

Master Thesis in Marine Technology 2015

Valuing Flexibility in Ship Design

A Real Options Approach

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INTRODUCTION

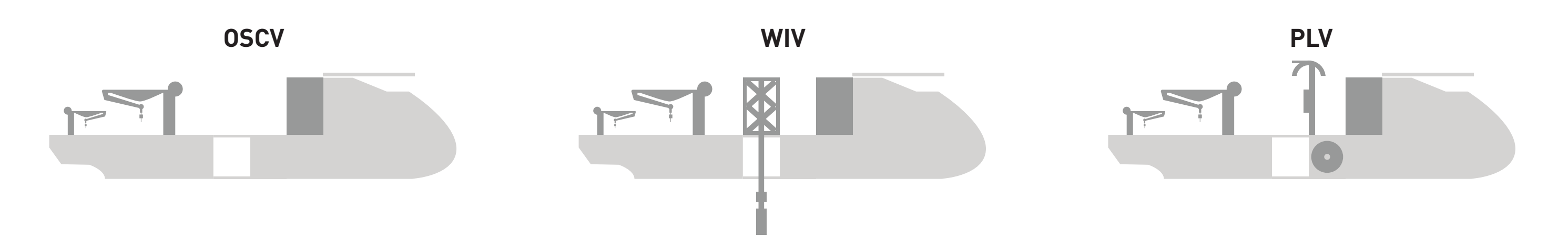
The fundamental way of thinking when designing ships has been to optimize the vessel for one specific set of tasks and requirements, which restricts the vessel to operate in one specific market. This can be unfortunate since the markets are uncertain and contain risk. The absence of adapting quickly to new business actualities can cause a business to loose big money due to their inability to scale. Tomorrow’s market winners will be the companies that know how to combine investments with flexibility. A real options analysis is one of the tools that can be used by investors to find the value of owning a flexible design concept. In ship design, flexibility can be added by initially preparing the vessel to handle several types of equipment of different sizes. This way the cost of rebuilding and reinforcing the ship is reduced.

The subsea market blossomed in the past due to a high oil price and new discoveries, and the demand for OSCV, WIV and PLV increased. Last year’s oil price drop in combination with oil production moving into deeper and harsher waters has resulted in an increased focus on cost efficiency and improved technology. This has led to initiatives on multifunctionality.

CASE DESCRIPTION

The object of this thesis is to find a value of owning a Multipurpose Offshore Construction Vessel with the option to switch between the OSCV, PLV and WIV markets instead of buying three separate vessels. The thesis seeks to identify and price the underlying assets necessary for the design of each vessel type. Initially the vessel will be constructed as an OSCV, because the deck equipment on an OSCV works as a common denominator between the different vessel types. The equipment capacities are based on the reference vessel, Island Performer. Thus, the chosen deck equipment is a 250t KBC, a 300t MHT, a 100t skidding system, a 250t VLS and a 2500t carousel.

- The case is limited from the following boundaries:
- At T=0 the vessel will be completed as an OSCV, and the following first phase she operates as an OSCV
 - At the end of each period the owner has the option to switch to a different vessel type
 - The vessel can enter into the OSCV, WIV or PLV market
 - Each of the three markets have different contract lengths
 - Each contract represents a period in the analysis
 - The analysis only considers the first four periods of the vessel’s lifetime



REAL OPTIONS

In this thesis we are using the Black Scholes Option Pricing Model (BS OPM), which is commonly utilized to analyse the option value of European Call options. These option types provide the option holder with the right to buy a specified quantity of an underlying asset (with a value, S) for a fixed price (called the strike price, K) at the expiration date of the option. Since it is a right and not an obligation, the holder can choose not to exercise the right and allow the option to expire. At expiration, the option holder makes the decision based on the results from the BS OPM, if the option value is positive, the option is most

likely to be exercised, or if the stock price (S) is higher than the strike price (K). Other variables related to the BS OPM are the volatility (σ) of the stock price, the risk-free interest rate (r) and the time to maturity of the option (T). The BS OPM also considers the cumulative distribution function where N(d₁) represents the probability of S>K at the expiration, and N(d₂) is the future value of S, if and only if, S>K at the expiration. The equations 1, 2 and 3 show the BS OPM (Black & Scholes, 1973). Table 1 shows how the value of the call option changes with an increase in one of the factors in the formula.

