The Transport of Bulk Cargoes



Lecture roadmap

The lecture begins with the origins of bulk shipping, when coal was carried in wooden colliers and the John Bowes set the template for iron, screw-driven carriers. It then turns to the fleet and the bulk trades, showing how the commodity and its handling shape the ship. Four principles of bulk transport follow, and the lecture closes with the liquid and dry bulk trades, from crude oil and products to the major and minor dry bulks. Together these steps move from history to a view of the whole transport system.

01 Origins, fleet and trades

02 Four principles of bulk transport

03 Liquid bulk: crude oil and products

04 Dry bulk: major and minor trades

Learning objectives

Distinguish

Bulk commodity from bulk cargo

Apply

The four principles to a transport system

Explain

How trade patterns drive ship demand

The chapter asks you to separate bulk commodities from bulk cargoes: the same commodity in a container becomes general cargo. You will then apply the four principles to a transport system and explain how trade patterns drive ship demand. Each objective is tested against the cases in this chapter.

Origins of bulk shipping

Bulk shipping began with coal

Bulk shipping has its roots in the 18th-century coal trade from North England to London, where the standard ‘collier’ was a wooden sailing brig until better ships were needed. Trade grew from 1.4 to 49.3 million tons between 1840 and 1887, and earlier examples of bulk carriage include the Roman grain fleet, Dutch fly boats and tea clippers.

1.4 → 49.3 mt

Trade growth, 1840-1887





The John Bowes set the template

Built at Jarrow in 1852, the John Bowes combined an iron hull with screw propulsion, and carried 600 tons of coal per voyage against about 280 for a sailing collier. Its double bottom carried ballast, its machinery sat aft and its hold stayed open amidships. The higher capital cost was outweighed by more round trips, so the design set the template for the bulk carriers that followed.

600

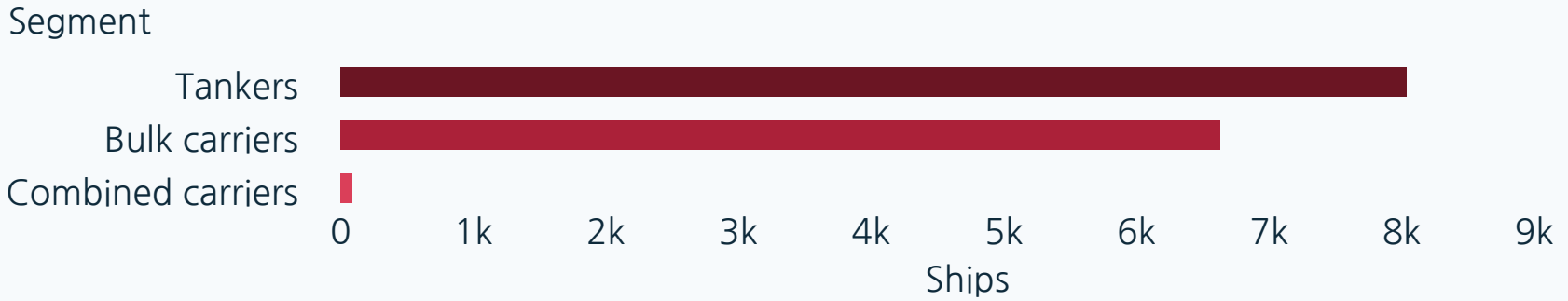
tons per voyage

~280

sailing collier

The bulk fleet

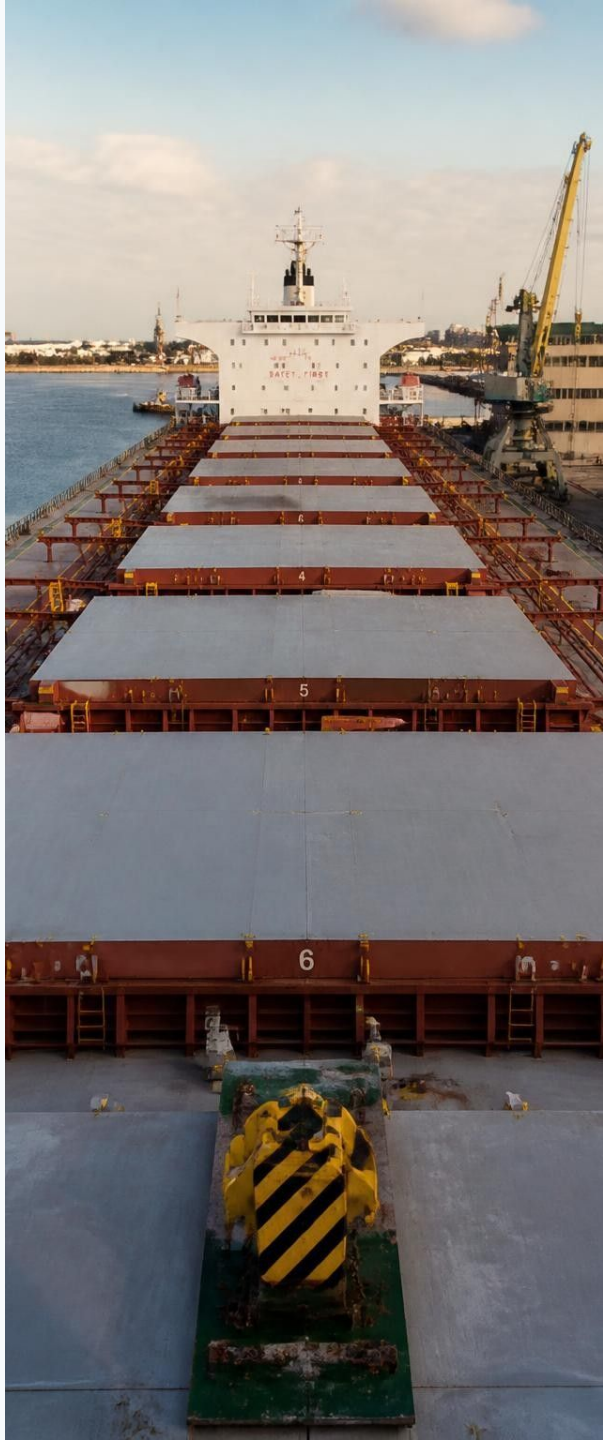
Bulk fleet: 6,631 bulk carriers in 2007, 15,131 in 2026



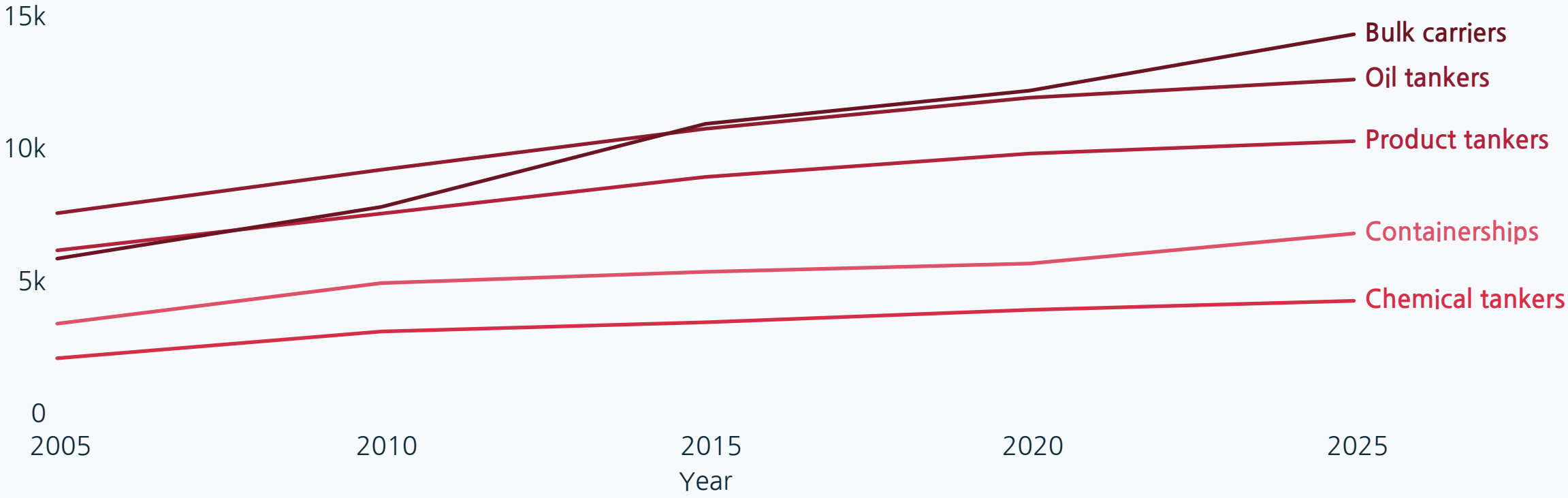
Segment (Clarksons basis, 100+ GT)	July 2007	Oct 2026	Change
Bulk carriers	6,631	15,131	+129%
Oil tankers	8,368	13,142	+57%
Product tankers	6,793	10,730	+58%
Chemical tankers	2,482	4,526	+82%
Containerships	4,246	7,215	+70%

