

Vessel Strategy for Greenfield Oil & Gas Project

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Summary: The objective of this research is to design a buy-or-lease decision making tool to assist maritime companies in calculating the range of costs and quantify the associated risks with a particular strategy. By using Monte Carlo simulation, the Net Present Value of the total costs of pursuing the different strategies are analyzed to help make the investment decision.



About the authors:

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KEY INSIGHTS

1. The discount rate, which captures the opportunity cost of capital in addition to helping adjust the value of future cash flows, plays a crucial role in determining which strategy to pursue. A higher discount rate tilts the decision in favor of leasing vessels, while a lower discount rate favors buying and operating the vessels.
2. Regardless of the investment strategy that is decided upon, several qualitative factors should be given due consideration, such as current global fleet capacity, projected demand, steel prices, development of alternate fuel sources.

Introduction

The oil and gas industry is involved in the exploration, extraction, refinement, transportation, and trading of crude oil and petroleum products. These products currently satisfy the world's primary energy needs. Once potential oil reserves are discovered, the firms arrange to drill out the crude oil and get it delivered to refineries. After refining, finished products are shipped to various customers spread across the globe. The generally accepted mode of transportation for crude oil and finished products is by vessels (ships). These are very capital intensive

investments, and given the amount of uncertainty with regards to market conditions, the risk associated with owning these assets is very high. The unpredictability of oil prices further complicates the decision-making process. As an alternative to owning these vessels, firms have an option of chartering or leasing vessels from other ship owners to satisfy their requirements. This way, they are not locking-in capital, and are thus not subject to the risk of foregoing a return of investment. Several factors come to play when deciding which policy to pursue such as freight rates and ship market conditions. New ship building prices widely vary from time to time, and so do the freight rates. A second-hand ship may occasionally be as expensive as buying a new ship. Since the effect of demand and supply is a consequence of macro-economic conditions which in turn dictates how the market functions, it is highly challenging to predict or forecast freight rates and ship prices for a 20 year timeline. Thus, the problem statement can be summarized as:

Given the market volatility and uncertainties in the oil and gas world, what is the best vessel investment strategy?

Literature Review

The new-building market has been reviewed extensively by Stopford (2009). He states that since the ship has to be built, the contract negotiations are more complex than the sale and purchase market, extending beyond price to such factors as specification, delivery date, stage payments and finance. Prices are just as volatile as second-hand prices and sometimes follow the same pattern. Mulligan (2008) proposed a model for estimating newbuilding costs using Regression equations on a large data set of shipyard deliveries reported in Lloyd's Shipping Economist between the years 2003–2007. The equations he developed could be used for economic analyses involving new ship construction and operating costs.

For the second hand market, Pruyn et al. (2011) surveyed the literature for a 20 year period (1991–2011) regarding the pricing of second-hand vessels. They observed that most of the papers released in the first 10 years preferred Efficient Market Hypothesis for estimating pricing. The papers released towards the second half of the period focus on micro-economic valuation of the vessel, incorporating particulars such as deadweight tonnage, age, speed, horsepower, hull type and others. They also observed that in several sub-markets, even though price seemed to influence the volume traded, volume did not seem to influence the price, thus eliminating volume as a variable in the determination of the price.

For the voyage and time charter markets, Merikas et al. (2014) found that freight rate volatility generally increased during both upswings and downswings of the market, but become evidently more intense during market upswings. Subsequently, the effect of changes in the market structure upon the formation and volatility of VLCC spot and time charter freight rates was investigated. They substantiated a positive relationship between spot freight rates and market concentration over the period examined, concluding that expectations regarding the future course of concentration were critical for forecasting the direction of freight rates in the future.

In general, when there is a problem that is too difficult to solve analytically, simulations may be appropriate. In a simulation a controlled sampling

experiment is conducted on a computer using random numbers. Statistics arising from the sampling experiments (examples are sample mean, sample proportion) are used to estimate some parameters of interest in the original problem, system, or population. Here, Monte Carlo simulations are used to evaluate definite multiple integrals in mathematical physics. There is now a resurgence of interest in such methods, particularly in finance and statistical inference (Dagpunar, 2007).

Methodology

Total cost equations relevant to each investment strategy were developed. Then data regarding parameters that constituted these strategies were obtained from the case study company *SerVek*, and from literature review. The data was analyzed and 'cleaned'. A Monte Carlo simulation was run on these cost equations for different scenarios, and the resulting distribution for the total costs for each strategy were analyzed. The available investment strategies are presented in Figure 1:

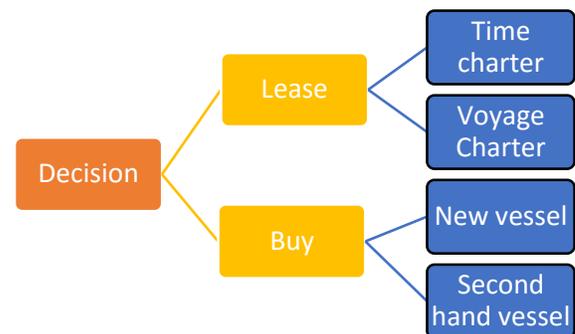


Figure 1 Investment Strategies. Source: Authors

The cost equations were designed to calculate the cash flows for a time period (year), and the Net Present value of these cash flows were used to compare the total cost of the different strategies.

