TÉCNICO LISBOA

TMP

Maritime Transportation and Ports I

2nd Project – Investment Analysis

Prof. Tiago Santos

Fabio Bentivogli

Matr. 102376

Davide Melozzi

Matr. 1102230

Academic year: 2021/2022, 1st February 2022

M.Sc. MENO – Naval Architecture and Ocean Engineering

INDEX

INTRODUCTION

The shipping industry is constantly worried with predicting what the next major source of commerce will be. The variations of global trade govern which ships will transport the most in-demand merchandise. Merchants and shipowners who can take advantage of such conditions will have a higher chance of profiting the most. An investment analysis is one method of attempting to examine the performance of a ships voyage. It might involve examining previous returns to anticipate future performance, picking the type of investment instrument that best meets an investor's needs, or evaluating assets such as stocks and bonds, or a category of securities, for risk, yield potential, or price movements.

Depending on the market scenario, shipowners and shipping corporations will pursue investment or divestment strategies in the international containers shipping industry. Because of the volatility of freight and ship prices, shipowners and shipping businesses find it difficult to forecast market trends and, therefore, make commercial decisions. If the shipowner and the shipping firm make an incorrect assessment of the market's development tendency, the investment may fail and the company may go bankrupt.

In general, ship owners are keen to purchase more modern ships to occupy market share in the future in order to maximize earnings, owing to the high freight in the market. However, because of the protracted shipbuilding cycle, if market freight after delivery differs from expectations, these new ships would exacerbate the challenge of excess supply of shipping market capacity. Furthermore, the high capital cost of operating a new ship will put the corporation under significant financial strain, and capital turnover issues are likely to appear.

Whenever we contemplate that freight rates may fall in the future, it is a better option to acquire used ships since, when compared to new shipbuilding, used ships may be put on the market sooner, allowing shipping businesses to satisfy trade demand on time. However, the high maintenance costs of the used ship may diminish the enterprise's overall profit. As can be seen, choosing between new and used shipbuilding is a challenging subject for shipowners and shipping businesses when making investment decisions.

This being known, our project will consist of an investment analysis of the container ship (Maersk Munich) based on the voyage carried out in the first project (Shanghai-Rotterdam), in which, however, variants relating to the loading and unloading ports will be introduced on the total plan (Shanghai-Shenzen-Singapore-Pireaus-Sines-Rotterdam) and this time we will consider a round voyage which takes into account an outward journey with a loaded ship, having a calculated and pre-established operating speed, and a return trip in ballast situation, in which the speed will further vary in order to respect a subdivision of whole numbers of weeks on the total number of days of travel, thus respecting the weekly departure schedule

imposed by the company, in order to maximize efficiency and profit related to its fleet. Our investment analysis will be done based on this trip and projected on a 10-year basis.

INVESTMENT ANALYSIS

Considerations

Fig.1 Actual Global Container Index

At the base of the investment analysis and its essential peculiarities, we implement a global consideration related to the trend of the markets and its prices: the most recent anomaly related to the freight rate surcharge in the intermodal market, would have hindered and confused the results of our analysis, reason for which, the evaluation and choice of this parameter is made on a consistent and linear choice with the trend of the markets related to the last 15 years.

We cannot foresee exactly from today's date to a future relative to the next 10 years, which will be the trend relative to the freight rate, reason for which our supposition and imposition remains constant and coherent with the investment analysis carried out in the past.

In our case, from the analysis of the trend related to the pandemic, we have deviated from an average price of 9660 USD/TEU, setting it to a time average in which there was a value of 1400 USD/TEU.