The bulk fleet is dominated by two segments. Tankers numbered 8,040 and bulk carriers 6,631 in July 2007, together 14,671 of the 14,756 ships. The 85 combined carriers can carry either oil or dry bulk, a segment that straddles both trades.

Source: Clarksons Research, Oct 2026; 100+ GT basis. Clarksons tanker classes are defined differently from the book's 8,040 tankers, so the two are not directly comparable and are not summed.



Fleet growth 2005 – 2026



Growth is steady across all five segments. Bulk carriers numbered 5,850 in 2005 against 7,567 oil tankers. By 2015 they had passed oil tankers, 10,943 to 10,757, and reached 15,131 by October 2026.

Source: Clarksons Research, SIN Timeseries, © Clarkson Research Services 2026; start-of-year counts, Oct 2026 latest; 100+ GT basis.

World fleet at 1 January 2025: 2.44 billion dwt

Vessel type	Thousand dwt	Share	Change vs 2024
Bulk carriers	1,036,158	42.5%	+3.0%
Oil tankers	669,842	27.5%	+0.7%
Container ships	363,759	14.9%	+9.7%
Liquefied gas carriers	100,462	4.1%	+7.0%

Fleet capacity reached about 2.44 billion dwt, up 3.4%, below the 20-year average of 5.1% a year. Bulk carriers are the largest segment at 42.5% of capacity. Container ships grew fastest of the four, at +9.7%. UNCTAD's bulk carrier group includes combination carriers.

~112,500

commercial vessels of 100+ GT

42.5%

bulk carriers' share of world dwt

Source: UNCTAD, Review of Maritime Transport 2025



Size is the dominant feature

Average bulk carrier, 1976-2006

31,000 → 56,000

dwt

Average tanker

75,000 → 90,000

dwt, up 20%

Size is the dominant feature of each segment, and bigger-ship segments grow faster as ports and trade volumes widen. The average bulk carrier grew from 31,000 to 56,000 dwt between 1976 and 2006, while the average tanker rose from 75,000 to 90,000 dwt, up 20%. Size and hull design are the two defining characteristics of the 21 segments.



Tanker segments follow haul length

Segment	Employment
VLCC	Long-haul crude
Suezmax	West Africa to USA
Aframax	Shorter hauls, e.g. Mediterranean
Panamax and Handy	Caribbean and products

Tanker segments follow haul length. VLCCs carry the long-haul Middle East exports, while Suezmaxes serve West Africa to the USA and Aframaxes trade shorter hauls, such as across the Mediterranean. Panamax and Handy tankers serve the Caribbean and products trades. Each segment is matched to its haul, so the ship size follows the distance.

Dry bulk segments and specialists

Capesize, Panamax, Handymax, Handy

The dry bulk fleet divides into Capesize, Panamax, Handymax and Handy ships, and specialists serve particular cargoes. Open hatch vessels carry unit loads, ore, woodchip and cement, and self-unloaders discharge by conveyor belt. Combined carriers ‘triangulate’ to cut ballast time, but declined for 20 years.





Segments are not impenetrable barriers

Ships move between adjacent segments when freight rates justify it, so segment boundaries are not impenetrable barriers. A VLCC might enter the West African oil trade, generally a Suezmax trade, if the freight makes it worth the effort. The movement of fuel oil in 2004 from 30,000 dwt vessels to 440,000 dwt ULCCs shows how far ships can shift between segments.

2004: fuel oil moved from 30,000 dwt vessels to 440,000 dwt ULCCs.

DISCUSSION

What does this do to investment risk?

The bulk trades

Bulk commodity vs bulk cargo

A bulk commodity is one traded in large quantities and easy to handle in bulk, such as grain, ores and coal. Bulk cargo describes the transport mode, not the commodity itself, so the same goods can travel as bulk or as general cargo. A commodity shipped in a container becomes general cargo, which means the choice of transport, not the goods, decides which it is.

COMMODITY

Traded in large quantities

Easy to handle in bulk; grain, ores and coal are typical examples.

CARGO

The transport mode

Describes how it moves, not the commodity.

Same commodity in a container becomes general cargo.

Four tests of suitability for bulk

A cargo goes bulk only when it passes four tests. It needs volume enough to fill a ship, since cargoes shipped regularly in large quantities justify investment. Its handling and stowage must suit bulk equipment, and its value must be low enough that large parcels make sense. Its trade must also be regular, because the sugar trade, which is very fragmented, has benefited less from bulk systems.

Volume

Enough to fill a ship: cargoes shipped regularly in large quantities justify investment.

Handling and stowage

Granular, dense or light, delicate, dangerous. Grain, ores and coal suit automated grabs and conveyors.

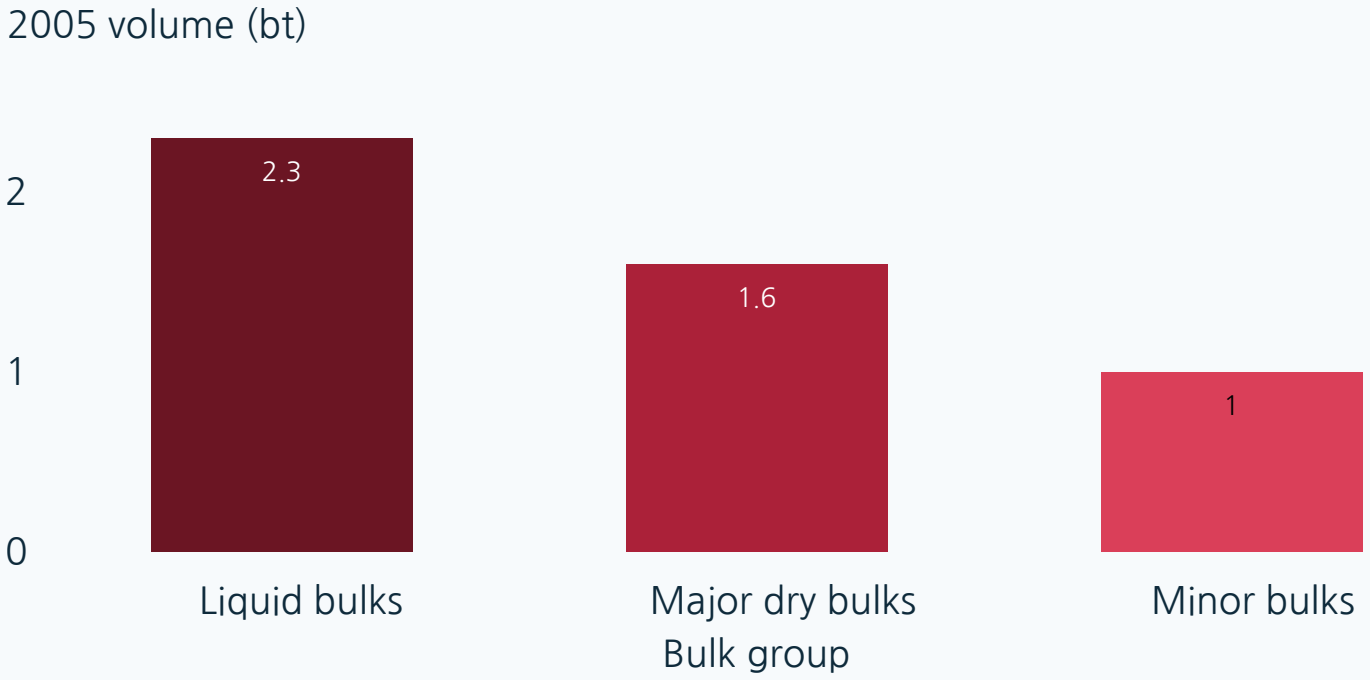
Cargo value

High value favours small parcels; low-value iron ore can be stockpiled.

