the commodities traded by sea. In the second half of the chapter we introduce the supply of shipping, looking at the transport system and the merchant fleet used to carry trade. We also make some introductory comments about ports and the economics of supply. Finally, we discuss the shipping companies that run the business and the governments that regulate them. The conclusion is that shipping is ultimately a group of people – shippers, shipowners, brokers, shipbuilders, bankers and regulators – who work together on the constantly changing task of transporting cargo by sea. To many of them shipping is not just a business. It is a fascinating way of life.

2.2 OVERVIEW OF THE MARITIME INDUSTRY

In 2005 the shipping industry transported 7.0 billion tons of cargo between 160 countries. It is a truly global industry. Businesses based in Amsterdam, Oslo, Copenhagen, London, Hamburg, Genoa, Piraeus, Dubai, Hong Kong, Singapore, Shanghai, Tokyo, New York, Geneva and many other maritime centres compete on equal terms. English is the common language, which nearly everyone speaks. Ships, the industry's main assets, are physically mobile, and international flags allow shipping companies to choose their legal jurisdiction, and with it their tax and financial environment. It is also ruthlessly competitive, and some parts of the industry still conform to the 'perfect competition' model developed by classical economists in the nineteenth century.

Merchant shipping accounts for roughly a third of the total maritime activity as can be seen from Table 2.1, which divides the maritime business into five groups: vessel operations (i.e. those directly involved with ships); shipbuilding and marine engineering; marine resources, which include offshore oil, gas, renewable energy and minerals; marine fisheries, including aquaculture and seafood processing; and other marine activities, mainly tourism and services. When all these businesses are taken into account the marine industry's annual turnover in 2004 was over $1 trillion. Although these figures contain many estimates, they make a useful starting point because they put the business into context and provide a reminder of the other businesses with which shipping shares the oceans. Many of them use ships too – fishing, offshore, submarine cables, research and ports are examples – providing diversification opportunities for shipping investors.

In 2004 merchant shipping was much the biggest, with a turnover of about $426 billion. The business had grown very rapidly during the previous five years, due to the freight market boom which was just starting in 2004. In 2007 it operated a fleet of 74,398 ships, of which 47,433 were cargo vessels. Another 26,880 non-cargo merchant vessels were engaged in fishing, research, port services, cruise and the offshore industry (see Table 2.5 for details). This makes shipping comparable in size with the airline industry, which has about 15,000 much faster aircraft.

It employs about 1.23 million seafarers, of whom 404,000 are officers and 823,000 are ratings,[1] with smaller numbers employed onshore in the various shipping offices and services. These are relatively small numbers for a global industry.

Naval shipping is worth about $170 billion a year, which includes personnel, equipment and armaments. Although not strictly involved in commerce, navies are responsible for its protection and preserving open lines of commercial navigation on the major waterways of the world.[2] About 9,000 naval vessels, including patrol craft, operate worldwide with annual orders for about 160 new vessels. Cruise and ports complete the vessel operations section. There are over 3,000 major ports and terminals around the world, with many thousands of smaller ones engaged in local trades. So this is a major industry.

Supporting these core activities are the shipbuilding and marine equipment industries. There are over 300 large merchant shipyards building vessels over 5,000 dwt worldwide, and many more small ship- and boatbuilding yards with a turnover of

Table 2.1 Marine activities, 1999–2004

US$ millions	Turnover US$ m.[a] 1999	2004	Growth 99–04 (% p.a.)	Share in 2004%
1. Vessel operations				
Merchant shipping	160,598	426,297	22%	31%
Naval shipping	150,000	173,891	3%	13%
Cruise industry	8,255	14,925	12%	1%
Ports	26,985	31,115	3%	2%
Total	345,838	646,229	13%	47%
2. Shipbuilding				
Shipbuilding (merchant)	33,968	46,948	7%	3%
Shipbuilding (naval)	30,919	35,898	3%	3%
Marine equipment	68,283	90,636	6%	7%
Total	133,170	173,482	5%	13%
3. Marine resources				
Offshore oil and gas	92,831	113,366	4%	8%
Renewable energy	—	159		0%
Minerals and aggregates	2,447	3,409	7%	0%
Total marine resources	95,278	116,933	4%	8%
4. Marine fisheries			–	
Marine fishing	71,903	69,631	–1%	5%
Marine aquaculture	17,575	29,696	11%	2%
Seaweed	6,863	7,448	2%	1%
Seafood processing	89,477	99,327	2%	7%
Total marine fisheries	185,817	206,103	2%	15%
5. Other marine related activities				
Maritime tourism	151,771	209,190	7%	15%
Research and Development	10,868	13,221	4%	1%
Marine services	4,426	8,507	14%	1%
Marine IT	1,390	4,441	26%	0%
Marine biotechnology	1,883	2,724	8%	0%
Ocean survey	2,152	2,504	3%	0%
Education and training	1,846	1,911	1%	0%
Submarine telecoms	5,131	1,401	–23%	0%
Total other activities	179,466	243,898	6%	18%
Total marine activities	939,570	1,386,645	8%	100%

[a] The information in this table is based on many estimates and should be regarded as no more than a rough indication of the relative size of the various segments of the maritime business. The totals include some duplication, for example marine equipment is double-counted.

Source: Douglas-Westwood Ltd

around $67 billion in 2004. In the 1990s the annual investment in new cargo ships was $20 billion, but in 2007 $187 billion's worth of new ships were ordered and shipbuilding capacity was growing rapidly.[3] Another $53 billion was spent on second-hand ships, a very large figure in comparison with previous years.[4] In addition, a network of ship repair yards maintain merchant, naval and offshore ships. The shipyards are supported by the marine equipment manufacturers, paint manufacturers and suppliers of the host

of equipment needed to construct and maintain the complex mechanical structures which we refer to as merchant ships. Their turnover in 2004 was about $90 billion.

A third group of businesses are concerned with marine resources, mainly oil and gas which turns over about $113 billion per annum. Marine fisheries, the fourth group, are also very significant, including fishing, aquaculture, seaweed and seafood processing. Marine tourism is larger still, but this group includes a wide range of activities, including research, surveys, IT, and submarine telecoms. Finally, there are the marine services such as insurance, shipbroking, banking, legal services, classification and publishing. Whilst it is doubtful whether any of these global figures are very accurate, they provide a starting point by putting the businesses we will study in this volume into the context of the marine industry as a whole.

2.3 THE INTERNATIONAL TRANSPORT INDUSTRY

The modern international transport system consists of roads, railways, inland waterways, shipping lines and air freight services, each using different vehicles (see Table 2.2). In practice the system falls into three zones: inter-regional transport, which covers deep-sea shipping and air freight; short-sea shipping, which transports cargoes short distances and often distributes cargoes brought in by deep-sea services; and inland transport, which includes road, rail, river and canal transport.