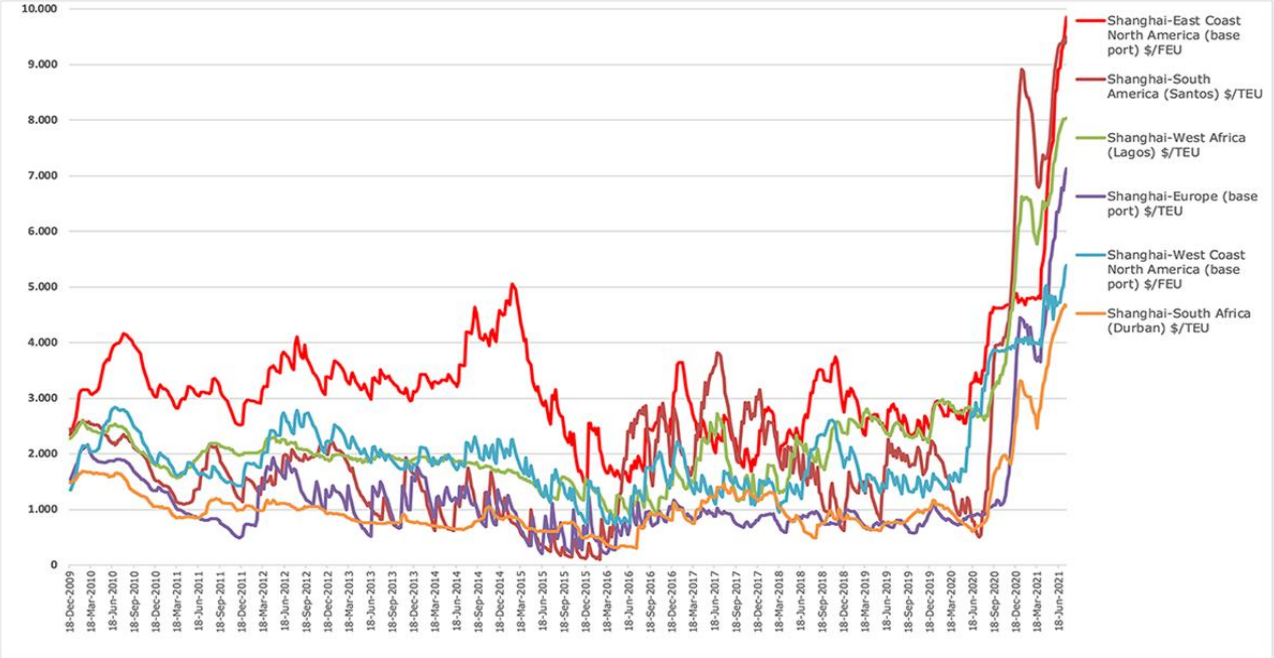

Fig.2 Shanghai containerized freight index, weekly spot rates. 18/12/2009 -09/04/2021

Analysis features

- **Net present value (NPV)**

The difference between the present value of cash inflows and the present value of cash withdrawals over time is defined as net present value (NPV). The net present value (NPV) is a calculation used in capital budgeting and investment planning to determine the profitability of a proposed investment or project. NPV is the outcome of calculations used to calculate today's value of a future stream of payments.
The formula used to calculate is:

$$NPV = \sum_{t=1}^{n} \frac{R_t}{(1+i)^t}$$

where:
Rt = net cash inflow-outflows during a single period.
ti = discount rate or return that could be earned in alternative investments.
t = number of timer period.

- **Internal Rate of Return (IRR)**

The internal rate of return (IRR) is a financial research indicator used to determine the profitability of possible investments. In a discounted cash flow analysis, IRR is a discount rate that makes the net present value (NPV) of all cash flows equal to zero. The IRR value uses the same formula as NPV calculations. Keep in mind that the IRR is not the project's real financial worth. The yearly return is what brings the NPV to zero.

The formula used to calculate it:

$$0 = \mathrm{NPV} = \sum_{t=1}^{T} \frac{C_t}{(1+IRR)^t} - C_0$$

where:

Ct = net cash inflow during the period t.
C0 = total initial investment costs.
IRR = Internal Rate of Return.
t = number of time periods.

- **Discount rate and factor**

A discount rate is the rate of return used to reduce the present value of future cash flows to their current value. This rate is frequently a company's Weighted Average Cost of Capital (WACC), needed rate of return, or the rate at which investors anticipate to earn a certain amount of money in relation to the risk of the investment.

A discount rate is used to determine a company's Net Present Value (NPV) as part of a Discounted Cash Flow (DCF) analysis. It is also used to:

- Consider the temporal worth of money.
- Consider the risk of an investment.
- Represent a firm's opportunity cost
- Serve as a criterion for investment choices
- Make various investments more comparable.

The discount factor measures the present value of an investment’s future worth.