Regularity

Regularity of trade flow. The sugar trade, which is very fragmented, has benefited less from bulk systems.

4.9 billion tons by sea in 2005



Bulk cargo carried by sea reached 4.9 billion tons in 2005. Liquid bulks made up 2.3 billion tons, major dry bulks 1.6 billion and minor bulks 1 billion, so roughly two-thirds of sea trade moves in bulk. Total bulk trade grew by 3.0% a year between 1985 and 2005.

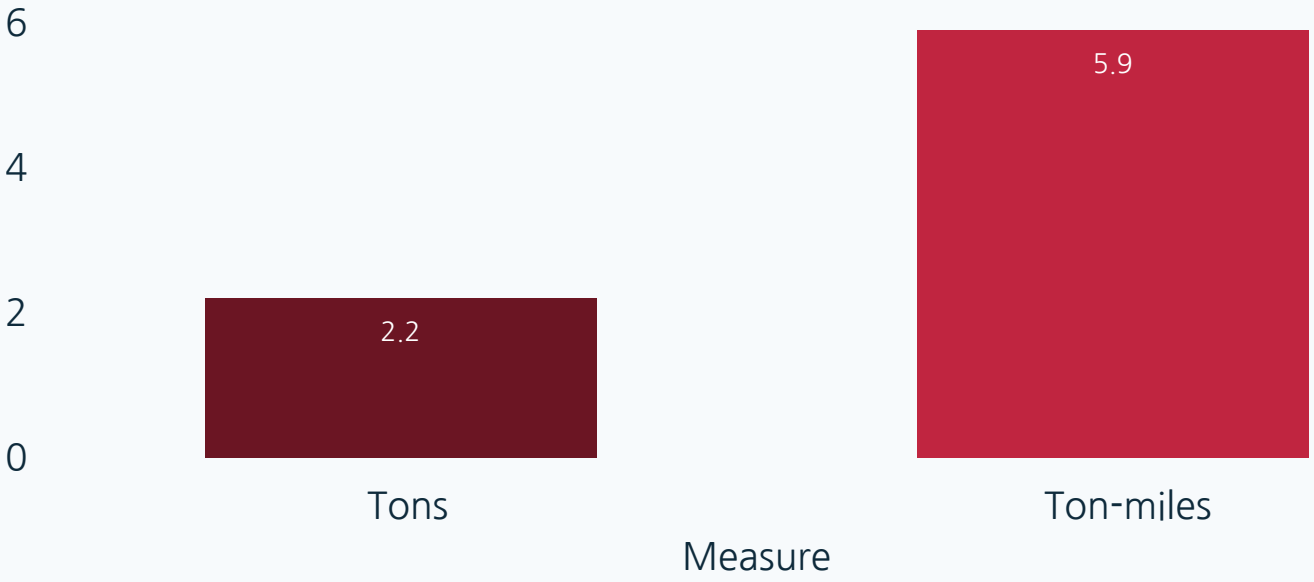
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of sea trade: 2.3 billion tons liquid, 1.6 billion major dry, 1 billion minor dry.

3.0%

Total bulk trade growth a year, 1985-2005

2024: 12,720 million tons by sea, and longer voyages

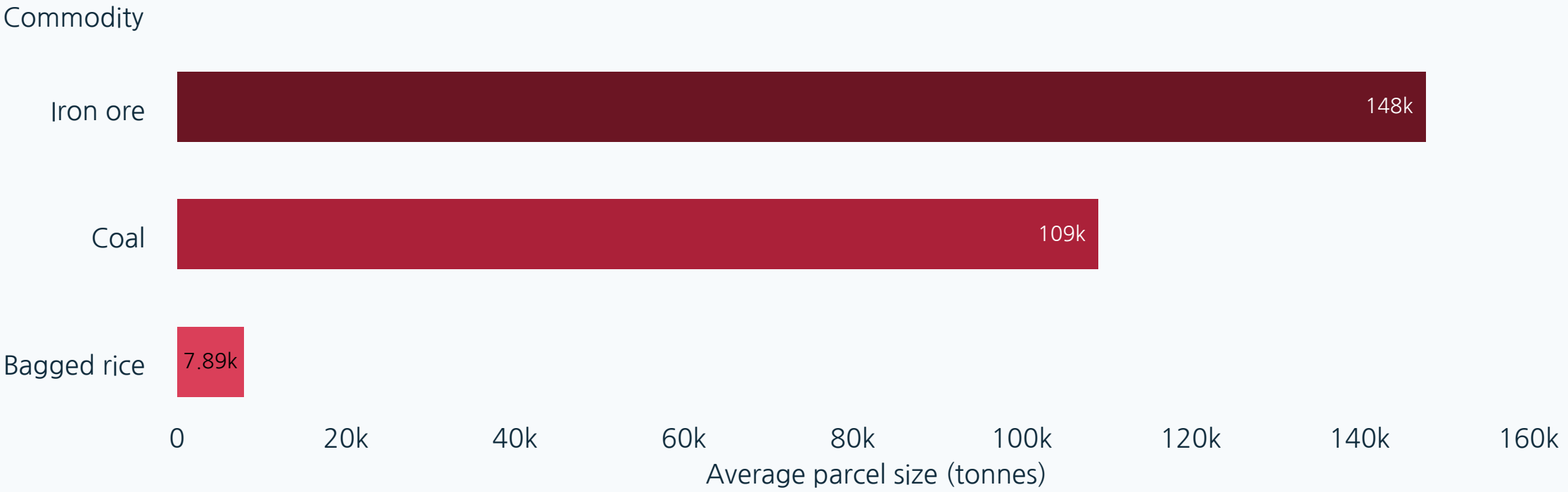


- Volumes: 12,720 million tons, +2.2%
- Ton-miles: 66,781 billion, +5.9%, fastest since 2011
- Average haul: 4,831 miles (2018) to 5,245 miles (2024)
- Ton-miles projected +0.3% in 2025

Ton-miles grew nearly three times as fast as tonnage, driven by Red Sea rerouting and Panama Canal restrictions. Longer hauls absorb more ship capacity than tonnage alone suggests. This is the ship demand multiplier at work: distance drives ship demand as much as tonnage does. Volume growth of 2.2% sat above the 2013-2023 average of 1.8% but below the 2003-2023 average of 2.9%.

Source: UNCTAD, Review of Maritime Transport 2025

Parcel sizes: 147,804 down to 7,893 tonnes



Average parcel size falls steeply from the largest bulks to the smallest. Iron ore parcels average 147,804 tonnes and coal 109,046 tonnes, while bagged rice falls to 7,893 tonnes. Many parcels fall in the 20,000-45,000 tonne range, and the parcel sizes gradually diminish.