Table 1: Call Value Change with parameters

| Variable Increase | Call Value Change |
|-------------------------|-------------------|
| Stock price | Increase |
| Strike price | Decrease |
| Volatility | Increase |
| Risk-Free Interest Rate | Increase |
| Time to Maturity | Increase |

(1) $C(S,t) = N(d_1)S - N(d_2)Ke^{-rT}$

(2) $d_1 = \frac{1}{\sigma\sqrt{T}} \left[\ln\left(\frac{S}{K}\right) - \left(r + \frac{\sigma^2}{2}\right)T \right]$

(3) $d_2 = \frac{1}{\sigma\sqrt{T}} \left[\ln\left(\frac{S}{K}\right) - \left(r - \frac{\sigma^2}{2}\right)T \right] = d_1 - \sigma\sqrt{T}$

ASSUMPTIONS

The concept of real options has its origin from finance theory, but it has been adapted to engineering systems since the 90s. Therefore many of the factors involved in the BS OPM are describing stock behavior. Hence some assumptions had to be made in order to correspond the real data to the theoretical factors in the model, prior to implementing the input data into the BS OPM:

The Time to Maturity, T
The time to maturity represents the time period the option holder has to decide whether to exercise the option or not. Here T is assumed to be the contract length of the previous phase. This is because when switching between vessel types the window of opportunity, to justify this choice, is the time left of our current contract.

The Stock Price, S
The stock price is here represented by the current daily hire rate of the three vessel types, and multiplied by the amount of operating days in their respective contracts. This is because in finance, the stock price is the value of which you can sell a stock. When chartering out a ship, the potential income comes from the vessel’s daily hire rate. The daily hire rates for each vessel type in 2015 are assumed for vessels operating in the North Sea based on long to medium term contract.

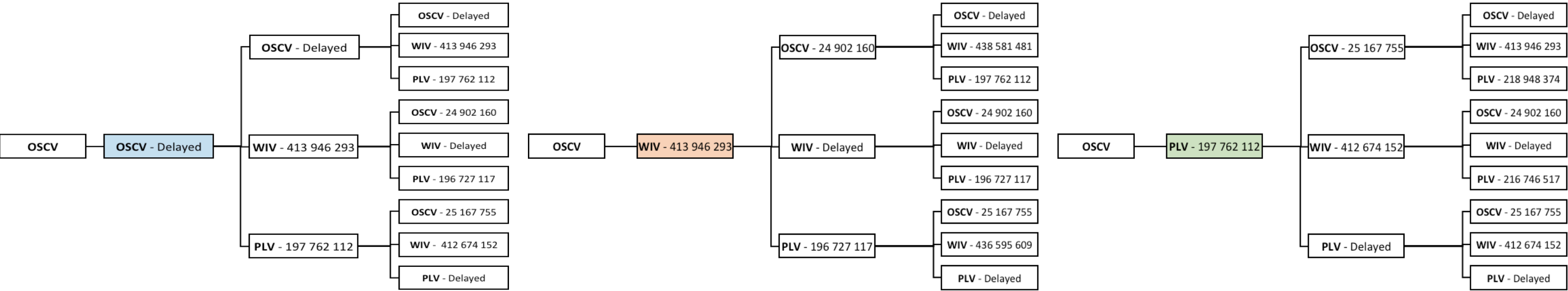
The Strike Price, K
The strike price is financially defined as the price paid to exercise the option. This is translatable to the cost related to transforming the vessel from one phase to another. The transformation cost includes the price of buying the necessary deck equipment, further it is included an additional cost for mobilization and demobilization of the equipment, which consists of the cost of man-hours and the use of equipment required to perform the installation, such as cranes. Since the vessel is prepared for the additional deck equipment, costs of rebuilding and reinforcing the vessel are not included in the strike price. In the analysis is it assumed that the first time the vessel will undergo a change into a new vessel type, the shipowner will have to acquire all the necessary equipment, but once it is bought the equipment can be stored for future periods. This is implemented in the calculations by calculating different stock prices based on what operational modes the vessel is switching between.

The Volatility, σ
The volatility is defined as the fluctuation of the stock price over time. By looking at the yearly historical change in the daily hire rates we can derive the historical volatility of them, and use them to predict the future of the price. It is calculated a different volatility for each vessel type.

The Risk-Free Interest Rate, r
The risk-free interest rate is the theoretical rate of return from an investment made in a market with zero risk. This is not possible in real life, but the factor is important in finance because it is used as a starting point for calculating the cost of equity and capital. The risk-free rate is usually based on government bonds, since they are the safest investments one can make. In this analysis the annual risk-free rate is collected from a Norwegian market report performed by PWC in 2014.

RESULTS

The results shown below have been calculated by implementing the BS OPM with all its assumptions into each possible scenario. Each node shows the call option value for the vessel type in the given order.



CONCLUSION

It is exciting how real options thinking has revolutionized investors’ ways of handling companies as it forces the option holder to consider hidden assets as a business opportunity. Still, options are challenging to value when the underlying asset is non-liquid such as property, equipment, oilrigs, offshore vessels and commodities, and this matter is also the source to all the analytical errors. Other errors occur from the fact that real options theory is betting on market uncertainty and volatility, and that one will eventually need a plan B. With errors and omissions accepted, the results from this analysis show that all call option values are strictly positive. From this we can draw the conclusion that a multifunctional vessel design is profitable for the owner in an uncertain market.

REFERENCES

Black, Fisher and Scholes, Myron (1973). The Pricing of Options and Corporate Liabilities. Chicago Journals
PWC (2014). Risikopremien i det Norske Markedet

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