Discount Factor = 1 / (1 * (1 + Discount Rate)*Period Number)

- **Cash flow**

The net amount of cash and cash equivalents transported into and out of a business is referred to as cash flow. Inflows are represented by cash received, whereas outflows are represented by money spent.

A company's cash flow is the amount of money that comes in and goes out. Businesses earn money from sales and spend money on expenditures. They may also earn money through interest and investments.

Free Cash Flow = Net income + Depreciation/Amortization – Change in Working Capital – Capital Expenditure

The Net Income is the profit or loss of a corporation after all expenditures have been removed.

Depreciation vs Amortization: Depreciation is the process of reducing the value of a current asset over time, whereas amortization is the process of spreading the expense of an intangible asset over its lifetime.

Working capital is the money utilized to conduct a business's day-to-day operations.

Fixed company assets such as land and equipment are referred to as capital expenditures.

Parameters used for the investment analysis:

- Freight rates or passenger fares throughout the investment period are to be specified considering the relevant rate history and the current situation as regards the shipping cycle,
- Tankers and bulkers are to carry out as many voyages per year as possible; containerships and passenger ships carry out regular voyages (duration of one or more weeks),
- Operation speed of tankers and bulk carriers to be at maximum 1-2 knots below ship’s service speed; for container ships and passenger ships may be minimum 15 knots,
- Cargo handling costs not to be paid by owner except for expenses with power for operating cranes (geared bulkers, when loading and discharging) and pumps (tankers when discharging)
- Project lifetime: 10 years,
- Discount rate 7%,
- Initial investment: current newbuilding price from 1st project plus 5% additional general expenses,
- Bank loan 50%,
- Loan to be re-paid in 6 years in constant instalments, interest rate is LIBOR USD at 6 months+ 3% spread,

- Residual value: consider it to be the current second-hand price for a 10-year-old ship (same type and size),
- Manning costs increasing 2% a year,
- Fuel costs increasing 2.5% a year,
- Periodic maintenance costs and current maintenance and repair increasing 2.5% a year.
- Inflation rate, except increases in k), l) and m), not to be included,
- Taxes are paid at 21% rate (with linear depreciation throughout the 10 years)

CONSIDERATIONS AND ASSUMPTIONS

In this chapter we will analyze the conditions and considerations which made us decide the correct variables for the financial analysis of the project. The main values and costs obtained from the 1st project have been mantained and will be used throughout this project as well. Nevertheless, a few changes have been applied to obtain a more charatheristic set of values for our study.

Roundtrip Voyage

The calculations regarding the distance with each port has been calculated in the previous project but due to the really extended distance between each port (especially Shenzhen and Sines), two new ports have been added: Singapore and Athens. The decision of adjusting the route with these new ports have been taking mainly for these reasons:

- the port of Singapore is located in the Malacca Strait and its crucial position makes it one of the most visited and used ports to stock goods, consumables and cargo before heading towards the European territory.
- the port of Piraeus (Athens) is one of the main maritime hubs in the Mediterranean Sea (along with Antwerp and Hamburg), not to mention that this port also benefits from a unique geographical location at the crossroads of Europe, Asia, and Africa.

Adding these new ports to our route also helps identifying a more precise route in terms of nautical miles. The total nautical miles found at the end has been rounded up of a few hundred miles; this consideration has been done to take in account the potential inaccuracy when we calculate the distance between each port where it cuts through land. The Haversine formula between each port has been used and the new distances between each port is displayed in the following table:

Distance calculations			
Shanghai	Shenzhen	606.7	[miles]
Shenzhen	Singapore	1426.4	[miles]
Singapore	Athens	5293.5	[miles]
Athens	Sines	1952.5	[miles]
Sines	Rotterdam	1150.2	[miles]
Total distance:		10800	[miles]

Table 1: distance calculations.

