

An aerial photograph of the NHH building in Norway, a tall, modern structure with a clock tower, situated on a hillside overlooking a large body of water and mountains. The building is surrounded by greenery and a paved courtyard with some people walking. The sky is clear and blue.

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Shipping Economics and
Analytics-The economics of
shipping management L4

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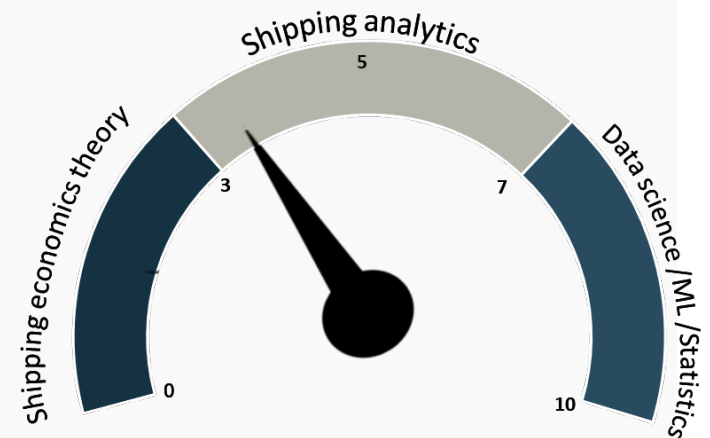
This lecture

Before break (45 min)

- Concepts of the geography of shipping transport, shipping markets, and vessel types
- Types of contracts

After break (45 min)

- Operational decisions related to vessel performance
 - **Cost vs output (tonnes)**
- Fuel consumption
- The cubic law revisited
- The effect of port efficiency in voyage efficiency
- Speed reduction measures for decarbonizing shipping
- The barriers for implementing speed reduction measures to reduce emissions
- Regulations effect on shipping management costs



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Today in the news

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Shipowners Forum Greece 2025

National Gallery, Athens | 23 September 2025

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Northern Sea Route transit traffic inches higher for 2025's first summer sailing quarter

Crude oil flows from Russia to China account for over half volumes shipped, but container traffic is rising



A convoy of ships sailing through the Northern Sea Route. (Photo: Rosatom)

IN THE HIGH COURT OF GUJARAT ADMIRALTY AND VICE ADMIRALTY JURISDICTION

SALE OF VESSEL BY PUBLIC AUCTION

The Honourable High Court of Gujarat by order, dated 28.07.2025 passed in Admiralty Suit No. 20 of 2025 with Civil Application (For Order) No.1 of 2025, directed to place forthwith Defendant Vessel Nirvana (Ex Name Dancy Dynamic (IMO No.9158161) sale only for demolition purpose through Public Auction.

Pursuant to the said direction, offers are invited in sealed cover addressed to the undersigned and to reach the undersigned on or before 10/09/2025 up to 5.00 PM in the Registry of High Court of Gujarat, SoLa, Ahmedabad-380060, Gujarat, India, for public auction sale of the Vessel Nirvana (Ex Name Dancy Dynamic (IMO No.9158161) as per details given below:-

Type	: Oil Products Tanker
Built	: 1999
Gross Tonnage	: 27526 MT

At present lying at Alang Port, Bhavnagar in the State of Gujarat, India.

Lucy Hine
TradeWinds correspondent | London


Published 2 September 2025, 12:55

Shipping traffic on the Northern Sea Route (NSR) has risen in the summer sailing period from June to August, according to a new report from the Centre for High North Logistics (CHNL).



Based on satellite AIS data on vessel movements, the centre recorded 52 full transit voyages through the NSR during the three months.

ClassNK Fleet Cost Simulation

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Learning outcomes

This lecture will help with the following learning outcomes:

Knowledge

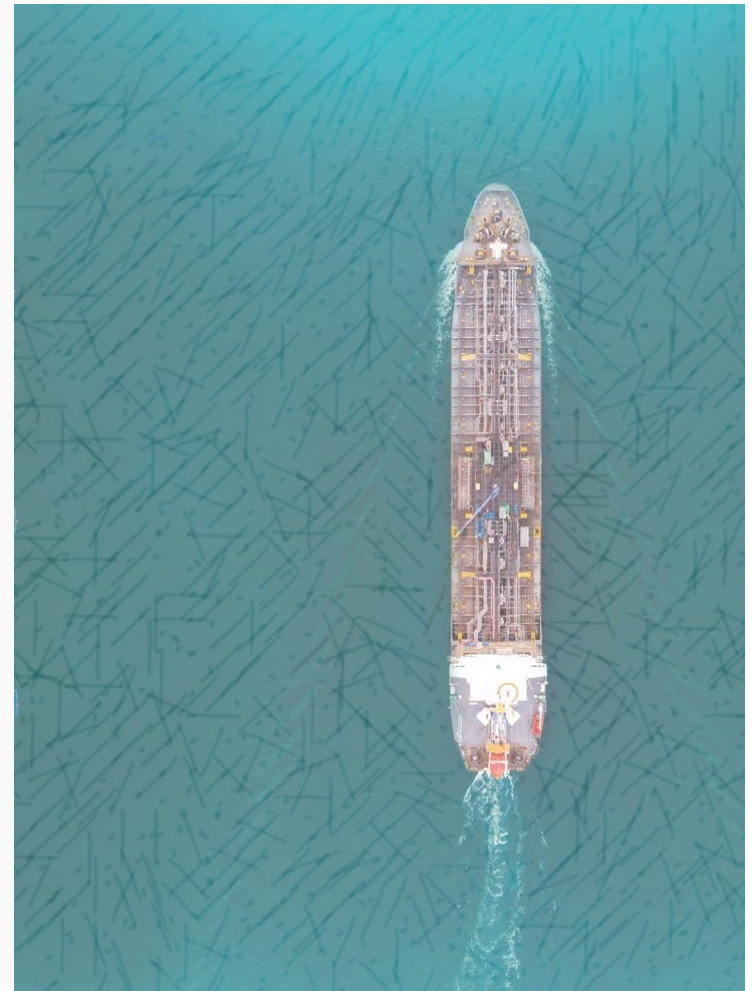
- is familiar with recent development in data-driven analysis applied to the freight markets and ship operation

Skills

- finds, synthesizes, and presents information on the international shipping
- can communicate with industry practitioners using correct terminology

Competency

- exchanges opinions and experiences with others with a background in the field



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Liner service

- Sails in a regular route
- Vessel types:
 - Container vessels,
 - Roll On Roll Off (Ro-Ro)
 - Break bulk cargo
 - Passengers
- 80% of container market share covered by 3 alliances:
 - Ocean Alliance (CMA CGM, Cosco Shipping, OOCL, Evergreen)
 - Gemini Cooperation (Hapag Lloyd, Maersk)
 - Premier Alliance (ONE, HMM, Yang Ming Marine)



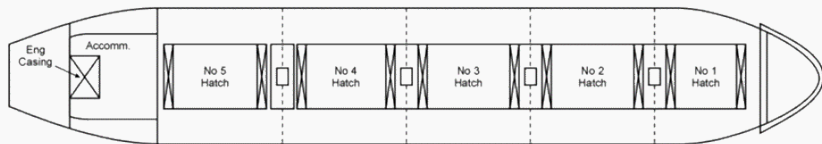
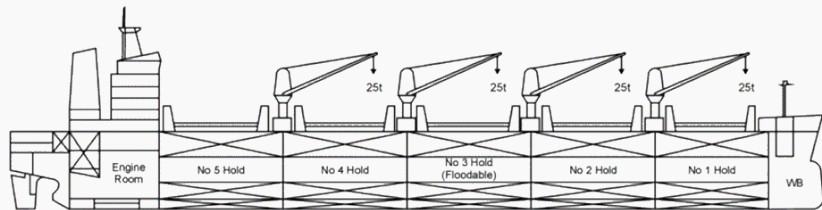
Tramp service

