

Vessel calculation practice

You work for a drybulk operator as a chartering manager. The company's business idea is to charter in Supramax vessels on a tripcharter contract (\$/day basis) and relet the vessels on a voyage charter (\$/tonne) for a specific cargo and route and attempt to make a profit from the difference between the voyage TCE and the tripcharter cost.

On December 9 at 12:00, you identify a potential cargo of 50 000 tonnes of metal scrap to be transported from Rotterdam (Netherlands) to Kandla port (India) on a voyage charter. Loading in Rotterdam will commence at 00:00 on December 23. (i.e. midnight 22nd Dec.) with certainty. The charterer requires a sailing speed of 12 knots for the laden voyage. The minimum possible sailing speed for the vessel is 8 knots.

Your broker identifies two identically designed ships of 58,000 DWT that are commercially available to perform the voyage and that can be chartered in on a tripcharter. Vessel A is currently positioned in the port of Iskenderun, Turkey, 3161 nautical miles from Rotterdam. Vessel B is currently located in the port of Marseille Fos, France, 2051 nautical miles from Rotterdam. Both vessels have just completed the previous discharge and are currently in ballast (empty). Assume that either vessel can be chartered immediately without delay due to negotiations etc.

The relationship between the sailing speed V (knots) and daily fuel consumption F (tonnes/day) for the two vessels is given by $F = 0.040907 \cdot V^{2.5}$. Ignore fuel consumption at anchorage or in port.

- a) Assume that there is no uncertainty with regards to the arrival time (e.g. bad weather delays) for the ballast voyage. Show that the optimal sailing speed to Rotterdam in this case is $V_A = 9.8$ knots for vessel A and $V_B = 8$ knots for vessel B.

The cargo will be transported on a voyage charter, where the operator is responsible for paying the fuel cost. Given that the laycan, voyage rate and laden speed are fixed, the only degree of freedom to maximize profits will be to select the ballast speed that minimizes the fuel cost. Since there is no uncertainty with regards to weather or other risk factors, this is simply a matter of sailing at the slowest possible speed that gets you to Rotterdam by the end of the laycan period.

Time available between 9. Dec noon and end of day 22. Dec. is 13.5 days. Given the remaining sailing distances, the corresponding vessel speeds are:

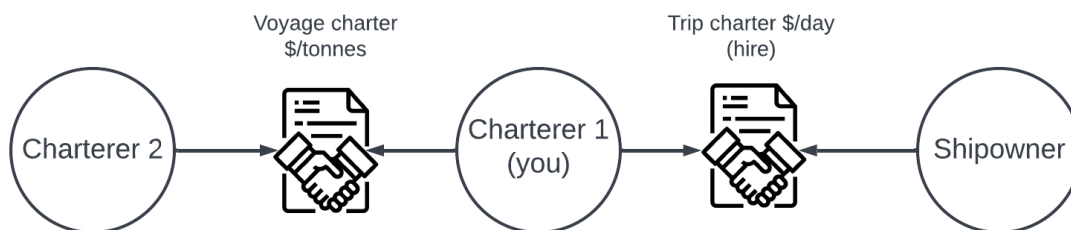
$$V_a = 3161/(24 \times 13.5) = 9.8 \text{ knots}$$

$$V_b = 2051/(24 \times 13.5) = 6.3 \text{ knots, which is below the minimum sailing speed of 8 knots}$$

The voyage freight rate for the scrap cargo is \$40/tonne. The vessels have enough fuel onboard for the entire trip at a cost of \$560/tonne. Total port costs and canal fees are \$200,000. The distance from Rotterdam to Kandla via the Suez Canal is 6230 nautical miles. The time spent in ports (loading and discharge) totals 5 days.

- b) Calculate the TCE for each vessel for the prospective scrap cargo. If vessel A can be chartered in on a trip charter for \$33,000/day and vessel B can be chartered in on a trip charter for \$35,000/day, which vessel should ultimately be chartered in to maximize the profit for the voyage?

This is the contractual arrangement. Check Lecture 4 slide 16 and 17 for a review on types of charter and who pays for what in every charter.



Calculate the fuel cost for the vessels.

Laden: Daily fuel consumption at 12 knots is $F = 0.040907 \times 12^{2.5} = 20.41 \text{ tonnes/day}$

Ballast A: Daily fuel consumption at 9.8 knots is $F = 0.040907 \times 9.8^{2.5} = 12.16 \text{ tonnes/day}$

Ballast B: Daily fuel consumption at 8 knots is $F = 0.040907 \times 8^{2.5} = 7.40 \text{ tonnes/day}$

Both vessels spend 5 days in port and $(6230 \text{ nm} / (12 \times 24)) = 21.6 \text{ days laden}$

Sailing days in ballast are:

Vessel A: $3161 / (24 \times 9.8) = 13.5 \text{ days}$

Vessel B: $2051 / (24 \times 8) = 10.7 \text{ days}$

Total fuel cost for the trip is the product of sailing days, daily fuel consumption on the two legs and the cost of fuel per tonne:

Vessel A: $\$560/\text{tonne} \times (13.5\text{days} \times 12.16\text{t/day} + 21.6\text{days} \times 20.41\text{t/day}) = \mathbf{339,138 \text{ USD}}$

Vessel B: $\$560/\text{tonne} \times (10.7\text{days} \times 7.40\text{t/day} + 21.6\text{days} \times 20.41\text{t/day}) = \mathbf{291,491 \text{ USD}}$

The timecharter equivalent is TCE = (gross freight - port/canal fees - fuel cost)/trip duration

Assume that the vessels are delivered (taken in control by you) where they become open. Then, the TCEs are calculated as:

*** If the instruction said that the vessel would be delivered at Rotterdam (load port), then you will only be concerned about the laden bunkers and the trip duration will be from Rotterdam + port time + canal time+ leg to Kandla.