Consequently, new adjustments on the cruise speed for the round trip has been studied. The average cruise speed chosen for the Shanghai - Rotterdam trip is 15 knots. This gave us a margin to consider the reduce of the speed while approaching ports, crossing the Suez Canal, Malacca Strait and entering the ECA. This way the days necessary to reach our destination in Netherlands is 30 days, which looks reasonable. In these days, we also included the waiting and queuing time in the ports. Next, we want to talk about the new loading and unloading ratio with the new ports added in our route.
As per Project 1, we calculated it using the formula from the slides given by the Professor:

$$Ts = 2 \times \frac{CDW}{Cll} \times c$$

This way new calculation for the total cargo loading/unloading time has been found:

Locations	Unload/load rate [container/h]	Fraction of CDW	Time [hours]	Time [days]
Shanghai	240	0.75	48.7	2.0
Shenzhen	240	0.3	38.9	1.6
Singapore	240	0.3	38.9	1.6
Athens	120	0.3	77.9	3.2
Sines	120	0.3	77.9	3.2
Rotterdam	210	0.75	55.6	2.3
Total				14.0

Table 2: loading/unloading time for each port.

Next, we will talk about the route of the Munich Maersk on the way back to Shanghai. We decided to take no containers one the way back, so we can approximate that the ship will arrive in Shanghai nearly empty, ready to be loaded again and sail one more time for its regular trip. This way, we can increase the cruise speed on the way back. After a few calculations, we found the value to be 17,31 knots. This way, the trip back from Rotterdam will take 26 days. In the following table we can see the different voyage times:

Total time		
[days]	Voyage	Cargo
Shanghai - Rotterdam	30	7
Rotterdam - Shanghai	26	7

Table 3: total time for a round voyage.

Freight Rate

Due to the fluctuation of the freight rate market and the uncommon trend of the last years it was decided to consider a range of values that go from June 2010 to June 2020. This way we were able to narrow the trend and find some suitable values for the project. The freight rate used for TEUs is 1000 USD/TEUs and for FEUs it's 1800 USD/FEUs. Now, if we consider our ship to be loaded 60% with TEUs and 40% with TEUs we will have 9346 TEUs and 6230 FEUs. The average freight rate, used to calculate the revenue at the end of the year, is 1400 USD/container.
A resume of the variables studied until now it's in the following table:

Voyage details		
CDW	15576	[TEUs]
Roundvoyage time	70	[days]
Distance	10800	[miles]
Navigation time (Sha - Rot)	30	[days]
Cruise speed (Sha - Rot)	15	[kn]
Navigation time (Rot - Sha)	26	[days]
Cruise speed (Rot - Sha)	17.3	[kn]
Port time	14	[days]
Off hire	5	[days]
Number voyages per year	5	[-]
Cargo carried per year	77880	[TEUs]
Freight rate	1400	[USD/TEUs]
Freight revenue	109032000	[USD/year]

Table 4: voyage details

It was decided to keep the off hire to 5 days; this way, the number of voyages per year (rounded down) is 5 and the total cargo carried is 77880 containers/year. By choosing the freight rate for our study the yearly freight revenue is 109032000 USD/year.

Capital costs

In this chapter we want to study the capital costs that are related to our investment. The table below shows the bank loan details that this study requires us to follow:

Bank loan details		
Discount Rate	7	[%]
Bank Loan	50	[%]
Loans	6	[re-paid 6 years]
Spread rate	3	[%]
LIBOR rate	0.5297	[%]
Loan Interest rate	3.5297	[%]
Taxes	21	[%]

Table 5: bank loan details

To start our financial analysis, we found the newbuilding price for our ship. Since it's EEE class type container ship owned by Maersk we found that the newbuilding price is 190 million USD. With a bank loan of 50% and initial investment equal to the newbuilding price plus 5% of the amount, it was possible to calculate and the study the first instalments (including the interest rate) to repay the loan in 6 years.
A discussion about the linear depreciation of the ship must be done as well. If we consider an average weight for a dry cargo container (gross weight) full at it's 50% of capacity, we'll be able to obtain the total weight of the cargo. By doing a simple equation:

$$CDW - cargo, passengers\ and\ effects\ weight = LW$$

It is possible to find the lightweight of the ship. Through excel some calculations have been made the lightweight has been found. In order to study the residual value of our ship when we will be selling it at the end of the investment's years, the scrapping market gave us the chance to calculate this value. We chose to scrap our ship in Pakistan where the ratio is 620 USD/ton.

LW	45953	[t]	(CDW-cargo, passengers and effects)
Scrap	620	[USD/t]	(Pakistan Scrap Market)

Table 6: lightweight and scrapping market prices.