- Don't follow a schedule
- Significantly more segregated market than liners
- Vessel types:
 - Bulk carriers
 - Crude and oil products tankers
 - Specialized tankers (LNG, LPG, chemical tankers)
- This course focus

Bulk carriers



Source: DryBulk magazine



Source: Marine Insight

- Capesize ~180k DWT (>150k DWT)
 - Coal and iron ore
- Panamax ~75K DWT
 - Coal, iron ore, grain
- Supramax ~56k DWT
 - Coal, grain, steel products etc.
- Handysize ~28k DWT
 - Grains and minor bulks

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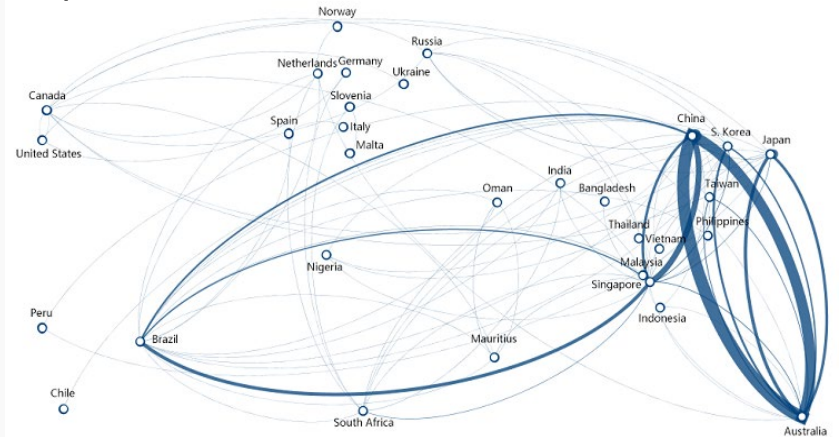
Main routes/trade

Bulk carriers

- Iron ore
 - Infrastructure development drives trade
 - Main exporters : Brazil, Australia, South Africa
 - Main importers : China, Japan, Korea
- Coal
 - Seasonal cargo. Driven by demand on electricity production
 - Main exporters: South Africa, South Eastern Australia, Colombia
 - Main importers: China, India, Northern Europe
- Grain
 - Driven by consumption on larger populations. Sudden increase of demand by droughts and war.
 - Main exporters: US Gulf, Brazil, Ukraine
 - Importers: China, Japan, Northern Europe

Other cargoes: Fertilizers, Scrap metal

Capesize vessels



Source: Maritime Executive

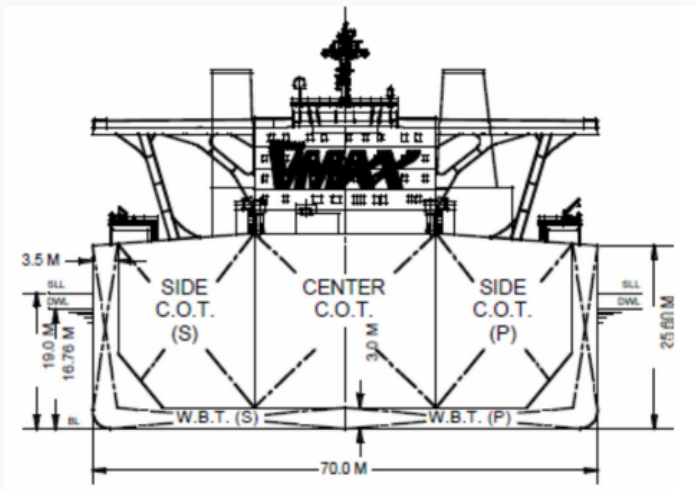
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Crude oil and product tankers



Source: Euronav



Source: Marine Insight

- Crude

- Very Large Crude Carriers (VLCC) ~ 300K DWT
- Suezmax ~160k DWT (120k to 180k)
- Aframax ~105k DWT

- Refined oil (products)

- Long range (LR2) >80k DWT
- Long range (LR1) ~65k DWT
- Medium range (MR) ~50k DWT

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Main routes/trade

Crude and oil products

- Crude oil
 - Seasonal cargo. Driven by demand on electricity production and infrastructure development
 - Main exporters : Nigeria, Saudi Arabia, UAE, Russia, US, Iraq
 - Main importers : US, China, Northern Europe, Japan, Korea, Singapore
- Product
 - Clean (Gasoline/Diesel) or dirty (Fuel oil or residual oils)
 - Trade tightly linked to crude oil prices and refineries stock and production
 - Main exporters: Northern Europe, UAE, US Gulf
 - Main importers: US Gulf, Japan, Singapore



Source: Euronav

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Specialized tankers



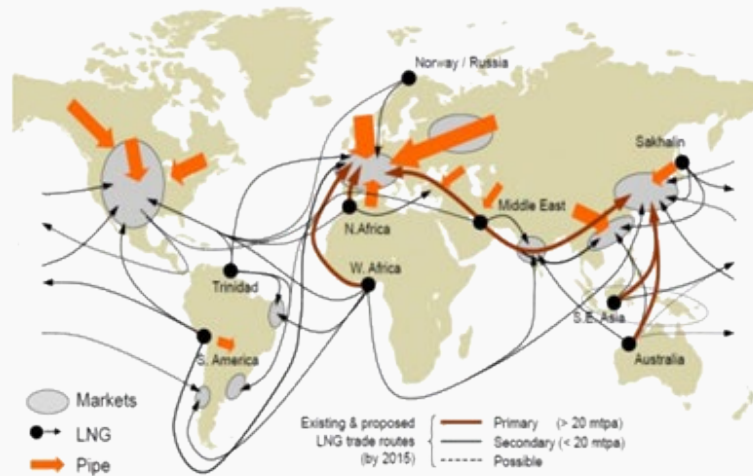
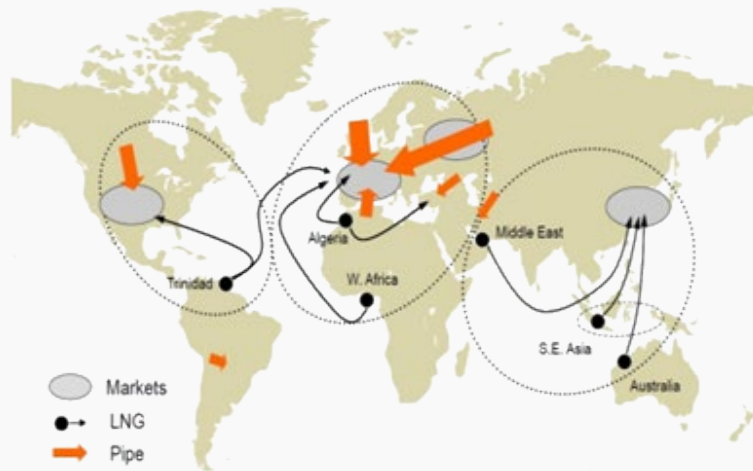
- Liquefied Natural Gas (LPG) carriers
 - Natural gas transported in its liquid form. Liquefaction happens at -160°C
- Liquefied Petroleum Gas (LPG) carriers
 - Liquefied by high pressure or by low temperature
- Chemical tankers
 - Any liquid cargo with specialized handling (e.g., dangerous or sensitive cargo)
 - Vessels with many coated tanks and multiple cargo pipes, manifolds (connection) layout