Deep-sea shipping and air freight

For high-volume inter-regional cargoes deep-sea shipping is the only economic transport between the continental landmasses. Traffic is particularly heavy on the routes between the major industrial regions of Asia, Europe and North America, but the global transport network is now very extensive, covering many thousands of ports and offering services ranging from low-cost bulk transport to fast regular liner services. Air freight started to become viable for transporting high-value commodities between regions in the 1960s. It competes with the liner services for premium cargo such as

Table 2.2 International transport zones and available transport modes

Zone	Area	Transport sector	Vehicle
1	Inter-regional	Deep-sea shipping	Ship
		Air freight	Plane
2	Short-sea	Coastal seas	Ship/ferry
3	Land	River and canal	Barge
		Road	Lorry
		Rail	Train

Source: Martin Stopford 2007

electronic goods, processed textiles, fresh fruit, vegetables and automotive spare parts. Since the 1960s air freight has grown at over 6% per annum, reaching 111 billion ton miles (btm) by 2005. Maritime trade has been growing more slowly, averaging 4.2% growth per annum over the same period, but the volume of cargo is much larger. Compared with the 28.9 trillion ton miles of maritime cargo in 2005, air freight still accounted for only 0.4% of the volume of goods transported between regions.[5] Its contribution has been to widen the range of freight transport by offering the option of very fast but high-cost transport.

Short-sea shipping

Short-sea shipping provides transport within regions. It distributes the cargo delivered to regional centres such as Hong Kong or Rotterdam by deep-sea vessels, and provides a port-to-port service, often in direct competition with land-based transport such as rail. This is a very different business from deep-sea shipping. The ships are generally smaller than their counterparts in the deep-sea trades, ranging in size from 400 dwt to 6,000 dwt, though there are no firm rules. Designs place much emphasis on cargo flexibility.

Short-sea cargoes include grain, fertilizer, coal, lumber, steel, clay, aggregates, containers, wheeled vehicles and passengers. Because trips are so short, and ships visit many more ports in a year than deep-sea vessels, trading in this market requires great organizational skills:

> It requires a knowledge of the precise capabilities of the ships involved, and a flexibility to arrange the disposition of vessels so that customers' requirements are met in an efficient and economic way. Good positioning, minimisation of ballast legs, avoiding being caught over weekends or holidays and accurate reading of the market are crucial for survival.[6]

The ships used in the short-sea trades are generally smaller versions of the ships trading deep-sea. Small tankers, bulk carriers, ferries, container-ships, gas tankers and vehicle carriers can be found trading in most of the regions on short-haul routes. Short-sea shipping is also subject to many political restrictions. The most important is cabotage, the practice by which countries enact laws reserving coastal trade to ships of their national fleet. This system has mainly been operated in countries with very long coastlines, such as the United States and Brazil, but is no longer as prevalent as it used to be.

Land transport and the integration of transport modes

The inland transport system consists of an extensive network of roads, railways, and waterways using trucks, railways and barges. It interfaces with the shipping system through ports and specialist terminals, as shown in Table 2.2, and one of the aims of

modern transport logistics is to integrate these transport systems so that cargo flows smoothly and with minimum manual handling from one part of the system to another.[7] This is achieved in three ways: first, by adopting international standards for the units in which cargoes are transported, and these standards are applied to containers, pallets, packaged lumber, bales (e.g. of wool) and bulk bags; second, by investing in integrated handling systems designed to move the cargo efficiently from one transport mode to another; and third, by designing the vehicles to integrate with these facilities – for example, by building rail hopper cars which speed up the discharge of iron ore and building open-hatch bulk carriers with holds that exactly comply with the standards for packaged lumber.

As a result, transport companies operate in a market governed by a mix of competition and cooperation. In many trades the competitive element is obvious: rail competes with road; short-sea shipping with road and rail; and deep-sea shipping with air freight for higher-value cargo. However, a few examples show that the scope of competition is much wider than appears possible at first sight. For example, over the last 50 years bulk carriers trading in the deep-sea markets have been in cut-throat competition with the railways. How is this possible? The answer is that users of raw materials, such as power stations and steel mills, often face a choice between use of domestic and imported raw materials. Thus, a power station at Jacksonville in Florida can import coal from Virginia by rail or from Colombia by sea. Or container services shipping from Asia to the US West Coast and then transporting the containers by rail to the East Coast are in competition with direct services by sea via the Panama Canal. Where transport accounts for a large proportion of the delivered cost, there is intense competition. But cost is not the only factor, as shown by the seasonal trade in perishable goods such as raspberries and asparagus. These products travel as air freight because the journey by refrigerated ship is too slow to allow delivery in prime condition. However, the shipping industry has tried to recapture that cargo by developing refrigerated containers with a controlled atmosphere to prevent deterioration.

Although the different sectors of the transport business are fiercely competitive, technical development depends upon close cooperation because each component in the transport system must fit in with the others by developing ports and terminals designed for efficient cargo storage and transfer from one mode to another. There are many examples of this cooperation. Much of the world's grain trade is handled by a system of barges, rail trucks and deep-sea ships. The modal points in the system are highly automated grain elevators which receive grain from one transport mode, store it temporarily and ship it out in another. Similarly, coal may be loaded in Colombia or Australia, shipped by sea in a large bulk carrier to Rotterdam, and distributed by a small short-sea vessel to the final consumer. The containerization of general cargo is built around standard containers which can be carried by road, rail or sea with equal facility. Often road transport companies are owned by railways and vice versa. One way or another, the driving force which guides the development of these transport systems is the quest to win more business by providing cheaper transport and a better service.

2.4 CHARACTERISTICS OF SEA TRANSPORT DEMAND

The sea transport product

The merchant shipping industry's product is transport. But that is like saying that restaurants serve food. It misses out the qualitative part of the service. People want different food for different occasions, so there are sandwich bars, fast-food chains and cordon bleu restaurants. The Rochdale Report, one of the most thorough investigations of the shipping industry ever carried out, commented on these sectoral divisions within the industry as follows:

> Shipping is a complex industry and the conditions which govern its operations in one sector do not necessarily apply to another; it might even, for some purposes, be better regarded as a group of related industries. Its main assets, the ships themselves, vary widely in size and type; they provide the whole range of services for a variety of goods, whether over shorter or longer distances. Although one can, for analytical purposes, usefully isolate sectors of the industry providing particular types of service, there is usually some interchange at the margin which cannot be ignored.[8]

Like restaurateurs, shipping companies provide different transport services to meet the specific needs of different customers, and this gives rise to three major segments in the shipping market, which we will refer to as liner, bulk and specialized shipping. The liner business carries different cargoes, provides different services and has a different economic structure than bulk shipping, whilst the 'specialist' market segments which focus on the transport of cars, forest products, chemicals, LNG and refrigerated produce each have their own, slightly different, characteristics. But as Rochdale points out, they do not operate in isolation. They often compete for the same cargo – for example, during the 1990s the container business won a major share of the refrigerated trade from the reefer fleet. In addition, some shipping companies are active in all the shipping sectors and investors from one sector will enter another if they see an opportunity.

So although there is some market segmentation, these markets are not isolated compartments. Investors can, and do, move their investment from one market sector to another,[9] and supply–demand imbalances in one part of the market soon ripple across to other sectors. In what follows we will first explore the characteristics of the world trade system which creates the demand for different types of transport service; then we discuss how this translates into price and qualitative aspects of the transport product; and finally, we discuss how this has led to segmentation in the shipping business (ground we have already covered historically in Chapter 1, but which we will now examine in a more structured way). Is shipping one industry or several?

