UNIVERSITY OF PIRAEUS
DEPARTMENT IN MARITIME STUDIES

M.Sc. Thesis
Whole Life Cycling Cost in Shipping Industry

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November 2013

Authentication

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Acknowledgments

First of all I would like to assign my truthful kind regards to my supervisor Professor Eleftherios Thalassinos. With his special academic as far as personal guidance Prof. Thalassinos proved to be a milestone in my life development. Since our first acquaintance, I was fortunate to be given opportunities that enabled me not only to participate in the department's administration but also in international official activities. The world of International Trade and Shipping was opened for me with the best of prospects thanks to Prof. Thalassinos. I will always be grateful that I stood next to a hard working, ambitious and capable inspiring man. These principles will follow me through my lifetime, helping me to build my future, and overpass my limits.

Furthermore, I would like to thank the members of my supervising committee Professor Andrea Merika and Assistant Professor Konstantino Liapi and for their valuable contribution, guidance and their help during the elaboration of this Thesis. The excellent and direct communication as well as the guiding pathways, which gave me throughout the study duration for the composition of this work was one of the most important factors, which helped me complete my work. Their support for the implementation of my goal was a key factor that helped in the outcome of this stage of the Masters Program.

Lastly, but also important I would like to thank my family for their support all these years and the values which have nurtured me.

Summary

The main purpose of the thesis is to introduce the notion of costs during the ship's life (Life Cycle Costs-LCC) and the total cost for the entire ship's life (Whole Life Costing-WLC) for the valuation of the investment in various ship types.
For operation of the ship there are specific cost. More specifically, we have operating costs (Operating Cost) and travel costs (Voyage Cost). Assuming, the ship is under long-term charter, where the travel cost burden the charterer; we manage to eliminate one parameter, which cannot be measure. So we have only the operating costs that are measurable. If you enter the construction costs, the reselling value and the cost of scrap, we have all the elements for the measurement of total costs during the ship's life (Life Cycle Costs-LCC).
In addition, if you enter and financing costs, income from the operation of the ship and several other cost factors extrinsic to the operation of the ship, we managed to gather all the parameters for measuring the total costs over the lifetime of the ship (Whole Life Costing).
The ship is of tangible item, with a limited life and with characteristics similar to the real estate market. In the sector of real estate market had been applied research methodologies of LCC and WLC. Based on these studies, will test the effectiveness of these methodologies in the shipping industry for ships in liquid and dry cargo, gathering information on all the above variables. Finally, we will proceed to create various scenarios to evaluate an investment based on the model we will construct.

More specifically, this work consists of five main parts. The first part deals with existing literature on the object we are examining. In the second part, we do an analysis of the shipping market. In the third part we present the information used to conduct the conclusions and analyzed the methodology that followed. Regarding the methodology we follow a model of Liapis et. al(2013), which had been applied only to the building industry so far. We analyzed all the possible parameters and customize it so that it is applicable to vessels as well. The next and most important step of this work was the appliance of the model we constructed in all the Bulk Carriers and Tanker vessels and the results of this analysis. In more detail, we build tree models for each ship category. We took an operation period of ten years, from 2000 to 2009 and we assume that in 1.1.2010 we resale the ship. In the tree models we construct

we took tree cases. In the first case the ship-owner is buying a new building vessel and operates for the examined period and in the end of this period he resale the vessel reaping profits. In the second case the ship owner is buying a five-year-old second hand vessel, which operates it for the exactly same period and then he resale it. In the third case the ship-owner for the same period buys a fifteen-year-old second hand vessel and in the end of the period he sales the vessel in the demolition market, in other words the ship goes for scrap. The results of these models varied depending on the ship type, which examined each time and the market the ship actives.

More generally comparing the two markets, the market of the bulk carries is being affected more by the economic cycles than the tankers market. The tankers market is determined more by the mayor oil companies.

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Chapter 1

Introduction

The vessel is a fixed asset trading not in permanent locations, whereas the management and generally the operation of the vessel can be established in any place around the globe. Therefore, the shipping industry has some special characteristics, which are unique in all industries. However, the vessel has some key characteristics, which can be linked with other forms of industries.

Real estate valuation procedures do not differ enough from the investment on a ship and the operation. The real estate has an initial construction value, an maintenance and repair cost and an income. At the end of the useful life of the construction, there is a salvage value, which reflects the last inflow from this investment.

In a similar way, the vessel has a construction value, which changes over the different types of vessels and designs. The capacity and the cargo that will carry are the most determinant factors that the ship owners consider in order to proceed with the order of the vessel. The initial cost is usually funded by own capitals as well as financed by a loan facility. During the life span of the vessel, there are several inflows, which are the freight and other repairs, maintenance costs and other costs, which are deducted from the revenues.

As the constructions in the same way vessels must not only be evaluated by initial expenses, but in the whole life of the asset. Following the pattern proposed by Liapis et al.(2011, 2014) among others, constructs a Whole Life Cost model, which manage to interpret the inflows and the outflows of the asset and determine the price of an asset during the whole life of the construction.

Restructuring and highlighting various factors of the Whole Life cost model, we manage to apply it on vessel values and shipping in generally. The final Whole Life Cost model constructed does not deviate from the same model of assets, but it sets out some key parameters from the operation of the shipping industry.

Purpose of this Research

The scope of this research is to highlight the applicability of real estate valuation models in the shipping industry and define the main factors that change the value of the vessel, through the life span of the asset. The second area of research is to simulate several scenarios, which change the outcomes of the WLC depending on the different ages of the asset acquisition and disposal, as well as with different types of vessels, which are carrying liquid bulk or dry bulk.

The third purpose of this study is to integrate both sectors of shipping in a unique model and what are the different outcomes for each sector. Through this process, we manage to determine, which is the most adequate investment for a ship owner to proceed. The investment is tested with the various factors included in the model.

Finally, the whole investment valuation procedure is based on Discounted Cash Flows, which is an easy and accessible method for any investor to apply. The system of equations proposed does not need complex solution approaches. In other words, is a simple stepwise methodology the solution of the WLC model.

Context of the Research

Initially, we describe the literature review on the WLC in constructions and determine the most significant parts and outcomes. In a later stage in literature review, we set out some approaches used in the shipping sector and define the main factors that must be isolated from shipping and industry, further defined and at the last part to included in our WLC model.

The second part of this study is to give a short but thorough glance in the shipping industry operation and determine the various ship designs and cargoes. Additionally, in this part a detailed analysis of the various income sources of the vessel are described and we derive in the most usual and significant chartering method.

The next part of this research is to analyze the model of Liapis et al. (2011,2014) determine the main equations and the factors included in this model. After omitting several factors, which are not applicable in shipping industry or they are provide in a more efficient way than the construction business, we derive a complex but substantial model to evaluate the WLC of the vessel. Another point we highlight in this part, is the total absence of taxation in vessels acquisitions and how does this alters the environment that the shipping industries are operating.

In the final part, we construct three different scenarios for two different types of vessels, namely dry bulk cargo and liquid bulk cargo carriers. Scenarios are based on different ages of vessels, which are operated for a predefined period and then sold for in the second hand market or in case they are very old, they are sold for scrap.

In general, the outcomes manage to signify the magnitude of the investment decision of the ship-owner. The two different sectors are having their own key characteristics, which differentiate the outcomes from the investment in dry bulk carries or liquid bulk carriers. This two sectors, though they are operating in a similar environment have different reflects on market conditions.

The outcomes set above are our initial expectations before the appliance of the WLC model. More specific, there is the tendency in shipping market for a new ship-owner to operate the dry bulk cargo and when the maturity in business is substantial to move on to the liquid bulk sector.

Chapter 2

Literature Review

2.1. Introduction

The meaning of the whole life cycle cost is not new in the construction industry. This term and this evaluation methodology started in the beginning from the need to calculate the various costs, which usually occur during the life span of a building. The assessment of this highly profitable information surely has a major importance in the investing decision process.

However, a vast majority of previous researchers addressed the problem of the various factor that affect the whole life cost of a building and the difficult to predict them. This problem was partly caused by the static initial whole life cycle cost models, which could not adhere the various changes. For that reason, researchers tried to estimate models, which will facilitate a strong dynamism and will use all the available data to reevaluate the whole life costs. Profoundly, this enhancement is based on the constant monitoring of the construction during its whole life.

Admiringly in the shipping sector, the implementation of the whole life cycle cost methodology has been gradually incorporated, without facilitating the already research contribution of the construction industry. A vast majority of researchers in the shipping sector manage to gather all the important factors needed to evaluate the vessel price. Most of these factors are common, with the Whole Life Cycle cost methodology.

The literature review following starts from the work of researchers in the construction industry, and the gradual need for Whole Life Cycle cost. Then it moves on to the shipping sector and the various methodologies used to determine the vessel price.

2.2. Building Industry

David Baccarini et al. (1996), introduced the complexity aspect to manage a construction. The key factors that take place in a construction project are so many. The concentration and estimation of all these factors, which may arise during the evolvement of the project is surely a significant work to carry out. The management of such projects presupposes planning and cost budgeting. Even if all the possible measurements have been taken, it is definitely very high the risk to lose the track. Each project has its own characteristics and it is obviously very difficult to predict what it might need during the evolvement of the project. In the case of Baccarini et al, they tried to carry out an analytic review of the theory of project construction, which in the ends leaves enough space for further research and discussion.

On the other hand Woodward et al. (1997) work moved in totally different patterns from the previous researchers. With construction activity elevating constantly in higher levels, there was a constant need to investigate all the phases of a construction. As a result, the phrase “value for money” had become a necessity to all activities, not only during the construction but also for the maintenance of a building. What needed in order to succeed was an effective management, which is going to calculate the whole life cycle of a construction from the beginning to the end. Life cycling cost is going to give to the operator the whole picture of an asset during its operational life. Thus an investor could be in a position to predict the earnings of the operation of a construction, leading him to whether purchase the asset or not.

In the same way, as the previous researchers, A. Al-Hajj et al. (1999) tried to shed more light in the whole life of the construction. The researchers noted that the entrance of Private Finance Initiative (PFI) in the construction industry increases the need for calculation of the Whole life cost of an asset. This diversification lies upon the need of the investors, who do not only want to know the construction cost, but as well as they want to evaluate the investment in a more holistic frame, from the design to the maintenance of the structure. A. Al-Hajj et al. believed that through a Virtual Reality (VR) model he could include all the factors that affect the WLC. In his research what he tried to do is to add the life cycle costing to the design phase of the

OSCON database, which was developed in the Salford University in the UK. The result of this research indicates that, if the life cycling cost was taken under consideration, when the design of the structure was taking place, then it will be profoundly easier to calculate the maintenance cost as well.

Mohammed Kishk et al. (2003), tried to introduce the definition of whole life cost (WLC) in the construction industry. The first step in their research was to carry a historical research and examine all the methods for the calculation of WLC. This initial research will further diminish the applicability of the Whole life cost methodology in construction industry. In addition to whole life cycle cost, they tried to sum up all the mathematical types, which were proposed in literature. When the concentration of all the mathematical types and the final construction of a Whole Life Cycle cost model were finalized, the next step was to concentrate any data needed for this model. The final results of this research were rather poor, since the researchers end up in the conclusion that the estimation of a Whole Life Cycle cost model in construction industry is significantly difficult.

Nicklaus Kohler et al. (2003) manifest that life cycle cost analysis of a building, should be a holistic approach, which will consider also the social impact of the structure. Social issues are arising by the environmental protection of the building and the ecological energy sustainability. Considering this aspect, researchers' support that life cycling cost analysis is a good initiative to move on to more environmental friendly buildings. Furthermore, Life cycling cost analysis is rather expensive to carry in a construction and could only be implemented, if there is any measured profit in the life of the construction. Obviously, an energy saving building can eliminate significant costs from the operation of the building during its life span. With this in mind the energy efficiency profit is measureable and can be calculated in the construction cost.

Henner de Ridder et al. (2004) supports again the difficulty to evaluate all the counter parameters, when a contract is signed, which this usually leads to dissatisfied customers. In order to avoid this, researchers tried to present a model, which depict a dynamic control of value, price and costs though the life cycle of a building. This model is founded on a change from considering fixed costs between different phases of the life cycle of the building, to a more dynamic and evolving model, which changes prices continuously during the life cycling period. This dynamic process is established through monitoring the value price cost of the building at all times, and acting instantly when a change occurs in the demand. Results are rather positive; with significant sings that there is a positive benefit generated from the dynamic control of the structure, which means that the value of the construction overwhelms the cost. Profoundly, this cannot be achieved without the involvement of the parties of the supply chain and off course this must be done in all the phases of the life cycle cost of the building.

Kirkham et al. (2004) supports that Private Finance Initiative (PFI) and Public Private Partnership (PPP) before proceeding to final decision for an investment must determine and examine the long term cost of the building. For that reason the calculation and implementation of Whole life cycle costing (WLCC) becomes a necessity on the evaluation of such an investment, and significantly increases the possibilities to end up with the most profitable scenario and investment. The researchers signify the absence of a an alternative investigation process to determine the WLCC based an interactive decision-making process. Establishing a model structure that will compromise the enhancement of a decision-making process, Kirkham et al. (2004) tried to compose an interactive WLCC model, which will give results based on the entire design process. With this enhancement they managed to obtain a dual result in the final WLCC design, the ability to simulate the changes in micro level, bringing up to date and optimize the WLCC design and also the ability to count the changes in macro level, which help them determine the optimal decision in a worldwide basis. Surprisingly, this enhancement in the final whole life cycle cost model gives the advance of a dynamic model construction, which will encompass all the worldwide changes in the construction industry.

2.3. Shipping Industry

Raiswell (1978) tried to define the strategy, where the building of a vessel is fundamentally based on. In order to accomplish this, he based his methodology on the work of Zanetos (1966) and Metaxas (1971). The results of this research define the managerial short falls as the major problem in the construction of the vessel, which finally lead to delay of the delivery of the new building vessel to the owners.

Hawdown (1978) tries through a model to analyze and explain the shipping market for tankers. He viewed the freight in the spot market of the tankers as an aggregation of the tanker services and the conditions in the tanker market. In addition to he supports that the orderbook is one more factor that also affect the freight. Furthermore in the start of his research he claims that the expectations of the ship-owners may also affect the freight rates. In the end the results from his model shows that the ship-owner barely affects the shipping market. What affect the shipping market in the case of tankers are the oil companies.

Jansson et al. (1982) compose a model to estimate the optimal ship size. In order to do that, they construct a model focus on the transportation of coal (bulk shipping). They use data of the ship operation and finance. They support that the optimum ship size, depends on the operating cost, the fuel cost, the distance of a trip, the capital costs and the port costs but according to P. Garrod et al. (1985) who took the Jansson research one step further whether the cost is, in the end in all of their cases the result was that the ship needed was larger than the one they use in their models. The actual outcome of this research is that the draft limitations of the ports, are responsible the ship sizes.

Miyashita (1982) determined the behavior of the investments in shipping and proposed a behavioral analysis of the investment planning. The investment decision, as Miyashita proposes is the close observation of the transportation services sales and the growth of the sales. On a second stage, Miyashita focus in rate of orders given for new building vessels.

Strandeness (1984) facilitated the Norship model in order to estimate the value of a second hand ship and time charters rates. Second hand values of Tanker vessels and Dry bulk vessels seem to have the strongest impact in the current profits and the long-term profitability. More specific VLCC are sensitive in changes in current markets conditions. On the other hand Panamax vessels are constantly change by variation in the long time charter rates.

Beenstock (1985), determines the ship as an capital asset, which can be treated a stock and this asset can be continuously traded. Beenstock describes the shipping market as result of two different segments, which are the freight market and the market for ships. In to order too exist an equilibrium in the Freight market, demand and supply must be equal in all terms, which means:

Qd=Qs, whereas Qd=F1 (WT, F) and QS=aβσK

WT is the seaborne World trade, F is the freight rates, 1-a is the number of vessels laid up, β is the carrying capacity, σ speed and K is the fleet size. Market for ships, in terms of supply and demand is as follows

ΔK=F(P,Ps,K)

The supply side consists of, ΔK is the change in fleet size, P is the price of a new ship, Ps is the scrap value. The demand size can be easily explained as proposed by Markowitch theorem:

$K^d P/W = F_s(R, R^* \quad)$,

W is the real wealth, R is the expected returns of the vessel and R^* is the returns of a competing asset.

The final step is the construction of three-equation model, which in the long-term period has a stable condition with no tremendous variations. This three-equation model is later on tested with the insertion of anticipated and non-anticipated shocks and how it reacts, before it reaches again the stage of equilibrium.

Glen (1990) evaluates the vessels based on gross profit margin for different routes profiles and different size of ships. The period covered (1970- 1978), is an era when different types of vessels started to be constructed. He focuses on the oil tanker market and tried to prove the homogeneity of the oil market. What the research shows is that in tanker market the margin profit differs according to the route the ship follows in a voyage. What is more the risk is based on the ship type and changes accordingly.

Adland et al.(2006) investigates the efficiency of forward ship value contracts(FOSVA) and how they can be applied in order to eliminate or reduce the risk taken from the sale and purchase of vessel. Considering that a vessel cans both traded or held for sale, there is always a cash generation process linked with the value of the asset and a cost of carry relationship. IN more detail, revenues from the operation of a vessel can be described by the following equation:

$I = \sum_{t=0}^{T}(\frac{365-t}{12}) \times (\frac{X(t)-C(t)}{(1+r)^{t}})$,

where as T=months of contract,

X(t)=T period time charter(dollars/day),

C(t)=Operating cost,

R=risk free interest,

The cost-of-carry relationship, has the usual form described by the following equation:

$F_0 = (S_0 - I)e^{rT}$,

Where as F_0 =forward price and

S_0 is the current market price.

The trading of the FOSVA agreement is initiating when the forward price of a vessel is estimated higher from the amount the current price, the optimal scenario is to maintain the ownership of the vessel and a sell a FOSVA agreement, which will have a maturity period equal with the charter contract of the vessel.

One of the major problems of this research is the lack of data since there are very few actual transactions of FOSVA agreements. However, researchers tried an alternative way to maintain forward prices by using hypothesized prices for the index. The next step was to check data sample for non stationarity, with the results signifying that all spot prices are of the same rank integration order. Johansen's co-integration technique revealed that in all cases the hypothesis of unbiasedness is rejected. In the forecast error, a risk premium is implied; varying from constant risk premium to time varying and in some cases both types of risk premium exists. Additionally, results are varying widely in all cases but this cannot be used as a reason of characterizing the market as insufficient. As far as it concerns the FOSVA agreements, there are serious notions that the volatility of the market is disrupting the efficiency of FOSVA agreements. For this reason, there is no use to enter into a FOSVA agreement to reduce the risk taken from the sale and purchase of vessels.

Haigh et al. (2001) made a research in which he tried to verify that bulk shipping is efficient and that all freight rates are interconnected. In order to succeed that he was collecting daily data for almost five years, observing the Baltic Exchange. Daily data were observations of BPI (Baltic Panamax Index). In order to examine the interconnectivity of the freight rates he uses Johansen's co-integration theory. Later on the research, three different processes were used in order to examine more closely the interconnection of freight rates, which are decomposition of forecast errors, directed acyclic graphs and last impulse response. In conclusion, this research reveals that the shipping markets are highly efficient.

Yung-Shun Chen et al. (2004) tried to calculate the volatility in shipping industry. He used four different routes returns for the three main bulk carrier vessels. The results of this research were that in the shipping market asymmetry volatility exists and is more obvious in a downsizing market. The investments would increase if the ship-owners could predict the volatility of the shipping market.

Adland (2006) used technical rules applied in the stock market to evaluate the decision to acquire a second hand vessel. The outcomes of this research were rather poor, because of the volatile nature of the shipping market, which might deliver wrong entry and exit signals.

Glen et al. (2006) tried to establish the validity of the notion that the time charter contracts with long duration are less risky and the size of the vessel is determining the risk accompanied with this investment. The results were surprisingly informative, because indeed large duration time charter contracts provide safer harbor to profit accumulation in the long term. Additionally, for the second part of the research, they manage to prove that the larger size carriers are a riskier investment.

Veenstra et al. (2006) tried to investigate the value of a vessel as a combination of both the design of the vessel and the economic performance. The design of the vessel is unpredicted because is highly connected to the expectations and the needs of the ship-owner. On the other hand the decision to make an investment depends on four main questions. First of all is the price of the vessel the time being. Secondly, what we have to take under consideration is the size of the vessel and the optimal speed. Thirdly the decision relies on the operation of the vessel and the chartering decisions. Finally, is the earning potential, since there are some fixed costs which they are related with all the above.

Scrarsi (2007) make a research about short period cycling patterns and ship-owners mistakes. He study for ten years the Handymax dry bulk vessel sector and describes the cyclicality characteristics of this period. Scrarsi attaches the blame for bad investments or investments that never take place in three factors, the lack of experience, the lack of managerial culture and mistakes connected to the decision making attitude.

Alizadeh et al. (2007) valuated the performance of various trading strategies in the market of second hand vessels. They estimate an equation that defines the current price of the vessels as the expected price of the vessel, the expected operational profits and expected rates of return. After a lot of research and different methodologies this strategy found to overpower in all cases simple buy and hold decision policies. In addition there seems to be more profit from investments in Capesize and Panamax vessels because these markets are more volatile.

Merikas et al. (2008) tried to evaluate the investment decision. The outcome of this research was that tanker market is for investors that averse the risk. More specific, higher market risk encounters in Suezmax and Aframax tanker vessels while in the market of VLCC's vessel it is indifferent if invest in a new building or in a secondhand.

Sodal et al. (2008) investigated a disserted type of vessel, the Ore-bulk-oil carrier. The advantage of this ship is that can carry dry bulk and liquid bulk cargoes without any modification need. The purpose of this research is to evaluate the option to entry-exit these two different markets and what will be the impact in the profitability. The outcomes from this real option model suggest that a future use of this type of vessels, might obtain better results than the traditional vessels, which focus only in one segment of the market and thus the construction of this type of vessels must reevaluated.

Sodal et al. (2009) tried to construct and then estimate a real option valuation model with stochastic freight rates. The purpose of this real option valuation model was to reflect the decision of a ship-owner whether to switch from Dry Bulk to Tanker market and vice-versa. In order to accomplish this purpose, they consider that the two markets are complete and fully integrated and the ship-owner has always the choice to switch from the one market to the other simultaneously, after estimating which market will generate the optimal profits. Despite this well designed effort, the outcomes were rather poor, without signifying any optimal decision scenario.

Dikos (2008) manifests that the shipping operation includes from its nature, several non-expected factors, which cannot be easily inserted in simple discounted cash flow model. Additionally, there is very strong heterogeneity in the shipping industry and the shipping companies. This heterogeneity is a result of different operation of the vessel and chartering strategies. In order to include all the prolific characteristics, he constructs and simulates two different models and test them with Poisson likelihood estimation, negative binomial with random effects and ordinary least squares with robust errors. Again, real option model is most suitable to obtain the best results, because it engulfs all the diversifications monitored in the shipping operation.

Mulligan (2008) creates a model in order to estimate the price of each type of vessel. As it seams the most expensive vessels are LNG and bulk carriers, tankers and containerships are cheaper. A reasonable profit margin is between the price and the cost of the vessel.

McQuilling (2009) mention a transition from traditional methods in the estimation of market value to more accounting methods included future discounted cash flows of a vessel. In addition, McQuilling, makes it clear that the value of a vessel is the sum of the current market facts in supply and demand and the valuations of the seller and the buyer.

Kou et al. (2010) tried to investigate the connection between the freight rates and the vessel prices for Handysize, Panamax and Capsize dry bulk carrier vessels and for Aframax, Suezmax and Vlcc tanker vessels. What was found from the research is that in the dry bulk sector co-integration exists in all cases. Tanker vessels do not show any co-integration except Vlcc. The researchers define that dry bulk sector rely on more to freight rates than the tanker sector. This analysis lead to that the asset play is more possible to happen in the tanker sector.

Jiang (2010) tried to search from the shipyards side how a vessel's price is formatted. He collect data from Chinese Shipyards and used a multiple linear model in order to find the most determine factors that affect the prices in the shipyards among credit rate, price cost margin, shipbuilding capacity, shipbuilding cost, credit rate and time charter rate. The result of his research was that the most determinant factor is the Time charter rate.

Jane Jing Xu et al. (2011) tried to explore the connection between freight rates and new building prices. In this research the data where collected from Baltic Dry Index, one year time charter rate and three years for Capesize, Panamax and Hadymax. In order to valuate the interrelationship they used panel data. The results show that there is possible co-integration relation between the variables. Furthermore the Grander casualty test results imply that time charter rates Granger cause new building prices in one way direction.

2.4. Conclusion

As far as it concerns the literature review in buildings, the observation is that, there has been a lot of research about the LCC and the WLC. On the other hand in shipping industry no one so far has made a detailed research in the LCC or the WLC on a vessel. The similarities between the buildings and the vessels allow as to use the research that already exists in building industry in order to fill the gap on the shipping industry.

Chapter 3

Market Analysis

3.1. Introduction

Seaborne Trade is the most efficient and inexpensive method to transport large amounts of goods. Through the years the percentage of the goods that are being transferred via seaborne trade is increasing radically. That led to the development of the shipping industry to the form, as we know it today. Actually, the changes are not radical, only the technology advanced the design of vessels and their carrying capacities, reducing even more the cost of seaborne trade. The operation of the vessel did not change in any way.

The competitors of shipping industry are airplane and railway transportation. Researchers said that with the technological development (speed increased in railway and airplane) the transportation through the shipping industry is going to be reduced but on the contrary no such fact has been reported. The volume of the goods that can be transferred through shipping industry is incomparable with other means of transportation.

3.2. Basic distinctions of maritime industry

The maritime industry is not uniform but consists of a set of markets segments. The criteria used to distinguish the individual markets are manifold. However, a first general distinction can rely on the type of ship and the cargo carried. On this basis of the features distinguished, there are the following markets-sectors:

1) **Bulk Shipping**

The bulk shipping consists of the bulk liquid tankers and dry cargo vessels. These cargoes are in bulk condition and they don't need any trimming or stowage. The format of this cargo does not need any special handling and can fill the total capacity of a bulk carrier. At the same time there are also loads which, though not loaded bulk in this class, as is true for taking the principle "one ship -a cargo" such as frozen products and cars. In the category of bulk cargoes mainly include raw materials transported mostly in large quantities (oil, grain, iron ore, coal, fertilizers, cement, etc.). The definition of bulk is based on their characteristics, which allow for the handling and transportation of them in large quantities, which occupy the entire ship, in order to reduce the unit cost of transportation.