Source: TradeWinds

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Trade evolution



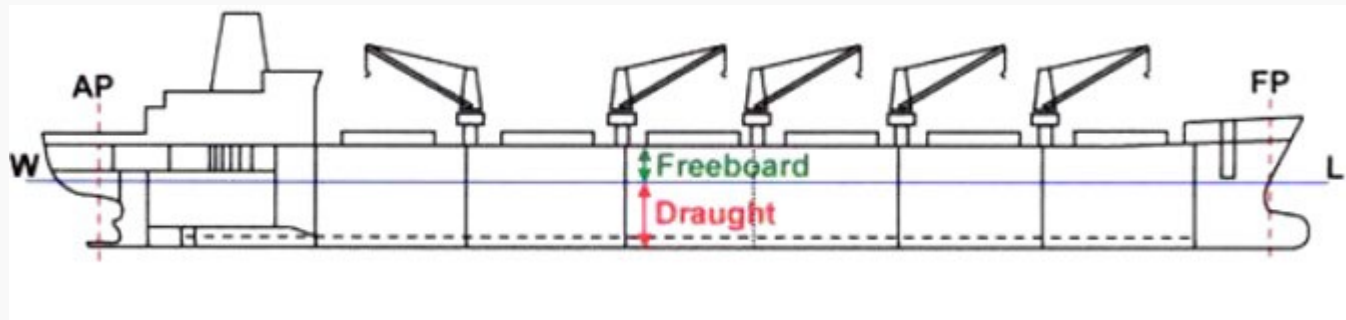
Source: CreditSuisse

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Physical limitation

Draught



Draught: depth to which a ship is immersed in water. Depends on ship design and water density.

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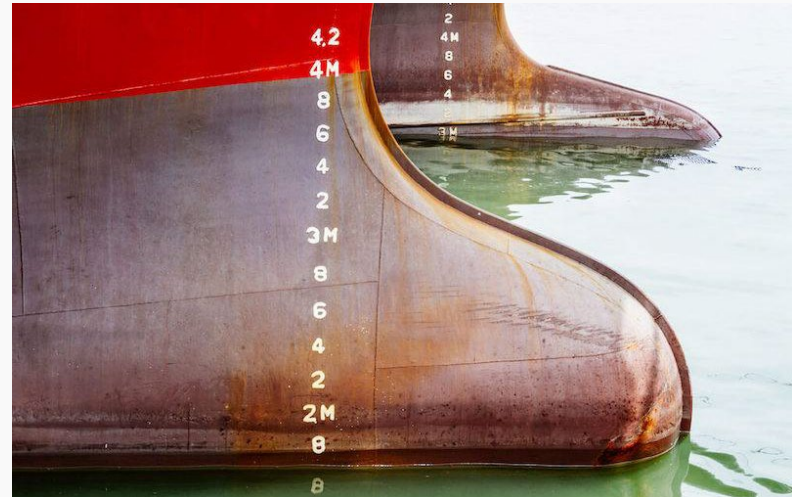


Physical limitation

Draught



Source: Britannia AS



Source: Marine Insight

Physical limitation

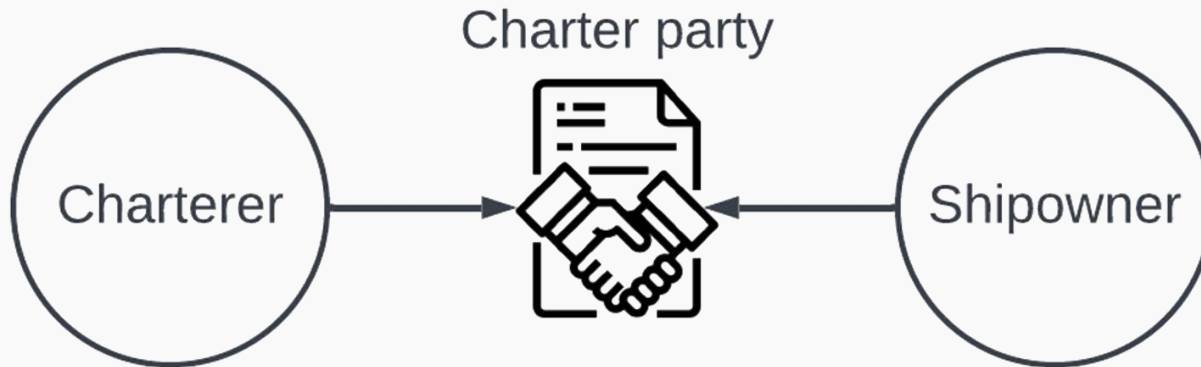


Break

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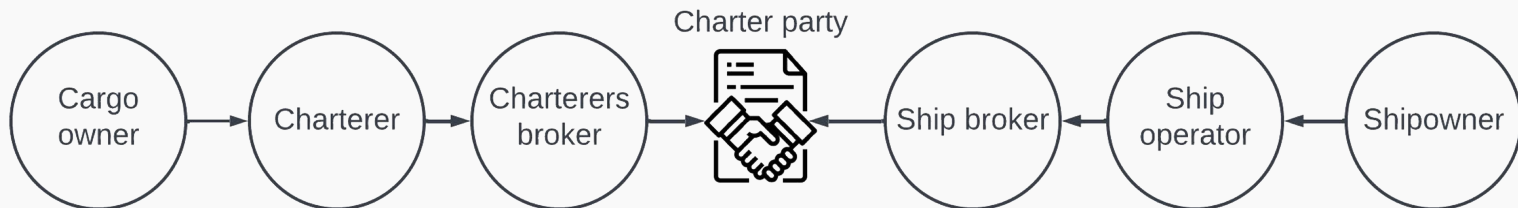
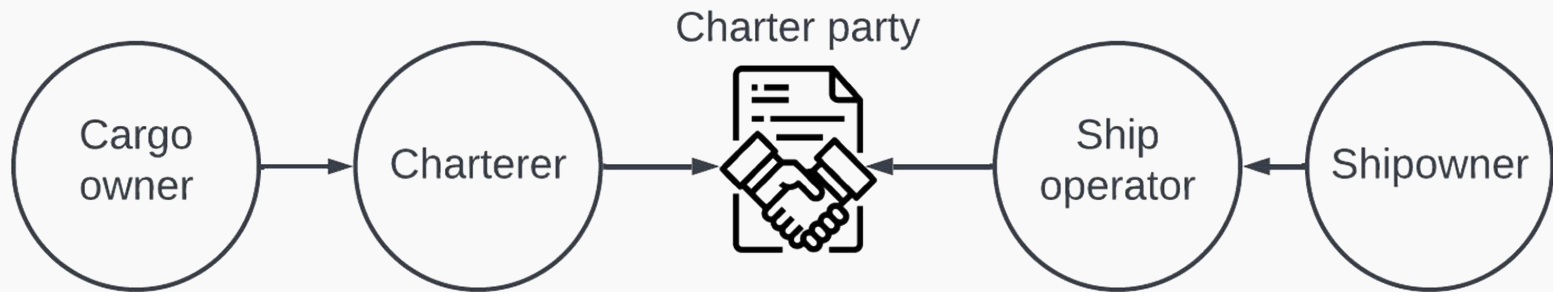
Who is who in a voyage venture?



Charterer: individual or company who hires a ship from a shipowner

Charter party: a contractual agreement between a shipowner and a charterer stipulating all terms and conditions for the hire of the ship or the space in the ship

Who is who in a voyage venture?



Shipbroker: person negotiating the terms for the charter of a ship on behalf of the charterer or shipowner

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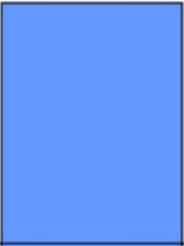




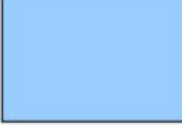
Types of charter



	Spot market employment	Long-term employment
Voyage charter	<p>The hiring of a vessel and crew for a voyage between a load port and a discharge port</p> <p>Control of the ship's operations remains with the shipowner</p>	<p>Consecutive voyages: The vessel is contracted for several voyages which follow consecutively (X voyages or as many as possible within period X)</p>
Time charter	<p>Tripcharter: A short time charter agreed for a specified trip only</p>	<p>Period timecharter: The hiring of a vessel for a specific period of time. The charterer has commercial control.</p> <p>Fixed or floating freight rate</p>
Contract of Affreightment (COA)		<p>Shipowner undertakes to carry a number of cargoes within a specified period of time on a specified route</p>
Bareboat charter		<p>A financial leasing arrangement whereby the hire covers only capital costs. The charterer becomes the disponent owner and is responsible for all technical and commercial management.</p>

Differs in payment terms and division of costs



Who pays for what?