The global sea transport demand model

Shipping companies work closely with the companies that generate and use cargo. As we saw in Chapter 1, today's multinational companies source raw materials where

they are cheapest and locate manufacturing facilities in any low-cost corner of the world, however remote, drawing many towns and cities into the global economy. These oil companies, chemical producers, steel mills, car manufacturers, sugar refiners, consumer goods manufacturers, retail chains and many others are the shipping industry's biggest customers.

These businesses need many different types of transport, and Figure 2.1 gives a bird's-eye view of how shipping serves their global businesses.[10] On the left are the four primary producing sectors of the world economy: energy, including coal, oil and gas; mining, including metal ores and other crude minerals; agriculture, including grain and oilseeds, refrigerated foods, vegetable oils, and live animals; and forestry. These commodities are the building-blocks of economic activity, and transporting them from areas of surplus to areas of shortage, usually in the largest parcels possible to reduce transport costs, is a major market for the shipping industry.

Most of these raw materials need primary processing, and whether this takes place before or after transport makes a major difference to the trade. The principal industries involved are listed in the centre of Figure 2.1. At the top are oil refining, chemicals, and steel; the corporations that control these heavy industrial plants are major users of bulk transport and their policies change. For example, oil may be shipped as crude or products, with very different consequences for the transport operation. The more important manufacturing industries shown in the lower part of the middle column include vehicle manufacturing, light engineering, food processing, textiles, and wood and paper processing. They import semi-manufactures such as steel products, pulp, petroleum, chemicals, vegetable oils, textile fibres, circuit boards and a host of other products. Although these products still travel in large quantities, the cargo parcels are usually smaller and the commodities are more valuable. For example, iron ore is worth about $40 per tonne, but steel products are worth about $600–1,000 per tonne. They may also use special ships and cargo-handling facilities, as in the case of forest products and chemicals tankers.

Manufactured goods are often shipped several times, first to assembly plants and then on to other plants for finishing and packaging. This is a very different business from the raw materials and semi-manufactures discussed in previous paragraphs. Physical quantities are generally much smaller, and the components shipped around the world from one fabricator to another are increasingly valuable. For many products tight inventory control calls for fast, reliable and secure shipment, often in relatively small parcels, and transport now plays a central part in the world business model. A recent development in trade theory argues that comparative advantage is driven by clusters of expertise scattered around the globe.[11] Clusters of companies specializing in a particular business, say manufacturing ski boot clamps (or maritime equipment for that matter) develop a 'comparative advantage' in that product.[12] With the right communications and transport, these clusters can market their products globally, leading to a broader trade matrix, improved global efficiency and in the process giving shipowners more cargo. This is a theme we will develop in Chapter 10 where we examine the principles underlying maritime trade. For the present we can simply note that these remote clusters of expertise are reliant on cheap and efficient transport to deliver their products to market, and

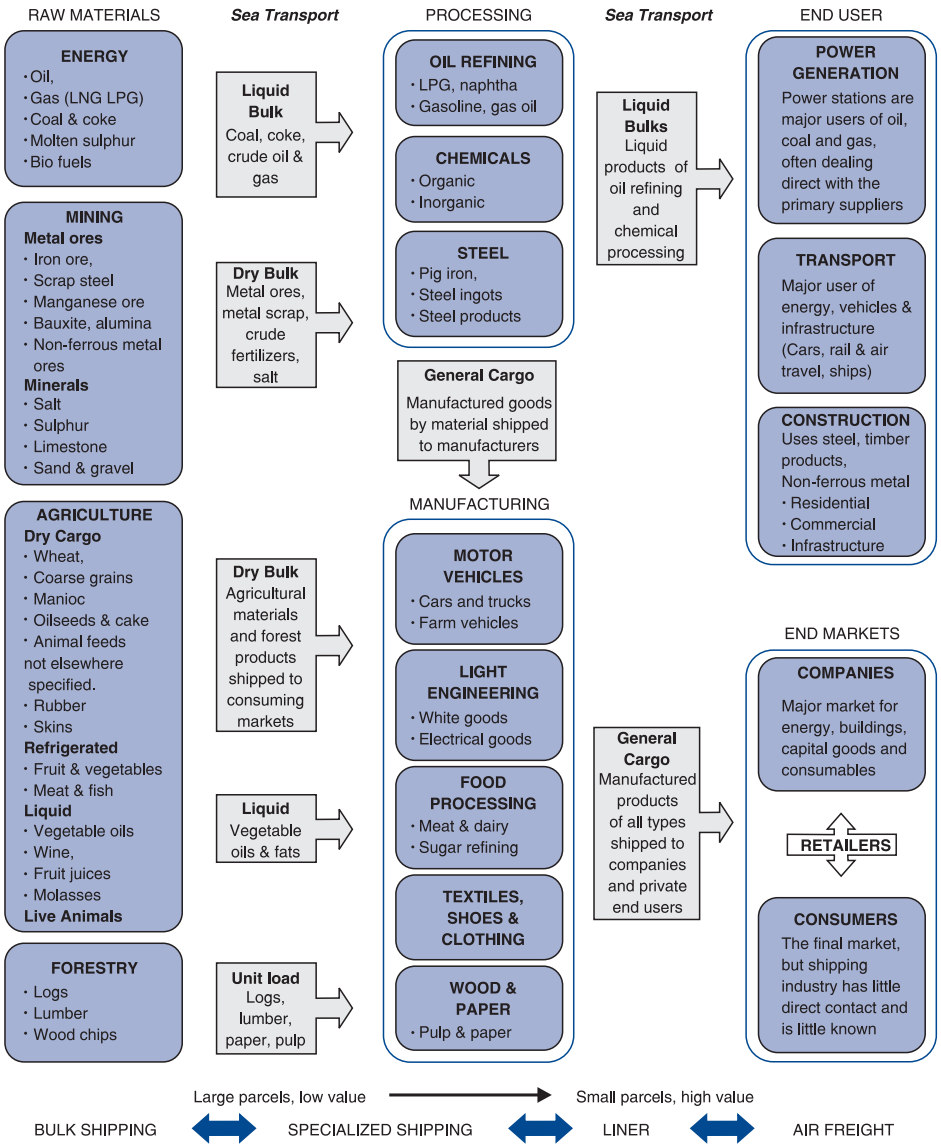


Figure 2.1
International transport system showing transport requirements
Source: Martin Stopford, 2007

the transport network developed by the container companies in the second half of the twentieth century must have contributed significantly to the growth of manufacturing in these areas.

In the right-hand column of Figure 2.1 are listed the final customer groups for the processed and manufactured products. At the top are three very important industries: power generation, transport and construction. These use large quantities of basic materials such as fuel, steel, cement and forest products. They are usually very sensitive to the

business cycle. Below them are listed the end markets for the goods and services produced by the world economy, loosely classified as companies and consumers.