The physical characteristics of each cargo determine the type of vessel will be used for routing, the equipment required for handling and overall structure of the transport system. Regarding the characteristics associated with loading, the bulk cargoes are divided into four main categories:

a) Bulk liquid cargoes, which are divided into three main categories:
   - Crude oil and its products (net-mainly kerosene, gasoline-and wastewater)
   - Liquefied gases (gas oil and natural gas)
   - Vegetable oils and liquid chemicals (ammonia, phosphoric acid, caustic soda, etc.)

b) The five main dry bulk cargo: iron ore, coal, grain, bauxite and alumina, and phosphates, which are the basic raw materials and the largest group of dry bulk cargoes.
c) The minor dry bulk cargoes, raw materials and semi finished products, such as steel products, forest products, cement, fertilizer, manganese, sugar, soybean, iron, salt, sulfur, which are the third largest group of loads
d) Special bulk cargoes for carriage, which require special conditions, present particular problems in handling during loading and unloading . Such loads are vehicles, products transported under refrigeration, steel products, prefabricated houses etc. Many of the cargoes in this category may not load bulk but unit. Because they shipped in large quantities and, in general, apply to them the principle of "one ship a load" classified as bulk. Cargoes of this class and minor dry bulk cargoes are transported by liner shipping .

2) Liner Shipping

Liner shipping includes ships, which load general and unitized cargo, transposing processed or finished products. More specific a large number of cargoes are mostly manufactured products, whose demand evolves smooth care in long term. A ship in liner shipping can carry many different cargoes simultaneously, each of which constitutes an insufficient amount to cover the carrying capacity. In general cargo, included goods particularly with high value or sensitivity, requiring special transportation service for which the owner prefers to pay fixed fare than the fare applicable to the free market. This characteristic of cargoes, lead to different approaches from the liner shipping relative to the bulk shipping. While the second is interested in the reduction of unit costs, the first focuses more on reliability, speed and quality of the transport service it provides. For this reason companies provide bulk cargo shipping generally offer homogenous services, while businesses in liner shipping put more emphasis on the diversification of services. Ships in liner shipping generally carry cargoes in known acquaintances before departure and arrival times, and predefined seaways, with known beforehand fares. The operator of the ship is responsible for all transport costs and transport conditions laid down by the bill of landing, which is the same for all shippers. These features differentiate the shipping liner from bulk cargo shipping. The transfer of many small loads and small volume implies a strong and complex administrative structure, while the obligation schedule travel limits business agility. While the owners of bulk cargo shipping may apply methods that allow them to face the imbalance of supply and demand as the lay up of ships, liner shipping companies are obliged to strictly observe the schedule of travel, regardless of short-term changes of demand.

The distinction of general cargo, due to the large number of them is based on how they are handled and loaded. The most basic way of transporting and handling and general cargo are:

a) Loose Cargo: Includes individual items, boxes, machinery components, etc., each of which must be loaded and stacked separately. In the past, all general cargo belonged to this category.
b) Containerized Cargo: This standard containers, used for cargo with specific dimensions. The unit of capacity of the container is twenty-foot equivalent (TEU). Today the containers are the main types of transfer of general cargo.

c) Palletized Cargo: In this category, the cargo is packed in pallets in order to facilitate the handling and stowage of.
d) Liquid Cargo: This cargo is in liquid form and is being transferred in deep tanks, containers or barrels.
e) Refrigerated Cargo: These are delicate cargoes, loaded either under refrigeration or freezing, either in separate holds of ships general cargo, or containers-freezer.
f) Heavy and awkward Cargo: This category includes the large volume cargoes, which present difficulties in storage such as motors, yacht, etc.

3) Passenger Shipping

The organization of passenger shipping is different from the bulk shipping. However, as in bulk shipping, so in passenger, the market is not uniform, since passengers who use its services, have no common characteristics. A first criterion to distinguish the sub-sector of passenger shipping is the nature of demand or otherwise, the purpose of the trip. In passenger shipping demand appears as producer and as primary. The demand for a passenger to transport, characterized as primary demand, and not about transportation purpose that relates to the manufacturing process, covered differently than the production demand.

Differentiating the objective demand and due to this distinction of individual sectors of passenger shipping lead to diversity of the types of ships used in each case.

Bellow there is a graph from the book of Stopford (1997), which described in detail the different types of shipments and the various segmentations.

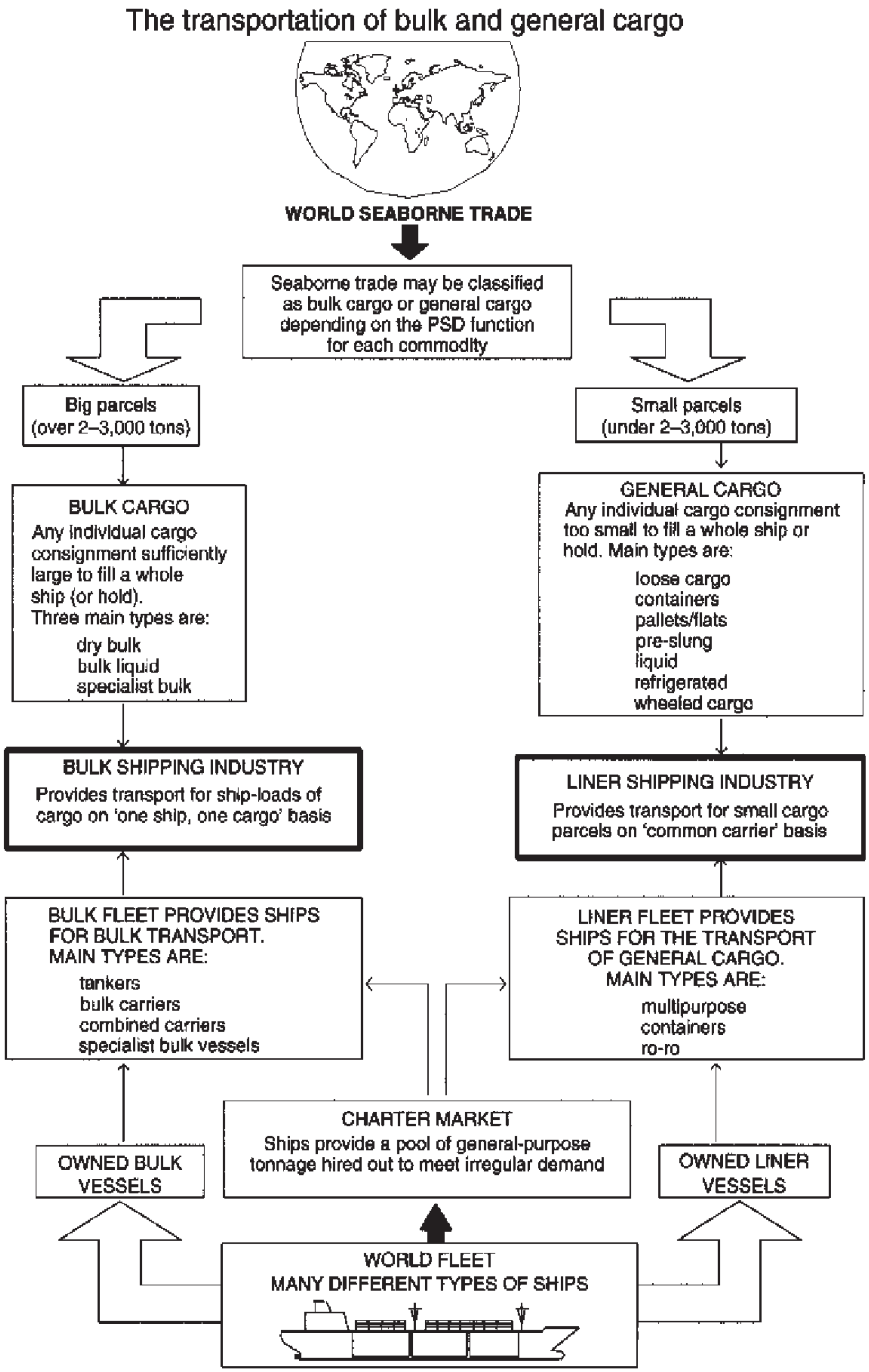


Figure 3.2.1. : Cargo transportation
Source: Maritime Economics, Martin Stopford 1997.

3.3. Ships Types

Bulk Dry Carriers

Many of dry bulk cargoes carried by bulk carrier ships, which may be equipped to handle the load. The large bulk carriers usually not have such equipment and for the handling of the cargo are based on the premises of ports. Also large size vessels usually transport different cargoes from small size vessels.

The basic bulk dry carriers are:

Mini bulkers: capacity under 10.000 dwt

Handysize: capacity 18.000-30.000 dwt, these are small bulk carriers that make up the majority of the world's short haul fleet. Handysize can refer either to a bulk carrier or tanker.

Handymax: capacity 30.000-50.000 dwt, these are a larger version of the Handysize vessels and popular for both bulk and crude carriers. These vessels have a large variation in size and characteristics.

Supramax: capacity 50.000-60.000 dwt

Panamax: capacity 60.000-80.000 dwt, this is the maximum size ship that can pass through the locks of the Panama Canal. Locks are 1000ft long by 110ft wide and 85ft deep. Panamax dimensions are: overall length (LOA) of 965ft (290m); beam of 106ft (32.3m); draft of 39.5ft (12.04m).

Capesize: capacity 80.000-200.000, these vessels are too large to pass through the locks of either the Panama or Suez Canals. As a result, these vessels must travel around the Cape of Good Hope in South Africa or Cape Horn in South America to their destinations. These vessels also require deep-water ports.

Very Large Ore Carriers: capacity over 200.000 dwt, these vessels are the largest bulk carriers and also cannot pass through either the Panama or Suez canals.

Product Tankers

These vessels carry refined petroleum products in numerous bulk tanks for safety and in order to carry a number of different products in a single voyage.

Tankers of less than 100,000 dwt are referred to as either "clean" or "dirty". Clean tankers carry refined petroleum products such as gasoline, kerosene, jet fuels, or chemicals. The so-called dirty vessels transport products such as heavy fuel oils or crude oil. Larger tankers usually carry only crude oil.

The basic tankers are:

Coastal: capacity 3,001 - 10,000 dwt**,** these are the smallest tankers and are generally used in coastal waters requiring a shallow draft. Coastal tankers typically carry kerosene, heating oils, fuels and chemicals.

Small: capacity 10,001 - 19,000 dwt, this is the next size up tanker and is still often used in coastal waters. These also typically carry kerosene, heating oils, fuels and chemicals.

Handy or Handysize: capacity 19,001 - 25,000 dwt**,** alternate: 10,000 - 34,999 dwt, this is a popular-sized tanker, but typically not used in very long voyages

Medium or Handymax: capacity 25,001 - 45,000 dwt, alternate 35,000 - 49,999 dwt**,** this is a larger "Handy" sized vessel.

Large/Long Range One (LRI): capacity 45,001 - 70,000 dwt**,** alternate: 45,000 to 79,999 dwt.

Large/Long Range Two (LRII): capacity 70,001 - 100,000+ dwt, alternate: 80,000 - 159,999.

Crude oil Tankers

These vessels carry bulk crude oil in tanks.Tankers of less than 100,000 dwt are referred to as either "clean" or "dirty". Clean tankers carry refined petroleum products such as gasoline, kerosene or jet fuels, or chemicals. The so-called dirty vessels transport products such as heavy fuel oils or crude oil. Larger tankers usually carry only crude oil.

Panamax: capacity 50,001 - 80,000 dwt, approximate 32.2m beam limitation, this is the maximum size ship that can pass through the locks of the Panama Canal. Locks are 1000ft long by 110ft wide and 85ft deep. Panamax dimensions are: overall length (LOA) of 965ft (290m); beam of 106ft (32.3m); draft of 39.5ft (12.04m).

Aframax: capacity 80,000 - 119,000 dwt, this is the largest crude oil tanker size in the AFRA (Average Freight Rate Assessment) tanker rate system.

Suezmax: capacity 120,000 - 150,000 dwt, this is the maximum size crude oil ship that can pass through the Suez Canal in Egypt.

Very Large Crude Carrier (VLCC): capacity 150,000 - 320,000 dwt, these are very large crude oil carriers that transport crude oil from the Gulf, West Africa, the North Sea and Prudhoe Bay to destinations in the United States, Mediterranean Europe and Asia. Although VLCCs are otherwise too large, it is possible to ballast these vessels through the Suez Canal.

Ultra Large Crude Carrier (ULCC): capacity 321,000+ dwt, these are the largest man-made vessels that move. Currently, the largest ULCC is 564,939 dwt. These ships sail the longest routes, typically from the Gulf to Europe, the United States and Asia. They are so large that they require custom-built terminals for loading and unloading.

High-Specialized Vessels

The last category of bulk carriers includes ships with high specialization, which typically have characteristics that allow them to handle and carry only one type of cargo. Ships with high specialization are many, the most important are:
Ore Carrier: transporting iron ore and created because of the peculiarities of the cargo

Vehicle Carrier: carrying vehicles and this is why they have many decks

Chip Carrier: transporting timber products, which unlike with iron ore, have large stowage factor and are difficult to handle.

Cement Carrier: transporting cement and have closed holds and a mechanism for loading and unloading.

Liquid Petroleum Gas (LPG) and Liquid Natural Gas (LNG) tanker: transporting petroleum gas and natural gas liquids, and therefore have insulated tanks and equipment enabling them the charge conservation at low temperatures and under specific atmospheric pressure.

Refrigerated Vessels: transporting perishable products at a certain temperature (meat, fruit etc.) and therefore have insulated holds on multiple decks that are actually cooling chamber, generally have hardware to handle these loads.

Heavy Lift Vessels: carrying heavy loads, which cannot be transferred from other types of ships and they are equipped with specific equipment for handling them.

General Cargo Ships

General and unitized cargoes carried by the following types of ships:

Tweendeckers: classic ships or bulk general cargo with capacity 18.0000 dwt, featuring double decks to carry large loads simultaneously and have facilities to handle them.

Containership: ships of various sizes carrying containers and have dominated in transport of general cargo because of their basic characteristics, their speed in navigation and handling.

Roll on-Roll off: ships, which are able to load vehicles which carrying cargo, as they have ramp and no lifting equipment.

Multi-purpose carrier: ships with double decks, holds grand opening and heavy lifting equipment to carry many different cargoes of bulk, refrigerated and containers.

3.4. The four shipping markets

Shipping companies operating ships, participate in a competitive freight market seeking employment for them, constructed or acquired secondhand vessels to expand their fleet, sell vessels, either to exploit them for operational or other reasons. They participate in four markets, which form an environment characterized by strong fluctuations and affect the competiveness of the business. Figure X shows the operation of these markets, interactions and variances between them.

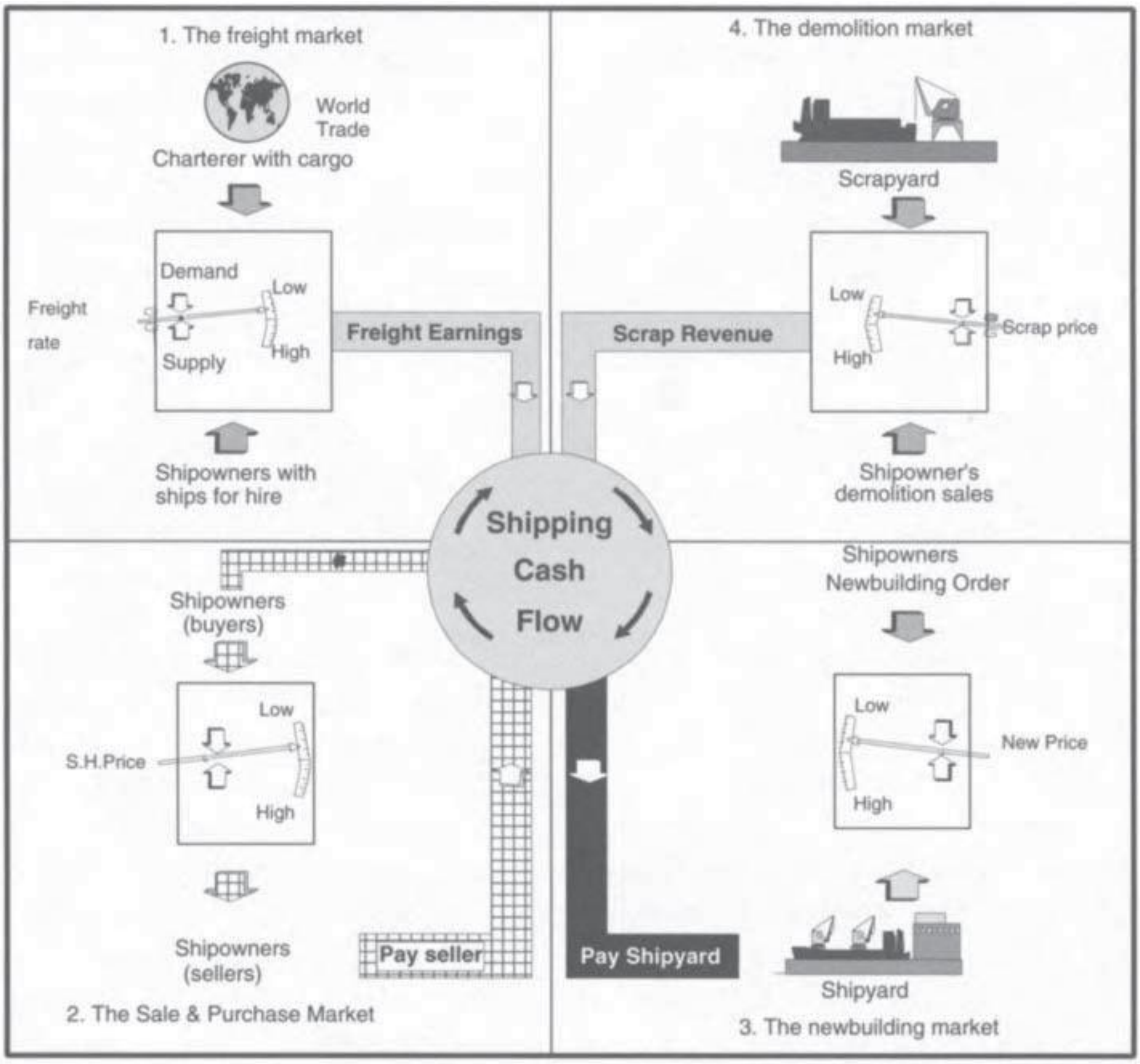


Figure 3.4.2.: The four shipping markets
Source: Maritime Economics, Martin Stopford 1997

Each of the four markets has a different role in shipping industry. In the freight market, there is buying and selling of maritime transport services, in secondhand markets there is buying and selling vessels, in shipbuilding markets is taking place transactions involving shipbuilding and finally, in demolition market ships are being bought or sold for scrap.

These four markets are common to all competing shipping companies. Considering this, these markets consist the environment in which shipping companies operate, compete, in order to attract customers / shippers as well as to supply with essential factors / resources. Certainly the markets of the freight market and secondhand ships include submarkets, which refers to the types of ships. Specialization of the fleet for shipping company is a factor that differentiates the influence of these markets.

The freight market

The freight market is the meeting place of supply and demand for transport services. The shipping company is going into freight markets offering seaworthy ships, with specific characteristics, and it is in search for a charterer. The shipper or charterer has a cargo and wishes to transport it from one place to another. An intermediary role assumed by the broker. The supply vessel capacity and demand for Cargo determine the level of fares. When the demand for freight has outstripped the supply capacity of a ship, then the fares rise. This increases the income of shipping companies, in other words their liquidity. Fluctuations fares may be particularly pronounced even in short-term periods, a feature due to the greater rate of change in demand compared to the supply. There are three main types of chartering, which are amongst the most common types of contracts. The description followed will highlight only the most important features of those agreements.

a) Voyage Charter: In this type of charter, the ship-owner undertakes against the charterer to carry a certain amount of cargo from an agreed port of loading to the agreed port of unloading with fee fixed sum fare, the amount of which is based on the freight market conditions. The two parties are free to choose any type of charter party and make any conversion in order to serve their interests.

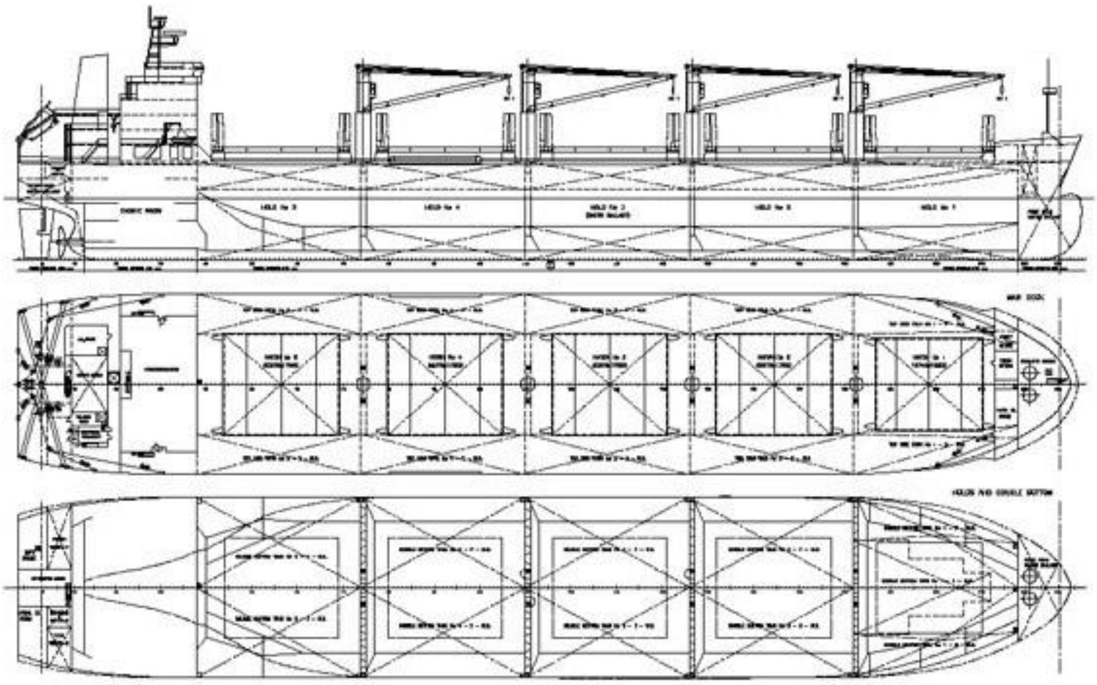
b) Time Charter: As time charter of a ship defined the type of charter in which the ship-owner hires his vessel to the charterer for an agreed period in exchange for a fee, known as hire. Depending on the manner and purpose of employment of the ship, as well as the place and time of delivery – redelivery, time charters include three main forms: the trip charter, the time charter round trip and the periodic time charter. The trip charter resembles with voyage charter because the ship should perform a particular journey. The difference is that the owner collects hire per day for the length of employment of the ship, instead of freight per unit of cargo as in voyage charter. The second case is like the first a mixed form charter, as the charterer charters a ship to perform a round trip and therefore undertakes to redelivery the ship at the same port or area where he received it. The third case is the usual charter, in which the ship is being chartered for a period of time and employed between the limits of a particular geographic region or global. The re-delivery is an agreed geographic region. The period of charter can last from a few days to years. In the time charter, the charterer undertakes the merchant occupation of the ship and therefore he bears with the variable costs include fuel expenses, port fees, cargo loading etc. and of course with the hire. However, the management of the ship and therefore the payment of fixed costs and capital costs remain to the responsibility of the owner.

c) The bareboat Charter: In this form of charter, which occurs rarely, the owner grants the ship naked (without crew, food, supplies and materials) to the charterer for a long time (up to the entire economic life of the ship). In exchange for this assignment, the owner receives from the shipper the agreed hire. On the other hand the charterer plays more the role of the owner of the ship at the time of the charter. The bareboat charter is not technically a charter contract for transportation of a cargo, but a contract for lease of a ship as it passes into the hands of the charterer both possession of the ship -not the property- but also the management, operation, control, employment, insurance, staffing and navigation.

The new building market

In periods of high demand for cargo transportation and consequently rising hires, expectations of higher profit leading shipping companies in the decision for new construction or for acquisition of second-hand ships. Companies are placing orders for new buildings to meet the requirements of the demand. This behavior is the intrinsic tendency for overinvestment whenever the freight market is at a high level, is deemed the structural feature of the shipping industry, which contributes to the cyclical character. But as orders are increasing for shipbuilding, and hence the demand for shipyards and the shipbuilding prices both rising. Simultaneously, as the

shipbuilding capacity can only be changed in the long term, the accumulation of the orders lead to fully exploit this capacity, increasing the time lag between order and delivery of the ship and, of course, a large increase in new building prices, even in the short term. In the time between order and delivery market conditions may change. For this reason the option of construction a vessel involves a degree of risk.
What is more in new building market is that the ship-owners can take advantage of the shipbuilding contracts or rights order signed with the shipyards the previous period and come to market with speculative mood, making them available for sale and reaping substantial profits.



In the Graph bellow, are the drawings of a New Building vessel, with cranes.

Figure 3.4.3.: Signed contract for building bulk carrier.

The second hand market

Shipping companies, who wishing to take advantage from the positive economic context in the freight market, are in search and purchase of second-hand vessels. Vessels are bought and sold like any other commodity markets. Companies, who for various reasons do not wish to further manage of their ships, come to the market as sellers. Companies wishing to acquire ship arrive in the market as buyers. The law of supply and demand is applied here as well for the formation of prices of second-hand vessels. The levels of rates, inflation, the age of the ship and the expectations of owners are, among others, the factors that affect the prices of ships. Must be taken into account and another item. In periods of high freight and hence positive returns for businesses, most of them do not want to reduce their fleet, unless compensated for the profits to be had if they continued the management of ships. This means that the supply of second-hand ships is reduced at the same time demand is increasing, thereby increasing their prices. With increasing freight both rising and business expectations and thus leading to increased demand for ships. In such periods, the prices of second-hand ships grow rapidly and are close to or exceed the shipbuilding prices of new building ships.

In the market for second-hand ships a significant number of companies operates, facing the ship as an asset and try to exploit price changes by buying when prices are low and selling when prices are high. These businesses sell when the difference between the buying price and the selling price is great. The yields, which may arise depending on the circumstances in the freight market, are impressive. Many times the gain is higher in comparison with the commercializing of the ship.

The scrap market

In the same way works the market of scrapping of ships. The mechanism of supply and demand is working here as well. Dissolution rates determined by supply of ships from the part of owners and the demand for scrap metal on the side of dismantling. In periods of high freights, when the entire fleet exploited efficiently, businesses do not sell their ships for scrap and offer of such vessels decreases. This has resulted in the rising of scrap prices.

3.5. Conclusion

There is no doubt that in reality the market is more complex. The analysis above is a general plan to understand how the shipping market is working. A ship-owner has to take into consideration all the facts before proceeding to an investment. Nowadays the information technology is so developed that everyone has access to worldwide incidents. This lead to believe that the market following full competition rules and there will be no ripples. But there is one factor that no one can estimate, the human decision factor. The ship-owners act like investors. No one can predict their expectations. This is why someone can see the differences in the shipping market. Furthermore there are ship-owners who have adopt a certain investment profile and it is difficult to start act like the market.

Chapter 4

Data and Methodology

4.1. Data

The main source of the shipping data is collected by Clarksons. Clarksons database is chosed as the optimum shipping database, which has several sets of data for long periods without gaps in some years. The procedure followed by clarksons to acquire the data is from broker's reports, who actually determine the trend of the prices in case in some period there is not any transaction in the sale and purchase of vessels. In this research we use from Clarksons database, the New building Prices, the Second Hand Prices and the Scrap Value Prices.