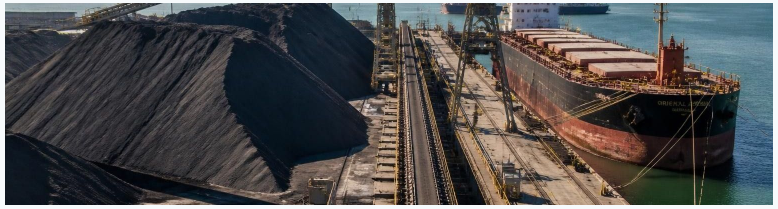
Sample: 2,549 spot cargoes fixed in 2001-2.

Four principles of bulk transport

A transport chain has 17 handling operations

A bulk cargo passes through a chain of handling operations between origin and destination. One sea voyage, two land journeys and four storage areas make up the chain, with four handling operations on and off land vehicles and eight movements to and from storage. Storage buffers timing differences between legs, so each leg can run at its own pace.





Storage buffers timing differences between legs.

The system constrains ship size

Ship size is limited by the system around the ship, not only by the ship itself. Water depth and berth length cap the size of ship a port can take. Port storage must hold the parcel, so a terminal that handles 60,000 tons of grain cannot take a 70,000-ton cargo. Annual throughput limits cargo size even where terminals allow big ships.

Berth

Water depth and berth length cap ship size.

Storage

Port storage must hold the parcel. A terminal that handles 60,000 tons of grain cannot take a 70,000-ton cargo.

Plant

Annual throughput limits cargo size even where terminals allow big ships.

The designer's checklist

1 Efficient cargo handling at scale

2 Minimize cargo handling

3 Integrate transport modes

4 Optimize stocks

Each principle has a capital cost, and some conflict with the others. Just-in-time stocks (Principle 4) clash with the few large deliveries of Principle 1. Efficient handling at scale, minimal handling, integrated modes and optimized stocks must therefore be balanced against one another, and no single principle can be followed in isolation.

Principle 1: Use economies of scale

Bigger ships have lower unit costs, but savings diminish.

Bigger ships have lower unit costs, but the savings diminish as ships grow. Handling matters less as haul length grows, because cargo handling does not change with voyage distance, so the cost advantage of size is greatest on long hauls. Big ships are less flexible, however, and markets therefore use a portfolio of sizes rather than one.

Haul length

Handling matters less as haul length grows, because cargo handling does not change with voyage distance.

Flexibility

Big ships are less flexible; markets use a portfolio of sizes.

When does a trade ‘go bulk’?

50,000 tons

Wheat

New Orleans-Rotterdam

Bulk carrier

500 tons

Malting barley

Tilbury-West Africa

Bags or containers

A trade goes bulk when its cargo is large enough to fill a hold, and the smallest practical unit is one hold. Wheat moves in 50,000-ton lots from New Orleans to Rotterdam in a bulk carrier, while malting barley at 500 tons from Tilbury to West Africa travels in bags or containers. Below 3,000 tons it gets hard, and one expert puts the watershed at 1,000 tons.

Principle 2: Minimize handling

Handling is where time is lost, and the contrast between two grain systems shows why. The 15,000 dwt ’tweendecker in a small African port took weeks to discharge grain, which was lifted with grabs, bagged by hand and trucked away. A modern grain elevator loads 5,000 tons an hour onto ships, so the same vessel could be handled in a day.

15,000 dwt ’tweendecker

In a small African port, grain is unloaded with grabs, bagged by hand and trucked away, so discharge can take weeks.

Modern grain elevator

2,000 tons/hour from barges.

5,000 tons/hour onto ships.

The same vessel could be handled in a day.

Relocate plants to coastal sites; build specialist terminals.

Principle 3: Integrate the modes

Standardize units: containers, bags, pallets, packaged lumber.



Design as one system.

Integrating the modes means treating ships, terminals, storage and land transport as one system. Standardized units such as containers, bags, pallets and packaged lumber make the links between them work. Iron ore was probably the first integrated system; it works best with regular flows under one company, planned through from mine to steel plant.

Principle 4: Optimize stocks

Manganese ore: a 170,000 dwt ship is cheaper, yet parcels average 20,000 tons.

Stockholding cost can exceed the freight saving.

Stockholding has a cost, and that cost can exceed the freight saving. Manganese ore shows the tension: a 170,000 dwt ship is cheaper per ton, yet parcels average 20,000 tons. Just-in-time stocks conflict with Principle 1, because high-value cargoes tend to travel in small parcels.



Exercise: Match the ship to the power plant

A power plant consumes 3.0 million tonnes of coal per year.

- Monthly consumption: 250,000 tonnes
- Daily consumption: approximately 8,200 tonnes
- Maximum on-site storage: 500,000 tonnes
- Minimum safety stock: 100,000 tonnes

Compare two feasible vessel options

Vessel option	DWT	Approximate coal cargo per voyage
Panamax	75,000 dwt	70,000 tonnes
Capesize	170,000 dwt	155,000 tonnes

The terminal can receive both options, and its maximum parcel size is 160,000 tonnes.

Tasks

1. Calculate how many cargoes per year are needed with each vessel.
2. Calculate approximately how many days of plant consumption each cargo represents.
3. Which option would you prefer? Explain the trade-off between fewer, larger deliveries and inventory, storage and scheduling flexibility.
4. What additional information would you need before making a final choice?

Solution: Comparing the two vessel options

The plant consumes **3.0 million tonnes per year**
= 250,000 tonnes per month
≈ 8,200 tonnes per day

	Panamax	Capesize
Approximate coal cargo	70,000 t	155,000 t
Cargoes per year	3,000,000 ÷ 70,000 ≈ **43**	3,000,000 ÷ 155,000 ≈ **20**
Days of consumption per cargo	70,000 ÷ 8,200 ≈ **8.5 days**	155,000 ÷ 8,200 ≈ **19 days**
Stock after delivery at the 100,000 t safety-stock trigger	**170,000 t**	**255,000 t**

What does the comparison tell us?

Capesize ships mean fewer port calls and larger deliveries. Panamax ships deliver smaller parcels and offer more scheduling flexibility. Both parcels fit the **500,000-tonne storage capacity** and the terminal's **160,000-tonne maximum parcel size**.

Decision: The figures show that both options are feasible. A final choice also requires freight rates, voyage lead time, delivery reliability and inventory costs.

Figures are approximate; the final cargo in a year may be smaller than a full cargo. DWT is not the same as cargo capacity.

Four participants

Four participants shape bulk transport, and each takes a different role. Cargo owners own fleets, time charter, or trade spot or COA. Commodity traders work mostly in the spot market, focused on the immediate cost of shipping today. Shipowners invest to minimize capital and operating costs, while operators take COA contracts and charter in ships at the margin, which is risky.

Cargo owners

Own fleets, time charter, spot or COA.

Commodity traders

Mostly spot market, with a focus on the immediate cost of shipping today.

Shipowners

Invest and minimize capital and operating costs, in ships suited to their markets.

Operators

Take COA contracts and charter in ships; they work at the margin, which is risky.

How bulk investors decide

Most investment is speculative, not discounted cash flow.

Most bulk investment is speculative rather than decided by discounted cash flow. Investors weigh size, utilization, backhaul, speed and gear, and very big ships may be unable to get backhaul cargoes. Owners hold portfolios of sizes, and ordering follows cycles: at the top for liquidity, at the bottom for cheap ships.

Trade-offs: size, utilization, backhaul, speed, gear. Very big ships may be unable to get backhaul cargoes.

Owners hold portfolios of sizes; Aframaxes won short-haul share until VLCCs moved into West Africa.

Ordering follows cycles: at the top for liquidity, at the bottom for cheap ships.

Terminals: oil and iron ore

Oil and iron ore terminals show two different systems. At an oil terminal, terminal pumps load the ship and the ship's pumps discharge, through tanks and pipelines. An iron ore terminal stockpiles ore, which is reclaimed by a bucket drum onto a belt and loaded by a ship loader at up to 16,000 tons an hour.