This diversity of cargo makes analysing trade flows between these industries complex. Whilst primary materials, such as oil, iron ore and coal, move from areas of surplus to areas of shortage, and are quite simple to analyse, specialist cargoes are often traded for competitive reasons rather than supply and demand deficit – for example, the United States produces motor vehicles locally, but is also a major export market for manufacturers in Asia and Europe. In fact, when we view trade from the viewpoint of the underlying economic forces which drive it, there are three quite different categories. First, there is deficit trade, which occurs when there is a physical shortage of a product in one area and a surplus in another, leading to a trade flow which fills the gap in the importing country. This is very common in the raw material trades but also for semi-manufactures, for example when there are difficulties in expanding processing plant. Second, there is competitive trade. A country may be capable of producing a product, but cheaper supplies are available overseas. Or consumers or manufacturers may wish for diversity. For example, many cars are shipped by sea because consumers like a greater choice than domestic car manufacturers can offer. Third, there is cyclical trade which occurs in times of temporary shortages, for example due to poor harvests, or business cycles, leading to temporary trade flows. Steel products, cement and grain are commodities which often exhibit this characteristic. These are all issues which come up in discussing the trades in Part 4. This chapter simply introduces the transport systems that have developed to carry the cargoes.

The job of the shipping industry is to transport all these goods from place to place. There are about 3,000 significant ports handling cargo, with a theoretical 9 million routes between them. Add the complex mix of commodities and customers outlined above (a ton of iron ore is very different from a ton of steel manufactured into a Ferrari!) and the complexity of the shipping industry's job becomes all too apparent. How does it organize the job?

The commodities shipped by sea

We can now look more closely at the commodities the industry transports. In 2006 the trade consisted of many different commodities. Raw materials such as oil, iron ore, bauxite and coal; agricultural products such as grain, sugar and refrigerated food; industrial materials such as rubber, forest products, cement, textile fibres and chemicals; and manufactures such as heavy plant, motor cars, machinery and consumer goods. It covers everything from a 4 million barrel parcel of oil to a cardboard box of Christmas gifts.

One of the prime tasks of shipping analysts is to explain and forecast the development of these commodity trades, and to do this each commodity must be analysed in the context of its economic role in the world economy. Where commodities are related to the same industry, it makes sense to study them as a group so that interrelationships can be seen. For example, crude oil and oil products are interchangeable – if oil is refined before shipment then it is transported as products instead of crude oil. Similarly, if a country exporting iron ore sets up a steel mill, the trade in iron ore may be transformed into a

Table 2.3 World seaborne trade by commodity and average growth rate

	Million tonnes of cargo				% growth p.a.
	1995	2000	2005	2006	1995–2006
1. Energy trades					
Crude oil	1,400	1,656	1,885	1,896	2.8%
Oil products	460	518	671	706	4.0%
Steam coal	238	346	507	544	7.8%
LPG	34	39	37	39	1.3%
LNG	69	104	142	168	8.5%
Total	2,201	2,663	3,242	3,354	3.9%
			Share of total in 2006		44%
2. Metal industry trades					
Iron ore	402	448	661	721	5.5%
Coking coal	160	174	182	185	1.3%
Pig iron	14	13	17	17	1.8%
Steel product	198	184	226	255	2.3%
Scrap	46	62	90	94	6.7%
Coke	15	24	25	24	4.4%
Bauxite/alumina	52	54	68	69	2.6%
Total	887	960	1,269	1,366	4.0%
			Share of total in 2006		18%
3. Agricultural trades					
Wheat/coarse grain	184	214	206	213	1.3%
Soya beans	32	50	65	67	7.0%
Sugar	34	37	48	48	3.2%
Agribulks	80	88	97	93	1.4%
Fertilizer	63	70	78	80	2.2%
Phosphate rock	30	28	31	31	0.2%
Forest products	167	161	170	174	0.3%
Total	590	648	695	706	1.6%
			Share of total in 2006		9.4%
4. Other cargoes					
Cement	53	46	60	65	1.9%
Other minor bulk	31	36	42	44	3.2%
Other dry cargo	1,116	1,559	1,937	2,016	5.5%
Total	1,200	1,641	2,039	2,125	5.3%
			Share of total in 2006		28%
memo: Containerized	389	628	1,020	1,134	
	4,878	5,912	7,246	7,550	4.1%

Source: CRSL, *Dry Bulk Trades Outlook*, April 2007, *Oil & Tanker Trades Outlook*, April 2007, *Shipping Review & Outlook*, April 2007

smaller trade in steel products. To show how the various seaborne trades interrelate, the main seaborne commodity trades are shown in Table 2.3, arranged into four groups reflecting the area of economic activity to which they are most closely related. The growth rate of each commodity between 1995 and 2006 is also shown in the final column, illustrating the difference in character of the different trades. These groups can be summarized as follows.

- *Energy trades*. Energy dominates bulk shipping. This group of commodities, which by weight accounts for 44% of seaborne trade, comprises crude oil, oil products, liquefied gas and thermal coal for use in generating electricity. These fuel sources compete with each other and non-traded energy commodities such as nuclear power. For example, the substitution of coal for oil in power stations in the 1980s transformed the pattern of these two trades. The analysis of the energy trades is concerned with the world energy economy.
- *Metal industry trades*. This major commodity group, which accounts for 18% of sea trade, represents the second building-block of modern industrial society. Under this heading we group the raw materials and products of the steel and non-ferrous metal industries, including iron ore, metallurgical grade coal, non-ferrous metal ores, steel products and scrap.
- *Agricultural and forestry trades*. A total of seven commodities, accounting for just over 9% of sea trade, are the products or raw materials of the agricultural industry. They include cereals such as wheat and barley, soya beans, sugar, agribulks, fertilizers and forest products. The analysis of these trades is concerned with the demand for foodstuffs, which depends on income and population. It is also concerned with the important derived demand for animal feeds. On the supply side, we are led into the discussion of land use and agricultural productivity. Forest products are primarily industrial materials used for the manufacture of paper, paper board and in the construction industry. This section includes timber (logs and lumber) wood pulp, plywood, paper and various wood products, totalling about 174 mt. The trade is strongly influenced by the availability of forestry resources.
- *Other cargoes*. There are a wide range of commodities which together account for 28% of sea trade. Some are industrial materials such as cement, salt, gypsum, mineral sands, chemicals and many others. But there are also large quantities of semi-manufactures and manufactures such as textiles, machinery, capital goods and vehicles. Many of these commodities have a high value so their share in value is probably closer to 50%. They are the mainstay of the liner trades and the memo item at the bottom of the table estimates the volume of containerized cargo at 1.1 billion tons in 2006.

Viewing the trade as a whole, over 60% of the tonnage of seaborne trade is associated with the energy and metal industries, so the shipping industry is highly dependent upon developments in these two industries. But although these trade statistics convey the scale of the merchant shipping business, they disguise its physical complexity. Some shipments are regular, others irregular; some are large, others are small; some shippers are in a hurry, others are not; some cargoes can be handled with suction or grabs, while others are fragile; some cargo is boxed, containerized or packed on pallets, while other cargo is loose.