For each type of ship, we consider three different scenarios based on the age of the vessels.

A) In the first scenario, we evaluate the returns of a New Building vessel. We consider that the ship-owner operates the ship for ten years and then he sells it. As the year of purchase we take the year 2000, we operate the ship until 31 December 2009 and in 1 January 2010 we resell it. In our model we use an average of the New building prices for the year 2000. In the same way for the resale value we use an average of the year 2010 of the Second hand prices.

B) In the second scenario we examine the return of a Second hand five-year-old vessel. We assume that a ship-owner in the year 2000 purchases a five-year-old vessel and he operates it for a ten years period. What differentiates this scenario from this first one is that the reselling value of the ships is that of a fifteen-year-old vessel. In the same way, as the first scenario, we use an average of the second hand prices for the year 2000. In the first day of January 2010 the ship-owner decides to instantly resale the vessel. The resale value used here is the second hand value for a 15 years old vessel.

C) The last scenario does not alter from the previous one. The difference in this scenario is that in the year 2000 the ship-owner purchases a fifteen years old vessel which operates for ten years period. In 1st January 2010 the vessel is no longer operative, and the ship-owner takes the decision to sale it to the scrap market. What we have now is an average of the scrap value for the year 2010. Surely a vessel that is entering the twenty fifth year of life is not listed as a non-operative. This year is a benchmarking year for all vessels, since they have to undergo a serious and thorough survey from the classification society, which tightens the conditions so as the vessel to pass the survey. Furthermore, prior to the classification society special survey, the vessel has to undergo various repairs and maintenance in order to reach a status that could pass the survey criteria of the classification. The cost of this dry-docking repairs and maintenance is too high and for that reason the ship owner considers the option to sell the vessel for its scrap value.

The second part of our data is the earnings from the operation of the vessel. As it concerns the earnings we took an index known as one-year time charter rates. The time charter index is the only index published for the earnings of a commercial vessel that provides the daily charter rate. The data are collected daily and weekly direct from Clarksons brokers. Time charter rates are data for all the types of bulk carriers (Handysize, Handymax, Panamax, Capesize) and oil tankers (Suezmax, Aframax, VLCC, and clean product carries), gas carriers (VLGC) and containerships.

As described in chapter 3, there are tree basic types of charter parties, the time charter, the voyage charter and the bareboat charter. The most common charters are the voyage charter and the time charter. In our research we are going to use only data for the time charter because the voyage charter we can convert it in time charter. The reason for this decision lays to the fact that in the time charter rate the ship-owner pay only the operating and financial cost of the vessel. The charter is liable to pay the rest of the costs, which include port expenses, bunkers, cargo related costs and others. In evaluation procedures all voyage charter agreements in the end are transformed into time charter equivalents.

The operating cost of the vessel varies between different age of vessels, condition of the vessels and other parameters that highlight the maintenance of the vessel from the ship owner. However, there are several Research firms that carry the procedure to collect data from various shipping companies and construct an average operating cost index, which includes the most key features for the estimation of the operating cost. In this study, we use the data from Drewry shipping report, which is the most renowned provider of operating cost data. The operating costs include:

Manning Costs: include wages, victualing, transportations, medical expenses, manning agent fees, etc. The figure below describes all the manning costs in detail.

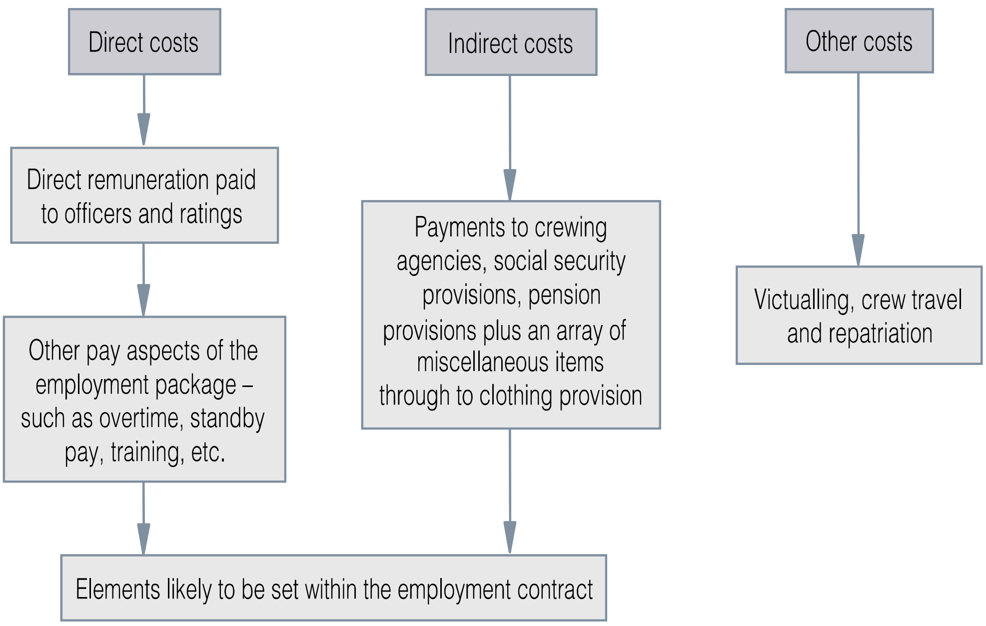


Figure 4.1.1.: Manning Costs
Source: Drewry research 2011

Insurance costs: including Hull & Machinery, P&I club fees, OPA 90, War Risk, KnR (Kidnap and Ransom) etc. The figure below explains all the Insurance costs:

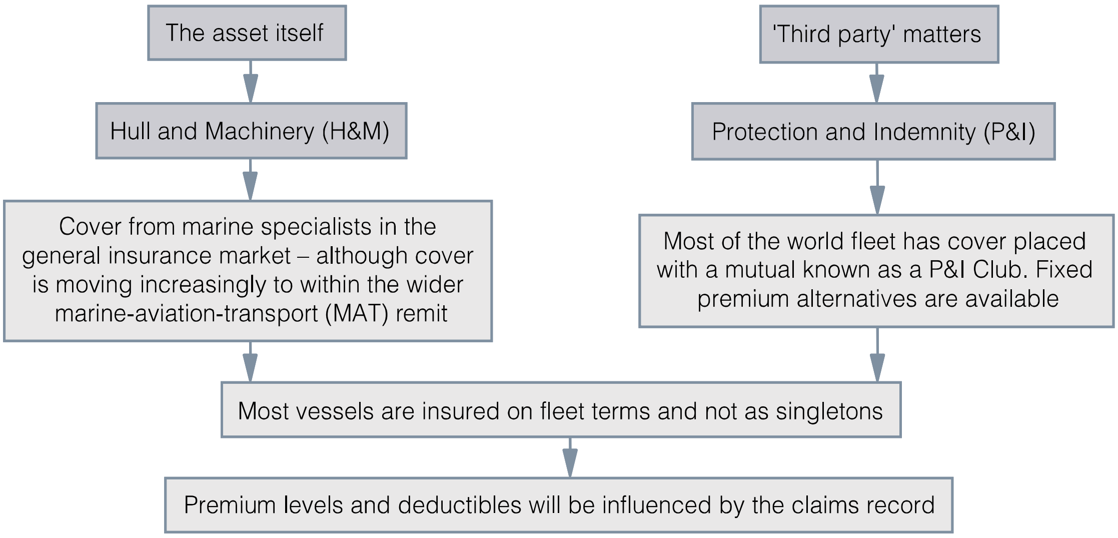


Figure 4.1.2.: Insurance costs
Source: Drewry research 2011

Repairs and Maintenance costs: including general repairs, superintended expenses, classification surveys, radio and navigation repairs, paints and coatings, spares forwarding etc. The figure below explains the types of repairs:

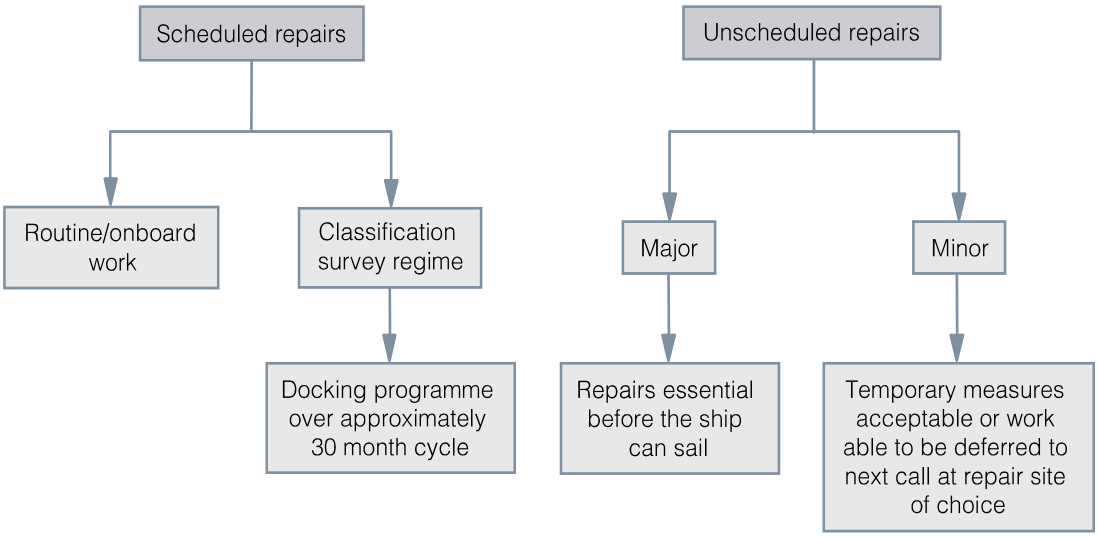


Figure 4.1.3.: Reapairs and Maintenance costs
Source: Drewry research 2011

Stores and Lubes costs: including deck stores, engine stores, cabin stores, chemicals, lubricants etc. The figure below shows the main stores and supplies budget elements:

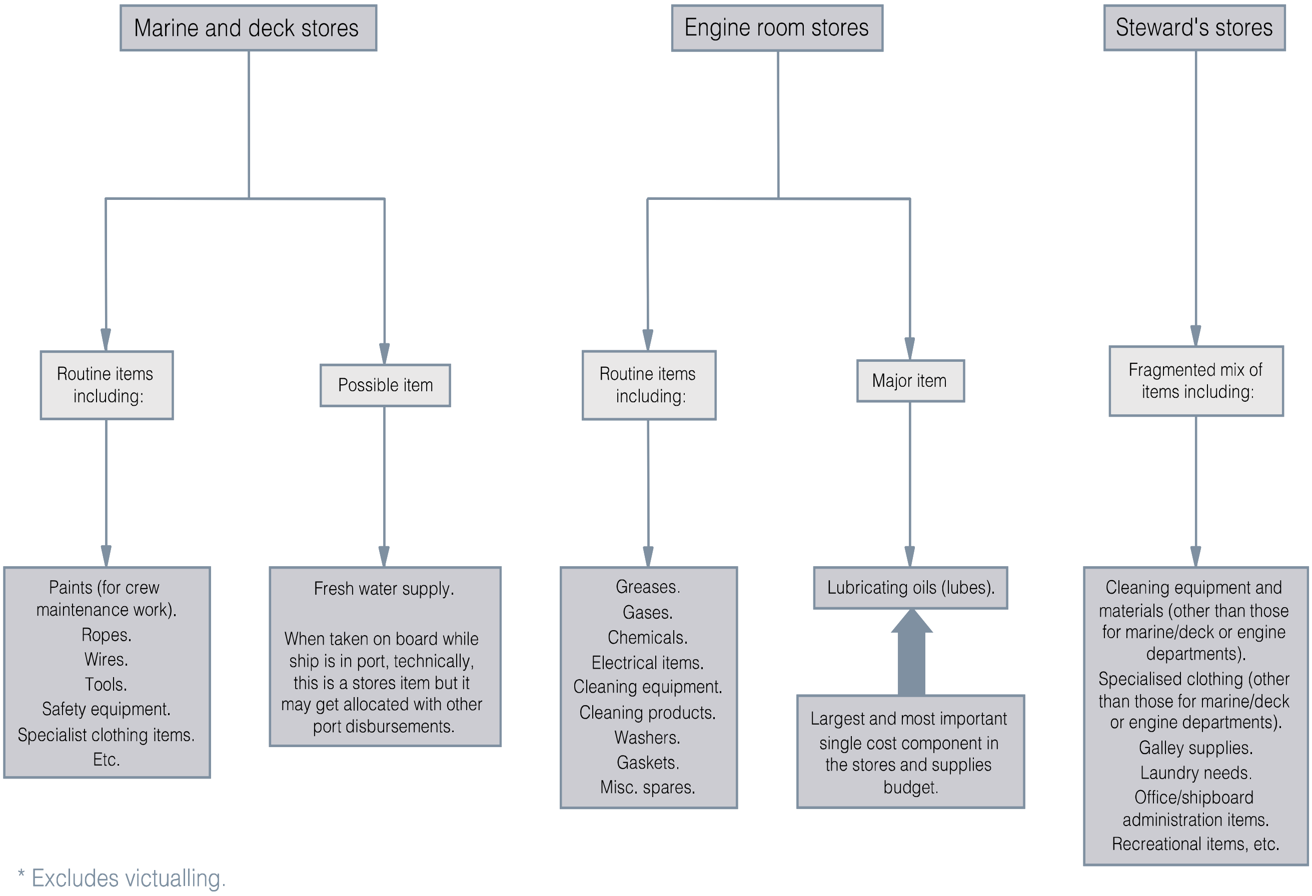


Figure 4.1.4.: Stores and Lubes costs
Source: Drewry research 2011

Other costs: Taxation, communication, Management fees, flag expenses, etc.

4.2. Methodology

The vessel as a fixed asset has several similarities with the real estate assets. Evaluation procedure of the vessel should be carried on through out the whole period of the assets life. Between those years there are cash outflows and inflows in the investment. The part of the outflows consists not only by the construction of the vessel but also from all the maintenance and operations cost. In the same way the inflows of an investment are the accumulated income and the reselling value of the asset, if it has not reached the end of the operation life, where in that case the final inflow is the scrap value of the vessel.

In the same way in their research of Liapis et al.(2013), addresses the following inputs in order to calculate the whole life cost of an real estate asset. First of all the project life-time, in the shipping industry these are the operation years of the vessel. The discount rate using in the assets is the same for a vessel. In shipping industry we can take into consideration the inflation rate and more specific in this research we are using the inflation rate of the U.S.A. because all our values are in U.S.A. dollars. In shipping industry there is in no taxation environment, because the vessels are operating in worldwide spectrum. Only, the flag country charges a fee as a tonnage tax, which is included in OPEX. In the real estate industry, we meet various forms of costs, there is the construction cost, the operating cost, the repair and maintenance costs, the occupancy cost, end of life or disposal costs, non construction cost. All these types of cost we meet and in the shipping industry but in a different way, the construction cost is the new building price, the operating, maintenance, repair, occupancy cost in shipping industry are considering as one cost and we called "OPEX". We don't have non-construction costs and disposal of life costs. The income in a real estate asset is the rent, in the shipping industry the income is the freight that the ship-owner collects according to the charter party. The WLC can be described by the following figure :

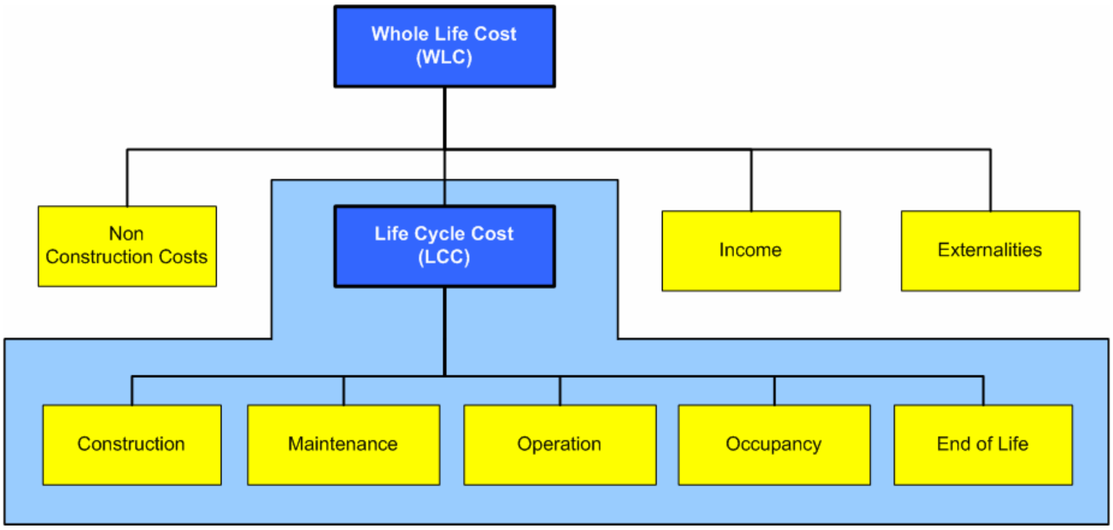


Figure 4.2.1. Whole life Cost (WLC)
Source: Liapis et al.(2013)

4.2.1. The mathematical approach of the WLC

The WLC is based on the NPV of an asset. Based on Kishk et al. (2003) the best way to express the NPV is the following equation:

$$NPV = C_0 + \sum_{t=1}^{T} O_t + \sum_{t=1}^{T} M_t - SAV \quad (1)$$

C_0 : the initial construction costs (at time zero)

$\sum_{t=1}^{T} O_t$: the sum of discounted operation costs at time t

$\sum_{t=1}^{T} M_t$: the sum of discounted maintenance costs at time t

SAV : the discounted salvage value = $RV_T - DC_T$

RV_T : the discounted resale value (at the end of the analysis period)

DC_T : the discounted disposal costs (at the end of the analysis period)

T : the analysis period in years (project life-cycle)

The above equation concerns the real estate assets. In the shipping industry the equation is transformed as follows:

$$\mathrm{NPV} = \mathrm{C_0} + \sum_{t=1}^{T} \mathrm{O_t} - \mathrm{SAV} \qquad (2)$$

Where,

C_0 : the initial construction costs (at time zero) – new building price

$\sum_{t=1}^{T} O_t$: the sum of discounted operation and maintenance costs at time t

SAV : the discounted salvage value = $\mathrm{RV_T} - \mathrm{DC_T}$

$\mathrm{RV_T}$: the discounted resale value (at the end of the analysis period)-second hand value

$\mathrm{DC_T}$: the discounted disposal costs (at the end of the analysis period)

T : the analysis period in years (project life-cycle) –scrap value

The proposed WLC model for the shipping industry

The whole model is based on WLC model for commercial real property investments. Below we are going to present the real property model and therefore the shipping model analysing the differences.

4.2.2. The time value of money – Net Present Value (NPV)

The (undiscounted) net value (NV) of a real property project can be expressed mathematically as follows:

NV = R – WLC (3)

Where:

NV *Net Value*

R *Revenue* (i.e. income from sales/rents, tax allowances)

WLC *Whole-Life Cost*

Based on the BS ISO 15686-5:2008 (Figure 1), the project whole-life cost breakdown structure (WLCBS) is analysed as follows:

WLC = LCC + NCC + EXT (4)

LCC = C + O + M + OC – SAV (5)

SAV = RV – DC (6)

Where:

LCC *Life-Cycle Cost*

NCC *Non-Construction Costs* (initial capital costs, i.e. land acquisition, pre-construction design, engineering and consulting costs, costs of permits issuance, finance for land purchase and/or construction)

EXT *Externalities* (positive like public health and safety improvement and/or other social benefits and negative like environmental pollution, traffic congestion and/or social costs) – the analysis and evaluation of these external costs and benefits is beyond the scope of this paper and will be addressed by the authors in latter research work

C *Construction Cost* (i.e. preliminaries, site set-up, earthworks, substructures, super-structures, installations, finishing works, etc. including quality assurance costs)

O *Operation Cost* (cleaning, utilities and administrative costs)

M *Maintenance Cost* (for major replacements, minor scheduled and unscheduled works, adaptations, redecorations, grounds maintenance and gardening)

OC *Occupancy Cost* (security, help-desks, telephones, IT services, car parks, etc.)

SAV *Salvage Value*

RV *Resale Value*

DC *Disposal Cost* (materials disposal/recycling, demolitions/site clearance, reconstruction/ restoration/refurbishment)

Therefore:

$$NV = R - (LCC + NCC + EXT) \quad (7)$$

$$NV = R - [(C + O + M + OC - SAV) + NCC + EXT] \quad (8)$$

$$NV = R - [C + O + M + OC - (RV - DC) + NCC + EXT] \quad (9)$$

$$NV = (R + RV) - (C + O + M + OC + DC + NCC + EXT) \quad (10)$$

According to the theory of finance, the NPV of a real estate investment project can be calculated as follows:

$$\mathrm{NPV} = \sum_{t=1}^{T} \frac{\mathrm{NCF}_t}{(1+\mathrm{WACC})^t} \qquad (10)$$

Where:

NCF_t : Net cash-flow of the project at year t

t : 1, …, T and T = total years of property life-cycle (the analysis period)

WACC : The discount rate or the Weighted Average Cost of Capital

In shipping industries the NV can be expressed in the same way as in real estate model.

NV = R – WLC (11)

Where:

NV *Net Value*

R *Revenue* (i.e. income from sales/rents, tax allowances)

WLC *Whole-Life Cost*

What change is the way the WLC is calculated, in the shipping industry we don't have separate non-construction costs they are included in the New-Building price. What is more, the operation cost, the maintenance cost and the occupancy cost is calculated as an index, which we are going to symbolize with O from OPEX. Therefore:

WLC = LCC + EXT (12)

LCC = O + OC – SAV (13)

SAV = RV – DC (14)

Taking into consideration the above equations we have:

NV = R − (LCC + EXT) (15)

NV= R – [(C + O – SAV) + EXT] (16)

NV = R – [C + O – (RV – DC) + EXT] (17)

NV = (R + RV) – (C + O + DC + EXT) (18)

4.2.3. Operating Cash-Flow (OCF) and Net Cash-Flow (NCF)

The cash flow of an investment project in real estate where we apply returns measures (like NPV, IRR) is the operating cash-flow (OCF). The OCF is calculated if, from the revenues of the investment project, we remove its fixed and variable costs. Thus:

$\mathrm{OCF_t = R_t - TC_{ot}}$ (11)

Where:

$\mathrm{OCF_t}$: Operating cash-flow at year t

$\mathrm{R_t}$: Revenue (income) at year t:

$\mathrm{R_t = (R_{ot} + RV_T)}$ (19)

ot : Operating period

T : End year of property life-cycle

$\mathrm{R_{ot}}$: Revenue (income) at operating year t

$\mathrm{RV_T}$: Resale value at the end year of property life-cycle

$\mathrm{TC_{ot}}$: Fixed and variable (total) costs at operating year t:

$\mathrm{TC_{ot} = (O_{ot} + M_{ot} + OC_{ot})}$ (20)

$\mathrm{O_{ot}}$: Operating costs at operating year t

$\mathrm{M_{ot}}$: Maintenance costs at operating year t

$\mathrm{OC_{ot}}$: Occupancy costs at operating year t

Thus:

$\mathrm{OCF_t = (R_{ot} + RV_T) - (O_{ot} + M_{ot} + OC_{ot})}$ (21)

In order to calculate the project's net cash-flow (NCF), we deduct from the OCF the initial costs of the investment (construction, non-construction and disposal costs) and the taxes that correspond to the revenues minus the tax deductive amounts (i.e. the depreciation of the fixed asset):

$$NCF_t = OCF_t - \varphi_t^y.(OCF_t - D_t) - P_{ct,T} = OCF_t.\left(1 - \varphi_t^y\right) + \varphi_t^y.D_t - P_{ct,T} \qquad (22)$$

Where:

φ_t^y : Corporate tax rate (tax on income)

D_t : Annual depreciation

$P_{ct,T}$: Initial construction and non-construction costs plus disposal cost at the end year of property life-cycle:

$$P_{ct,T} = \left(C_{ct} + NCC_{pct} + DC_T\right) \qquad (16)$$

ct : Construction period

pct : Pre-construction period

C_{ct} : Construction cost at construction period

NCC_{pct} : Non-construction cost at pre-construction period

DC_T : Disposal cost at the end year of property life-cycle

Thus:

$$NCF_t = [(R_{ot} + RV_T) - (O_{ot} + M_{ot} + OC_{ot})].(1 - \varphi_t^y) + \varphi_t^y.D_t - \left(C_{ct} + NCC_{pct} + DC_T\right) \qquad (23)$$

Assuming that we follow the constant depreciation method per year and that there is a Salvage Value (SAV) of the investment at the end of the construction period:

$$D_t = a.\left(C_{ct} + NCC_{pct} - SAV_{T,ct}\right) = a.\left(C_{ct} + NCC_{pct} - (RV_{T,ct} - DC_{T,ct})\right) \qquad (24)$$

Where:

a : Rate of constant depreciation of fixed asset (1/useful life)

$SAV_{T,ct}$: Salvage Value of fixed asset at the end of construction period:

$$SAV_{T,ct} = (RV_{T,ct} - DC_{T,ct}) \tag{25}$$

Thus:

$$D_t = a.\left(C_{ct} + NCC_{pct} + DC_{T,ct} - RV_{T,ct}\right) \tag{26}$$

Therefore:

$$NCF_t = [(R_{ot} + RV_T) - (O_{ot} + M_{ot} + OC_{ot})].(1 - \varphi_t^y) + \varphi_t^y.a.\left(C_{ct} + NCC_{pct} + DC_{T,ct} - RV_{T,ct}\right) - \left(C_{ct} + NCC_{pct} + DC_T\right) \tag{27}$$

In addition, if we suppose that a property tax exists:

φ_t^p : Property tax rate

Usually, property tax is not a tax deductible amount increasing the project whole-life cost:

$$NCF_t = [(R_{ot} + RV_T) - (O_{ot} + M_{ot} + OC_{ot})].(1 - \varphi_t^y) + \varphi_t^y.a.\left(C_{ct} + NCC_{pct} + DC_{T,ct} - RV_{T,ct}\right) - \varphi_t^p.\left(C_{ct} + NCC_{pct}\right) - \left(C_{ct} + NCC_{pct} + DC_T\right) \tag{28}$$

But, Value Added Tax (VAT) and other indirect taxes also exist in construction and operational periods, thus:

$$NCF_t = [(R_{ot} + RV_T) - (O_{ot} + M_{ot} + OC_{ot}).(1 + \varphi_t^{ind})].(1 - \varphi_t^y) + \varphi_t^y.a.\left(C_{ct} + NCC_{pct} + DC_{T,ct} - RV_{T,ct}\right) - \varphi_t^p.\left(C_{ct} + NCC_{pct}\right) - \left(C_{ct} + NCC_{pct} + DC_T\right).(1 + \varphi_t^{ind}) \tag{29}$$

If indirect taxes like VAT also exist on revenues and resale value, then:

$$NCF_t = [(R_{ot} + RV_T).\left(1 + \varphi_t^{ind}\right) - (O_{ot} + M_{ot} + OC_{ot}).\left(1 + \varphi_t^{ind}\right)].(1 - \varphi_t^y) + \varphi_t^y.a.\left(C_{ct} + NCC_{pct} + DC_{T,ct} - RV_{T,ct}\right) - \varphi_t^p.\left(C_{ct} + NCC_{pct}\right) - \left(C_{ct} + NCC_{pct} + DC_T\right).(1 + \varphi_t^{ind}) \tag{30}$$

Hence:

$$NCF_t = [(R_{ot} + RV_T) - (O_{ot} + M_{ot} + OC_{ot})].\left(1 + \varphi_t^{ind}\right).\left(1 - \varphi_t^{y}\right) + \varphi_t^{y}.a.\left(C_{ct} + NCC_{pct} + DC_{T,ct} - RV_{T,ct}\right) - \varphi_t^{p}.\left(C_{ct} + NCC_{pct}\right) - \left(C_{ct} + NCC_{pct} + DC_T\right).\left(1 + \varphi_t^{ind}\right) \quad (31)$$

Where:

φ_t^{ind} : Indirect tax rate.