<u>Cost</u>	<u>Main Components</u>	<u>Bareboat</u>	<u>Time**</u>	<u>Voyage***</u>
Capital	Deposit			
	Repayment of loan principal			
	Interest			
Operating	Manning			
	Insurance			
	Repairs & maintenance			
	Stores, spares and supplies			
	Administration & management			
Voyage	Fuel (bunkers)			
	Port disbursements****			
	Canal & seaway transit costs			

 Cost for charterer's account
  Cost for owner's account

* Also known as a demise charter. Mainly a financing tool. Bareboat charterer may have option to buy.

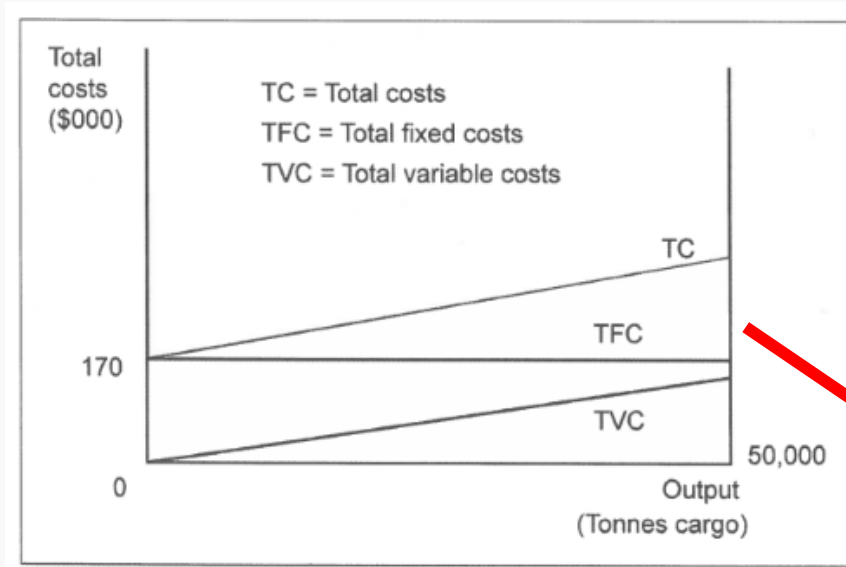
** Includes period charters and time charter trips (or trip charters); *** Single voyages, consecutive voyages and contracts of affreightment (COA)

**** Fio basis – all costs on charterer's account. Liner terms – all costs on owner's account. Gross load/discharge free – loading costs on owner's account, discharge cost on charterer's account

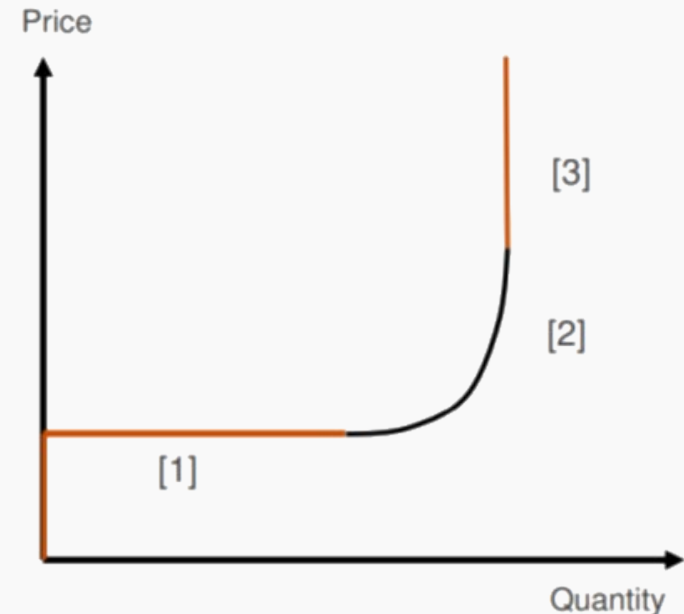
Source: Drewry Shipping Consultants Ltd



Short review...



Source: Institute of Chartered Shipbrokers, 2016



Source: Roar Adland

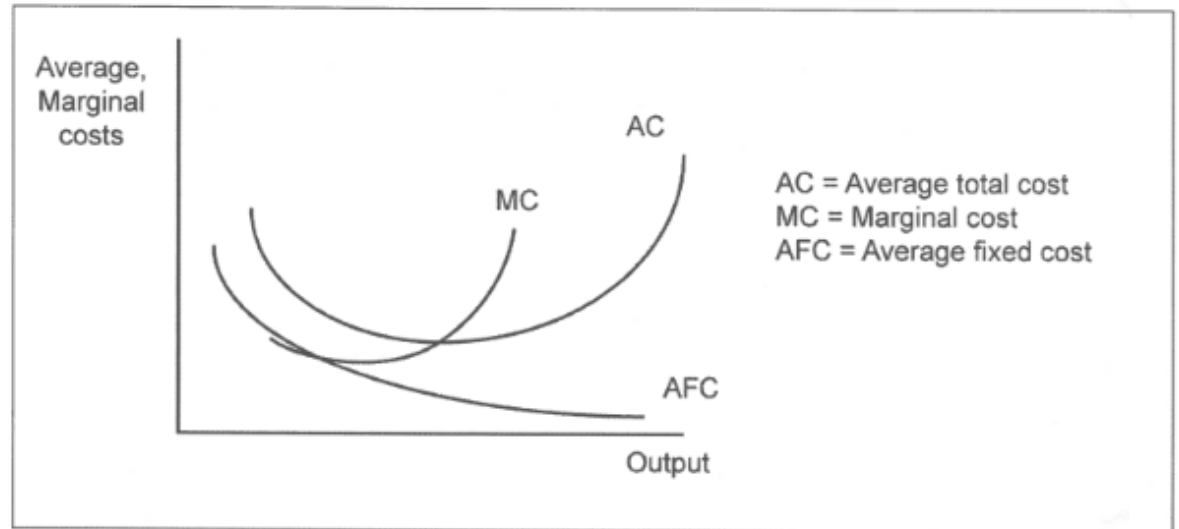
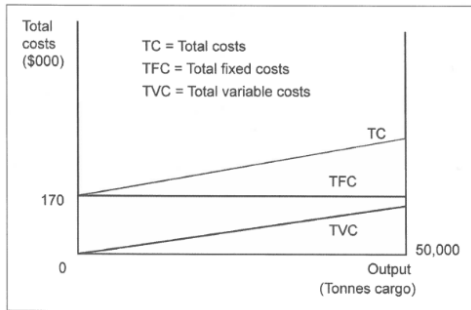
- **Short run**

- Fix costs (capital and operational) – constant
- Variable/voyage costs (fuel, port, canal dues)–function of output.
 - Fuel consumption marginally increase with weight
 - Port cost per quantity (tonnes) of cargo handled

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Cost and output (tonnes transported) relationship



Source: Institute of Chartered Shipbrokers, 2016

- Average cost (Fix or Variable) = Fix or variable cost/tonnes (\$/tonnesxmiles)

Then :

- Average total cost = Average fix cost + Average variable cost
 - Remember that on the short run, Variable cost=Marginal cost
 - Fix costs cannot be altered in a short run, by definition.