Parcel size distribution

To explain how the shipping industry transports this complex mix of cargoes, we use the parcel size distribution (PSD) function. A ‘parcel’ is an individual consignment of

cargo for shipment, for example 60,000 tonnes of grain that a trader has bought; 15,000 tonnes of raw sugar for a sugar refinery; 100 cases of wine for a wholesaler in the UK; or a consignment of auto parts. The list is endless. For a particular commodity trade, the PSD function describes the range of parcel sizes in which that commodity is transported. If, for example, we take the case of coal shown in Figure 2.2(a), individual shipments ranged in size from under 20,000 tons to over 160,000 tons, with clusters around 60,000 tons and 150,000 tons. However, the PSD for grain, shown in Figure 2.2(b), is very different, with only a few parcels over 100,000 tons, many clustered around 60,000 tons and a second cluster around 25,000 tons. Figure 2.2(c) shows two even more extreme trades – iron ore is almost all shipped in vessels over 100,000 dwt, with the largest cluster of cargoes around 150,000 dwt, whilst bulk sugar, a much smaller trade, clusters around 25,000 tons.

There are hundreds of commodities shipped by sea (see Table 11.1 in Chapter 11 for more examples of the bulk commodities) and each has its own PSD function, the shape of which is determined by its economic characteristic. Three factors which have a particular impact on the shape of the PSD function are the stock levels held by users (e.g. a sugar refinery with an annual throughput of 50,000 tons is hardly likely to import raw sugar in 70,000 ton parcels); the depth of water at the loading and discharging terminals; and the cost savings by using a bigger ship (economies of scale become smaller as ship size increases and eventually using a bigger ship may not be worth the trouble). From these factors shipping investors have to sort out the mix of cargo parcels they think will be shipped in future and from this decide what size of ship to order. Will the average size of iron ore cargoes move up from 150,000 tons

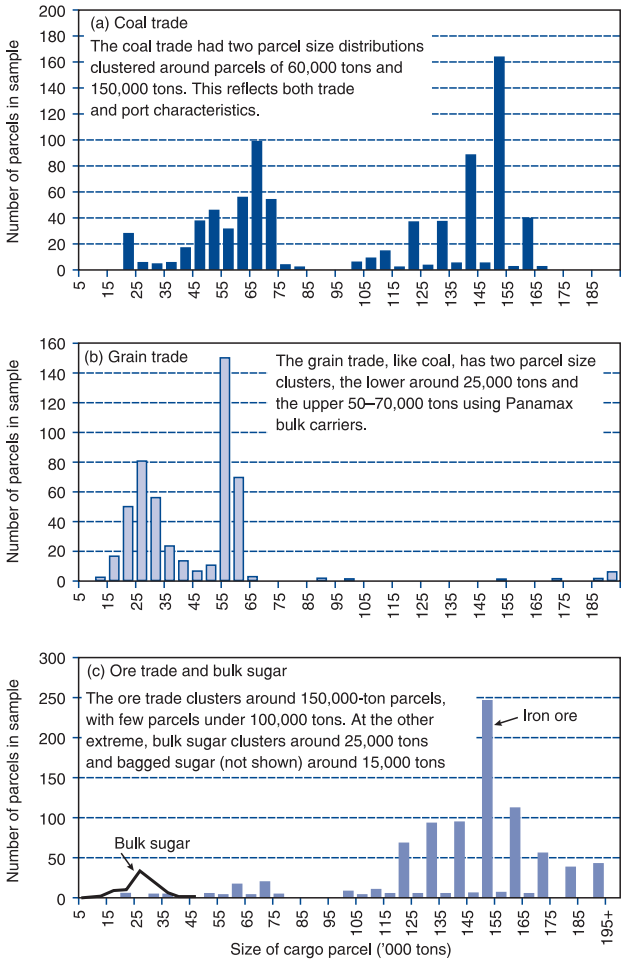


Figure 2.2
Parcel size distribution for coal, grain, ore and bulk sugar
Source: Sample of 7,000 dry cargo fixtures 2001–2

to 200,000 tons? If so, they should be ordering bigger Capesize bulk carriers. These are all subjects that we discuss more extensively in Part 4; for the present, we simply establish the principle that it is quite normal for the same commodity to be shipped in many different parcel sizes.

The importance of the PSD function is that it answers the question of which cargoes go in which ships. Cargoes of similar size and characteristics tend to be transported in the same type of shipping operation. One important division is between 'bulk cargo', which consists of large homogeneous cargo parcels big enough to fill a whole ship, and 'general cargo', which consists of many small consignments, each too small to fill a ship, that have to be packed with other cargo for transport. Another concerns ship size. Some bulk cargoes travel in small bulk carriers, while others use the biggest ships available. Each commodity trade has its own distinctive PSD, with individual consignments ranging from the very small to the very large.[13]

For many commodities the PSD contains parcels that are too small to fill a ship – for example, 500 tons of steel products – and that will travel as general cargo, and others – say, 5,000 tons of steel products – that are large enough to travel in bulk. As the trade grows, the proportion of cargo parcels large enough to travel in bulk may increase and the trade will gradually switch from being a liner trade to being predominantly a minor bulk trade. This happened in many trades during the 1960s and 1970s, and as a result the bulk trade grew faster than general cargo trade. Because many commodities travel partly in bulk and partly as general cargo, commodity trades cannot be neatly divided into 'bulk' and 'general' cargo. To do this it is necessary to know the PSD function for each commodity.

Product differentiation in shipping

In addition to the parcel size, there are other factors which determine how a cargo is shipped. Although sea transport is often treated as a 'commodity' (i.e. all cargoes are assumed to be the same), this is an obvious oversimplification. In the real world different customer groups have different requirements about the type and level of service they want from their sea transport suppliers, and this introduces an element of product differentiation. Some just want a very basic service, but others want more. In practice there are four main aspects to the transport service which contribute to the product 'delivered' by shipping companies:

- *Price*. The freight cost is always important, but the greater the proportion of freight in the overall cost equation, the more emphasis shippers are likely to place on it. For example, in the 1950s the average cost of transporting a barrel of oil from the Middle East to Europe was 35% of its c.i.f. cost. As a result, oil companies devoted great effort to finding ways to reduce the cost of transport. By the 1990s the price of oil had increased and the cost of transport had fallen to just 2.5% of the c.i.f. price, so transport cost became less important. In general, demand is relatively price inelastic. Dropping the transport cost of a barrel of oil or a container load of sports shoes has little or no impact on the volume of cargo transported, at least in the short term.

- *Speed*. Time in transit incurs an inventory cost, so shippers of high-value commodities prefer fast delivery. The cost of holding high-value commodities in stock may make it cheaper to ship small quantities frequently, even if the freight cost is greater. On a three-month journey a cargo worth $1 million incurs an inventory cost of $25,000 if interest rates are 10% per annum. If the journey time can be halved, it is worth paying up to $12,500 extra in freight. Speed may also be important for commercial reasons. A European manufacturer ordering spare parts from the Far East may be happy to pay ten times the freight for delivery in three days by air if the alternative is to have machinery out of service for five or six weeks while the spares are delivered by sea.
- *Reliability*. With the growing importance of 'just in time' stock control systems, transport reliability has taken on a new significance. Some shippers may be prepared to pay more for a service which is guaranteed to operate to time and provides the services which it has promised.
- *Security*. Loss or damage in transit is an insurable risk, but raises many difficulties for the shipper, especially when the parcels are high in value and fragile. In this case they may be prepared to pay more for secure transportation with lower risk of damage.