Through Excel, by using the TREND function, we simply calculated the value of the ship at the end of the investment. The values are in the following table:

Ship's depreciation			
0	[year]	190000000	[USD]
25	[year]	28490860	[USD]
10	[year]	125396344	[USD]
Residual Value		125396344	

Table 7: ship's depreciation.

After that, it was possible to display the capital costs available in our 10 years' investment:

Year	Investment	Installments	Capital in debt	Debt Interests	Capital Costs	Residual Value
0	-99750000	0	0	-	-99750000	-
1	0	-16625000	99750000	-3520875.75	-20145875.75	-
2	0	-16625000	83125000	-2934063.125	-19559063.13	-
3	0	-16625000	66500000	-2347250.5	-18972250.5	-
4	0	-16625000	49875000	-1760437.875	-18385437.88	-
5	0	-16625000	33250000	-1173625.25	-17798625.25	-
6	0	-16625000	16625000	-586812.625	-17211812.63	-
7	0	0	0	0	0	-
8	0	0	0	0	0	-
9	0	0	0	0	0	-
10	0	0	0	0	0	125396344

Table 8: capital costs.

Operational and voyage costs

With the capital costs obtained, we can move to the operational and voyage costs. These were simply calculated in the previous project. They have been rearranged and adjusted considering the new route.

Costs			
Newbuilding Cost	190000000	[USD]	
Initial Investment	199500000	[USD]	(Newbuilding + 5%)
Manning	900707.4	[USD/year]	(+2% each year)
Stores and Consumables	464845.8	[USD/year]	
Periodic Maintenance	1898892	[USD/year]	(+2,5% each year)
Insurance and P&I	1675715	[USD/year]	
Administration Fees	120000	[USD/year]	
Fuel Costs	50215105	[USD/year]	(+2,5% each year)
Ports Costs	963836	[USD/year]	

Table 9: main operational and voyage costs.

After that, we simply introduced these values in our financial analysis and obtained the following table:

Operational Costs							
Manning	Stores and Consumables	Periodic Maintenance	Insurance and P&I	Administration	Fuel costs	Ports Costs	Annual Average
0	0	0	0	0	0	0	0
-900707.4	-464845.8	-1898892	-1675715	-120000	-50215105	-963836	-56239101.2
-918721.548	-464845.8	-1946364.3	-1675715	-120000	-51470482.63	-963836	-57559965.27
-937095.979	-464845.8	-1995023.408	-1675715	-120000	-52757244.69	-963836	-58913760.88
-955837.8985	-464845.8	-2044898.993	-1675715	-120000	-54076175.81	-963836	-60301309.5
-974954.6565	-464845.8	-2096021.468	-1675715	-120000	-55428080.2	-963836	-61723453.13
-994453.7496	-464845.8	-2148422.004	-1675715	-120000	-56813782.21	-963836	-63181054.76
-1014342.825	-464845.8	-2202132.554	-1675715	-120000	-58234126.76	-963836	-64674998.94
-1034629.681	-464845.8	-2257185.868	-1675715	-120000	-59689979.93	-963836	-66206192.28
-1055322.275	-464845.8	-2313615.515	-1675715	-120000	-61182229.43	-963836	-67775564.02
-1076428.72	-464845.8	-2371455.903	-1675715	-120000	-62711785.17	-963836	-69384066.59

Table 10: operational costs.

Annual costs and revenue

After finding all the equivalent costs for each year, it's possible to calculate the annual costs and the revenue. The first will be the sum of each necessary costs that we found in our financial analysis and the revenue is the profit we will make each year by exporting the cargo throughout our voyage, respectively. In the following table the values:

Annual Costs	Revenue
0	0
-56239101.2	80350561.13
-57559965.27	80350561.13
-58913760.88	80350561.13
-60301309.5	80350561.13
-61723453.13	80350561.13
-63181054.76	80350561.13
-64674998.94	80350561.13
-66206192.28	80350561.13
-67775564.02	80350561.13
-69384066.59	80350561.13

Table 11: annual costs and revenue.