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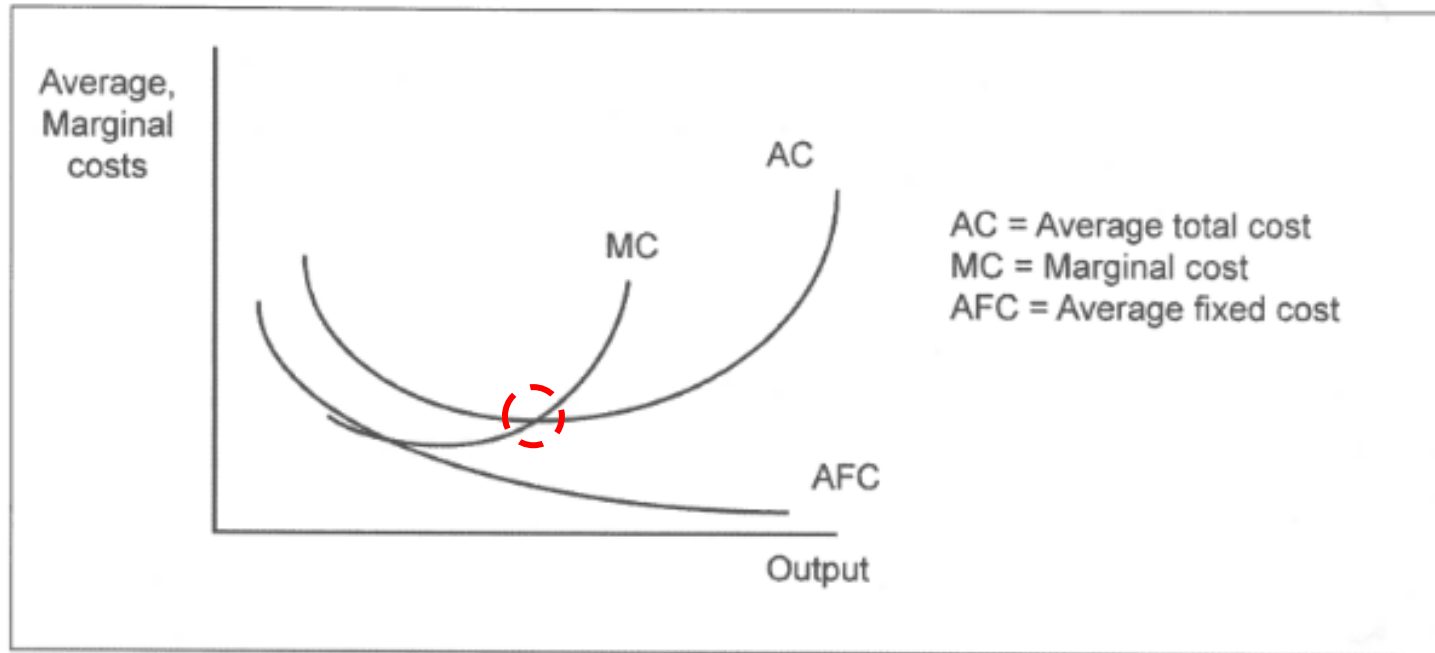


What can alter this cost vs tonnes output relation?

1. The cargo load factor (*Average fix cost change*)
2. Proportion of journey spent in ballast (empty) (*Average fix cost change*)
3. Voyage distance (*Average variable cost and avg. fix cost change*)
4. Vessel speed at sea (*Average variable cost and avg. fix cost change*)
5. Cargo handling rates (*Average variable cost and avg. fix cost change*)

The relation is: *more voyage time more fix cost (crew + capital payments), more distance then more variable cost (bunkers), more cargo (more variable cargo handling cost)*

1) The cargo load factor



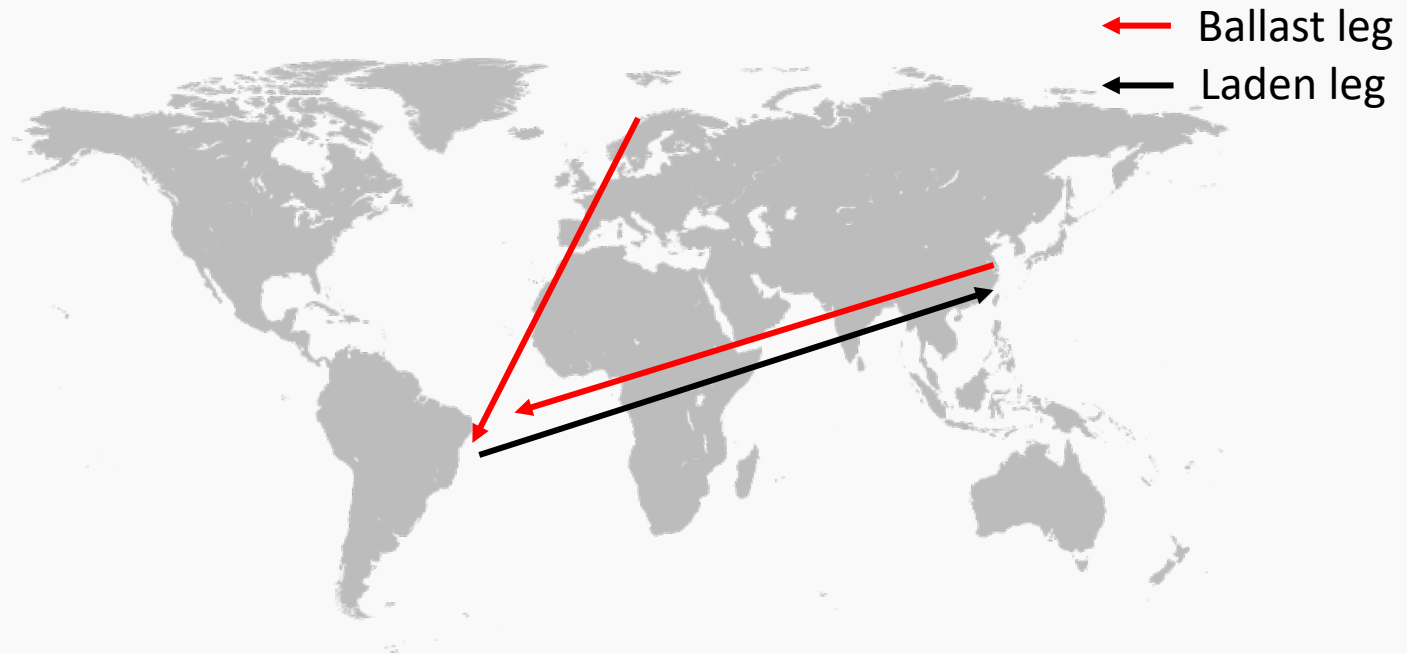
Source: Institute of Chartered Shipbrokers, 2016

- Translates as: fill the vessel for the minimum average cost
- Average variable cost marginally change (extra fuel consumption is small with additional cargo)
 - What if the fuel price decrease?