Oil

Terminal pumps load; ship pumps discharge, through tanks and pipelines.



Iron ore

Spreader, reclaimer, conveyor, ship loader. Ore is stockpiled, then reclaimed by a bucket drum onto a belt.

Loading up to 16,000 tons an hour; grabs about 60 cycles an hour.



Liquid bulk: a network, not a trade

Tankers link raw materials, processing plants and products, ferrying in the raw materials and shipping out the product. Liquid bulk is therefore a network rather than a single trade, covering crude oil, LPG, LNG, chemicals and agricultural liquids. The ships range from crude tankers of 441,000 dwt down to bitumen carriers of 2,000 dwt.

441,000 dwt → 2,000 dwt

From crude tankers down to bitumen carriers.

The crude oil trade

Origins of seaborne oil

1859

First commercial crude

Titusville, Pennsylvania; the first cargo, in barrels for London, followed two years later.

Barrels → case oil → tanks

1886

Glückauf

First purpose-built tanker using the hull as containment.

Bulk shipping of oil began with the first commercial crude at Titusville, Pennsylvania, in 1859, when the first cargo went to London in barrels two years later. Bulk saved 4s a barrel, and half of UK oil imports came in bulk within three years. The Glückauf of 1886 was the first purpose-built tanker, using the hull as containment, and the fleet grew from 12 bulk tankers that year to 90 by 1891.

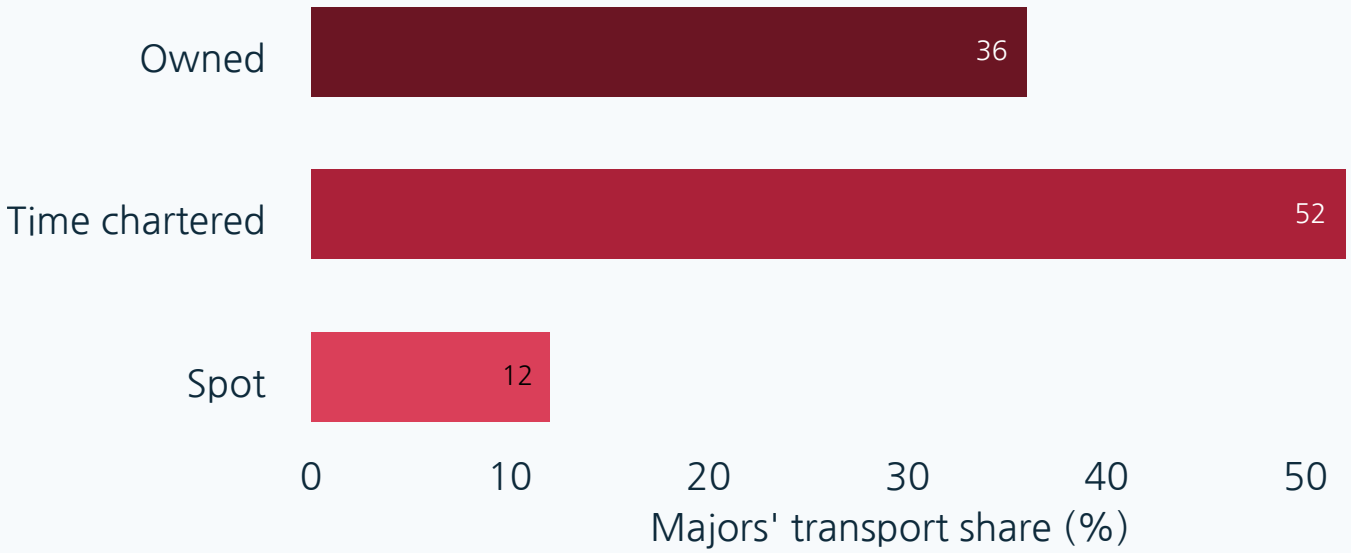




The oil majors' transport machine, 1950 – 70

Between 1950 and 1970 the oil majors ran their transport near the theoretical optimum. Moving from 80,000 to 200,000 dwt cut round-trip cost per ton by 34%: in 1968 an 80,000 dwt tanker cost about 27s 5d per ton on the Rotterdam-Kuwait round trip, against 18s 1d for a 200,000 dwt ship. Time charters ran for 15-20 years.

Late 1960s



Late 1960s, approximate shares.

From planned system to spot market

In the 1970s demand fell, supply got out of control, and the oil companies stopped treating transport as a core business. Oil transport moved from industrial planning to market operation. The spot share of the independent fleet rose from about 20% in the early 1970s to over 70% in the early 1990s.

EARLY 1970S

~20%

Spot share of independent fleet

EARLY 1990S

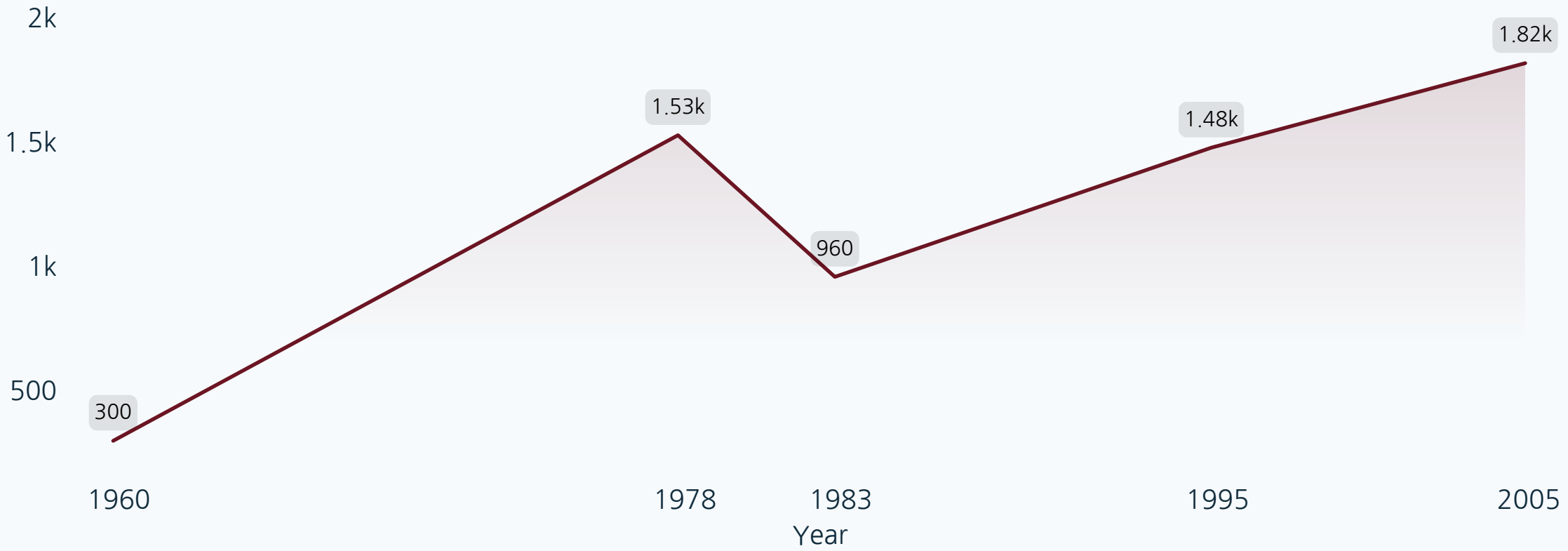
>70%

Spot share of independent fleet

Oil transport moved from industrial planning to market operation.

Volatile oil trade volumes

World oil trade (mt)



World oil trade was volatile. It rose from 300 mt in 1960 to a peak of 1530 mt in 1978, then fell to 960 mt in 1983, recovered to 1480 mt in 1995 and reached 1820 mt in 2005. The causes of the fall were mature markets, two depressions, $30 oil and substitution.