In the shipping industry the operating cash flow (OCF) is as much the same. The only point that changes is the equation of the Fixed and variable total cost. As explained earlier, in shipping industry we have one index for all the costs of the vessel which we called Opex. So the equation for the OCF in shipping industry is:

$$OCF_t = (R_{ot} + RV_T) - (O_{ot}) \quad (32)$$

As far as it concerns the net cash flow (NCF) in the shipping industry is calculated by the operating cash flow, as described above, minus the initial costs of the investment. In a shipping industry no taxes are applied, thus:

$$NCF_t = [(R_{ot} + RV_T) - (O_{ot}) - (C_{ct} + DC_T)] \quad (33)$$

4.2.4. Relationship between Price and Revenue

According to the theory of finance and existing literature (Liapis *et al.*, 2011), the relationship between price and revenue (income) is described by the following formula:

$$R_t = P_t.\left[\left(i_{FR} - \varphi_t^{p}\right).\left(1 - \varphi_t^{y}\right) + \delta_t + \Lambda_t - EG_{t+1}\right] \quad (34)$$

And if depreciation of the price of property asset is tax deductible we have:

$$R_t = P_t.\left[\left(i_{FR} - \varphi_t^{p}\right).\left(1 - \varphi_t^{y} + a.\varphi_t^{y}\right) + \delta_t + \Lambda_t - EG_{t+1}\right] \quad (35)$$

Where:

i_{FR} : Risk-free rate of interest

φ_t^{p} : Property tax

φ_t^{y} : Income tax (corporate tax) on property yield (annual rent) a : Depreciation rate on tax-deductible amount of price of property

δ_t : Rate of operating, maintenance and occupancy cost

Λ_t : Risk premium, for commercial properties investments

EG_{t+1} : Expected capital gains (profits) at year t+1, but in terms of WLC is closely to 0

But:

$$R_t = (R_{ot} + RV_T) \quad (36)$$

$$P_t = (C_{ct} + NCC_{pct} + DC_T - RV_T).(1 + \varphi_t^{ind}) \quad (37)$$

Thus:

$$R_{ot} + RV_T = (C_{ct} + NCC_{pct} + DC_T - RV_T).(1 + \varphi_t^{ind}).\left[(i_{FR} - \varphi_t^{p}).(1 - \varphi_t^{y} + a.\varphi_t^{y}) + \delta_t + \Lambda_t - EG_{t+1}\right] \quad (38)$$

According to the above equation, price should be high relative to rents and from this we take a similar formula for property assets like Price per Earnings (P/E) formula in capital markets, thus:

$$\frac{P_t}{R_t} = \frac{(C_{ct}+NCC_{pct} + DC_T-RV_T).(1+\varphi_t^{ind})}{R_{ot}+RV_T} = \frac{1}{[(i_{FR}-\varphi_t^{p}).(1-\varphi_t^{y}+a.\varphi_t^{y})+\delta_t+\Lambda_t-EG_{t+1}]} \quad (39)$$

If indirect tax (like VAT) exists also on revenues and resale value, then:

$$\frac{P_t}{R_t} = \frac{(C_{ct}+NCC_{pct} + DC_T-RV_T)}{R_{ot}+RV_T} = \frac{1}{[(i_{FR}-\varphi_t^{p}).(1-\varphi_t^{y}+a.\varphi_t^{y})+\delta_t+\Lambda_t-EG_{t+1}]} \quad (40)$$

A number of restrictions are applied on the above equation:

$\varphi_t^{p} < i_{FR}$: If this restriction does not exist – investing in commercial property has no meaning and only gains from risk premium are expected;

$EG_{t+1} < (i_{FR} - \varphi_t^{p}).(1 - \varphi_t^{y} + a.\varphi_t^{y}) + \delta_t + \Lambda_t$: If this restriction does not exist the property from the finance point of view is affected by strong externalities or market cycles;

If t = 1, …, n, …, T, then: $n.a.P_t < (C_{ct} + NCC_{pct} + DC_T - RV_T)$, the cumulative depreciation is never greater than depreciated part of property asset; in real property the land remains as the residual value.

We assume that external variables have equal influence both on price and revenue, especially the environmental factors and the uniqueness of property assets; therefore, the index P_t/R_t remains constant.

If AC denotes the direct cost of property asset which is equal to cost ratio exempt risk premium and capital gains, we have:

$$AC_t = [(i_{FR} - \varphi_t^p)(1 - \varphi_t^y + a.\varphi_t^y) + \delta_t] \qquad (41)$$

Where:

$$\delta_t = \frac{(O_{ot} + M_{ot} + OC_{ot})}{(C_{ct} + NCC_{pct})} \qquad (42)$$

Also, according to finance theory:

$$i_{FR} = i_* + i_{inf} \qquad (43)$$

Where:

i_* : Risk-free rate of interest in an economy without inflation

i_{inf} : Inflation rate

The relationship between price and revenue in shipping is calculated by the following formula:

$$R_t = P_t.[(i_{FR}) + \delta_t + \Lambda_t - EG_{t+1}]$$

Where:

i_{FR} : Risk-free rate of interest – Ten year Tbill bond

δ_t : Rate of operating, maintenance and occupancy cost - OPEX

Λ_t : Risk premium, for commercial properties investments - Libor

EG_{t+1} : Expected capital gains (profits) at year t+1, but in terms of WLC is closely to 0

But:

$$R_t = (R_{ot} + RV_T) \qquad (44)$$

$$P_t = \left(C_{ct} + NCC_{pct} + DC_T - RV_T\right).\,(1 + \varphi_t^{ind}) \quad (45)$$

Thus:

$$R_{ot} + RV_T = (C_{ct} + DC_T - RV_T).\,[(i_{FR}).+\delta_t + \Lambda_t - EG_{t+1}]$$

Considering the above equation, price should be high relative to the freights so we have:

$$\frac{P_t}{R_t} = \frac{(C_{ct} + DC_T - RV_T)}{R_{ot} + RV_T} = \frac{1}{[(C_{ct} + DC_T - RV_T).[(i_{FR}).+\delta_t + \Lambda_t - EG_{t+1}]]} \quad (46)$$

AC denotes the direct cost of the vessel.

$$AC_t = [(i_{FR}) + \delta_t] \quad (47)$$

4.2.4. Discount Factor or Weighted Average Cost of Capital (WACC)

As discount factor in evaluation measures, a rate from funding cost of investment is commonly used. An investor could be using his own capital or debt financing or a mix of them. The investor's total cost of capital is an important benchmark in many popular forms of performance analysis in real estate projects. The total cost of capital or the Weighted Average Cost of Capital (WACC) is:

$$WACC = i_D.\left(1 - \varphi_t^y\right).\left(\frac{D}{D+S}\right) + i_S.\left(\frac{S}{D+S}\right) \quad (48)$$

Where:

i_D : Average interest rate of debt

i_S : Average interest rate of investor's capital

D : Debt

S : Investor's equity capital

φ_t^y : Income tax rate

The average interest rate of investor's capital, according to the work of Liapis *et al.* (2011), is calculated by the following equation:

$$i_S = \exp\left(\frac{\ln 2 * \ln(1+g)}{\ln\left(1+\frac{g}{AC_t+\Lambda_t-g}\right)}\right) - 1 \quad (49)$$

Where:

g : Growth rate

Thus, investor's equity return depends on direct cost of property asset, risk premium and growth rates but in terms of WLC g is closely to 0.

In shipping industry the equation is exactly the same minus the taxes with the asset market. As the average interest rate of debt i_D we consider the Libor and as the average interest of investor's capital i_S we consider the 10years yield bond. Considering the above we have the following equation:

$$WACC = i_D.\left(\frac{D}{D+S}\right) + i_S.\left(\frac{S}{D+S}\right) \quad (50)$$

After restructuring the model provided by Liapis(2013) and omitting variables, which do not have any relation with the shipping industry, we end up with a WLC model that is applicable for the evaluation of a shipping asset.

Chapter 5

Bulk Carriers Results

5.1.Handysize

5.1.1. Handysize New Building Vessel

After the restructuring and reformation of the WLCC model provided by Liapis et al.(2013), the final variables that will be included are shown in the Table 5.1.1.1. The Revenue calculation is based on the average daily charter of a New Handysize vessel per day for the period 2000-2009, after multiplying with the days of one year. In order to capture any idle day of the vessel, the total yearly revenue is multiplied by 95%, which recognize 5% possible idle days for dry-docking or in case of an off-hire, because of deviation from the charter party or inability to find cargo to transfer.

Construction value is the market-based value of a New Building in the shipyard, which is for a typical Handysize vessel with no any customization or any enhancement in the construction. More specific, the value of the vessel does not incorporate changes in the design of the vessel or any mechanical enhancement, like eco –speed propulsion system. Actually, the deviation from this average price, in case a vessel has special characteristics, is non-significant. In any way, it would be impossible to derive any dataset that will include the different designs specifications and enhancement, without earning any actual gain from this diversification.

Operating cost variable is provided from Drewry research and it is a typical value for all sorts of vessels, without again discriminating for different designs of vessels. Surely, the operating cost might change, if the vessel is equipped with any modern lubricator or if the number of the crew needed for operation is less than the typical Handysize vessel, but again the actual gain from this diversification is meaningless.

Finance profile of the vessel is based on a ratio of 35% percent as a loan facility and the other 65% as private capitals. The ratio between Debt and private Capitals is the usual procedure that is followed in shipping industry. In addition, this diversification lowers instantly the WACC interest, with direct effects of WLCC valuation procedure. The WLCC model is estimated for a decade only and the impact from low WACC interest affects drastically the investment results.

Inflation rate is the same value for all categories and reflects the conditions of the American economy. Spread is an opportunity cost of the financial institution. The financial institutions are deriving their income from the spread interest in the loan. However, this information is disclosed from the banks from many reasons. In addition the spread changes for different customers, based on their profile and their solvency. The T-bond yields are a good measurement of the alternative investment choice that Financial institutions might consider instead of providing a loan facility to a ship-owner. Therefore, this yield is the minimum amount that they expect to gain from this facility.

Depreciation rate is average ratio of the initial value of the vessel, after deducting the scrap value of the vessel. The depreciation ratio is different from company to company, but a ratio of 4% is not a high depreciation rate.

The rest of the value set in the WLCC valuation model are free risk, which is calculated with the equation (43). Risk premium is the average three-month libor rate for the period of ownership of the vessel. Finally, growth rate is the average value for the same period.

NEW BUILDING HANDYSIZE BULK CARRIER				
	%	values	Finance	
			D	S
R(TC*365*95%)	34.28%	5,177,509	65.00%	35.00%
CONSTRUCTION VALUE		15,104,167	life-cycle (yrs)	10.00
			WACC	13.09%
OPEX	9.74%	1,471,140	Credit Spread	4.39%
			Inflation Rate	2.57%
			Depreciation, a	4.00%
RV(SH PRICE)		22,000,000	Free risk rate	6.97%
DC(SCRAP VALUE)		-	Risk Premium Λ	3.33%
			Growth Rate g	1.81%
			Free risk rate i*	4.39%

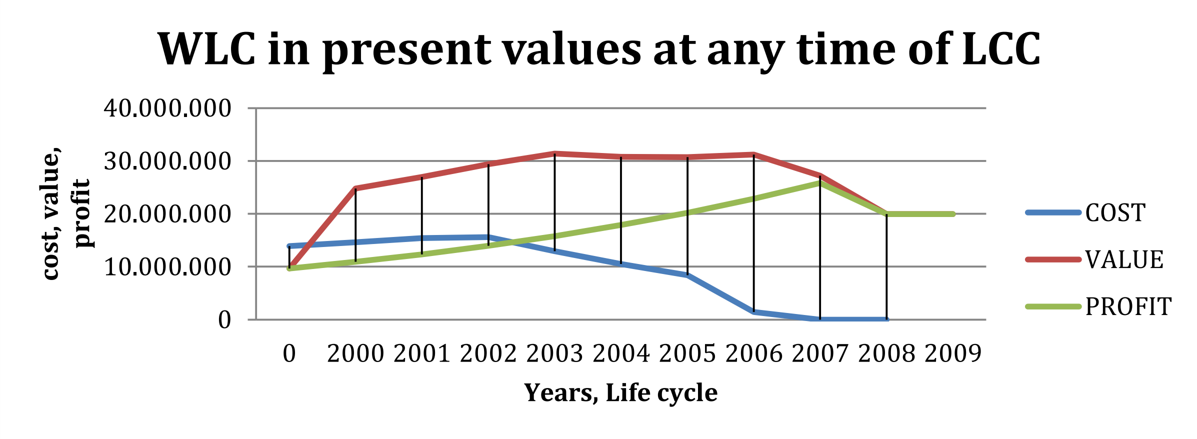
Table 5.1.1.1.: Description of the model's input-output figures for a new building Handysize bulk carrier.

Empirical Results

Graph (5.1.1.1.) suggests that the profit from the operation of the vessel has an upward trend starting from the first year of operation, reaching the highest levels one year before the sale of the vessel and then has downward trend. The downward trend is related with the conditions of the market, which change after 2008 and have significant relation with the beginning of the subprime crisis and the financial instability started at this period.

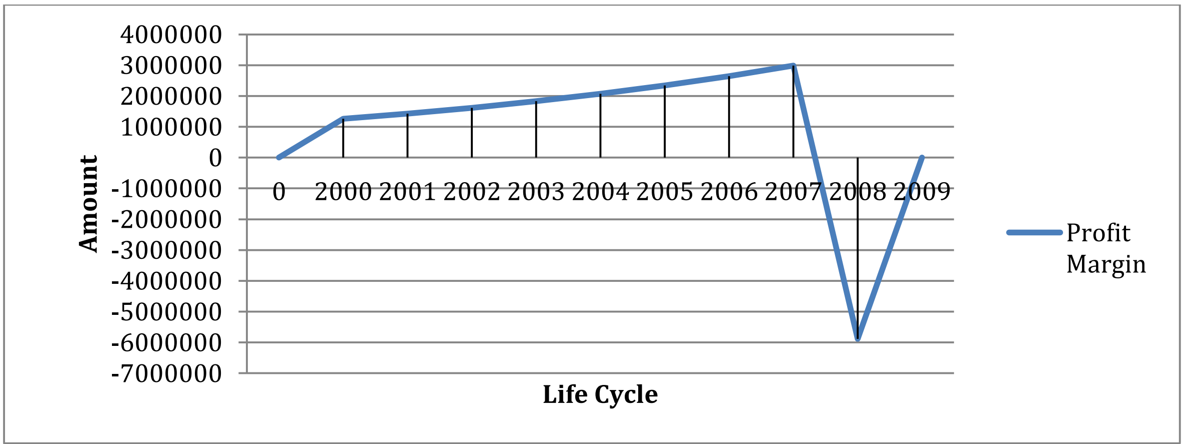
Cost of the vessel has an upward trend in the beginning of the period estimated and after the third year there is a obvious decline starting to taking place. Cost declines in such a high ratio, because of the boom in the time charter rates at this period, which actually manage to eliminate the initial cost, before the vessel is finally sold.

Finally, the value of the vessel follows the trend of cost, but the margin between the prices of these two is always too high. The value of the asset at the end of the period is significantly higher than the initial price of the vessel, suggesting that the reselling price in this case is actually higher.

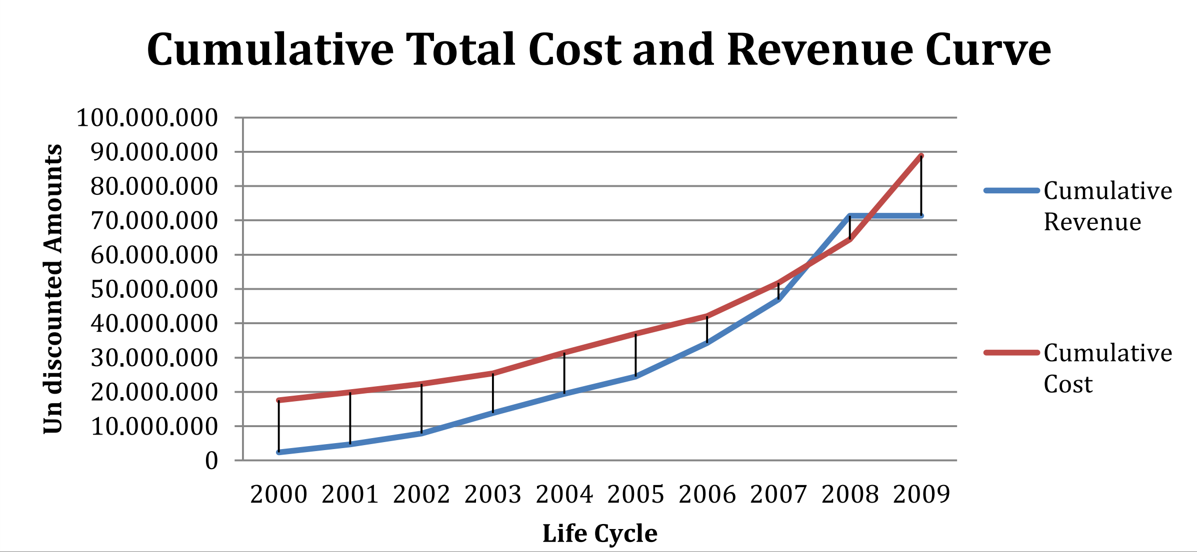


Graph 5.1.1.1.: Cost-Value-Profit curves in present values at any time of life-cycle for a new building Handysize bulk carrier.

Profit margins have a stable upward trend from the beginning of the investment until the eight-year, where a significant drop is taking place. This change again, is contributed to the financial instability at this period, which affected the shipping market in a high degree and resulted in the significant reduction of the time charter rates. Time charter rates after the financial crisis bottomed and sometimes contributed to the lay-up of the vessel, because there were no cargoes to be transported. Profit margin closes to zero after the sale of the vessel.



Graph 5.1.1.2.: Profit Margin curve in present values at any time of life cycle for a new building Handysize bulk carrier.



Graph 5.1.1.3.: Undiscounted Cumulative Cost and Revenue at any time of life-cycle of a new building Handysize bulk carrier.

The final graph (5.1.1.3.) provides interesting outcomes for the investment on a second hand vessel. In the year 2007 the vessel manages to repay the accumulated cost from the beginning of the investment and surpass the cost after that. Again, in the year 2008 the effect of the financial crisis changes the scene, and the cumulative cost is leading and creates an obvious distance from the cumulative revenue.

General Outcomes

WLCC model manage to capture in a very well manner the investment on Handysize vessel. The empirical results suggest that for the period investigated, a new building Handysize vessel provides cash flows, which actually repay the initial price of the vessel. However the scene changes dramatically, after the financial crisis, which causes a tremendous plunge of the hire rates and the profits accumulated from the previous period are vanished. In this case the investing proposal would be to acquire the vessel at the beginning of the period investigating and sold before the financial crisis.

5.1.2.Handysize 5 Years Old

All the above hypothesis remain exactly the same. What changes is that now we apply our model to a five year old handysize vessel, which we operate for a ten-year period from 2000 to 2009.

In this model instead of the construction value, we have the second hand price for a five-year-old handysize vessel. The second hand price used in this model is an average of the monthly second hand prices of the year 2000. This value is the acquisition price of the vessel.

As far as it concerns the operating costs we use the costs provided by Drewry research. In reality the operation costs are different for a newbuilding vessel and for a five-year-old secondhand vessel but the differences are not great importance to include them in our model.

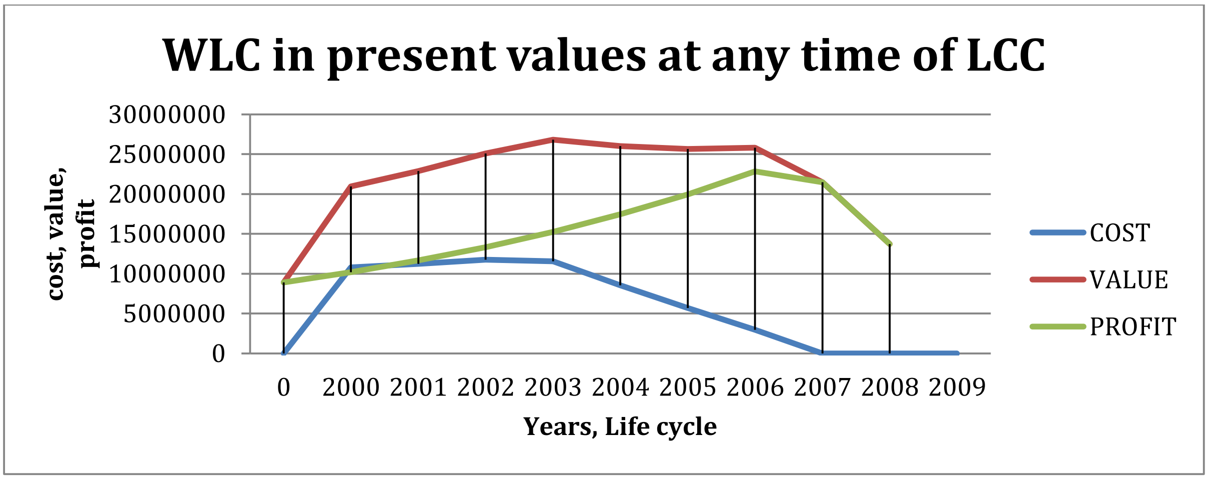
FIVE YEARS OLD HANDYSIZE BULK CARRIER				
	%	values	Finance	
			D	S
R(TC*365*95%)	45.15%	5,177,509	35.00%	65.00%
CONSTRUCTION VALUE		12,000,000	life-cycle (yrs)	10.00
			WACC	14.39%
OPEX	12.26%	1,471,140	Credit Spread	4.39%
			Inflation Rate	2.57%
			Depreciation, a	4.00%
RV(SH PRICE)		15,125,000	Free risk rate	6.97%
DC(SCRAP VALUE)		-	Risk Premium Λ	3.33%
			Growth Rate g	1.81%
			Free risk rate i*	4.39%

Table 5.1.2.1.: Description of the model's input-output figures for a five years old Handysize bulk carrier

Empirical Results

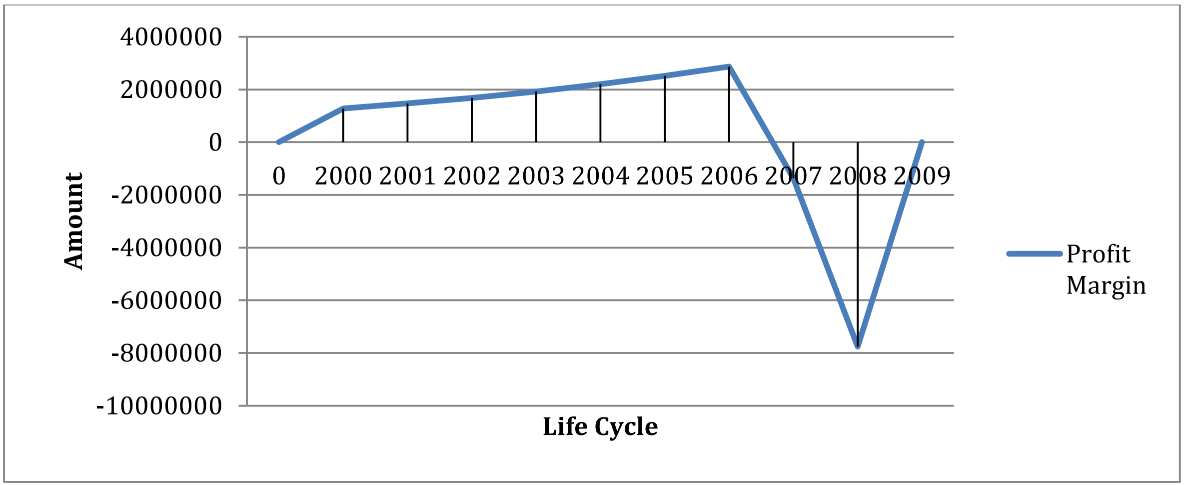
Graph (5.1.2.1.) suggests that the profit from the operation of the vessel has an upward trend starting from the first year of operation, reaching the highest levels in 2006 and then has a downward trend until 2008. The downward trend is related with the conditions of the market, which change after 2008 and have significant relation with the beginning of the subprime crisis and the financial instability started at this period.

Cost of the vessel has an upward trend in the beginning of the period estimated and after the third year there is an obvious decline starting to taking place. Cost declines in such a high ratio, because of the boom in the time charter rates at this period, which actually manage to eliminate the initial cost, before the vessel is finally sold. Finally, the value of the vessel follows the trend of cost, but the margin between the prices of these two is always too high. The value of the asset at the end of the period is significantly higher than the initial price of the vessel, suggesting that the reselling price in this case is actually higher.

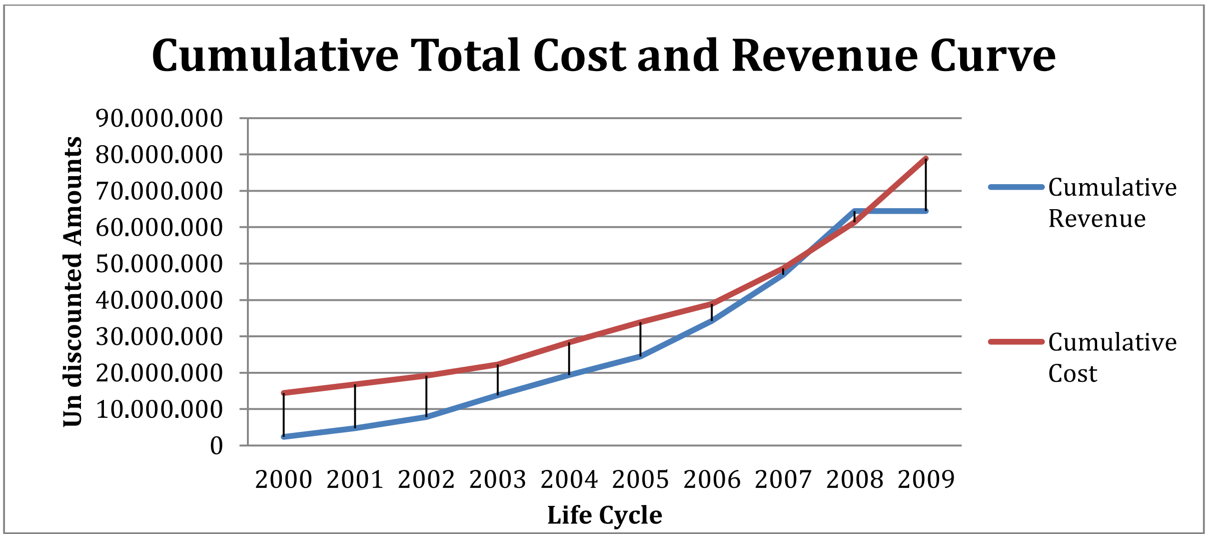


Graph 5.1.2.1.: Cost-Value-Profit curves in present values at any time of life-cycle for a five years old Handysize bulk carrier.