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2) Proportion of journey spent in ballast Triangulation

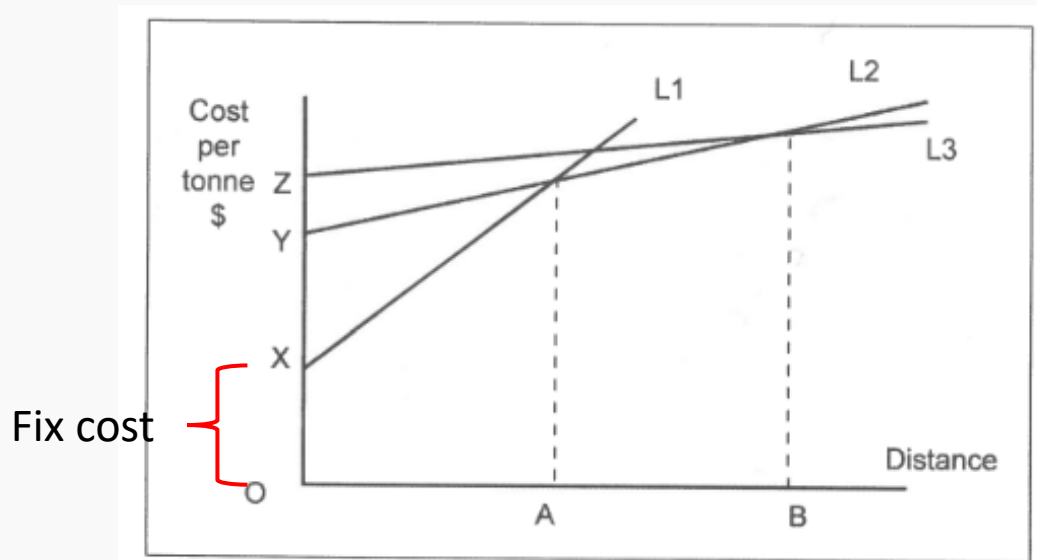


- Also a matter of utilization. The best you use your vessel to transport cargo (income) then the more spread of the fix cost and lower voyage costs

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3) Voyage distance



L1: Smallest ship
L3: Largest ship

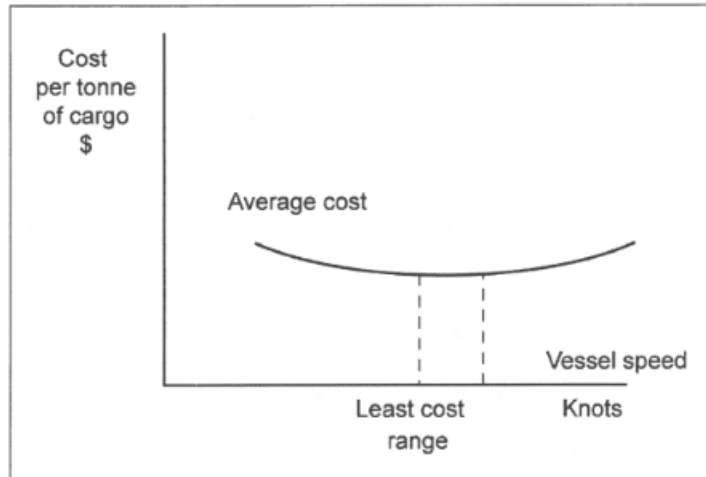
Source: Institute of Chartered Shipbrokers, 2016

- Larger capital costs and operational costs on larger vessels
- Lines slopes depict the voyage cost (bunkers). Slope decreases with the ship size as fuel consumption increases less than proportionally with ship size and more cargo is moved
- Bigger vessels are more economic on longer distances

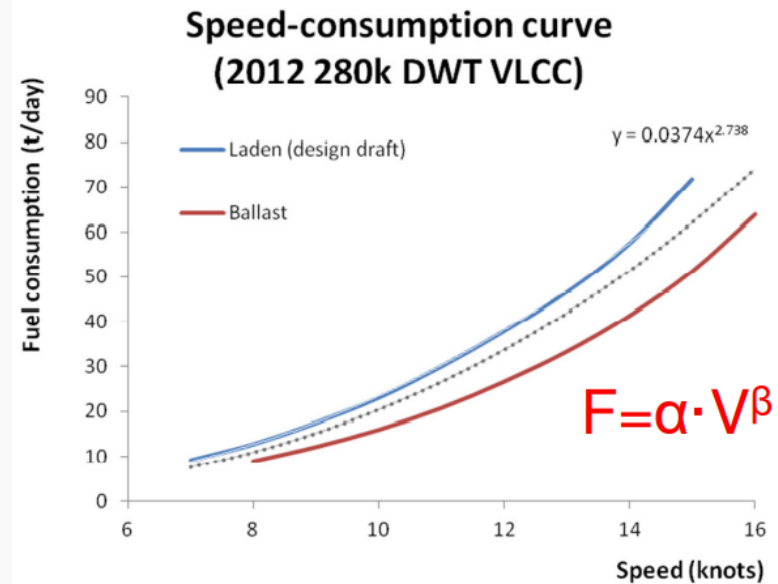
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4) Vessel speed



Source: Institute of Chartered Shipbrokers, 2016



Source: Roar Adland

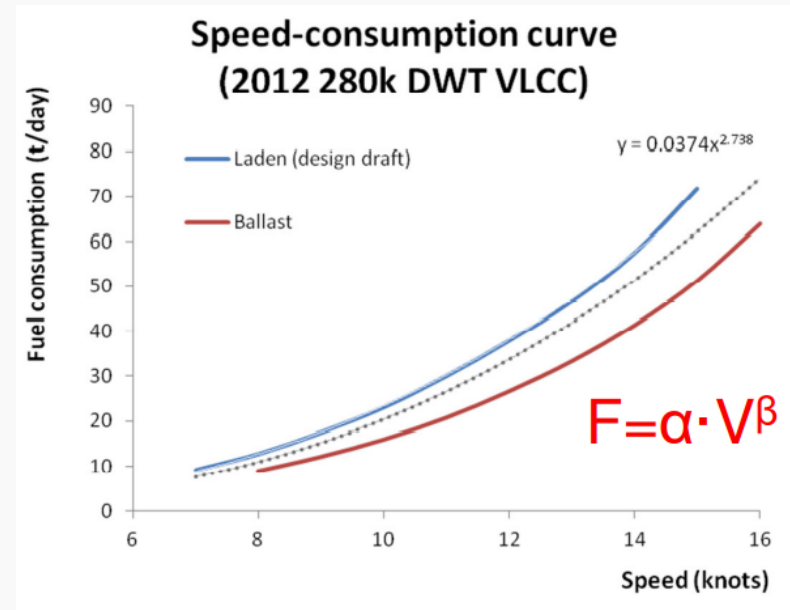
- Speed reduces fuel consumption
- A reduction on speed (less voyage costs), increases the voyage time (more operational costs). Tradeoff is necessary and it varies based on route, freight rate, fuel consumption curve, elasticity (β) Adland et al., 2020
- Freight rates promote speeding up, out of optimal areas of the curve. Supply needed and adjusted by speed in a short run.
- Bunker prices increase, shift the cost curve (left figure) up

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Theoretical speed-consumption relationship

- Approximate a cubic function of vessel speed (Ronen, 1982)
- Based on ship design and hull design and condition
- Estimated from simulations, model trials and sea trials when the ship is delivered in calm sea conditions
- Weather margin of 10 to 20% is customary as a buffer for weather
- External limits on speed due to:
 - Engine limitations (Maximum Continuous Rating MCR)
 - Minimum steering speed (6-7 kts)
 - Engine fouling at low speeds
 - Charter party clauses (e.g., target laden speed may be 12 kts +/- 0.5 kts)

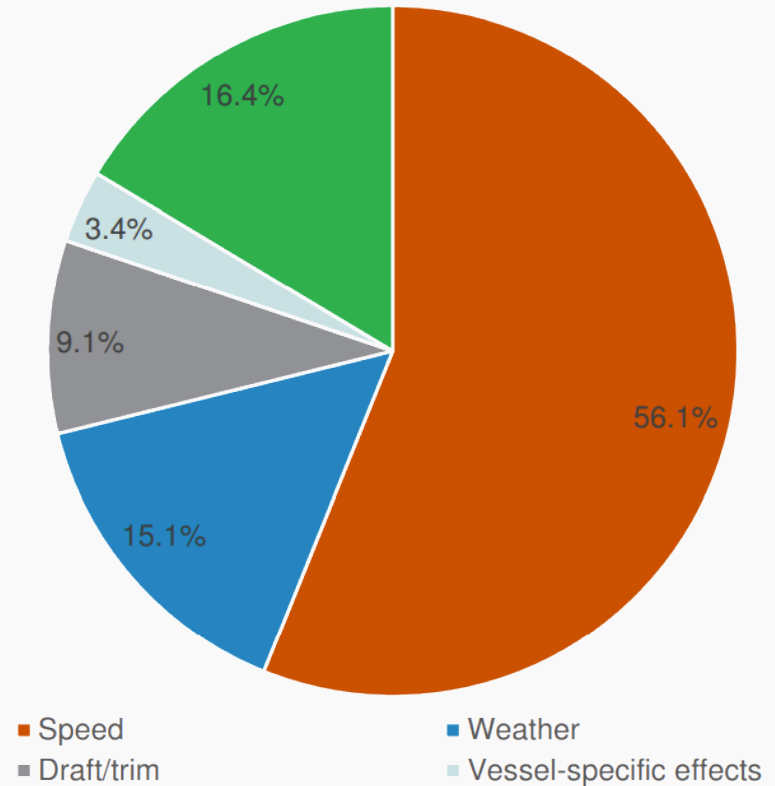


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What drives the fuel consumption?