Where the oil comes from

The Middle East holds 60% of proven reserves and supplied 47% of 2004 exports, so it is the dominant origin of crude oil. Most other suppliers cluster around the North Atlantic, in the North Sea, West Africa and Russia. Shipping from the Middle East is long: about 12,000 miles round the Cape to western Europe, and over 6,000 miles to Japan.







The ship demand multiplier

Middle East is the swing supplier.

01

Exports grow

Middle East share and average haul rise.

02

Imports fall

The process reverses.

7,000 → 4,450

Average haul in miles: mid-1970s to 1985.

The Middle East is the swing supplier, and its share of exports drives ship demand. When Middle East exports grow, the average haul rises; when imports fall, the process reverses. The crude oil haul rose from 4,500 miles in the 1960s to over 7,000 miles, so each change in the swing share multiplies the ships needed.

Oil cargoes, VLCCs and chokepoints

Cargo types differ by density and cleanliness: dirty vs clean. Crude oil is shipped in parcels typically over 100,000 tonnes, and the VLCC is the ship built for the longest hauls. The Suez Canal, deepened after 1975, shapes which ships can use it, as the figures below show.

VLCC, 300,000 dwt

About 2 million barrels; 22 m draught; pumping 15,000–20,000 tons an hour.

Suez after 1975

Deepened to 16.2 m: loaded ships up to 150,000 dwt. Canal oil shipments were 85 mt in 2004, below the 167 mt peak before 1967.





The oil products trade

~500 mt

By sea in 2005;
half clean, half dirty.

About 500 mt of products moved by sea in 2005, half clean and half dirty. Three drivers shape the trade: refinery location, balancing trades and the deficit trade. Middle East export refineries shipped about 117 mt of products in 2006, and Asia accounts for two-thirds of the growth among the ‘other’ importers.



Transporting oil products

Most trade moves in tankers of 6,000-60,000 dwt, often coated. Clean products need coated, clean tanks, while dirty ones can use conventional tankers. In the 2005-6 sample the average parcel was 44,600 tonnes, carried by a ship of 53,800 tonnes, and dead freight amounts to 18%, or 22% for naphtha.

2005-6 sample	Average
Parcel	44,600 t
Ship	53,800 t

18%

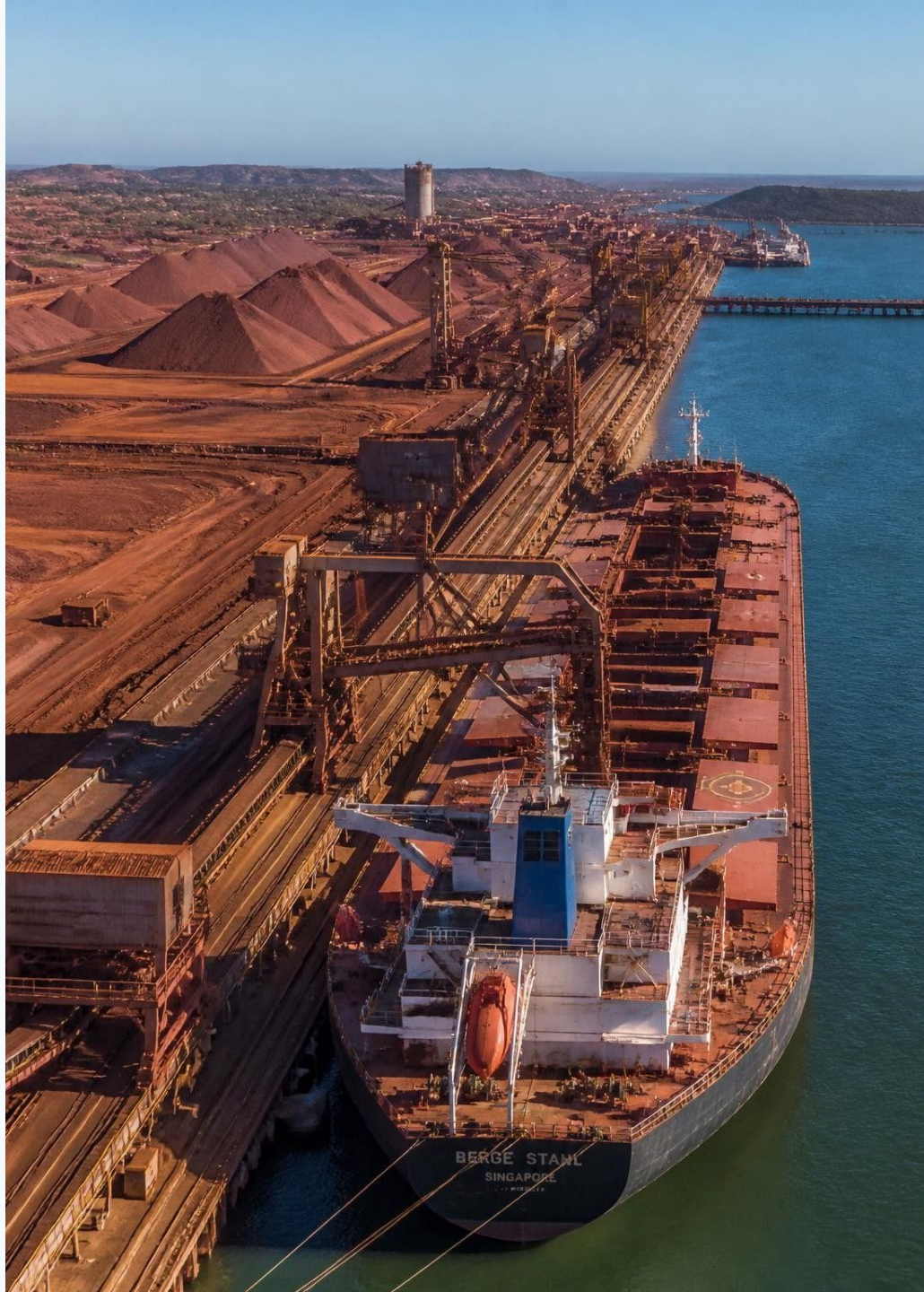
Dead freight; 22% for naphtha.

Major dry bulk trades

Iron ore: the steel industry's raw material

590 mt

Iron ore is dense, sells for about $40 per tonne, and has a stowage factor of 0.3 cubic metres per ton. Australia (206 mt) and Brazil (205 mt) supply 70% of exports. China added 300 mt of steel capacity in 2002-6, driving the trade to 720 mt.





Iron ore: the integrated shuttle system

Iron ore shipping became an integrated shuttle system, with ships built to run between mine and plant. The prototype was Bethlehem Steel's at Sparrow's Point in the early 1920s, with two 22,000 dwt carriers loading ore at Cruz Grande, Chile. Ships grew from 120,000 to 170,000 dwt between the 1960s and 2007.

Period	Ship size
1960s → 2007	120,000 → 170,000 dwt
1965	80% in ships under 40,000 dwt
2005	80% in ships over 80,000 dwt

Coal: two different markets

2004 imports: 665 mt.