Profit margins have a stable upward trend from the beginning of the investment until 2006, where a significant drop is taking place. This change again, is contributed to the financial instability at this period, which affected the shipping market in a high degree and resulted in the significant reduction of the time charter rates. Time charter rates after the financial crisis bottomed and sometimes contributed to the lay-up of the vessel, because there were no cargoes to be transported. Profit margin closes to zero after the sale of the vessel.



Graph 5.1.2.2. : Profit Margin curve in present values at any time of life cycle for a five years old Handysize bulk carrier.



Graph 5.1.2.3.: Undiscounted Cumulative Cost and Revenue at any time of life-cycle of a five years old Handysize bulk carrier.

The final graph (5.1.2.3.) provides interesting outcomes for the investment on a second hand vessel. In the year 2007 the vessel manages to repay the accumulated cost from the beginning of the investment and surpass the cost after that and the cumulative revenue is leading and then drops again ending slightly lower.

General Outcomes

WLCC model manage to capture in a very well manner the investment on Handysize vessel. The empirical results suggest that for the period investigated, a five years old Handysize vessel provides cash flows, which actually repay the initial price of the vessel. However the scene changes dramatically, after the financial crisis, which causes a tremendous plunge of the hire rates and the profits accumulated from the previous period are vanished. In this case the investing proposal would be to acquire the vessel at the beginning of the period investigating and sold before the financial crisis. As it was expected a new building Handysize vessel has no spectacular differences for the same operating period with a five-year-old secondhand vessel.

5.1.3. Handysize 15 Years Old

Moving in the same pattern as the above models we have the table below:

TEN YEARS OLD HANDYSIZE BULK CARRIER				
	%	values	Finance	
			D	S
R(TC*365*95%)	116.57%	5,177,509	35.00%	65.00%
CONSTRUCTION VALUE		4,441,456	life-cycle (yrs)	10.00
			WACC	26.01%
OPEX	33.12%	1,471,140	Credit Spread	4.39%
			Inflation Rate	2.57%
			Depreciation, a	4.00%
RV(SH PRICE)		-	Free risk rate	6.97%
DC(SCRAP VALUE)		3,200,000	Risk Premium Λ	3.33%
			Growth Rate g	1.81%
			Free risk rate i*	4.39%

Table 5.1.3.1.: Description of the model's input-output figures for a fifteen years old Handysize bulk carrier

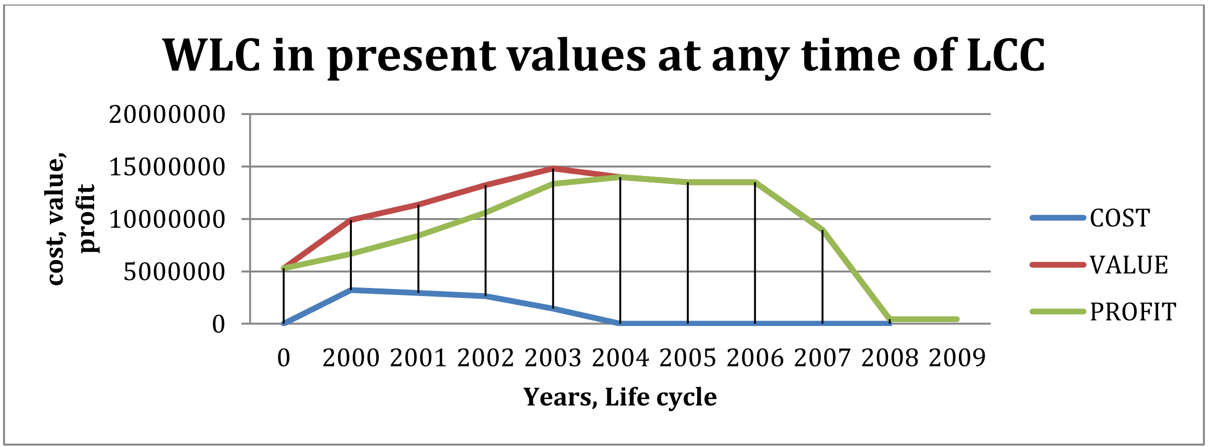
This time we have a fifteen years secondhand vessel operating for the same period as the above models, from 2000 to 2009. In the end of 2009 the vessel is 25 years old and is better to resell it for scrap instead of operation use. So in the end of 2009 the vessel goes for scrap.

Empirical results

Graph (5.1.3.1.) suggests that the profit from the operation of the vessel has an upward trend starting from the first year of operation, reaching the highest levels in 2004 and then it moves in the same pattern until 2006, where starts a downward trend. The downward trend is related with the conditions of the market, which change because so many new buildings enter to the market and after 2008 have significant relation with the beginning of the subprime crisis and the financial instability started at this period.

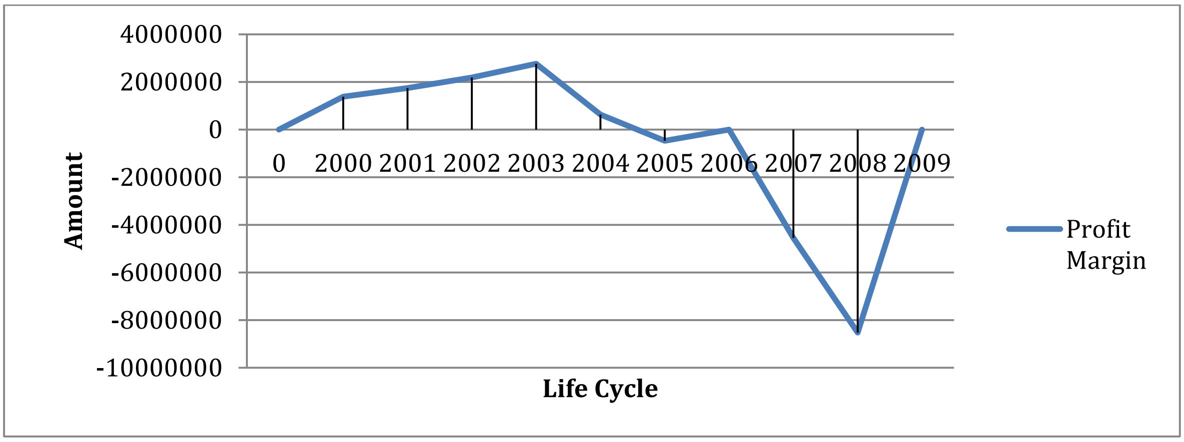
Cost of the vessel has an upward trend in the beginning of the period estimated and after the first year there is a obvious decline starting to taking place. Cost declines in such a high ratio, because of the boom in the time charter rates at this period, which actually manage to eliminate the initial cost, before the vessel is finally goes for scrap.

Finally, the value of the vessel unlikely with the trend of cost after the first year started to rise up until 2004 that started to move in the same way as the profit. The margin between the prices of the cost and the value these two is always too high. The value of the asset at the end of the period is almost turned to zero, which explained, by the financial crises.

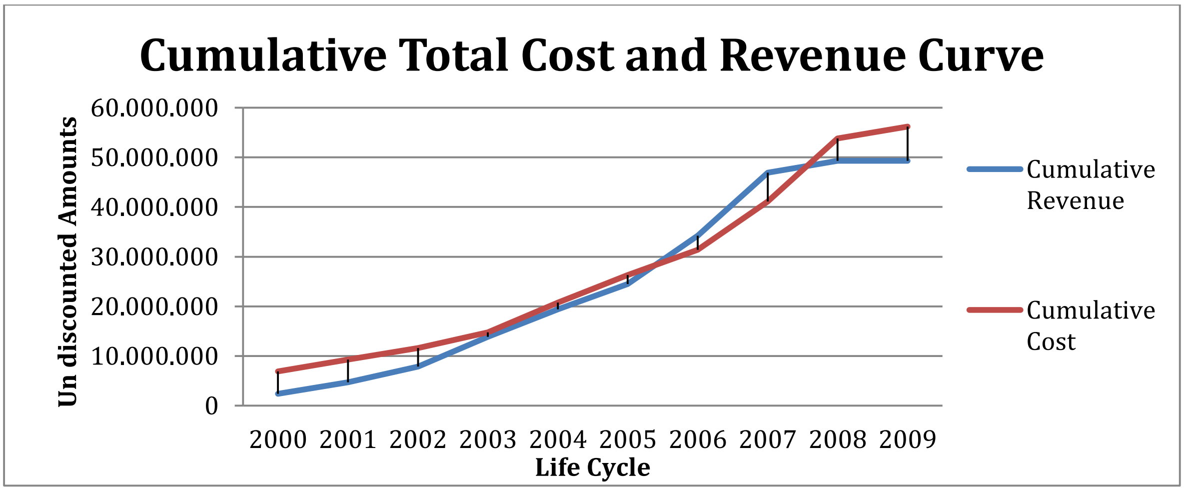


Graph 5.1.2.1.: Cost-Value-Profit curves in present values at any time of life-cycle for a fifteen yeas old Handysize bulk carrier.

Profit margins have a stable upward trend from the beginning of the investment until the fourth year, where a significant drop is taking place. This change again, is contributed to the financial instability at this period, which affected the shipping market in a high degree and resulted in the significant reduction of the time charter rates. Time charter rates after the financial crisis bottomed and sometimes contributed to the lay-up of the vessel, because there were no cargoes to be transported. Profit margin closes to zero after the sale of the vessel



Graph 5.1.2.2.: Profit Margin curve in present values at any time of life cycle for a fifteen years old Handysize bulk carrier.



Graph 5.1.2.3.: Undiscounted Cumulative Cost and Revenue at any time of life-cycle of a fifteen years old Handysize bulk carrier.

The final graph (5.1.2.3.) provides interesting outcomes for the investment on a second hand vessel. In the end of the first semester of 2005 the vessel manages to repay the accumulated cost from the beginning of the investment and surpass the cost after that. Again, in the year 2008 the effect of the financial crisis changes the scene, and the cumulative cost is leading and creates an obvious distance from the cumulative revenue.

General Outcomes

WLCC model manage to capture in a very well manner the investment on Handysize vessel. The empirical results suggest that for the period investigated, a fifteen years old fifteen-year-old Handysize vessel provides cash flows, which actually repay the initial price of the vessel. However the scene changes dramatically, after the financial crisis, which causes a tremendous plunge of the hire rates and the profits accumulated from the previous period are vanished. In this case the investing proposal would be to acquire the vessel at the beginning of the period investigating and sold before the financial crisis.

Proposals

Comparing the three models of a Handysize vessel it is obvious that there are no major differences. As it seems, in the three cases the cash flows generated from the operation of the vessels resulted in the repay of the initial price and leave the ship-owner with profits sometimes really high sometimes less high. Considering the three cases the most profitable investment for a ship owner is to buy a five years old vessel, operating for ten years and then resale it. Five years old Handysize vessel is the only one, which has positive revenue curve until 2008, the year that the crisis had, began.

5.2. Panamax

5.2.1.Panamax New Building

Moving with the same method of analysis, we adapt the model to a New Building Panamax Vessel. The table below includes all the information:

NEW BUILDING PANAMAX BULK CARRIER				
	%	Values	Finance	
			D	S
R(TC*365*95%)	23.36%	5,334,200	35.00%	65.00%
CONSTRUCTION VALUE		22,833,333	Life-cycle (yrs)	10.00
			WACC	12.47%
OPEX	8.51%	1,943,921	Credit Spread	4.39%
			Inflation Rate	2.57%
			Depreciation, a	4.00%
RV(SH PRICE)		31,104,167	Free risk rate	6.97%
DC(SCRAP VALUE)		-	Risk Premium Λ	3.33%
			Growth Rate g	1.81%
			Free risk rate i*	4.39%

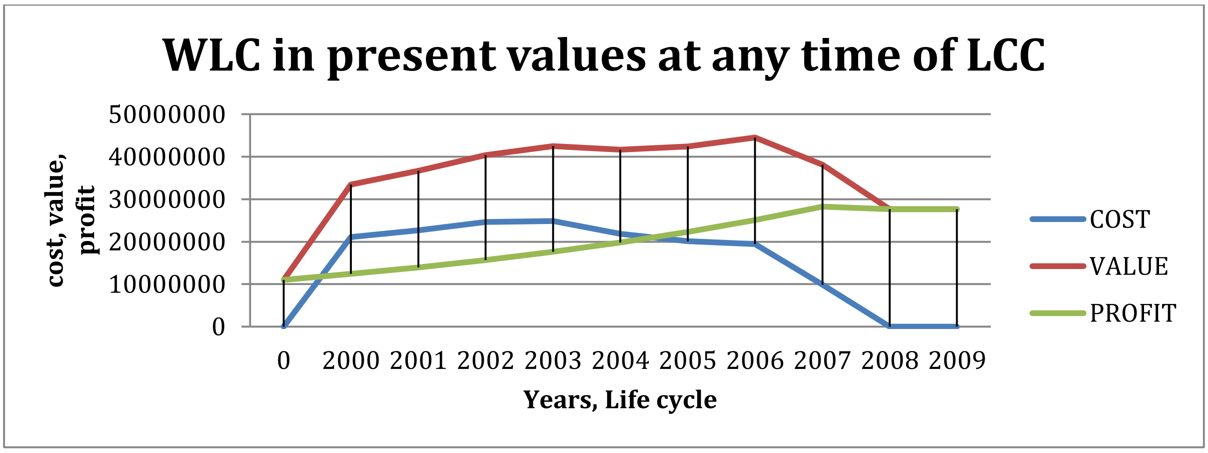
Table 5.2.1.1.: Description of the model's input-output figures for a new building Panamax bulk carrier

Empirical results

Graph (5.2.1.1.) suggests that the profit from the operation of the vessel has an upward trend starting from the first year of operation, reaching the highest levels in 2007 and then it follows a stable trend until the year of the sale of the vessel. The stable trend is related with the conditions of the market, which change after 2007 and have significant relation with the beginning of the subprime crisis and the financial instability started at this period.

Cost of the vessel has an upward trend in the beginning of the period estimated and after the fourth year there is an obvious decline starting to take place. In 2008 the cost reaches zero. Cost declines in such a high ratio, because of the boom in the time charter rates at this period, which actually manage to eliminate the initial cost, before the vessel is finally sold.

Finally, the value of the vessel follows the trend of cost, but the margin between the prices of these two is always too high. The value of the asset at the end of the period is significantly higher than the initial price of the vessel, suggesting that the reselling price in this case is actually higher.



Graph 5.2.1.1.: Cost-Value-Profit curves in present values at any time of life-cycle for a new building Panamax bulk carrier.

Profit margins have a stable upward trend from the beginning of the investment until the eight-year, where a significant drop is taking place. This change again, is contributed to the financial instability at this period, which affected the shipping market in a high degree and resulted in the significant reduction of the time charter rates. Time charter rates after the financial crisis bottomed and sometimes contributed to the lay-up of the vessel, because there were no cargoes to be transported. Profit margin closes to zero after the sale of the vessel.

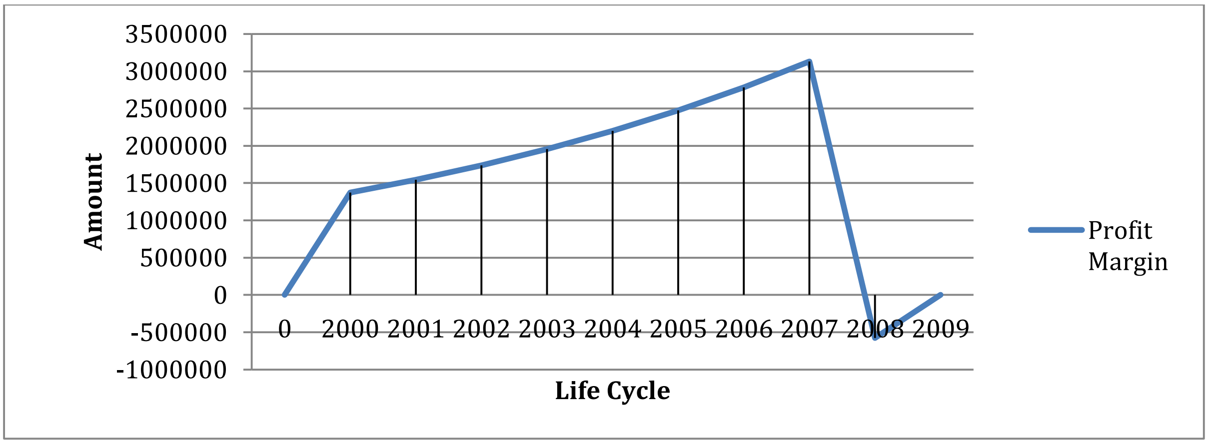
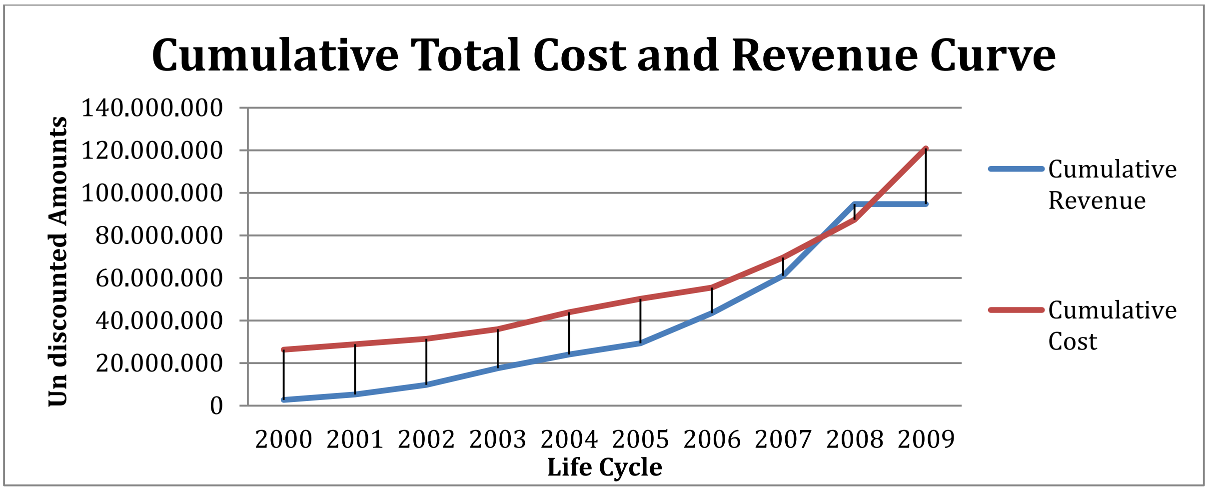


Chart 5.2.1.2.: Profit Margin curve in present values at any time of life cycle for a new building Panamax bulk carrier.



Graph 5.2.1.3.: Undiscounted Cumulative Cost and Revenue at any time of life-cycle of a newbuilding Panamax bulk carrier.

The final graph (5.2.1.3.) provides interesting outcomes for the investment on a second hand vessel. In the end of the first semester in 2007 the vessel manages to repay the accumulated cost from the beginning of the investment, but then again lays upper than the revenues.

General Outcomes

WLCC model manage to capture in a very well manner the investment on Panamax vessel. The empirical results suggest that for the period investigated, a new building Panamax vessel provides cash flows, which actually repay the initial price of the vessel. However the scene changes dramatically, after the financial crisis, which causes a tremendous plunge of the hire rates and the profits accumulated from the previous period are vanished. In this case the investing proposal would be to acquire the vessel at the beginning of the period investigating and sold before the financial crisis.

5.2.2. Panamax 5years old vessel

In the same way goes the next model comprising a five years old Panamax vessel. The following table describes the inputs and the outputs of the model.

5 YEARS OLD PANAMAX BULK CARRIER				
	%	values	Finance	
			D	S
R(TC*365*95%)	32.09%	5,334,200	35.00%	65.00%
CONSTRUCTION VALUE		16,625,000	life-cycle (yrs)	10.00
			WACC	0.00%
OPEX	11.69%	1,943,921	Credit Spread	4.39%
			Inflation Rate	2.57%
			Depreciation, a	4.00%
RV(SH PRICE)		23,250,000	Free risk rate	6.97%
DC(SCRAP VALUE)		-	Risk Premium Λ	3.33%
			Growth Rate g	1.81%
			Free risk rate i*	4.39%

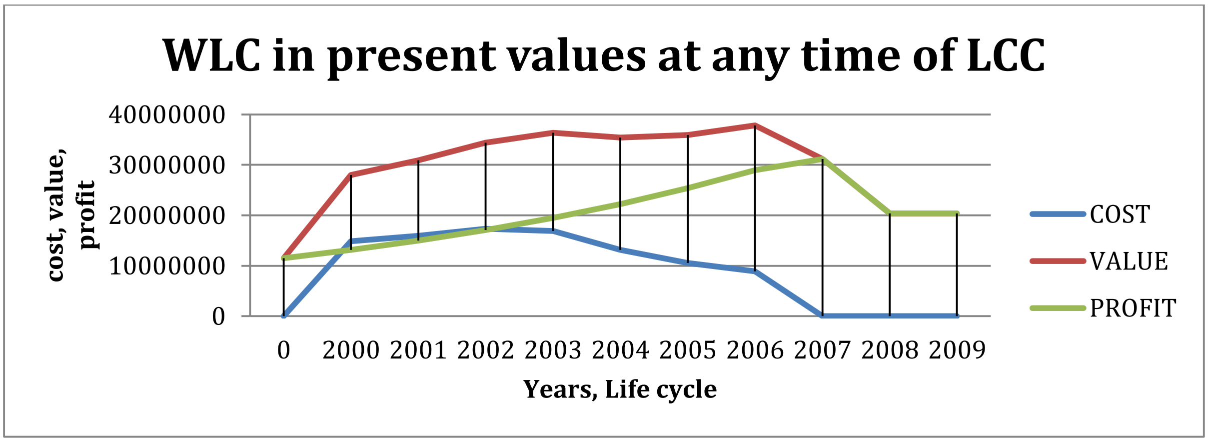
Table 5.2.2.1.: Description of the model's input-output figures for a five years old Panamax bulk carrier

Empirical Results

Graph (5.2.2.1.) suggests that the profit from the operation of the vessel has an upward trend starting from the first year of operation, reaching the highest levels in 2007 and then has downward trend until 2008 and then is following a stable trend until 2009. The downward trend is related with the conditions of the market, which change after 2008 and have significant relation with the beginning of the subprime crisis and the financial instability started at this period.

Cost of the vessel has an upward trend in the beginning of the period estimated and after the third year there is a obvious decline starting to taking place until 2007 which reaches zero. Cost declines in such a high ratio, because of the boom in the time charter rates at this period, which actually manage to eliminate the initial cost, before the vessel is finally sold.

Finally, the value of the vessel follows an upward trend from the begging until the year 2006. From 2006 and after, it starts to follow a downward trend until 2008, which later on is stabilized. The margin in the prices between value and cost is always too high. The value of the asset at the end of the period is significantly higher than the initial price of the vessel, suggesting that the reselling price in this case is actually higher.



Graph 5.2.2.1.: Cost-Value-Profit curves in present values at any time of life-cycle for a five years old Panamax bulk carrier.

Profit margins have a stable upward trend from the beginning of the investment until the 2006, where a significant drop is starting to take place. This change again, is contributed to the financial instability at this period, which affected the shipping market in a high degree and resulted in the significant reduction of the time charter rates. Time charter rates after the financial crisis bottomed and sometimes contributed to the lay-up of the vessel, because there were no cargoes to be transported. Profit margin closes to zero before the sale of the vessel

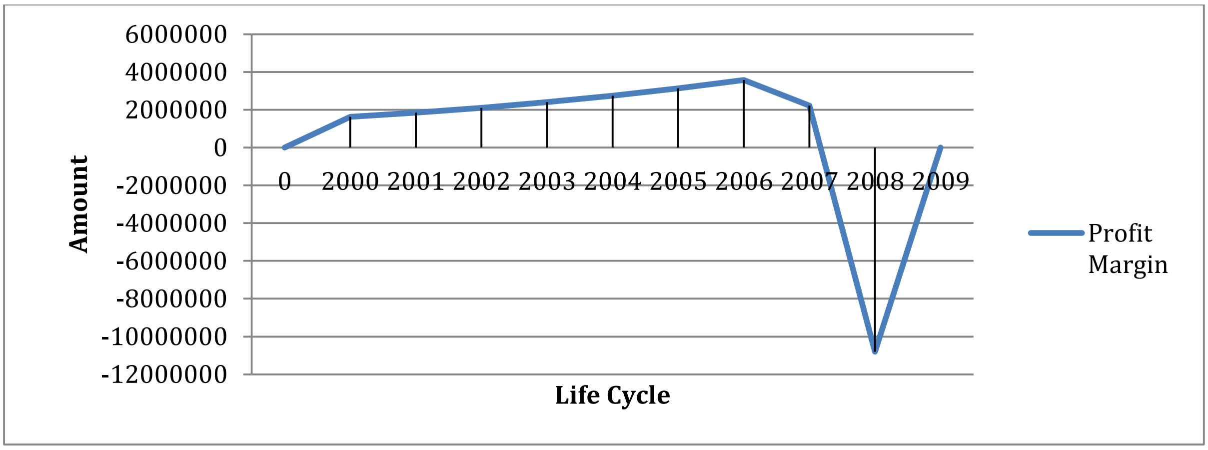


Chart 5.2.2.2.: Profit Margin curve in present values at any time of life cycle for a five years old Panamax bulk carrier.