- Speed
 - Speed clause negotiated
 - Laycan negotiations, when you arrive impacts the voyage speed
 - Efficient port calls, less time at port
- Hull cleaning
 - If permitted at port
 - Inexpensive
- Weather
 - Vessels are slow so you can avoid weather to some extent
- Draft
 - Cargo intake is a commercial decision
 - Trim. Complex. At sea your trim readings are just estimates.



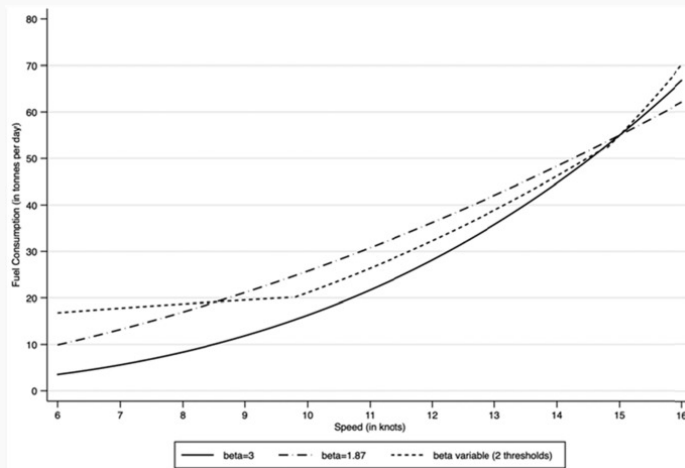
Source: Roar Adland

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Cubic law revisited – Adland et al. 2020

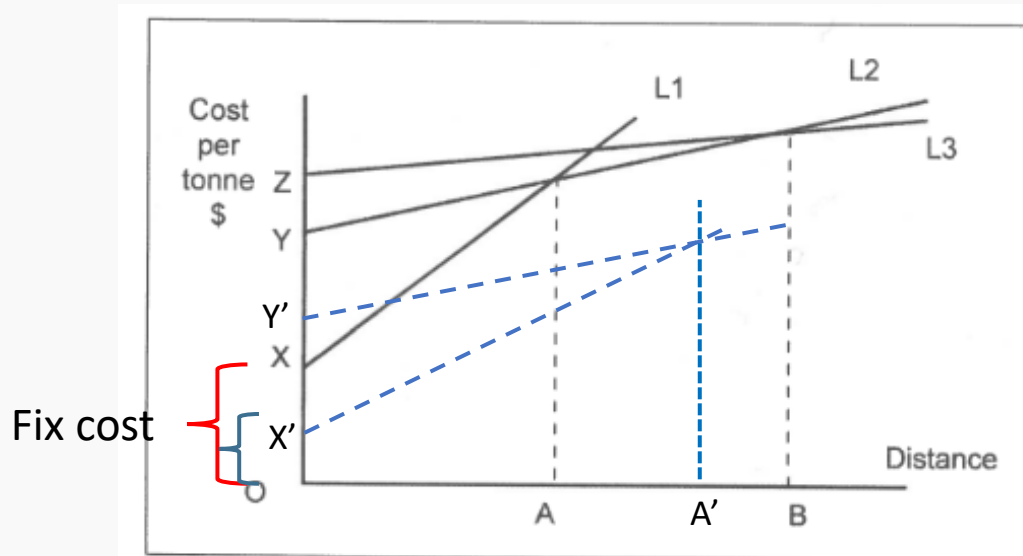
- Cubic close to design speed
- Changes in elasticities based on speed area
- Relevant for speed reduction assumptions – Emissions vs FC (1 on 1)



Study	Vessel type	Beta
MAN Diesel & Turbo (2004)	Feeder containership	3.5
	Large containership	4
Psaraftis and Kontovas (2010)	Oil Tanker	3–4
Notteboom and Cariou (2009)	Containership	3.3
Wang and Meng (2012)	Containerships (<20 kt)	2.7–3.3
Adland, Cariou and Wolff (2018)	Oil Tanker (Aframax/Suezmax)	1.5–2.1
Kristensen (2019)	Oil Tanker (4.5–15 kt) (15,000–110,000) & (110 000 +) dwt	(1.6–4.8) & (1.7–3.7)
	Bulk Carrier (4.1–15 kt) (15 000–75 000) & (175 000+) dwt	(1.6–4.3) & (1.6–3.7)
	Containership (5.6 to 23.5 kt) (1500 TEU) & (5000 + TEU)	(1.9–4.4) & (1.8–3.5)



5) Cargo handling rates – Port efficiency



L1: Smallest ship
L3: Largest ship

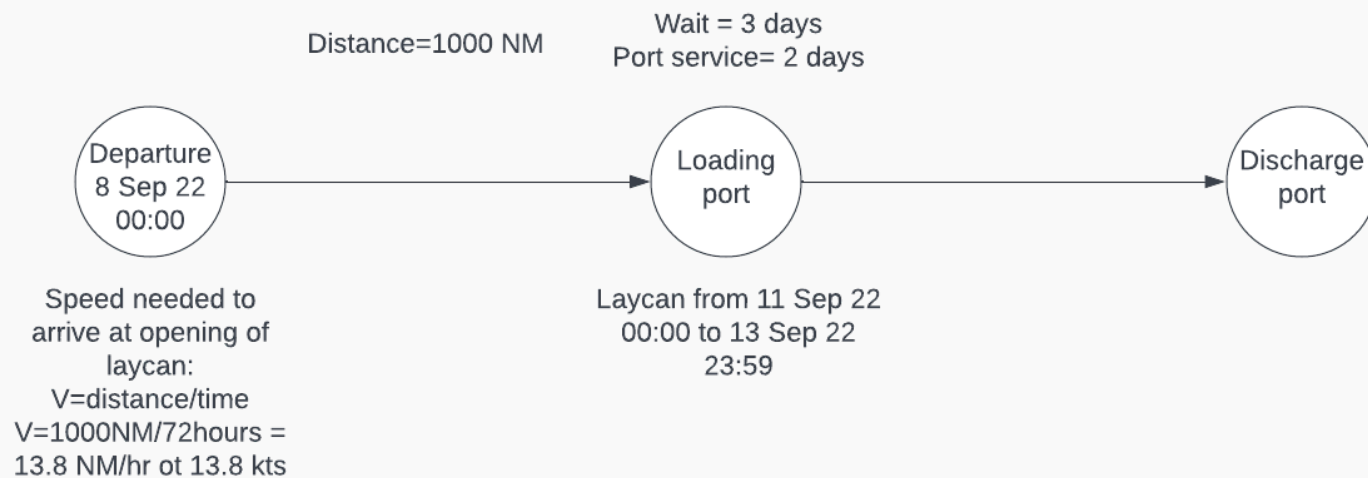
Source: Institute of Chartered Shipbrokers, 2016