Final cashflow, NPV and IRR

Finally, we're able to study and understand how worth our investment would be. First, we filter revenues and costs in order to find a cashflow. We then considered the depreciation of the ship each year and applied the taxes where necessary. At the end of this financial analysis, the table below shows the total cashflow we obtained:

Cashflow (before)	Depreciation	Cashflow (after)	Taxes (21%)	Cashflow (after taxes)	Discount factor 7%	Discounted cashflow	Year
-99750000	0	-99750000	0	-99750000	1	-99750000	0
3965584.183	-6460365.6	-2494781.417	523904.0977	-1970877.32	0.934579439	-1841941.42	1
3231532.735	-6460364.6	-3228831.865	678054.6917	-2550777.174	0.873438728	-2227947.571	2
2464549.755	-6460363.6	-3995813.845	839120.9074	-3156692.937	0.816297877	-2576801.743	3
1663813.758	-6460362.6	-4796548.842	1007275.257	-3789273.585	0.762895212	-2890818.675	4
828482.7555	-6460361.6	-5631878.845	1182694.557	-4449184.287	0.712986179	-3172206.907	5
-42306.25444	-6460360.6	-6502666.854	1365560.039	-5137106.815	0.666342224	-3423071.179	6
15675562.19	-6460359.6	9215202.59	-1935192.544	7280010.046	0.622749742	4533624.377	7
14144368.85	-6460358.6	7684010.251	-1613642.153	6070368.098	0.582009105	3533009.501	8
12574997.11	-6460357.6	6114639.512	-1284074.298	4830565.215	0.543933743	2627507.416	9
136362838.5	-6460356.6	129902481.9	-27279521.21	102622960.7	0.508349292	52168309.45	10

Table 12: final cashflow.

This financial analysis has been done for an initial assumption of the freight rate of 1400 USD/TEUs. It was possible to calculate the NPV and IRR at the end of the analysis and it can be seen in the table below:

Total cargo	77880	[TEUs/year]	NPV	106122338.7
Freight revenue	109032000	[USD]		
Freight Rate	1400	[USD]	IRR	21%

After that, we calculated the required freight rate for having NPV zero. To calculate this value we used the solver add-in on Excel to change the NPV to zero by modifying the freight rate:

Total cargo	77880	[TEUs/year]	NPV	0.000106059
Freight revenue	89906134.73	[USD]		
Freight Rate	1154.418782	[USD]	IRR	7%

CONCLUSIONS

The proposed investment analysis depicts economic and financial conditions dependent on a principal value, the freight rate. We can see that as the freight rate varies, the company obtains different financial results relating to cashflows and revenues, which are correlated by a global planning of the ship's market of operation, type of voyage, operating costs and capital costs. The company's investment is conditioned by the law of the market, which in turn is conditioned by macroscopic scenarios of a political/geographical nature. According to our investment analysis, at our selected freight rate the company obtains a positive total cashflow (net present value), which allows it to be in profit and consequently correlates to this the percentage value of the internal rate of return that determines an important role in the annulment of the NPV. As a final consideration we can say that as the freight rate varies, consequently different scenarios are obtained: our final aim was to iterate, through the use of the solver add-in, different conditions of freight rate in order to obtain the equality we sought (NPV=0) in the prediction of scenarios related to the time frame of 10 years and to the good planning of a sustainable business and compatible with the demand and supply of the world market.

At the end, the NPV was computed in one approach (using the sum of the discounted cashflows and the function in the column of cashflow after axes with the appropriate discount rate). The IRR was estimated as well, and it is 21%. The freight rate, on the other hand, is determined by the economic relationship, global position, and market conditions. As a result, as a shipowner, it is desirable to be familiar with various global economic situations in order to determine the minimal freight rate at which to run in order to avoid losing money. In other words, the goal is to determine the lowest freight rate at which the NPV is equal to zero.

The freight rate to obtain a NPV of zero is roughly 1154 USD/TEU.

BIBLIOGRAPHY

- https://www.go-shipping.net/demolition-market
- https://fbx.freightos.com/
- https://classic.searoutes.com/routing/4294967519/4294967954/4294967713/4294967496/4294968664/4294967340?speed=20&panama=true&suez=true&kiel=true&rivers=block&roads=block&nw=true&ne=true
- https://www.investopedia.com/
- https://www.springerprofessional.de/en/financial-analysis-and-the-modeling-of-ship-investment/11041436
- https://gocardless.com/guides/posts/how-to-calculate-discount-factor/
- https://unctad.org/es/node/34144
- https://www.economist.com/finance-and-economics/a-perfect-storm-for-container-shipping/21804500