SerVek aims to have a Greenfield oil refinery near South East Asia up and running soon. The company has identified key sources for crude oil from the Middle East as well as potential customers in South East Asia. Forecasts for the amount of crude oil that will be refined is available. The company wishes to know which optimal strategy to pursue when it comes to operating the vessels.

Total cost equations were developed for each of the

strategies:

- 1) Cost of buying a new or second-hand vessel and operating it per time period:

$$F_t = CX_t + [(CH + V) * NV_t] + (OX * 365) - S_t$$

- 2) Cost per time period to operate under a Time Charter strategy:

$$F_t = DH * 365 + [(CH + V) * NV_t]$$

- 3) Cost per period to operate under a Voyage charter strategy:

$$F_t = CMT * WT * NV_t$$

The total cost of operating under each of these strategies is assessed on a year-on-year basis, and the expected Net Present Value (NPV) is calculated for the entire duration of the project.

$$NPV(i, N) = \sum_{t=0}^N \frac{F_t}{(1+i)^t}$$

Data was collected from SerVek for each parameter that constituted these equations.

Using Analytical Solver, for the parameters which exhibited a random behavior, the data was analyzed and distributions were defined. The costing model was created in MS Excel, and the simulation was run for all four strategies simultaneously. The resultant Net Present Values of the total costs are generated with mean values and standard deviations.

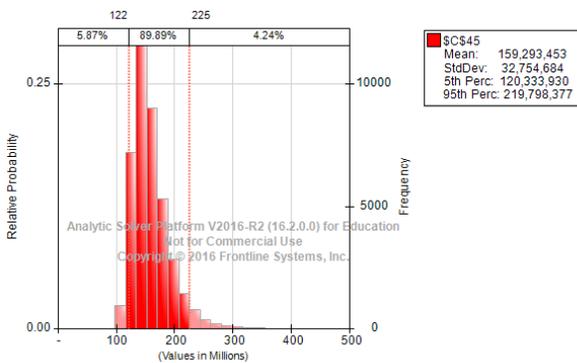


Figure 2 NPV distribution for second-hand strategy.

Source: Authors

The resulting NPV of owning and operating a secondhand VLCC vessel for 15 years is shown in Figure 2. Similar graphs are generated for the NPV's of each strategy.

Results

Project length (years)	Option	Strategy description	Mean μ (Million USD)	Coefficient of variation
25	1	Buy: New ship	199	0.33
	2	Buy: Secondhand ship	181	0.18
	3	Lease: Time charter	168	0.05
	4	Lease: Voyage charter	156	0.12
15	1	Buy: New ship	177	0.59
	2	Buy: Secondhand ship	159	0.21
	3	Lease: Time charter	139	0.05
	4	Lease: Voyage charter	131	0.14
10	1	Buy: New ship	158	0.41
	2	Buy: Secondhand ship	141	0.23
	3	Lease: Time charter	111	0.05
	4	Lease: Voyage charter	106	0.16
5	1	Buy: New ship	133	0.44
	2	Buy: Secondhand ship	101	0.27
	3	Lease: Time charter	68	0.07
	4	Lease: Voyage charter	65	0.22

Table 1 Result for different scenarios.

Source: Authors

The optimal strategy is decided upon by comparing the means and the standard deviations of each strategy. A lower mean implies a lower total cost of operating under a specific strategy, and a lower Coefficient of Variation implies lower risk associated with that strategy. Multiple scenarios of varying project lengths, discount rates and inflation rates are analyzed.

Conclusions

The problem of owning assets versus leasing in highly variable and unpredictable environments has been studied here applied in the maritime industry. A decision – making tool has been developed for the purposes of this work. Using such a model, four possible investment strategies involving a VLCC vessel were analyzed. Taking into account certain global data and a set of assumptions, Monte Carlo simulations were run and the expected Net Present Value of the total cost of each strategy was computed.

The simulation model helps quantify the risk associated with pursuing a particular strategy. The input parameters can be varied to produce different scenarios, and the expected Net Present Value of the total cost can be simulated to give a probabilistic view of the results. The discount rate, which captures the opportunity cost of capital in addition to helping adjust the value of future cash flows, plays a crucial role in determining which strategy to pursue. A higher

discount rate tilts the decision in favor of leasing vessels, while a lower discount rate favors buying and operating the vessels.

Regardless of the investment strategy that is decided upon, one needs to keep in mind several qualitative factors that should be given due consideration such as current global fleet capacity and age, projected demand, steel prices, development of alternate fuel sources, piracy, regulations, and macro-economic conditions. Development of alternate fuel sources are a viable threat, in the sense that existing vessels designed to transport oil may not be suitable to transport other forms of energy such as pressurized gas. It may render the capital intensive investment useless before the end of its lifetime.

Limitations and further development

The model used for the purposes of this study is based on the life-cycle of a ship. Regulatory requirements decide if this life-cycle time is 15 years or 20 years, and hence this lifetime is not solely dependent on the ship's seaworthiness. For future models, the lifetime of the refinery could be considered, and the number of vessels required to sustain over this longer duration can be calculated (Table 2). Forecasting of ship prices and freight rates beyond the initial period can be tricky, since no known methods of forecasting have resulted in reliable long-term predictions so far. Hence it would be interesting to see how the model can be developed to incorporate such long term uncertainty. Scenario planning exercises could help decide strategies in this environment.

Further, the model only focuses on the total cost of owning or operating a vessel under a chartering strategy. It does not take into account the associated revenue or profits emerging from these strategies. Doing so would enable the company to have a holistic view of its decision.

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