- Less time in port = less overall cost so less fix cost
- All else equal, the distance at which the larger vessels are cheaper than the smaller vessels will reduce
- A shortest time at port might lead to reduced speed. The effect of speed reduction would decrease the slope.
 - What else would reduce the slope?
- This mix of speed reduction due to port efficiency is one short term measure for reducing emissions

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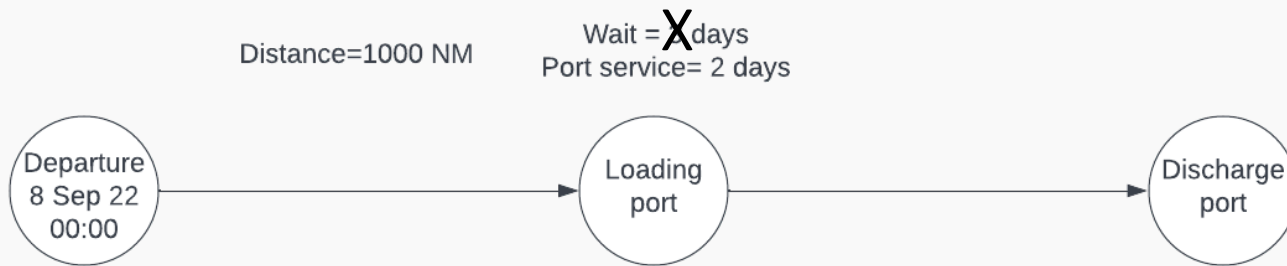


Speed reduction due to port efficiency



Laycan: The Lay days cancelling period is a specified timeframe within which the shipowner must make the ship available for the charterer's use. If the ship arrives post this period, the charterer reserves the right to cancel the charter.

Speed reduction due to port efficiency

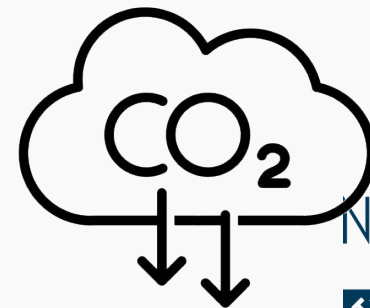
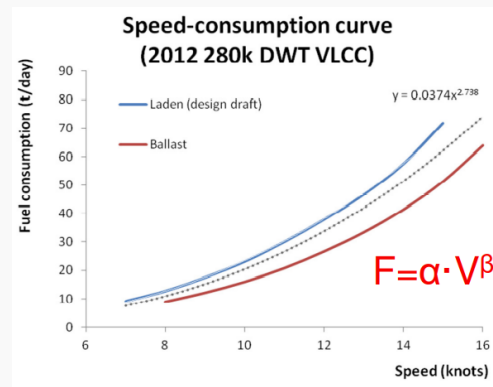


Speed needed to arrive JIT to be served
 $V = \text{distance} / \text{time}$

$V = 1000\text{NM} / 144\text{hours} = 6.9 \text{ NM/hr}$ or 6.9 kts

Just in Time (JIT)

Laycan from ~~11 Sep 22~~
 00:00 to ~~13 Sep 22~~
 23:59



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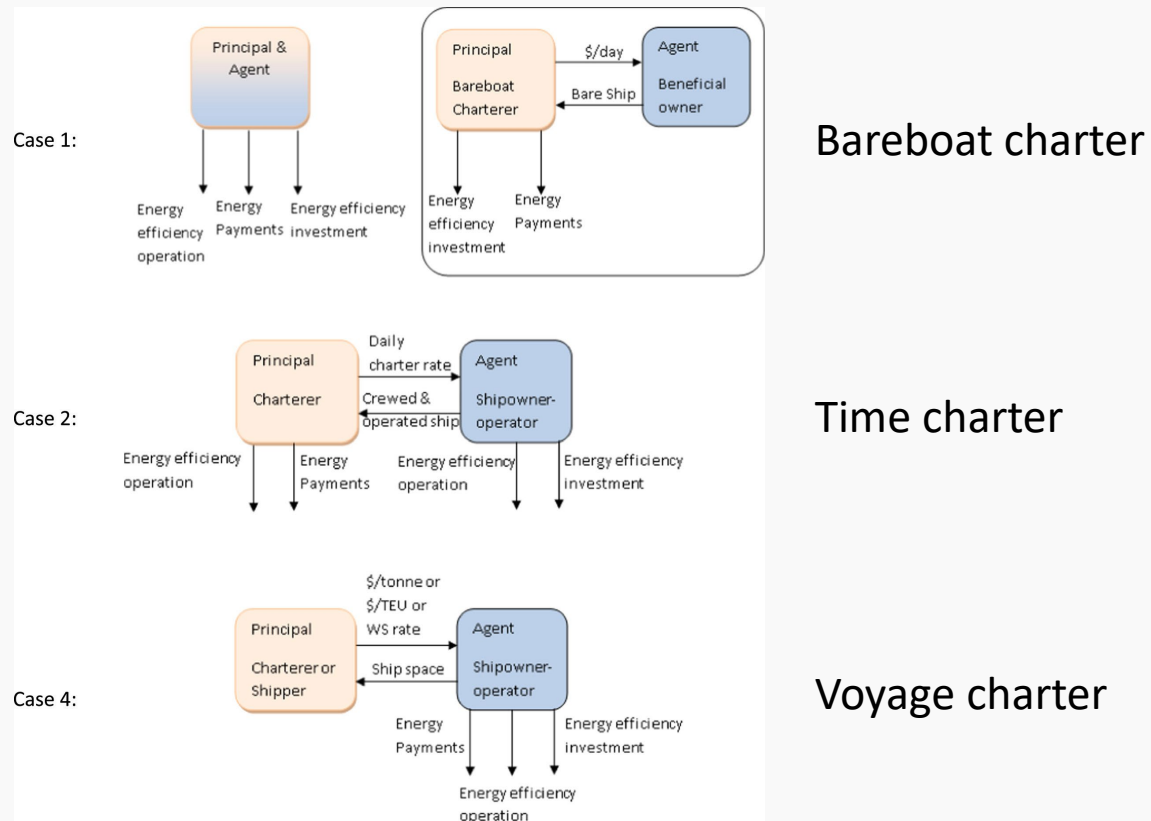
Barriers for implementation of speed reduction measures

Rehmatulla and Smith, T. (2015)

- Principal agent problems – Split Incentives and Informational problems
- Split incentives is a common problem for energy efficiency development
- Split incentive: the agent (shipowner) selects the energy efficiency tech and the principal (charterer) pays for the bill of that decision without making a choice (Time charter case). This applies when technical measures considered.
- For operational decision measures in a voyage charter (i.e, speed reduction measure), then the most important barrier is:
 - Contractual wording (laycan)
- Informational problems: unable or expensive to confirm the actions of the agent on regards of emissions savings

Barriers for implementation of speed reduction measures

Rehmatulla and Smith, T. (2015)



Source: Rehmatulla and Smith, T. (2015)



What can be done?

- Optimal hull cleaning
 - Inexpensive
 - Can reduce about 10% fuel consumption



- Implement contractual changes to remove inefficiencies and promote
 - Virtual arrival
 - Better communication and planning between port and vessels
 - JIT can reduce up to 19 % of emissions in the VLCC fleet

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References

- Adland, R. Cariou, P., & Wolff, F.-C. (2020). Optimal ship speed and the cubic law revisited: Empirical evidence from an oil tanker fleet. *Transportation Research. Part E, Logistics and Transportation Review*, 140, 101972
- Rehmatulla, & Smith, T. (2015). Barriers to energy efficiency in shipping: A triangulated approach to investigate the principal agent problem. *Energy Policy*, 84, 44–57.
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