Vessel A: $\text{TCE} = (50000 \times 40 - 200000 - 339138) / (13.5 + 5 + 21.6) = \mathbf{36,401 \text{ \$/day}}$

Vessel B: $\text{TCE} = (50000 \times 40 - 200000 - 291491) / (10.7 + 5 + 21.6) = \mathbf{40,442 \text{ \$/day}}$

After subtracting the daily trip charter cost, the daily profit per vessel is:

Vessel A: $\text{TCE} - \text{trip charter rate} = \$36,401/\text{day} - \$33,000/\text{day} = \mathbf{3,401 \text{ \$/day}}$

Vessel B: $\$40,442/\text{day} - \$35,000/\text{day} = \mathbf{5,442 \text{ \$/day}}$

Using Vessel B will maximize the profit since the duration of the charter is identical.

c) For this question only, you shall assume that the EU Emission Trading System (ETS) has come into effect. Under the ETS, shipowners have to pay a carbon tax per tonne CO₂ emitted for any voyage where the ship calls at an EU port. A voyage comprises the ballast voyage and subsequent laden voyage. If either the ballast or laden leg starts or ends outside the EU, only 50% of the emissions for that leg are taxed. For ships chartered on a voyage charter, you can assume that any carbon tax payable is passed in full to the charterer. Calculate the breakeven carbon tax (\$/tonne CO₂ emitted) for the proposed voyages for vessels A and B that brings your profit to zero. Both vessel A and B burn Very Low Sulphur Fuel Oil (VLSFO) for which the emission factor is 3.176 CO₂ g/g.

For vessel A, both the ballast and laden leg are to or from ports outside the EU, so the 50% tax applies, while for vessel B the ballast leg from France is taxed at 100% of emissions. The carbon emission factor of 3.176 tonnes CO₂ per tonnes of fuel consumed.

Taxable emissions can therefore be calculated as follows

Ves. A: $50\% \times 3.176 \times (13.5\text{days} \times 12.16\text{t/day} + 21.6\text{days} \times 20.41\text{t/day}) = \mathbf{961.7 \text{ tCO}_2}$

Ves. B: $100\% \cdot 3.176 \cdot 10.7 \text{ days} \cdot 7.40 \text{ t/day} + 50\% \cdot 3.176 \cdot 21.6 \text{ days} \cdot 20.41 \text{ t/day} = 951.6 \text{ tCO}_2$

Profit per vessel over the charter is

Vessel A: $\$3401/\text{day} \cdot (13.5 + 5 + 21.6) = 136,508$

Vessel B: $\$5442/\text{day} \cdot (10.7 + 5 + 21.6) = 202,987$

The breakeven CO₂ price would therefore be:

Vessel A: $\$136,508/961.7 \text{ t} = 141.95 \text{ \$/tonne CO}_2$

Vessel B: $\$202,987/951.6 \text{ t} = 213.31 \text{ \$/tonne CO}_2$

The vessel you chose in b) is chartered in to perform the voyage. Immediately after delivery of the vessel you get access to its historical vessel performance data (noon reports) and discover that the fuel consumption is substantially higher than its design values due to severe fouling of the ship's hull. Ignore the carbon tax from here on. The true fuel consumption function turns out to be given by the function $F = 0.040907 \cdot V^{2.6}$ (i.e. the exponent is 2.6 instead of 2.5). To rectify this situation, your technical management team suggests to do an underwater hull cleaning while in port in Rotterdam. This will not extend the duration of the voyage but the hull cleaning operation adds \$20 000 to the voyage costs. The hull cleaning operation will also reset the fuel consumption level to the design condition, as used in b).

d) Calculate whether it is optimal to do a hull cleaning in Rotterdam.

Vessel speeds and voyage duration remains the same. If no hull cleaning is undertaken then the fuel consumption in the laden condition increases as follows for vessel A. The ballast consumption will be identical both with and without hull cleaning and so does not influence the decision.

Laden: $F = 0.040907 \cdot 12^{2.6} = 26.16 \text{ t/day}$

The economic tradeoff is whether the reduction in total fuel costs exceed the cost of the underwater hull cleaning.

Fuel cost differential is $\$560/\text{tonne} \cdot 21.6 \text{ days} \cdot (26.16 \text{ t/day} - 20.41 \text{ t/day}) = \$69,728$

Fuel savings exceed the cost of hull cleaning by a big margin and so should be done

e) In real life there are multiple sources of uncertainty with regards to fuel consumption and delays. Briefly discuss these source of uncertainty and how they could affect the choice you made in b).

Given that the voyage takes place in November/December, weather risk (e.g., Bay of Biscay) is large. Bad weather would increase the fuel consumption and/or reduce the speed and thus lengthen the trip. This can hit the operator's bottom line twice, both through higher fuel costs and higher tripcharter (out) costs, without any corresponding increase in the agreed freight revenue. To account for the delay risk and the fact that a realistic charterparty includes a cancelling date (i.e., the final day of laycan period), the operator would have to build a buffer to arrive prior to loading, increasing the sailing speed and therefore the fuel costs. There is a double argument for vessel B: first, higher TCE. Second, the risks described above could therefore sway the decision to Vessel B which has the shorter ballast leg and slightly lower risk. It already has a buffer built in the ballast voyage since it has to wait some time at anchorage in Rotterdam such that bad weather delays would not affect the economics in the same way.