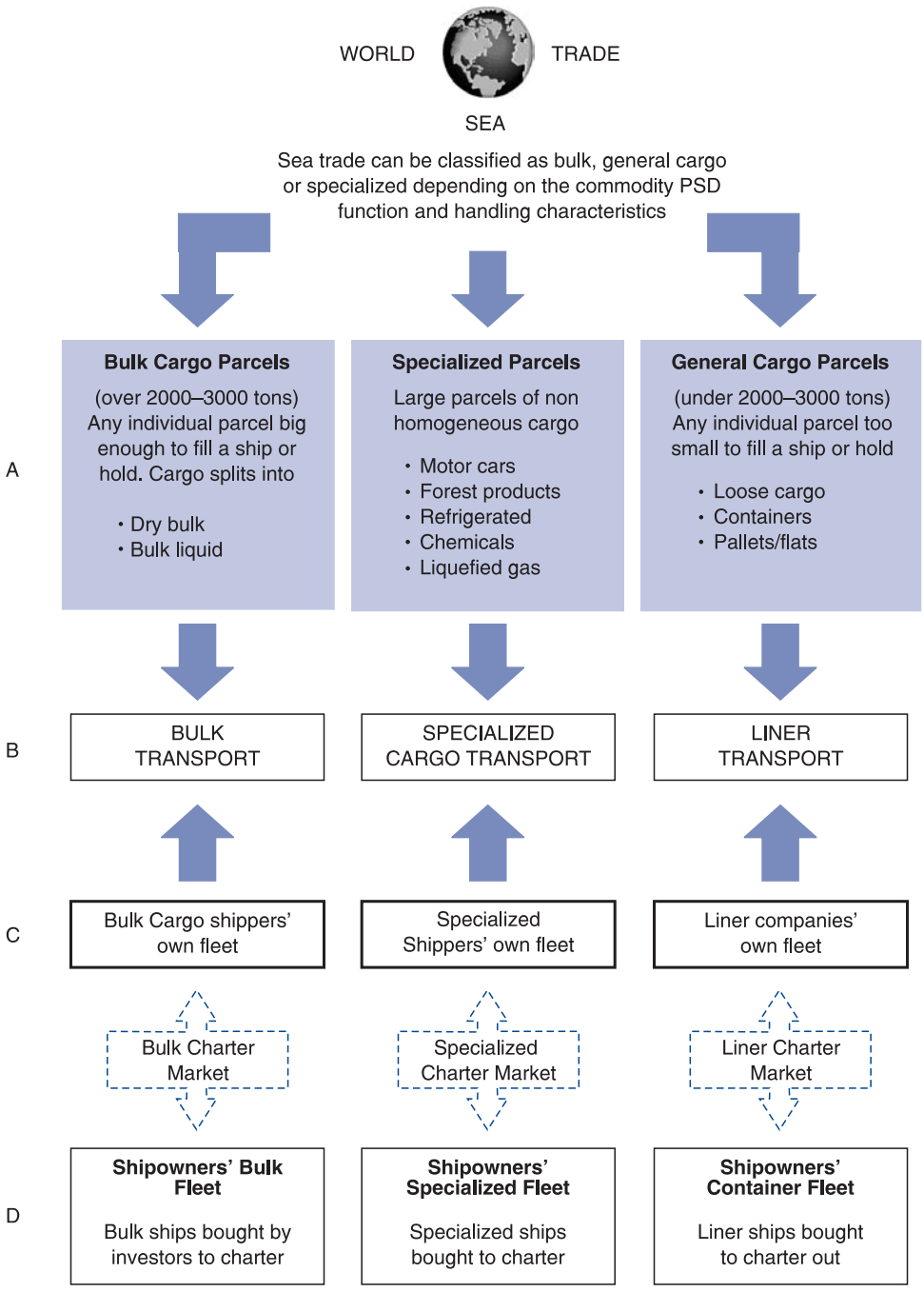
Together these introduce an element of differentiation into the business.

2.5 THE SEA TRANSPORT SYSTEM

The economic model for sea transport

In Chapter 1 we saw that over the last 50 years the shipping industry has developed a new transport system based on mechanization and systems technology. Within this system the economic pressures arising from the parcel size distribution and demand differentiation create the demand for different types of shipping service. Today's shipping market has evolved into three separate but closely connected segments: bulk shipping, specialized shipping and liner shipping. Although these segments belong to the same industry, each carries out different tasks and has a very different character.

The transport model is summarized in Figure 2.3. Starting at the top of this diagram (row A), world trade splits into three streams – bulk parcels, specialized parcels and general cargo parcels – depending on the PSD function for the commodity and service requirements of each cargo parcel. Large homogeneous parcels such as iron ore, coal and grain are carried by the bulk shipping industry; small parcels of general cargo are carried by the liner shipping industry; and specialized cargoes shipped in large volumes are transported by the specialized shipping industry. These three cargo streams create demand for bulk transport, specialized transport and liner transport (row B). The lower half of the diagram shows how the supply of ships is organized. A major distinction is drawn between the fleets of ships owned by the companies moving their own cargo in their own ships (row C) and the ships owned by independent shipowners (row D) and chartered



Supply Structure: The primary fleet is owned by the primary service operators shown in row C (shippers and liner companies). Additional capacity is hired from independent shipowners who buy ships to charter out. The 'charter market' arrows go both ways because shippers may charter their ships out as well as in.

Figure 2.3
The sea transport system, showing cargo demand and three shipping market segments
Source: Martin Stopford, 2008

to the cargo owners in Row C. Between rows C and D are the charter markets where rates for transport are negotiated. This is a highly flexible structure. For example, an oil company might decide to buy its own fleet of tankers to cover half of its oil transport needs and meet the other half by chartering tankers from shipowners. The same applies to the specialized and liner markets.

The bulk shipping industry on the left of Figure 2.3 carries large parcels of raw materials and bulky semi-manufactures. This is a very distinctive business. Bulk vessels handle few transactions, typically completing about six voyages with a single cargo each year, so the annual revenue depends on half a dozen negotiations per ship each year. In addition, service levels are usually low (see the discussion of pools in Section 2.9) so little overhead is required to run the ships and organize the cargo. Typically bulk shipping companies have 0.5–1.5 employees in the office for every ship at sea, so a fleet of 50 ships worth $1 billion could be run by a staff of 25–75 employees, depending on how much of the routine management is subcontracted. In short, bulk shipping businesses focus on minimizing the cost of providing safe transport and managing investment in the expensive ships needed to supply bulk transport.