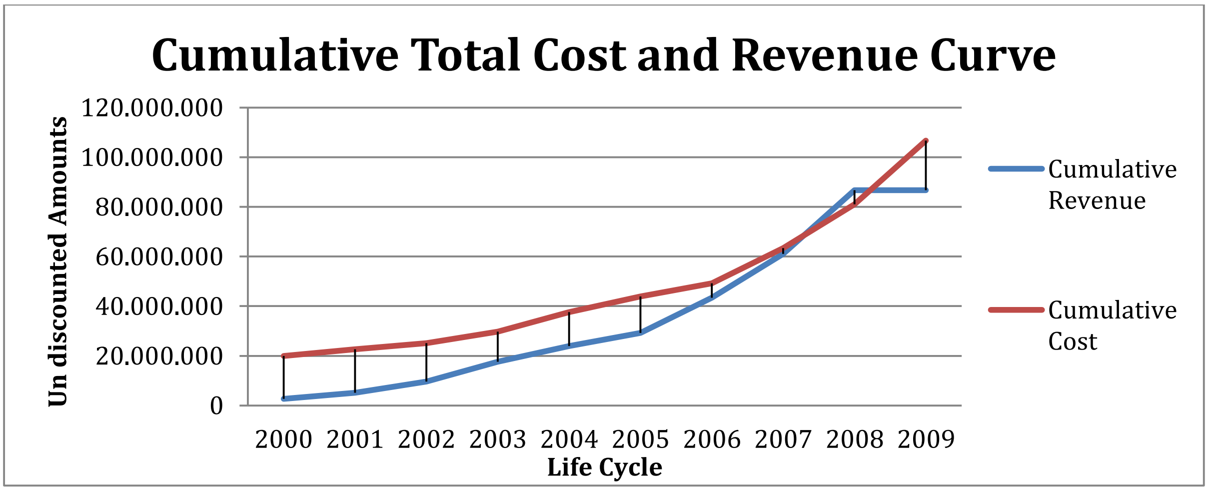


Chart 5.2.2.3.: Undiscounted Cumulative Cost and Revenue at any time of life-cycle of a five years old Panamax bulk carrier.

The final graph(5.2.2.3) provides interesting outcomes for the investment on a second hand vessel. In the first semester of the year 2007 the vessel manages to repay the accumulated cost from the beginning of the investment and the cumulative revenue surpass the cost. But because of the financial crisis the next year the cost is again higher that the revenue.

General Outcomes

WLCC model manage to capture in a very well manner the investment on Panamax vessel. The empirical results suggest that for the period investigated, a five years old Panamax vessel provides cash flows, which actually repay the initial price of the vessel. However the scene changes dramatically, after the financial crisis, which causes a tremendous plunge of the hire rates and the profits accumulated from the previous period are vanished. In this case the investing proposal would be to acquire the vessel at the beginning of the period investigating and sold before the financial crisis.

5.2.3. Panamax 15years old Vessel

Following the same pattern we have the following table for a fifteen years old Panamax vessel:

15 YEARS OLD PANAMAX BULK CARRIER				
	%	values	Finance	
			D	S
R(TC*365*95%)	73.05%	5,334,200	35.00%	65.00%
CONSTRUCTION VALUE		16,625,000	life-cycle (yrs)	10.00
			WACC	22.21%
OPEX	26.62%	1,943,921	Credit Spread	4.39%
			Inflation Rate	2.57%
			Depreciation, a	4.00%
RV(SH PRICE)		-	Free risk rate	6.97%
DC(SCRAP VALUE)		5,235,000	Risk Premium Λ	3.33%
			Growth Rate g	1.81%
			Free risk rate i*	4.39%

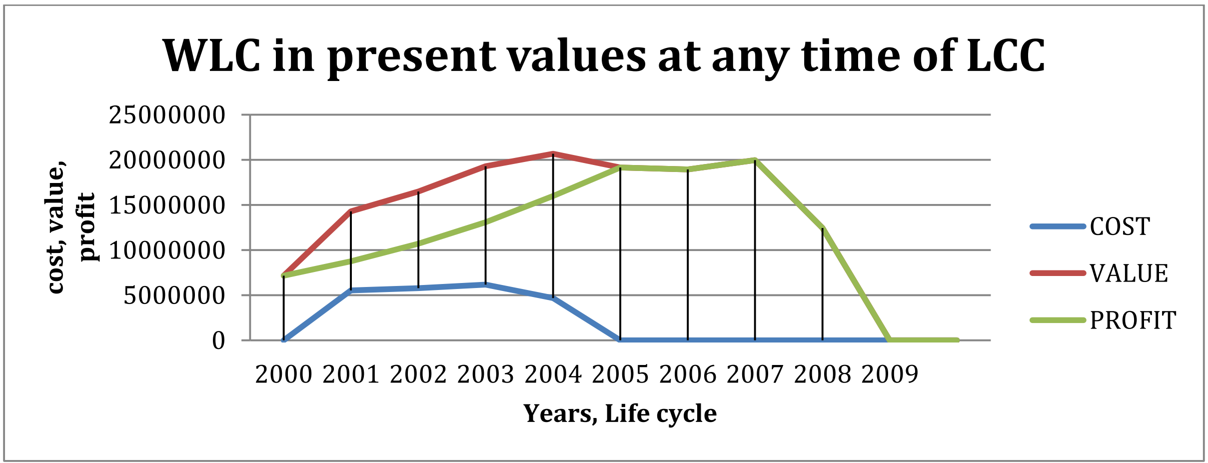
Table 5.2.3.1.: Description of the model's input-output figures for a fifteen years old Panamax bulk carrier

Empirical Results

Graph(5.2.3.1.) suggests that the profit from the operation of the vessel has an upward trend starting from the first year of operation, reaching the highest levels in 2007 and then has downward trend until 2009. The downward trend is related with the conditions of the market, which change after 2008 and have significant relation with the beginning of the subprime crisis and the financial instability started at this period.

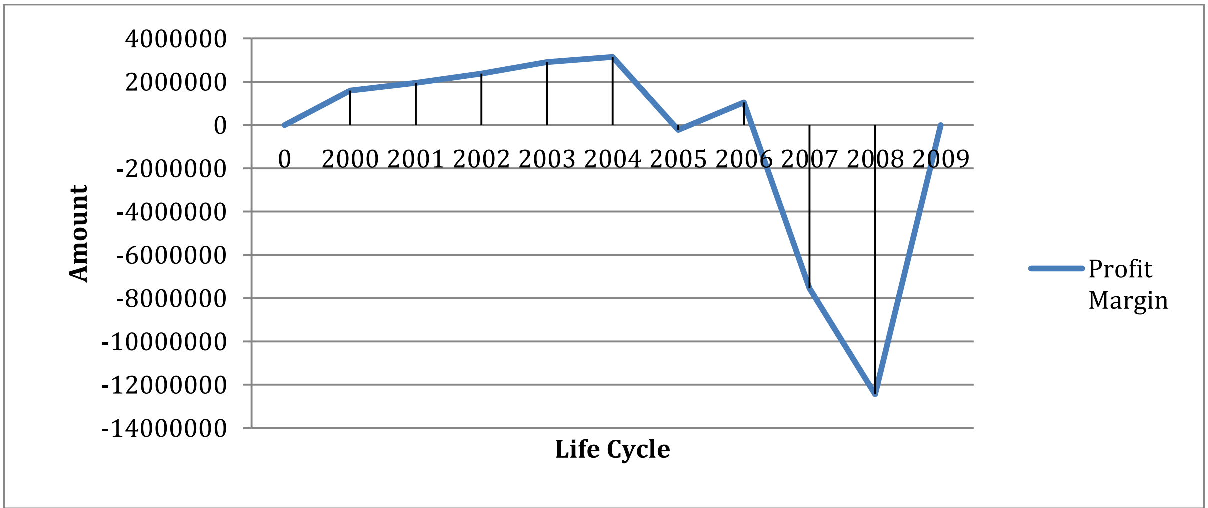
Cost of the vessel has an upward trend in the beginning of the period estimated and after the third year there is a obvious decline starting to taking place. Cost declines in such a high ratio, because of the boom in the time charter rates at this period, which actually manage to eliminate the initial cost, before the vessel is finally sold.

Finally, the value of the vessel follows an upward trend from the begging until the year 2004. From 2004 and after starts to follow a downward trend until, 2005 and then follows the trend of the profit. The margin in the prices between value and cost is always too high.

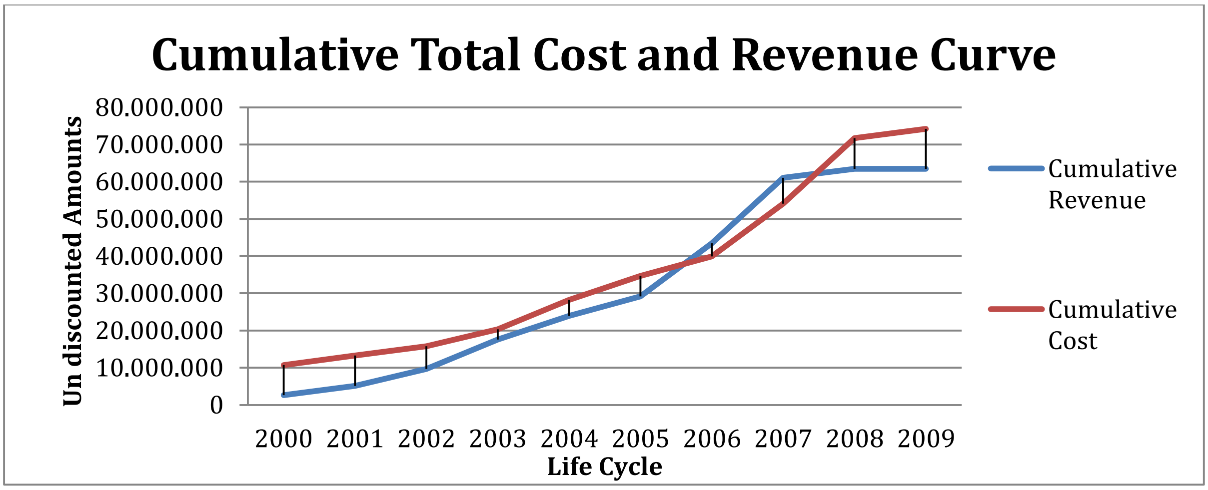


Graph 5.2.3.1.: Cost-Value-Profit curves in present values at any time of life-cycle for a fifteen years old Panamax bulk carrier.

Profit margins have a stable upward trend from the beginning of the investment until 2004, where a significant drop is taking place, reaching zero in 2005 and then rising up again until 2006 where we have prices below zero until 2009. This change again, is contributed to the financial instability at this period, which affected the shipping market in a high degree and resulted in the significant reduction of the time charter rates. Time charter rates after the financial crisis bottomed and sometimes contributed to the lay-up of the vessel, because there were no cargoes to be transported. Profit margin closes to zero after the sale of the vessel



Graph 5.2.3.2.: Profit Margin curve in present values at any time of life cycle for a fifteen years old Panamax bulk carrier.



Graph 5.2.3.3.: Undiscounted Cumulative Cost and Revenue at any time of life-cycle of a fifteen years old Panamax bulk carrier.

The final graph (5.2.3.3.) provides interesting outcomes for the investment on a second hand vessel. In the year 2006 the vessel manages to repay the accumulated cost from the beginning of the investment and surpass the cost until 2008 where the cost is again higher. This can explained from the financial crisis the global economy faced in 2008.

General Outcomes

WLCC model manage to capture in a very well manner the investment on Panamax vessel. The empirical results suggest that for the period investigated, a fifteen-year-old Panamax vessel provides cash flows, which actually repay the initial price of the vessel. However the scene changes dramatically, after the financial crisis, which causes a tremendous plunge of the hire rates and the profits accumulated from the previous period are vanished. In this case the investing proposal would be to acquire the vessel at the beginning of the period investigating and sold before the financial crisis.

Proposals

Comparing the three models of a Panamax vessel it is obvious that there are no major differences. As it seems, in the three cases the cash flows generated from the operation of the vessels resulted in the repay of the initial price and leave the ship-owner with profits sometimes really high sometimes less high. Considering the three cases the most profitable investment for a ship owner is to buy a new building vessel, operating for ten years and then resale it. The new building vessel has the higher profit margin and has positive revenue curve until 2008, the year that the crisis had, began.

5.3. Capesize

5.3.1. Capesize New Building

In the same pattern we continue our models in a Capesize vessel. Because lack of data we build only one model for a Capesize vessel. The following table, depicts the inputs and the outputs:

NEW BUILDING CAPESIZE BULK CARRIER				
	%	values	Finance	
			D	S
R(TC*365*95%)	43.75%	16,863,071	35.00%	65.00%
CONSTRUCTION VALUE		38,541,667	life-cycle (yrs)	10.00
			WACC	11.20%
OPEX	5.98%	2,303,084	Credit Spread	4.39%
			Inflation Rate	2.57%
			Depreciation, a	4.00%
RV(SH PRICE)		47,908,333	Free risk rate	6.97%
DC(SCRAP VALUE)		-	Risk Premium Λ	3.33%
			Growth Rate g	1.81%
			Free risk rate i*	4.39%

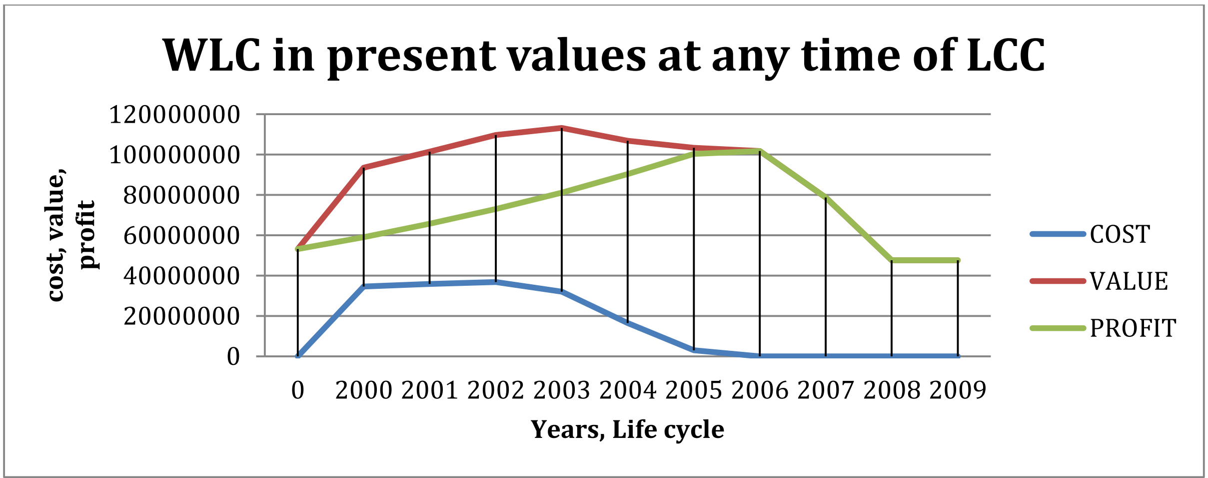
Table 5.3.1.1.: Description of the model's input-output figures for a new building Capesize bulk carrier

Empirical Results

Graph(5.3.1.1.) suggests that the profit from the operation of the vessel has an upward trend starting from the first year of operation, reaching the highest levels in 2005 and then a downward trend starts until 2008. From 2008 to 2009 the profit follows a stable trend. The downward trend is related with the conditions of the market, which change after 2008 and have significant relation with the beginning of the subprime crisis and the financial instability started at this period.

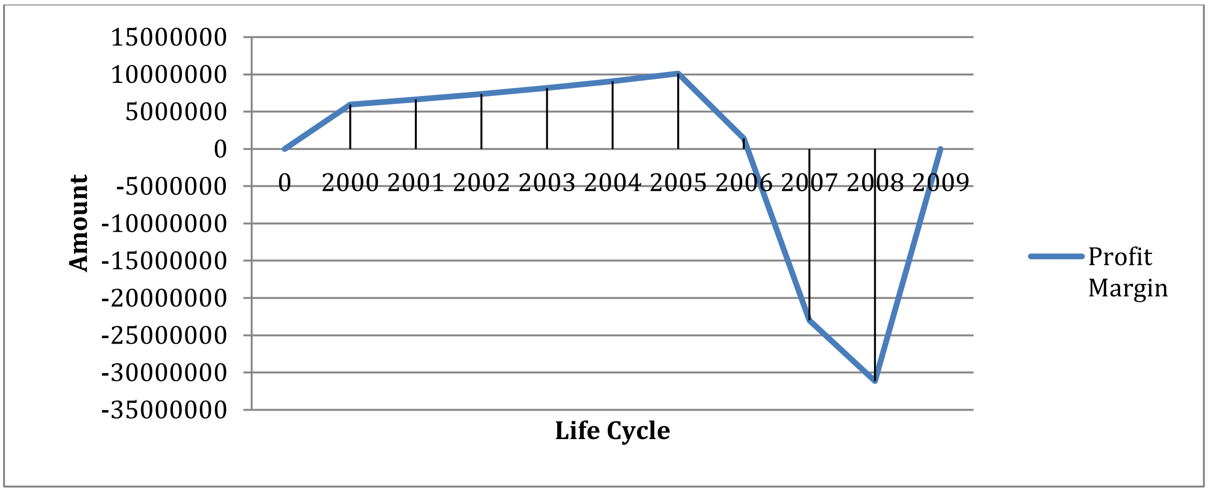
Cost of the vessel has an upward trend in the beginning of the period estimated and after the third year there is a obvious decline starting to taking place until 2005, where reaches zero. Cost declines in such a high ratio, because of the boom in the time charter rates at this period, which actually manage to eliminate the initial cost, before the vessel is finally sold.

Finally, the value of the vessel follows the trend of cost until 2005 and then follows the trend of the profit. The margin between the prices of these two is always too high. The value of the asset at the end of the period is significantly higher than the initial price of the vessel, suggesting that the reselling price in this case is actually higher.



Graph 5.3.1.1.: Cost-Value-Profit curves in present values at any time of life-cycle for a new building Capesize bulk carrier.

Profit margins have a stable upward trend from the beginning of the investment until the 2005, where a significant drop is taking place. This change again, is contributed to the financial instability at this period, which affected the shipping market in a high degree and resulted in the significant reduction of the time charter rates. Time charter rates after the financial crisis bottomed and sometimes contributed to the lay-up of the vessel, because there were no cargoes to be transported. Profit margin closes to zero after the sale of the vessel



Graph 5.3.1.2.: Profit Margin curve in present values at any time of life cycle for a new building Capezise bulk carrier.

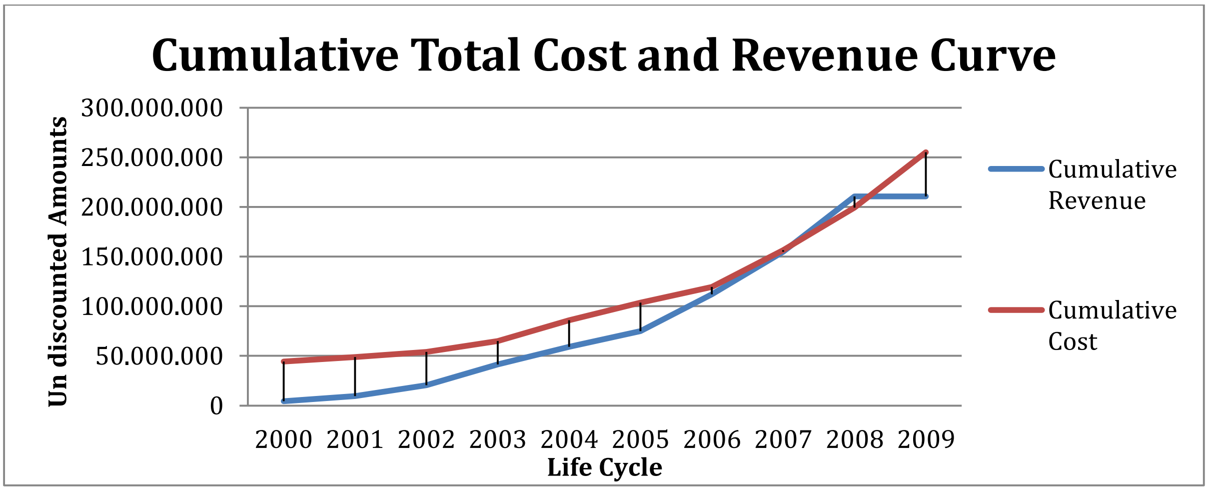


Table 5.3.1.3.: Undiscounted Cumulative Cost and Revenue at any time of life-cycle of a newbuilding Capesize bulk carrier.

The final graph(5.3.1.3.) provides interesting outcomes for the investment on a second hand vessel. In the year 2007 the vessel manages to repay the accumulated cost from the beginning of the investment and surpass the cost after that. Again, in the year 2008 the effect of the financial crisis changes the scene, and the cumulative cost is leading and creates an obvious distance from the cumulative revenue.

General Outcomes

WLCC model manage to capture in a very well manner the investment on Capesize vessel. The empirical results suggest that for the period investigated, a new building Capesize vessel provides cash flows, which actually repay the initial price of the vessel. However the scene changes dramatically, after the financial crisis, which causes a tremendous plunge of the hire rates and the profits accumulated from the previous period are vanished. In this case the investing proposal would be to acquire the vessel at the beginning of the period investigating and sold before the financial crisis.

Chapter 6

Tankers Results

The tanker market has interesting differences with the dry bulk sector, which will further highlighted above. Oil industry is a closed market, with the oil majors having a significant role in the trend of the freights. Substantially, the excessive liquidity of the financial system did not have such a tremendous imprint in tanker sector freight rates as in the bulk sector.

6.1. Handysize

6.1.1. Handysize New Building

Following the same pattern as in dry baulk sector, we construct three different scenarios for each different capacity vessel. Our analysis starts from the Handysize vessels, and the factors related with the WLC model are stressed bellow.

NEW BUILDING HANDYSIZE TANKER				
	%	values	Finance	
			D	S
R(TC*365*95%)	23.98%	6,864,604	35.00%	65.00%
CONSTRUCTION VALUE		28,625,000	life-cycle (yrs)	10.00
			WACC	11.81%
OPEX	7.21%	1,943,921	Credit Spread	4.39%
			Inflation Rate	2.57%
			Depreciation, a	4.00%
RV(SH PRICE)		23,250,000	Free risk rate	6.97%
DC(SCRAP VALUE)		-	Risk Premium Λ	3.33%
			Growth Rate g	1.81%
			Free risk rate i*	4.39%

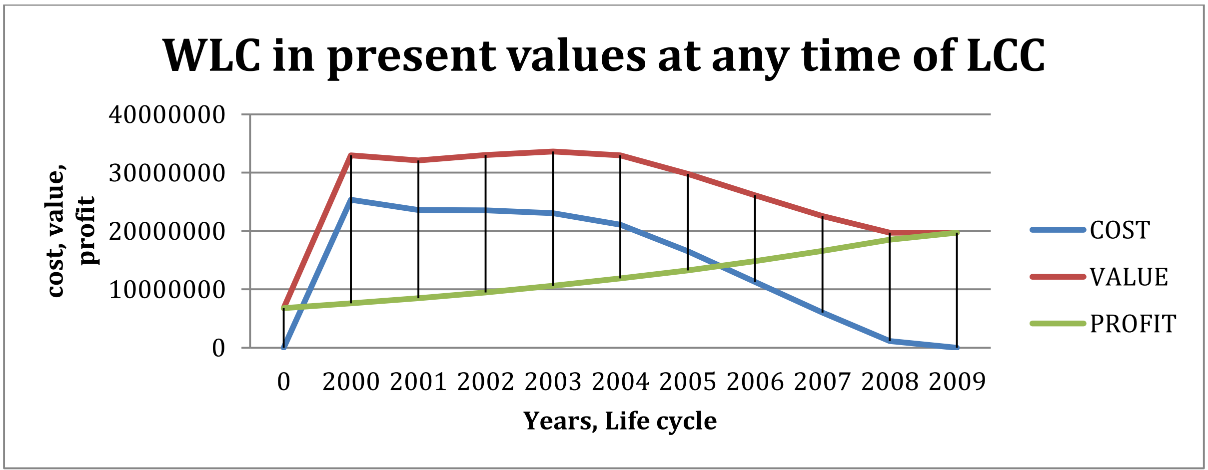
Table 6.1.1.1.: Description of the model's input-output figures for a new building Handysize tanker

Empirical Results

Graph(6.1.1.1.) suggests that the profit from the operation of the vessel has an upward trend starting from the first year of operation, reaching the highest levels in 2009. In comparison with a new building Handysize bulk carriers, where the profit eventually declined in 2008, in the Tanker sector the profit didn't downsized but it continues its upward trend.

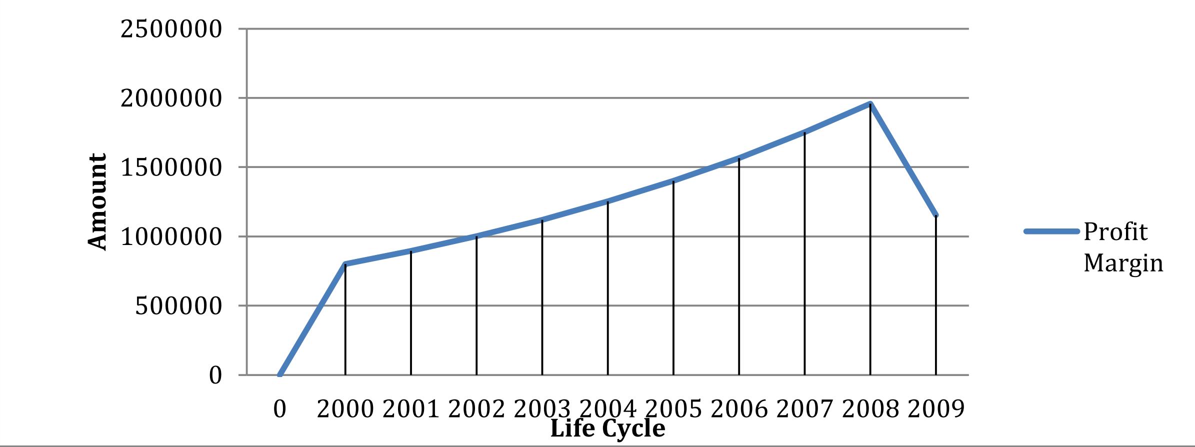
Cost of the vessel has an upward trend in the beginning of the period estimated and after the first year there is an obvious decline starting to take place. Cost declines in such a high ratio, because of the boom in the time charter rates at this period, which actually manage to eliminate the initial cost, before the vessel is finally sold.

Finally, the value of the vessel follows the trend of cost, but the margin between the prices of these two is always too high. The value of the asset at the end of the period is significantly higher than the initial price of the vessel, suggesting that the reselling price in this case is actually higher.