Coking coal

For steel

~2%

a year, 1980-2005

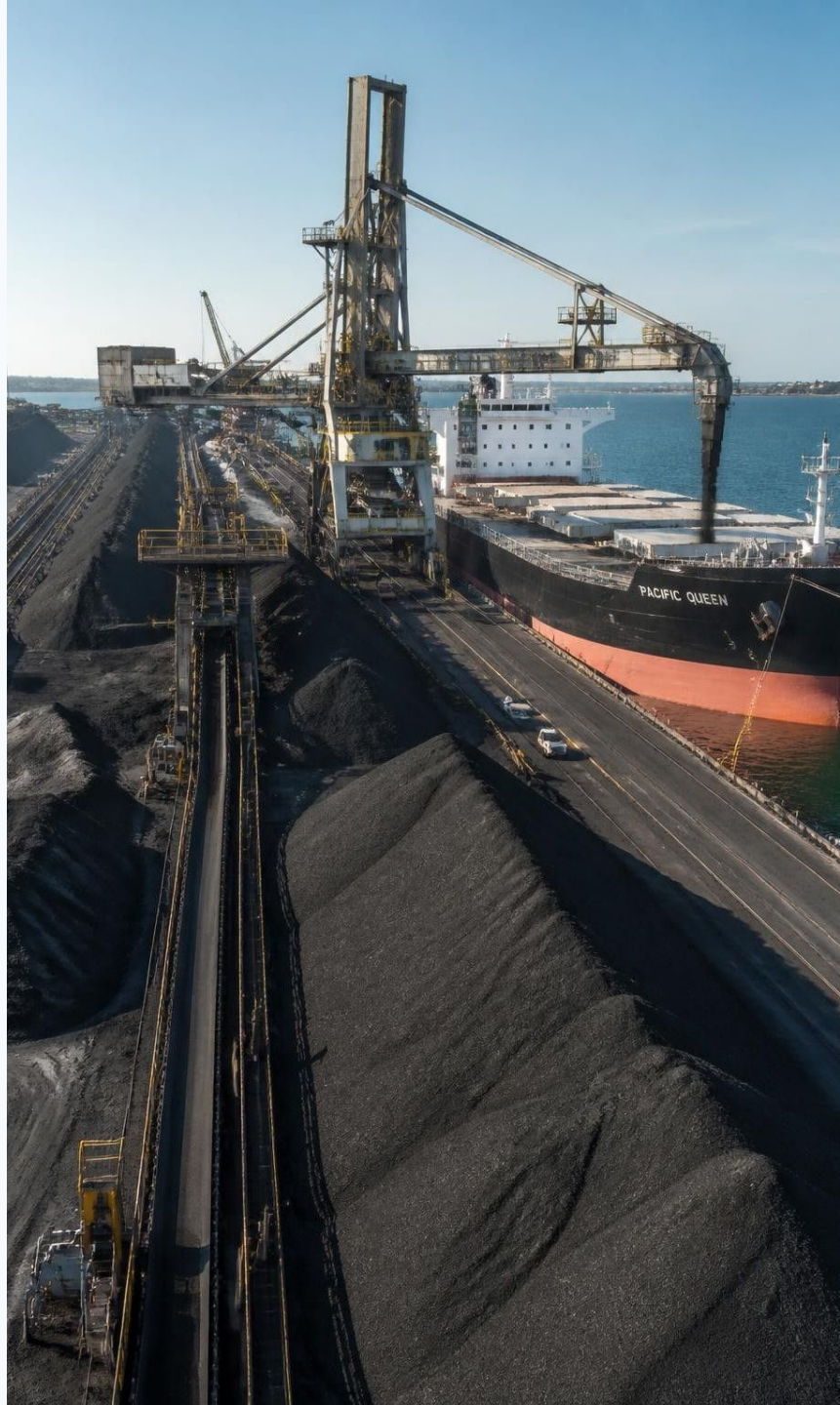
Thermal coal

For power

~9%

a year, 1980-2005

Coal trade divides into two different markets. Australia supplies over a third of exports. Coking coal is converted to coke for the blast furnace, while thermal coal fuels power stations, and the two grew at different rates, about 2% and 9% a year from 1980 to 2005.





Grain: a different business

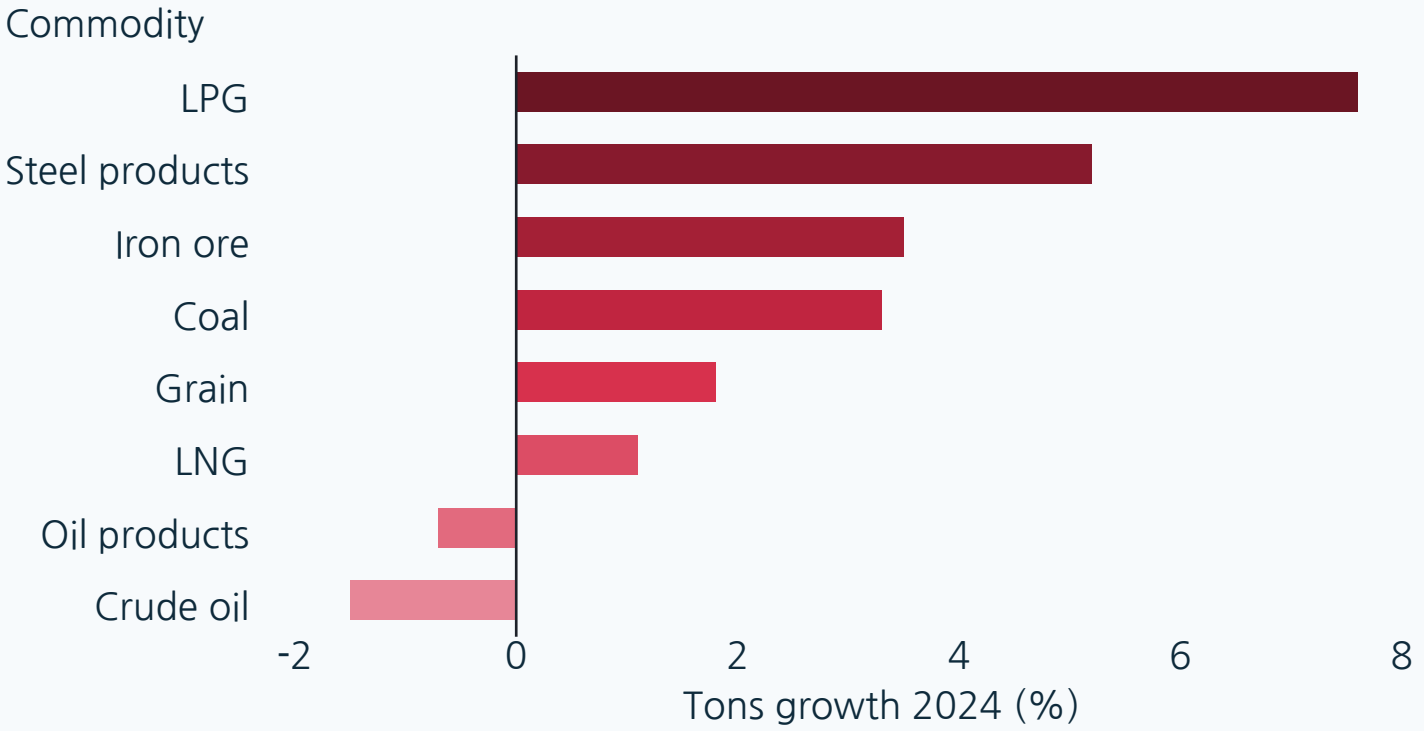
236 mt

In 2005; wheat about half.

Growth is driven by meat consumption and feed demand. The USA exports 46% of the trade and Australia 10%. Grain is seasonal in its trade and irregular in both volume and route, so its flows are fragmented, with seasonal peaks and many small importers.

Fragmented flows, seasonal peaks, many small importers.

2024 commodity scorecard: who grew, who fell



- Iron ore: +3.5% tons, +6.4% ton-miles
- Coal: +3.3% tons, highest tonnage since 1980
- Crude oil: -1.5% tons, +1.6% ton-miles
- Oil products: -0.7% tons, +6.5% ton-miles
- Grain: +1.8% tons, -0.7% ton-miles

Tonnage growth in 2024 was uneven across commodities. Ton-miles told a different story, rising on iron ore, coal and oil products even where tons fell or stalled. Longer routes, from Brazil, Australia, Colombia and the US, drove most of that gap. Grain was the clearest reversal, with tons up 1.8% but ton-miles down 0.7%.

Source: UNCTAD, Review of Maritime Transport 2025

Minor bulks: ingenuity in the margins

Agribulks, sugar, fertilizers, metals and minerals, steel and forest products. Sugar is very fragmented and has benefited less from bulk systems. Minor bulks total about 1 billion tons in 2005, growing 2.0% a year, and many straddle liner and bulk systems, served by specialized ships described in Chapter 12.