The liner service shown on the right of Figure 2.3 transports small parcels of general cargo, which includes manufactured and semi-manufactured goods and many small quantities of bulk commodities – malting barley, steel products, non-ferrous metal ores and even waste paper may be transported by liner. For example, a container-ship handles 10,000–50,000 revenue transactions each year, so a fleet of six ships completes 60,000–300,000 transactions per annum. Because there are so many parcels to handle on each voyage, this is a very organization-intensive business. In addition, the transport leg often forms part of an integrated production operation, so speed, reliability and high service levels are important. However, cost is also crucial because the whole business philosophy of international manufacturing depends on cheap transport. With so many transactions, the business relies on published prices, though nowadays prices are generally negotiated with major customers as part of a service agreement. In addition, cargo liners are involved in the through-transport of containers. This is a business where transaction costs are very high and the customers are just as interested in service levels as price.

Specialized shipping services, shown in the centre of Figure 2.3 transport difficult cargoes of which the five most important are motor cars, forest products, refrigerated cargo, chemicals and liquefied gas. These trades fall somewhere between bulk and liner – for example, a sophisticated chemical tanker carries 400–600 parcels a year, often under contracts of affreightment (COAs), but they may take ‘spot’ (i.e. individually negotiated) cargoes as well. Service providers in these trades invest in specialized ships and offer higher service levels than bulk shipping companies. Some of the operators become involved in terminals to improve the integration of the cargo-handling operations. They also work with shippers to rationalize and streamline the distribution chain. For example, motor manufacturers and chemical companies place high priority on this and in this sector the pressure for change often comes from its sophisticated clients.

So although the three segments of the shipping industry shown in Figure 2.3 all carry cargo in ships, they face different tasks in terms of the value and volume of cargo,

the number of transactions handled, and the commercial systems employed. Bulk shipping carries the high-volume, price-sensitive cargoes; specialized shipping carries those higher-value 'bulk' cargoes such as cars, refrigerated cargo, forest products and chemicals; the container business transports small parcels; and air freight does the rush jobs. But these segments also overlap, leading to intense competition for the minor bulk cargoes such as forest products, scrap, refrigerated cargo and even grain.

Definition of 'bulk shipping'

Bulk shipping developed as the major sector in the decades following the Second World War. A fleet of specialist crude oil tankers was built to service the rapidly expanding economies of Western Europe and Japan, with smaller vessels for the carriage of oil products and liquid chemicals. In the dry bulk trades, several important industries, notably steel, aluminium and fertilizer manufacture, turned to foreign suppliers for their high-quality raw materials and a fleet of large bulk carriers was built to service the trade, replacing the obsolete 'tweendeckers previously used to transport bulk commodities. As a result, bulk shipping became a rapidly expanding sector of the shipping industry, and bulk tonnage now accounts for about three-quarters of the world merchant fleet.

Most of the bulk cargoes are drawn from the raw material trades such as oil, iron ore, coal and grain, and are often described as 'bulk commodities' on the assumption that, for example, all iron ore is shipped in bulk. In the case of iron ore this is a reasonable assumption, but many smaller commodity trades are shipped partly in bulk and partly as general cargo; for example, a shipload of forest products would be rightly classified as bulk cargo but consignments of logs still travel as general cargo in a few trades. There are three main categories of bulk cargo:

- *Liquid bulk* requires tanker transportation. The main ones are crude oil, oil products, liquid chemicals such as caustic soda, vegetable oils, and wine. The size of individual consignments varies from a few thousand tons to half a million tons in the case of crude oil.
- The five *major bulks* – iron ore, grain, coal, phosphates and bauxite – are homogeneous bulk cargoes which can be transported satisfactorily in a conventional dry bulk carrier or multi-purpose (MPP) stowing at 45–55 cubic feet per ton.
- *Minor bulks* covers the many other commodities that travel in shiploads. The most important are steel products, steel scrap, cement, gypsum, non-ferrous metal ores, sugar, salt, sulphur, forest products, wood chips and chemicals.

Definition of 'liner shipping'

The operation of liner services is a very different business. General cargo consignments are too small to justify setting up a bulk shipping operation. In addition, they are often high-value or delicate, requiring a special shipping service for which the shippers prefer

a fixed tariff rather than a fluctuating market rate. There are no hard-and-fast rules about what constitutes general cargo – boxes, bales, machinery, 1,000 tons of steel products, 50 tons of bagged malting barley are typical examples. The main classes of general cargo from a shipping viewpoint are as follows:

- Loose cargo, individual items, boxes, pieces of machinery, etc., each of which must be handled and stowed separately. All general cargo used to be shipped this way, but now almost all has been unitized in one way or another.
- Containerized cargo, standard boxes, usually 8 feet wide, often 8 feet 6 inches high and mostly 20 or 40 feet long, filled with cargo. This is now the principal form of general cargo transport.
- Palletized cargo, for example cartons of apples, are packed onto standard pallets, secured by straps or pallet stretch film for easy stacking and fast handling.
- Pre-slung cargo, small items such as planks of wood lashed together into standard-sized packages.
- Liquid cargo travels in deep tanks, liquid containers or drums.
- Refrigerated cargo, perishable goods that must be shipped, chilled or frozen, in insulated holds or refrigerated containers.
- Heavy and awkward cargo, large and difficult to stow.

Until the mid-1960s most general cargo (called 'break-bulk' cargo) travelled loose and each item had to be packed in the hold of a cargo liner using 'dunnage' (pieces of wood or burlap) to keep it in place. This labour-intensive operation was slow, expensive, difficult to plan and the cargo was exposed to the risk of damage or pilferage. As a result cargo liners spent two-thirds of their time in port and cargo-handling costs escalated to more than one-quarter of the total shipping cost,[14] making it difficult for liner operators to provide the service at an economic cost, and their profit margins were squeezed.[15]

The shipping industry's response was to 'unitize' the transport system, applying the same technology which had been applied successfully on the production lines in manufacturing industry. Work was standardized, allowing investment to increase productivity. Since cargo handling was the main bottleneck, the key was to pack the cargo into internationally accepted standard units which could be handled quickly and cheaply with specially designed equipment. At the outset many systems of unitization were examined, but the two main contenders were pallets and containers. Pallets are flat trays, suitable for handling by fork-lift truck, on which single or multiple units can be packed for easy handling. Containers are standard boxes into which individual items are packed. The first deep-sea container service was introduced in 1966 and in the next 20 years containers came to dominate the transport of general cargo, with shipments of over 50 million units per year.

Definition of 'specialized shipping'

'Specialized' shipping sits somewhere between the liner and the bulk shipping sectors and has characteristics of both. Although it is treated as a separate sector of the

business, the dividing line is not particularly well defined, as we will see in Part 4. The principal distinguishing feature of these specialized trades is that they use ships designed to carry a specific cargo type and provide a service which is targeted at a particular customer group. Buying specialized ships is risky and is only worthwhile if the cargoes have handling or storage characteristics which make it worth investing in ships designed to improve transport performance of that specific cargo.

Over the years new ship types have been developed to meet specific needs, but many specialist cargoes continue to be carried in non-specialist ships. A brief review of the development of ship types designed for a specific commodity is provided in Table 2.4. Starting with the *John Bowes*, the first modern collier built in 1852, we have in rapid succession the cargo liner, the oil tanker, refrigerated cargo ships, the chemical parcel tanker, the container-ship, the LPG tanker, the forest products carrier, and the LNG tanker. Some of these trades have now grown so big that they are no longer regarded as being specialized, for example crude oil tankers. Today the five main specialized sectors are as follows.