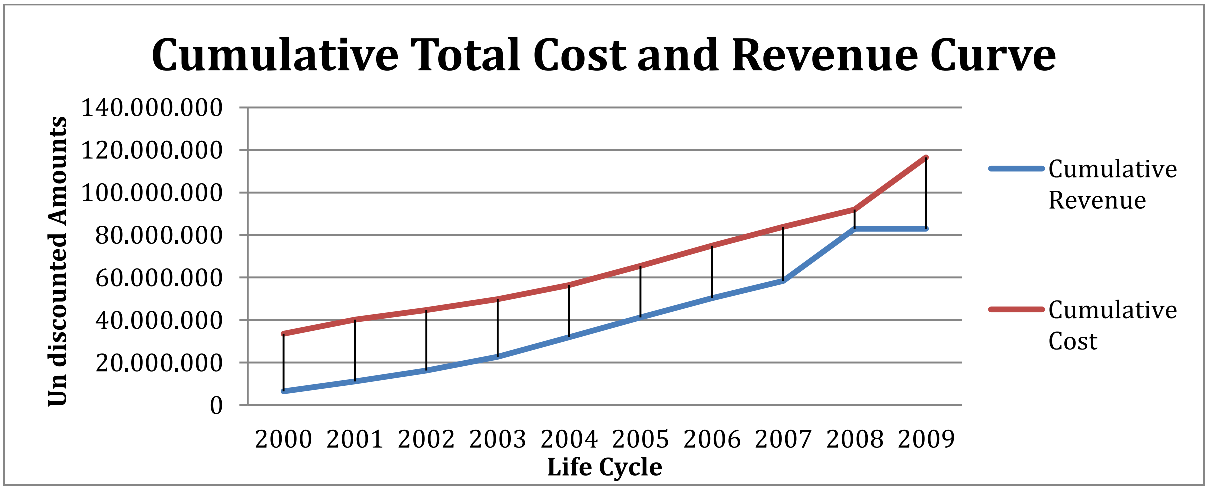


Graph 6.1.1.1.: Cost-Value-Profit curves in present values at any time of life-cycle for a new building Handysize tanker.

Profit margins have a stable upward trend from the beginning of the investment until the 2008, where a significant drop is taking place. This change again, is contributed to the financial instability at this period, which affected the shipping market in a high degree and resulted in the significant reduction of the time charter rates. Time charter rates after the financial crisis bottomed and sometimes contributed to the lay-up of the vessel, because there were no cargoes to be transported.



Graph 6.1.1.2.: Profit Margin curve in present values at any time of life cycle for a new building Handysize tanker.



Graph 6.1.1.3.: Undiscounted Cumulative Cost and Revenue at any time of life-cycle of a newbuilding Handysize tanker.

The final graph(6.1.1.3.) provides interesting outcomes for the investment on a second hand vessel. The cumulative revenue is following the same trend with the cumulative cost and the margin between them is always high. As it seams from the graph in 2008 the cumulative revenue tries to reach the cumulative cost but because of the financial crisis this never happened.

General Outcomes

WLCC model manage to capture in a very well manner the investment on Handysize vessel. The empirical results suggest that for the period investigated, a new building Handysize vessel provides cash flows, which actually repay the initial price of the vessel.

6.1.2. Handysize 5 Years Old

Continuing in the same way below is a table depict the five-year-old Handysize model :

5 YEARS OLD HANDYSIZE TANKER				
	%	values	Finance	
			D	S
R(TC*365*95%)	23.98%	6,864,604	35.00%	65.00%
CONSTRUCTION VALUE		28,625,000	life-cycle (yrs)	10.00
			WACC	12.73%
OPEX	7.21%	1,943,921	Credit Spread	4.39%
			Inflation Rate	2.57%
			Depreciation, a	4.00%
RV(SH PRICE)		23,250,000	Free risk rate	6.97%
DC(SCRAP VALUE)		-	Risk Premium Λ	3.33%
			Growth Rate g	1.81%
			Free risk rate i*	4.39%

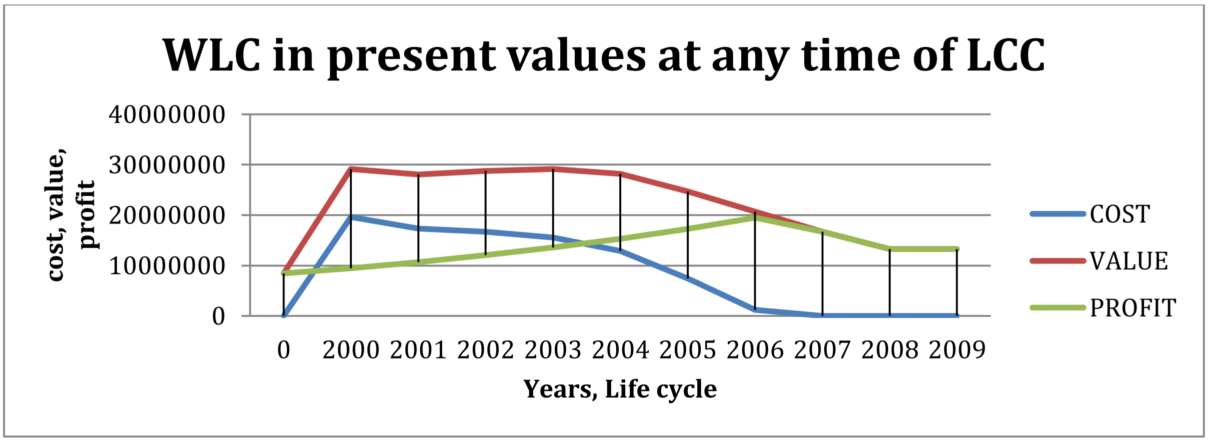
Table 6.1.2.1. Description of the model's input-output figures for a five years old Handysize tanker

Empirical Results

Graph(6.1.2.1.) suggests that the profit from the operation of the vessel has an upward trend starting from the first year of operation, reaching the highest levels in 2006 and then has downward trend. The downward trend is related with the conditions of the market, which change after 2008 and have significant relation with the beginning of the subprime crisis and the financial instability started at this period.

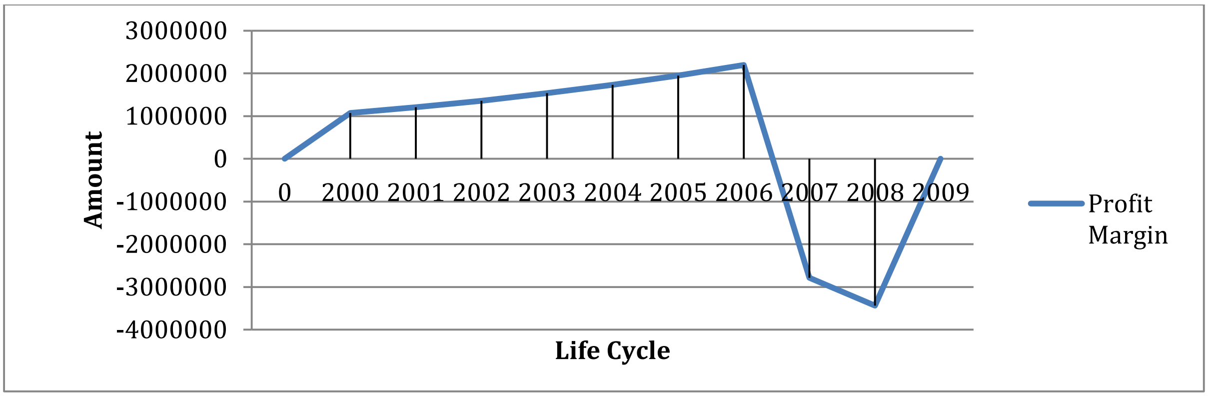
Cost of the vessel has an upward trend in the beginning of the period estimated and after the first year there is a obvious decline starting to taking place, until it reaches zero in 2006. Cost declines in such a high ratio, because of the boom in the time charter rates at this period, which actually manage to eliminate the initial cost, before the vessel is finally sold.

Finally, the value of the vessel follows the trend of cost, but the margin between the prices of these two is always too high. The value of the asset at the end of the period is significantly higher than the initial price of the vessel, suggesting that the reselling price in this case is actually higher.

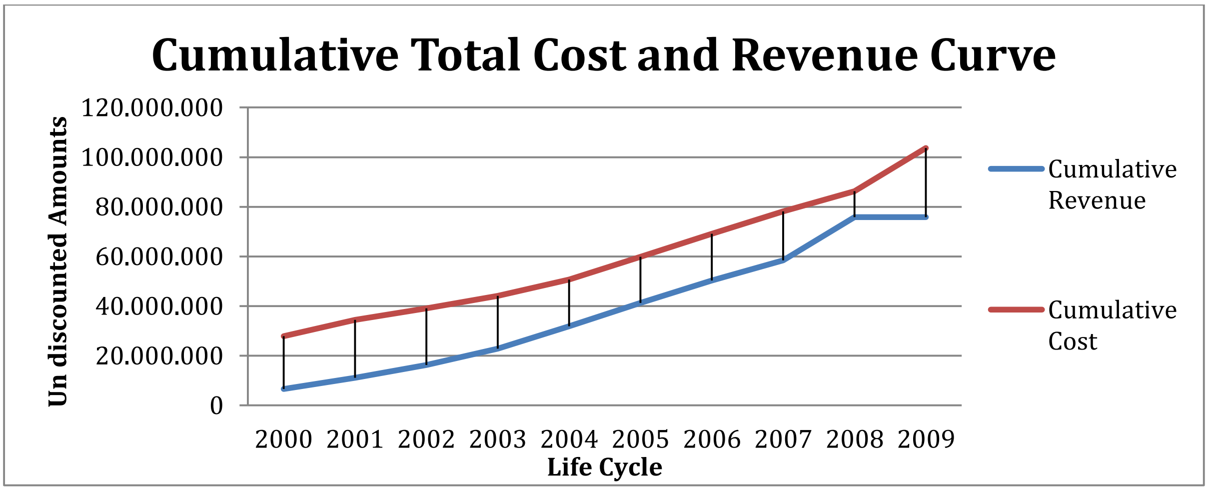


Graph 6.1.2.1.: Cost-Value-Profit curves in present values at any time of life-cycle for a five years old Handysize tanker.

Profit margins have a stable upward trend from the beginning of the investment until the 2006, where a significant drop is taking place. This change again, is contributed to the financial instability at this period, which affected the shipping market in a high degree and resulted in the significant reduction of the time charter rates. Time charter rates after the financial crisis bottomed and sometimes contributed to the lay-up of the vessel, because there were no cargoes to be transported. Profit margin closes to zero after the sale of the vessel



Graph 6.1.2.2.: Profit Margin curve in present values at any time of life cycle for a five years old Handysize tanker.



Graph 6.1.2.3.: Undiscounted Cumulative Cost and Revenue at any time of life-cycle of a five years old Handysize tanker.

The final graph(6.1.2.3.) provides interesting outcomes for the investment on a second hand vessel. The cumulative revenue is following the same trend with the cumulative cost and the margin between them is always high. As it seams from the graph in 2008 the cumulative revenue tries to reach the cumulative cost but because of the financial crisis this never happened.

General Outcomes

WLCC model manage to capture in a very well manner the investment on Handysize vessel. The empirical results suggest that for the period investigated, a five-year-old

Handysize vessel provides cash flows, which actually repay the initial price of the vessel.

6.1.3. Handysize 15 Years old

As far it concerns the fifteen years old model in all the cases of tankers models we have single hull in comparison with all the other models, which refer to tankers with double hull.

15 YEARS OLD HANDYSIZE TANKER				
	%	values	Finance	
			D	S
R(TC*365*95%)	55.47%	6,864,604	35.00%	65.00%
CONSTRUCTION VALUE		28,625,000	life-cycle (yrs)	10.00
			WACC	16.71%
OPEX	16.67%	1,943,921	Credit Spread	4.39%
			Inflation Rate	2.57%
			Depreciation, a	4.00%
RV(SH PRICE)		-	Free risk rate	6.97%
DC(SCRAP VALUE)		3,770,000	Risk Premium Λ	3.33%
			Growth Rate g	1.81%
			Free risk rate i*	4.39%

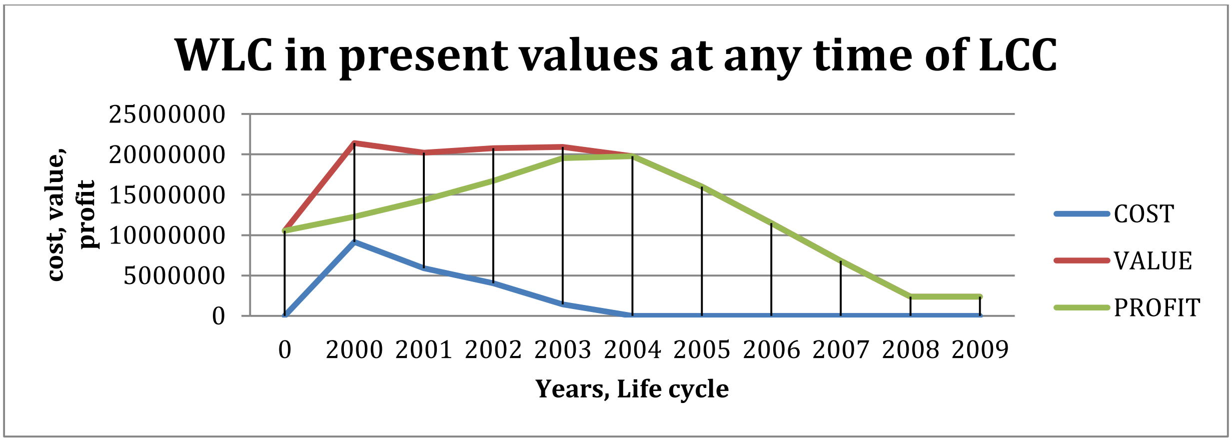
Table 6.1.3.1.: Description of the model's input-output figures for a fifteen years old Handysize tanker

Empirical Results

Graph(6.1.3.1.) suggests that the profit from the operation of the vessel has an upward trend starting from the first year of operation, reaching the highest levels in 2004 and then has downward trend. The downward trend is related with the conditions of the market, which change after 2008 and have significant relation with the beginning of the subprime crisis and the financial instability started at this period.

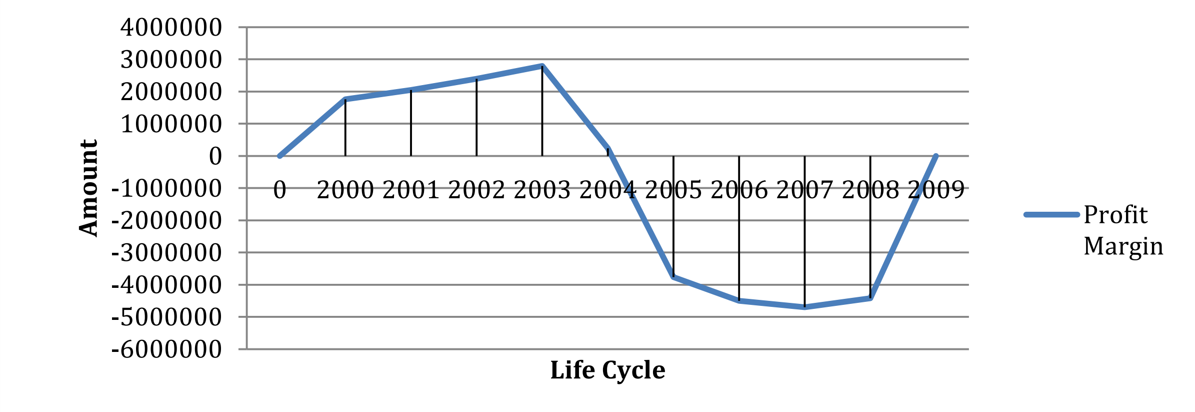
Cost of the vessel has an upward trend in the beginning of the period estimated and after the first year there is a obvious decline starting to taking place. Cost declines in such a high ratio, because of the boom in the time charter rates at this period, which actually manage to eliminate the initial cost, before the vessel is finally sold.

Finally, the value of the vessel follows the trend of cost, but the margin between the prices of these two is always too high. The value of the asset at the end of the period is significantly higher than the initial price of the vessel, suggesting that the reselling price in this case is actually higher

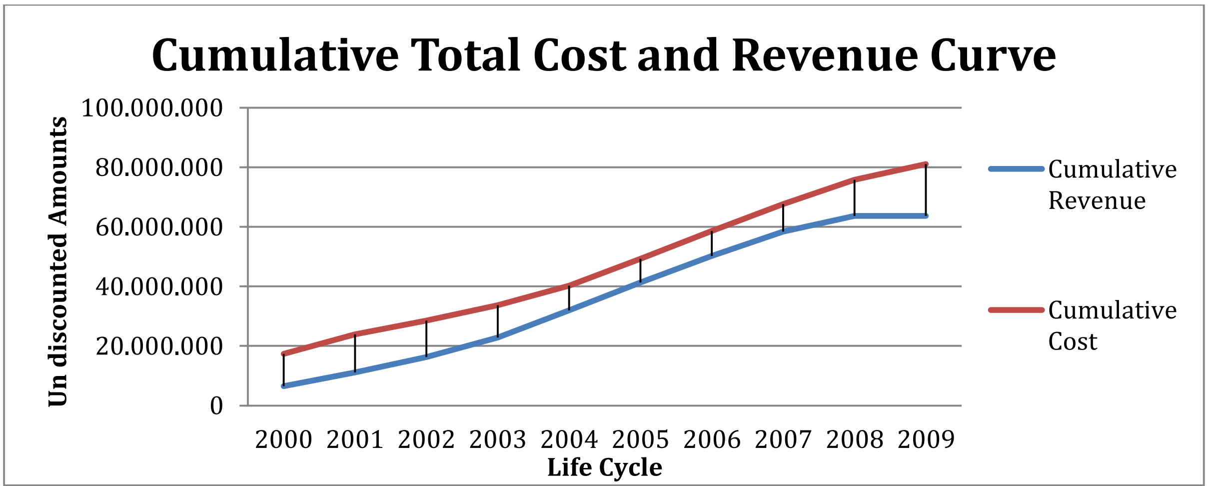


Graph 6.1.3.1.: Cost-Value-Profit curves in present values at any time of life-cycle for a fifteen years old Handysize tanker.

Profit margins have a stable upward trend from the beginning of the investment until the 2003, where a significant drop is taking place. This change is contributed to a regulation followed by the Erica incident in 2001. This regulation makes it specific that tankers with single hull should be converting to double hull according to the delivery year. So according to this regulation single hull vessels couldn't be in a position for trading after 2005.



Graph 6.1.3.2.: Profit Margin curve in present values at any time of life cycle for a fifteen years old Handysize tanker.



Graph 6.1.3.3.: Undiscounted Cumulative Cost and Revenue at any time of life-cycle of a fifteen years old Handysize tanker.

The final graph(6.1.3.3.) provides interesting outcomes for the investment on a second hand vessel. The cumulative revenue is following the same trend with the cumulative cost and the margin between them is always high.

General Outcomes

WLCC model manage to capture in a very well manner the investment on Handysize vessel. The empirical results suggest that for the period investigated, a fifteen-year-old Handysize vessel provides cash flows, which actually repay the initial price of the vessel.

6.2. Panamax

6.2.1.Panamax New Building

Continuing with a Panamax new building model. The table below describes the inputs and the outputs of the model

NEW BUILDING PANAMAX TANKER				
	%	values	Finance	
			D	S
R(TC*365*95%)	24.18%	8,362,886	35.00%	65.00%
CONSTRUCTION VALUE		34,583,333	life-cycle (yrs)	10.00
			WACC	12.42%
OPEX	8.41%	2,910,145	Credit Spread	4.39%
			Inflation Rate	2.57%
			Depreciation, a	4.00%
RV(SH PRICE)		28,125,000	Free risk rate	6.97%
DC(SCRAP VALUE)		-	Risk Premium Λ	3.33%
			Growth Rate g	1.81%
			Free risk rate i*	4.39%

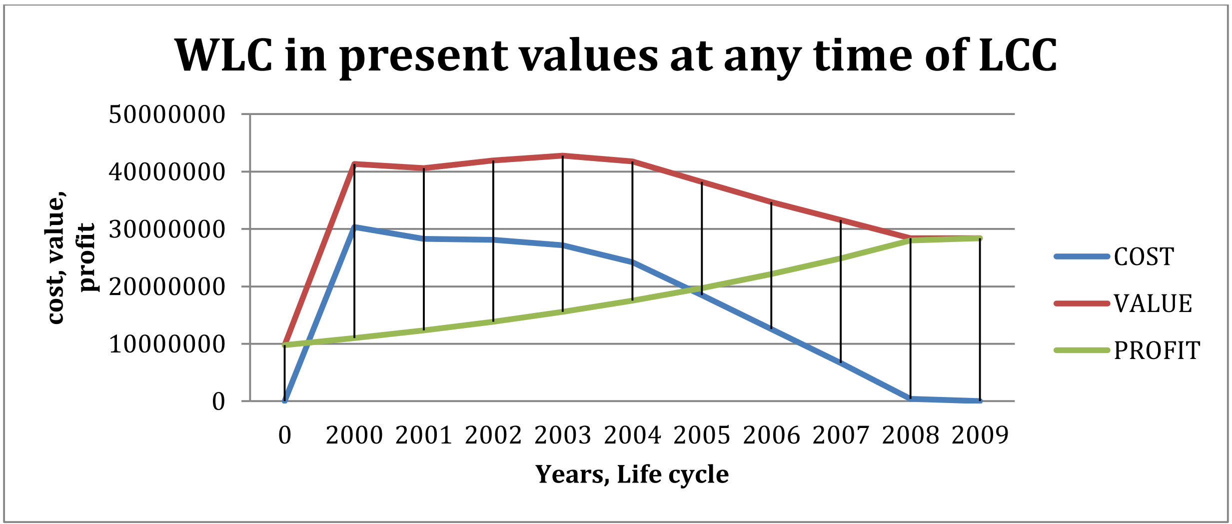
Table 6.2.1.1.: Description of the model's input-output figures for a new building Panamax tanker

Empirical Results

Graph(6.2.1.1.) suggests that the profit from the operation of the vessel has an upward trend starting from the first year of operation, reaching the highest levels in 2006 and then has downward trend. The downward trend is related with the conditions of the market, which change after 2008 and have significant relation with the beginning of the subprime crisis and the financial instability started at this period.

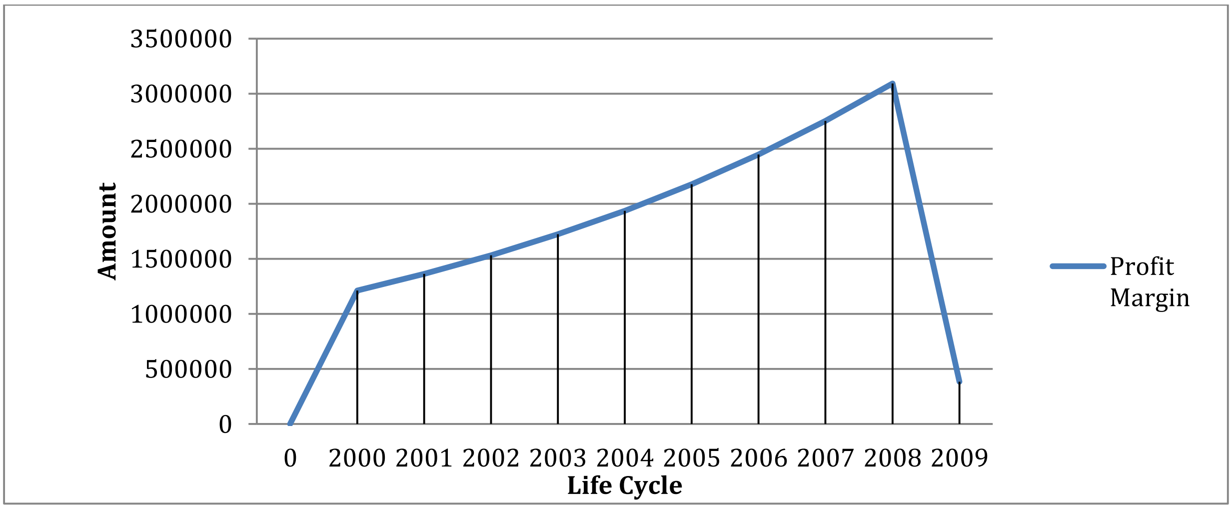
Cost of the vessel has an upward trend in the beginning of the period estimated and after the first year there is a obvious decline starting to taking place, until it reaches zero in 2006. Cost declines in such a high ratio, because of the boom in the time charter rates at this period, which actually manage to eliminate the initial cost, before the vessel is finally sold.

Finally, the value of the vessel follows the trend of cost, but the margin between the prices of these two is always too high. The value of the asset at the end of the period is significantly higher than the initial price of the vessel, suggesting that the reselling price in this case is actually higher.

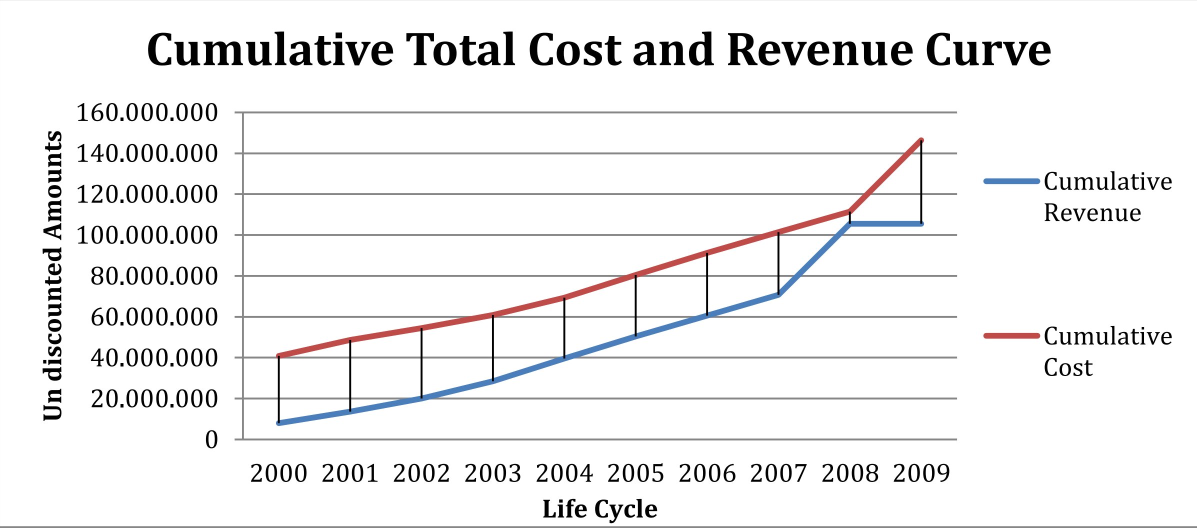


Graph 6.2.1.1.: Cost-Value-Profit curves in present values at any time of life-cycle for a new building Panamax tanker.

Profit margins have a stable upward trend from the beginning of the investment until the 2008, where a significant drop is taking place. This change again, is contributed to the financial instability at this period, which affected the shipping market in a high degree and resulted in the significant reduction of the time charter rates.



Graph 6.2.1.2.: Profit Margin curve in present values at any time of life cycle for a new building Handysize tanker.



Graph 6.2.1.3.: Undiscounted Cumulative Cost and Revenue at any time of life-cycle of a newbuilding Panamax tanker.

The final graph(6.2.1.3.) provides interesting outcomes for the investment on a second hand vessel. The cumulative revenue is following the same trend with the cumulative cost and the margin between them is always high. As it seams from the graph in 2008 the cumulative revenue tries to reach the cumulative cost but because of the financial crisis this never happened.

General Outcomes

WLCC model manage to capture in a very well manner the investment on Panamax vessel. The empirical results suggest that for the period investigated, on a new building Panamax vessel provides cash flows, which actually repay the initial price of the vessel.