~1 bt

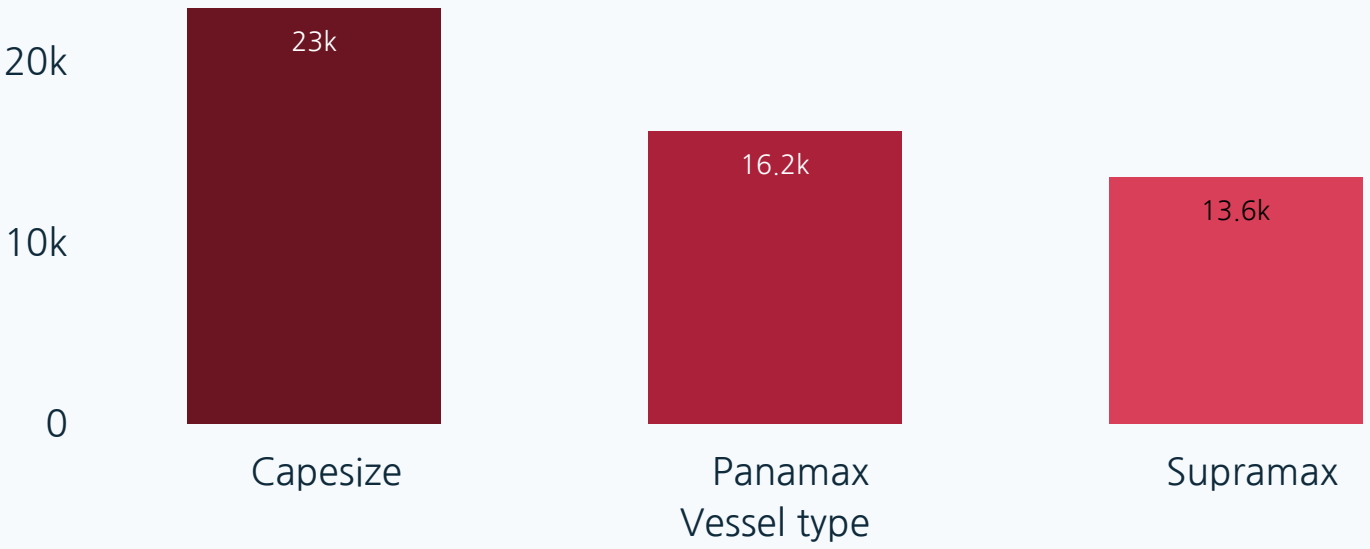
In 2005, growing 2.0% a year.

Many straddle liner and bulk systems; specialized ships (Chapter 12).



Freight markets 2024 – 25: strong, then softer

2024 average earnings (USD/day)



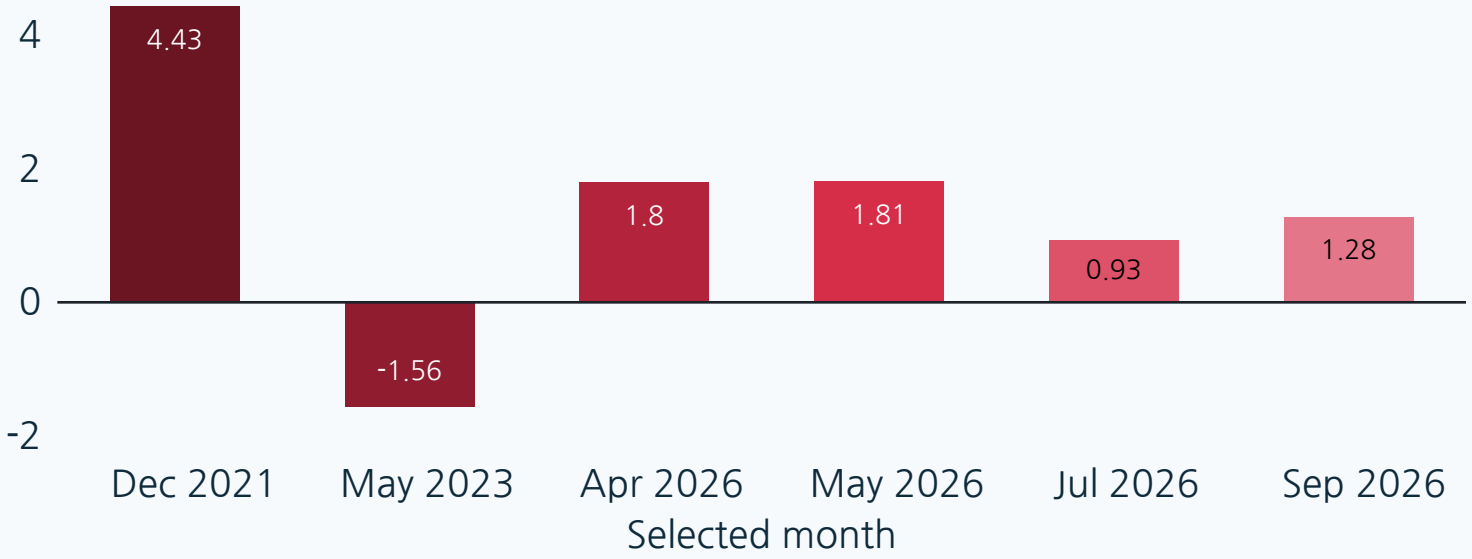
Capesize averaged $22,953/day in 2024 (2023: $16,389) and peaked above $35,000/day, while the dry bulk fleet grew about 3%. Weaker iron ore and coal demand pulled earnings down in 2025, with the BDI averaging 1,685.95 in June. Tanker earnings remain historically high despite falling from their 2022-2024 peaks. The Strait of Hormuz carries about 34% of global seaborne oil exports but only about 3% of dry bulk trade.

- Baltic Dry Index: 1,755 average in 2024, +27.3%
- H1 2025 dry bulk earnings: about $10,750/day, roughly 30% lower
- Crude tankers: $52,013/day in April 2025, $33,393 in June
- Product tankers: $25,916/day in March 2025, vs $44,555 a year earlier

Source: UNCTAD, Review of Maritime Transport 2025

Supply chain pressure: the GSCPI

GSCPI (standard deviations)



- Record high: 4.43 in Dec 2021
- Low: -1.56 in May 2023
- Latest: 1.28 in Sep 2026
- Chart shows selected points, not a continuous series

The New York Fed GSCPI combines transport-cost data, including the Baltic Dry Index for bulk shipping, with PMI delivery times, backlogs and purchased stocks for seven economies. It uses 27 variables, cleaned of demand effects and combined by principal component analysis. Zero is the average; values show standard deviations above or below it. The BDI is a bulk freight input, so bulk rates feed directly into this pressure gauge.

Source: Federal Reserve Bank of New York, GSCPI data; Benigno, di Giovanni, Groen and Noble (Jan 2022)

Summary: a system for every commodity

Integrated systems raised parcel sizes and held down transport costs.

Four tests decide when a cargo goes bulk, and four principles then guide its transport system, with trade-offs between them. Every commodity falls into one of three classes: liquid, major dry and minor bulks. Each class has its own system, and the chapter's cases show how each is designed.

Four tests

Decide when a cargo goes bulk.

Four principles

With trade-offs between them.

Three classes

Liquid, major dry, minor bulks.

Discussion questions

Each question asks you to reason from the chapter rather than from opinion. Answer the first by weighing the four principles against one another, since each has a capital cost and some conflict. Answer the second and third by tracing oil transport from planning to the spot market, and by following the Middle East's swing role through the tanker cycle. Support each answer with a figure or case from this chapter.

1 Which principle would you sacrifice first, and why?

2 Why did oil transport move from planning to the spot market?

3 How does the Middle East swing role amplify tanker cycles?