- *Motor vehicles*. Perhaps the best examples of a specialized transport sector. The cars are large, high-value and fragile units which need careful stowage. In the early days of the trade they were shipped on the deck of liners or in specially converted bulk carriers with fold-down decks. Apart from being inefficient, the cars were often damaged and in the 1950s purpose-built vessels were developed with multiple decks. The first car carrier was the 260 vehicle *Rigoletto* (see Table 2.4).

Table 2.4 Development of ship types designed for a specific commodity, 1852–2008

Date	First specialized ship of class	Name	Commodity	Size
1852	Bulk Carrier	SS *John Bowes*	Coal	650 dwt
1865	Cargo liner	SS *Agamemnon*	General cargo	3,500 dwt
1880	Reefer	SS *Strathleven*	Frozen meat	400 carcasses
1886	Oil Tanker	SS *Glückauf*	Oil	3,030 dwt
1921	Ore-Oil Carrier	*G.Harrison Smith*	Iron ore/oil	14,305 grt
1926	Heavy Lift Ship	*Belray*	Heavy cargo	4,280 dwt
1954	Chemical Parcel Tanker	*Marine Dow-Chem*	Chemical parcels	16,600 dwt
1950	LPG Tanker (Ammonia)	*Heroya*	Ammonia	1,500 dwt
1956	Car Carrier	*Rigoletto*	Wheeled vehicles	260 cars
1956	Containership (conversion)	*Ideal-X*	Containers/oil	58 TEU
1962	Forest Products Carrier	*MV Besseggen*	Lumber	9,200 dwt
1964	LNG Tanker (purpose built)	*Methane Princess*	LNG	27,400 m^3

Source: Martin Stopford 2007

Modern pure car and truck carriers (PCTCs) carry over 6,000 vehicles (see Chapter 14 for technical details).

- *Forest products*. The problem with logs and lumber is that although they can be carried easily in a conventional bulk carrier, cargo handling is slow and stowage is very inefficient. To deal with this the shippers started to 'package' lumber in standard sizes and built bulk carriers with holds designed around these sizes, hatches which opened the full width of the ship, and extensive cargo-handling gear. The first was the *Besseggen*, built in 1962. Companies such as Star Shipping and Gearbulk have built up extensive fleets of this sort of vessel.
- *Refrigerated foods*. The practice of insulating the hold of a ship and installing refrigeration equipment so that chilled or frozen food could be carried was developed in the nineteenth century. The first successful cargo was carried in the *Strathleven* in 1880. There has always been competition between the specialist 'reefer' operators and the liner service operators who used refrigerated holds or, more recently, refrigerated containers.
- *Liquid gas*. To transport gases such as butane, propane, methane, ammonia or ethylene by sea it is necessary to liquefy them by cooling, pressure or both. This requires specially built tankers and high levels of operation.
- *Chemical parcels*. Small parcels of chemicals, especially those which are dangerous or need special handling, can be carried more efficiently in large tankers designed with large numbers of segregated tanks. These are complex and expensive ships because each tank must have its own cargo-handling system.

The important point is that 'specialization' is not just about the ship design, it is about adapting the shipping operation to the needs of a specific customer group and cargo flow. Setting up a specialized shipping operation is a major commitment because the ships are often more expensive than conventional bulk vessels, with a restricted second-hand market, and provision of the service generally involves a close relationship with the cargo shippers. As a result, specialist shipping companies are easier to recognize than they are to define.

Some limitations of the transport statistics

An obvious question is: 'What is the tonnage of bulk, specialized and general cargo shipped by sea?' Unfortunately there is a statistical problem in determining how the commodities are transported. Because we only have commodity data, and transport of some commodities is carried out by more than one segment, the volume of trade in general cargo cannot be reliably calculated from commodity trade statistics. For example, we may guess that a parcel of 300 tons of steel products transported from the UK to West Africa will travel in containers, whereas a parcel of 6,000 tons from Japan to the USA would be shipped in bulk, but there is no way of knowing this for certain from the commodity statistics alone. As we have already noted, some commodities (such as iron ore) are almost always shipped in bulk and others (such as machinery) invariably travel as general cargo, but many commodities (such as steel products, forest products and

non-ferrous metal ores) straddle the two. In fact, as a trade flow grows it may start off being shipped as general cargo but eventually become sufficiently large to be shipped in bulk.[16] The difficulty of identifying bulk and general cargo trade from commodity trade statistics is very inconvenient for shipping economists, since seaborne trade data are collected mainly in this form and very little comprehensive information is available about cargo type.

2.6 THE WORLD MERCHANT FLEET

Ship types in the world fleet

In 2007 the world fleet of self-propelled sea-going merchant ships was about 74,398 vessels over 100 gt, though because there are many small vessels, the exact number depends on the precise lower size limit and whether vessels such as fishing boats are included. In Figure 2.4 the cargo fleet is divided into four main categories: bulk (oil tankers, bulk carriers and combined carriers), general cargo, specialized cargo and non-cargo. Although these groupings seem well defined, there are many grey areas. Merchant ships are not mass-produced like cars or trucks and classifying them into types relies on selecting distinguishing physical characteristics, an approach which has its limitations. For example, products tankers are difficult to distinguish from crude tankers on physical grounds, or ro-ro vessels which can be used in the deep-sea trades or as ferries, so which category does a particular ship belong in?

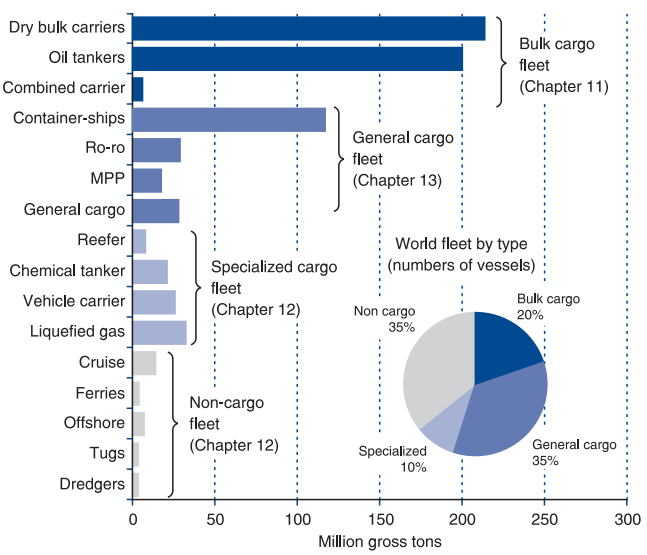


Figure 2.4
Merchant fleet classified by main cargo type. July 2007
Source: Clarkson Register, July 2007, CRS London

Detailed statistics of various ship types are shown in Table 2.5, which splits the fleet into 47,433 cargo ships and 26,880 non-cargo vessels. In the bulk cargo fleet there were 8040 oil tankers trading in July 2007, with the ships over 60,000 dwt mainly carrying crude oil and the smaller vessels carrying oil products such as gasoline and fuel oil. Note that there is also a fleet of chemical tankers which generally have more tanks and segregated cargo-handling systems, and these are included in the specialized