6.2.2.Panamax 5 Years old

5 YEARS OLD PANAMAX TANKER				
	%	**values**	**Finance**	
			D	**S**
R(TC*365*95%)	29.86%	8,362,886	35.00%	65.00%
CONSTRUCTION VALUE		28,005,000	**life-cycle (yrs)**	10.00
			WACC	13.43%
OPEX	10.39%	2,910,145	**Credit Spread**	4.39%
			Inflation Rate	2.57%
			Depreciation, a	4.00%
RV(SH PRICE)		13,750,00	**Free risk rate**	6.97%
DC(SCRAP VALUE)		-	**Risk Premium Λ**	3.33%
			Growth Rate g	1.81%
			Free risk rate i*	4.39%

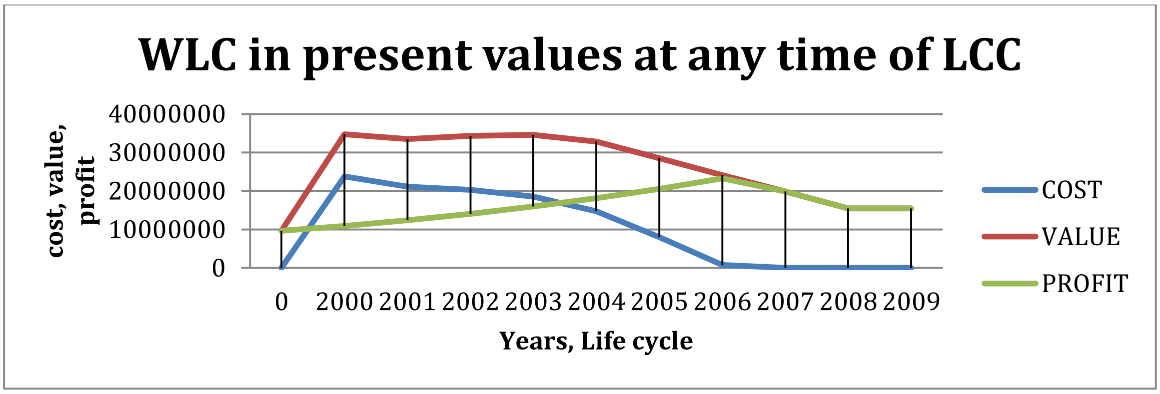
Table 6.2.2.1.: Description of the model's input-output figures for a five years old Panamax tanker

Empirical Results

Graph(6.2.2.1.) suggests that the profit from the operation of the vessel has an upward trend starting from the first year of operation, reaching the highest levels in 2006 and then has downward trend. The downward trend is continues until 2008 and then for one year until 2009 it follows a stable trend.

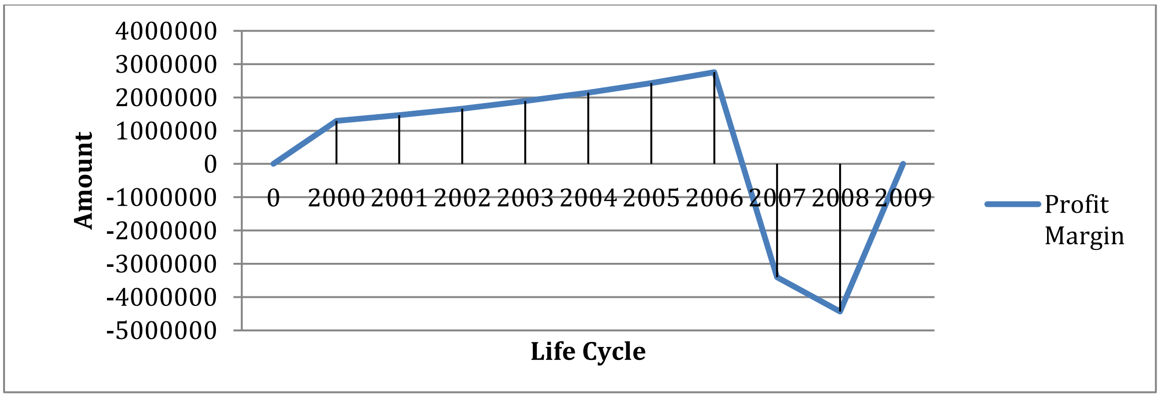
Cost of the vessel has an upward trend in the beginning of the period estimated and after the first year there is a obvious decline starting to taking place, until it reaches zero in 2006. Cost declines in such a high ratio, because of the boom in the time charter rates at this period, which actually manage to eliminate the initial cost, before the vessel is finally sold.

Finally, the value of the vessel follows the trend of cost, but the margin between the prices of these two is always too high. The value of the asset at the end of the period is significantly higher than the initial price of the vessel, suggesting that the reselling price in this case is actually higher.

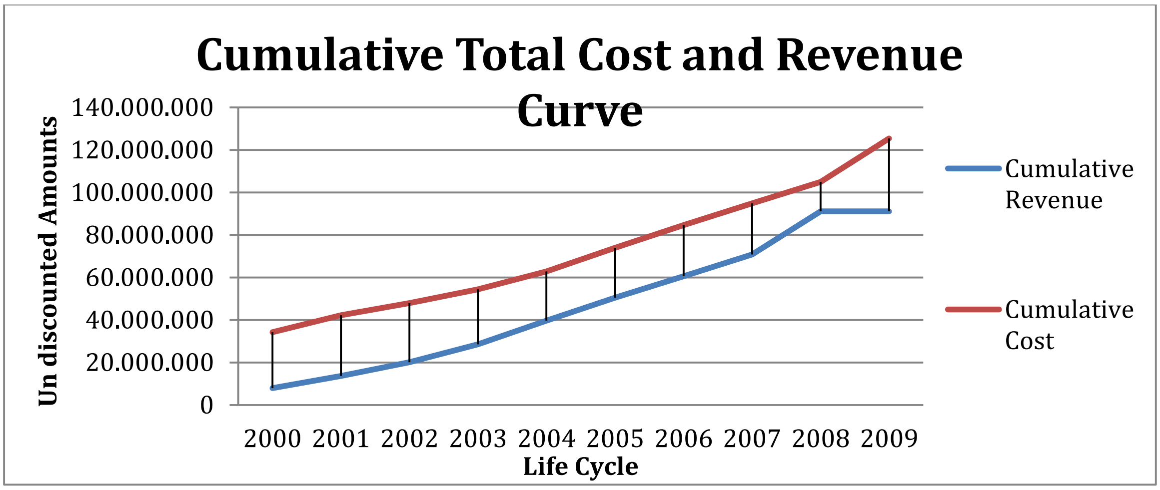


Graph 6.2.2.1.: Cost-Value-Profit curves in present values at any time of life-cycle for a five years Panamax tanker.

Profit margins have a stable upward trend from the beginning of the investment until 2006, where a significant drop is taking place. This change again, is contributed to the financial instability at this period, which affected the shipping market in a high degree and resulted in the significant reduction of the time charter rates.



Graph 6.2.2.2.: Profit Margin curve in present values at any time of life cycle for a five years old Panamax tanker.



Graph 6.2.2.3.: Undiscounted Cumulative Cost and Revenue at any time of life-cycle of a five years old Panamax tanker.

The final graph(6.2.2.3.) provides interesting outcomes for the investment on a second hand vessel. The cumulative revenue is following the same trend with the cumulative cost and the margin between them is always high. As it seams from the graph in 2008 the cumulative revenue stopped increasing and followed a stable price.

General Outcomes

WLCC model manage to capture in a very well manner the investment on Panamax vessel. The empirical results suggest that for the period investigated, a five-year-old Panamax vessel provides cash flows, which actually repay the initial price of the vessel.

6.2.3. Panamax 15 Years Old

15 YEARS OLD PANAMAX TANKER				
	%	values	Finance	
			D	S
R(TC*365*95%)	88.31%	8,362,886	35.00%	65.00%
CONSTRUCTION VALUE		9,469,697	life-cycle (yrs)	10.00
			WACC	24.60%
OPEX	30.73%	2,910,145	Credit Spread	4.39%
			Inflation Rate	2.57%
			Depreciation, a	4.00%
RV(SH PRICE)		-	Free risk rate	6.97%
DC(SCRAP VALUE)		5,235,000	Risk Premium Λ	3.33%
			Growth Rate g	1.81%
			Free risk rate i*	4.39%

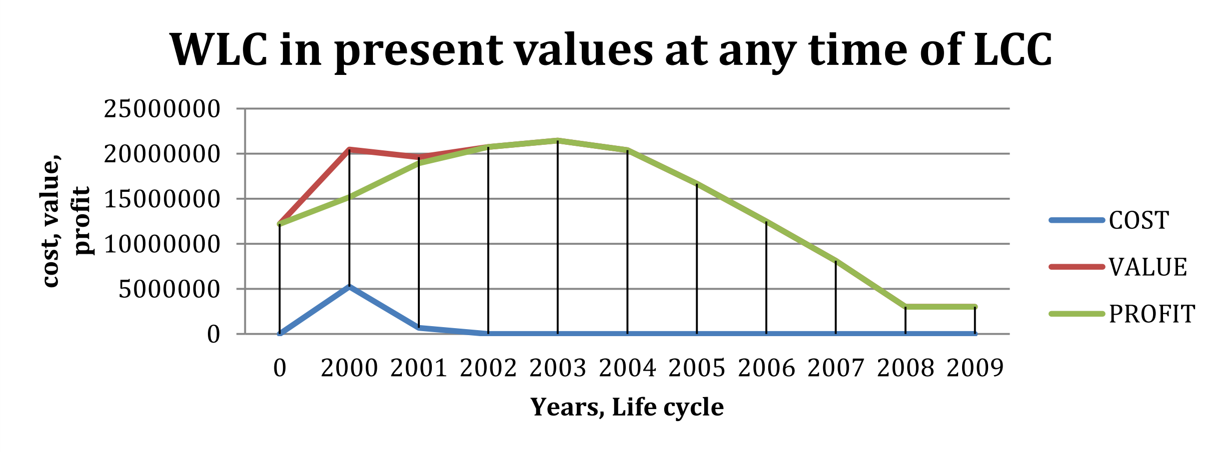
Table 6.2.3.1.: Description of the model's input-output figures for a fifteen years old Panamax tanker

Empirical Results

Graph(6.2.3.1.) suggests that the profit from the operation of the vessel has an upward trend starting from the first year of operation, reaching the highest levels in 2003 and then has a stable downward trend until 2008, where is stabilized until the end of the operation of the vessel. The downward trend is related with OPA 90, because the oil mayors during the years, progressively stopped charter single hull vessels.

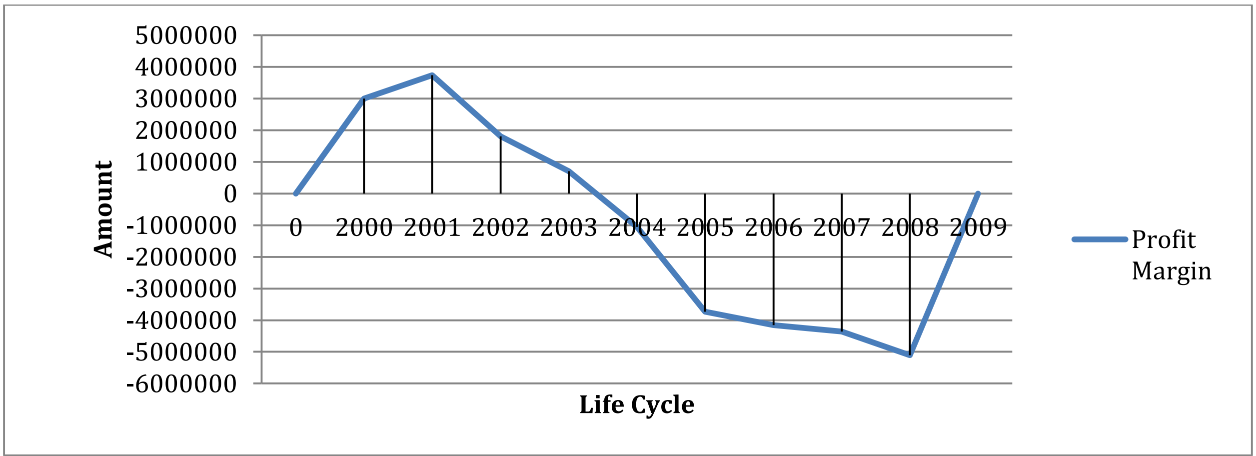
Cost of the vessel has an upward trend in the beginning of the period estimated and after the first year there is a obvious decline starting to taking place, until it reaches zero in 2001. Cost declines in such a high ratio, because of the boom in the time charter rates at this period, which actually manage to eliminate the initial cost, before the vessel is finally sold.

Finally, the value of the vessel follows the trend of cost, but the margin between the prices of these two is always too high. The asset has lost all of its value until the end of the operating period.



Graph 6.2.3.1.: Cost-Value-Profit curves in present values at any time of life-cycle for a fifteen years old Panamax tanker.

Profit margin has a stable upward trend from the beginning of the investment until the 2001, where a significant drop is taking place. This change again, is contributed to the OPA 90, because a single hull vessel is difficult to find cargo to transfer.



Graph 6.2.3.2.: Profit Margin curve in present values at any time of life cycle for a fifteen years old Panamax tanker.

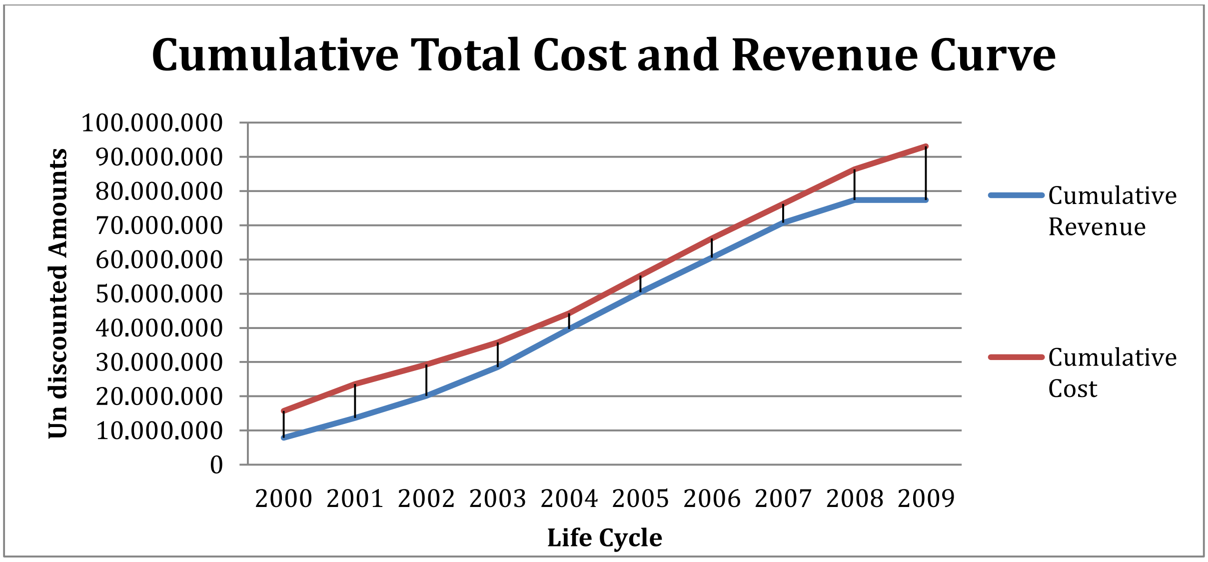


Table 6.2.3.3.: Undiscounted Cumulative Cost and Revenue at any time of life-cycle of a fifteen years old Panamax tanker.

The final graph(6.2.3.3.) provides interesting outcomes for the investment on a second hand vessel. The cumulative revenue is following the same trend with the cumulative cost and the margin between them is always high.

General Outcomes

WLCC model manage to capture in a very well manner the investment on Panamax vessel. The empirical results suggest that for the period investigated, a fifteen-year-old Panamax vessel provides cash flows, which actually repay the initial price of the vessel.

6.3. Aframax

6.3.1.Aframax New Building

NEW BUILDING AFRAMAX TANKER				
	%	values	Finance	
			D	S
R(TC*365*95%)	24.82%	9,502,443	35.00%	65.00%
CONSTRUCTION VALUE		38,291,667	life-cycle (yrs)	10.00
			WACC	12.01%
OPEX	7.60%	2,910,145	Credit Spread	4.39%
			Inflation Rate	2.57%
			Depreciation, a	4.00%
RV(SH PRICE)		30,708,333	Free risk rate	6.97%
DC(SCRAP VALUE)			Risk Premium Λ	3.33%
			Growth Rate g	1.81%
			Free risk rate i*	4.39%

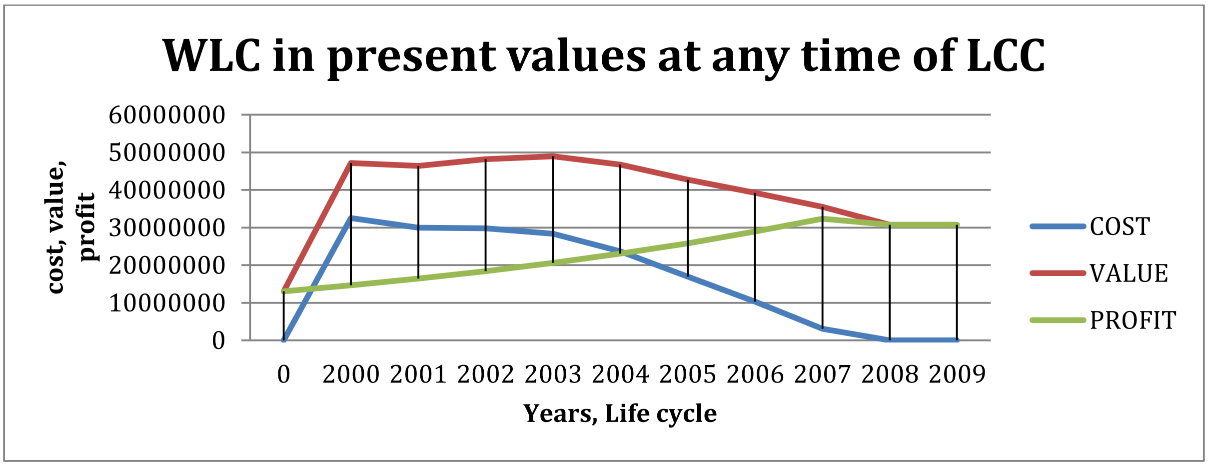
Table 6.3.1.1.: Description of the model's input-output figures for a new building Aframax tanker

Empirical Results

Graph(6.3.1.1.) suggests that the profit from the operation of the vessel has an upward trend starting from the first year of operation, reaching the highest levels in 2007 and then is following a stable trend until the end of the operation life for the period estimate.

Cost of the vessel has an upward trend in the beginning of the period estimated and after the first year there is a obvious decline starting to taking place, until it reaches zero in 2008. Cost declines in such a high ratio, because of the boom in the time charter rates at this period, which actually manage to eliminate the initial cost, before the vessel is finally sold.

Finally, the value of the vessel follows the trend of cost, but the margin between the prices of these two is always too high. The value of the asset at the end of the period is significantly higher than the initial price of the vessel, suggesting that the reselling price in this case is actually higher.



Graph 6.3.1.1.: Cost-Value-Profit curves in present values at any time of life-cycle for a new building Aframax tanker.

Profit margins have a stable upward trend from the beginning of the investment until the 2007, where a significant drop is taking place. This change again, is contributed to the financial instability at this period, which affected the shipping market in a high degree and resulted in the significant reduction of the time charter rates. Time charter rates after the financial crisis bottomed and sometimes contributed to the lay-up of the vessel, because there were no cargoes to be transported.

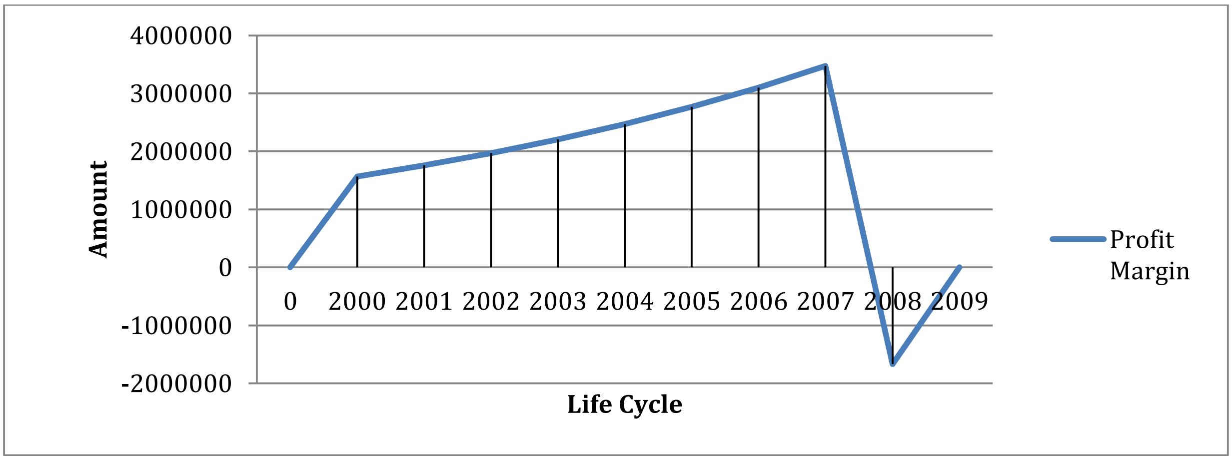
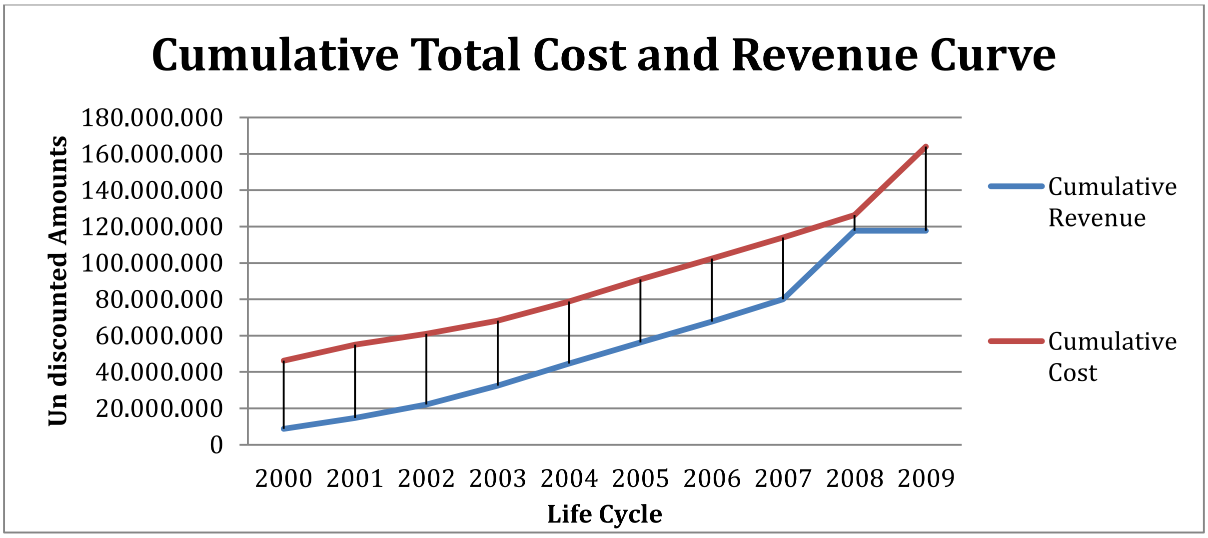


Chart 6.3.1.2.: Profit Margin curve in present values at any time of life cycle for new building Aframax tanker.



Graph 6.3.1.3.: Undiscounted Cumulative Cost and Revenue at any time of life-cycle of a newbuilding Aframax tanker.

The final graph(6.3.1.3.) provides interesting outcomes for the investment on a second hand vessel. The cumulative revenue is following the same trend with the cumulative cost and the margin between them is always high. As it seams from the graph in 2008 the cumulative revenue tries to reach the cumulative cost but because of the financial crisis this never happened.

General Outcomes

WLCC model manage to capture in a very well manner the investment on an Aframax vessel. The empirical results suggest that for the period investigated, a new building Aframax vessel provides cash flows, which actually repay the initial price of the vessel.

6.3.2. Aframax 5 Years Old

5 YEARS OLD AFRAMAX TANKER				
	%	values	Finance	
			D	S
R(TC*365*95%)	28.65%	9,502,443	35.00%	65.00%
CONSTRUCTION VALUE		33,166,667	life-cycle (yrs)	10.00
			WACC	12.01%
OPEX	8.77%	2,910,145	Credit Spread	4.39%
			Inflation Rate	2.57%
			Depreciation, a	4.00%
RV(SH PRICE)		16,166,667	Free risk rate	6.97%
DC(SCRAP VALUE)		-	Risk Premium Λ	3.33%
			Growth Rate g	1.81%
			Free risk rate i*	4.39%

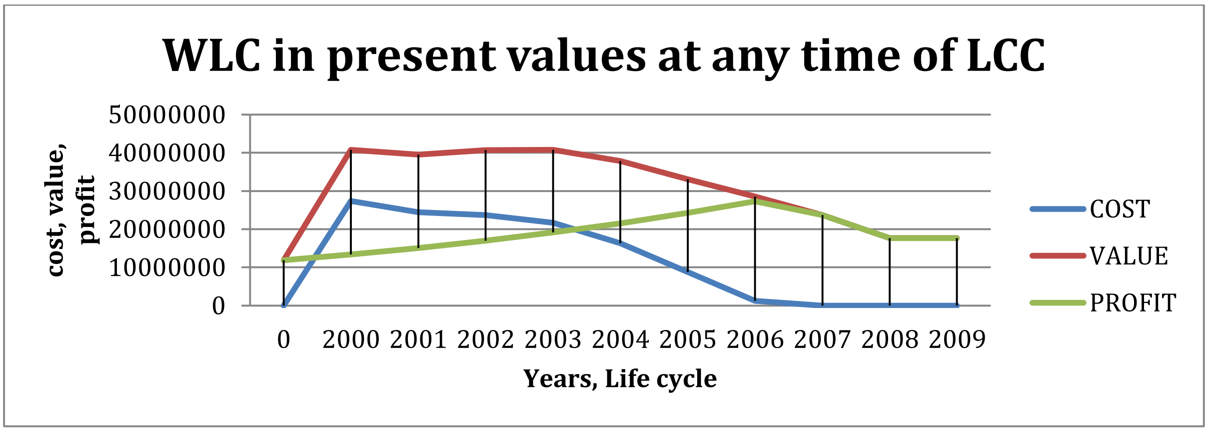
Table 6.3.2.1.: Description of the model's input-output figures for a five years old Aframax tanker

Empirical Results

Graph(6.3.2.1.) suggests that the profit from the operation of the vessel has an upward trend starting from the first year of operation, reaching the highest levels in 2006 and then has downward trend until 2008. From 2008 until the end of the operation period has a stable trend. . The downward trend is related with the conditions of the market, which change after 2008 and have significant relation with the beginning of the subprime crisis and the financial instability started at this period.

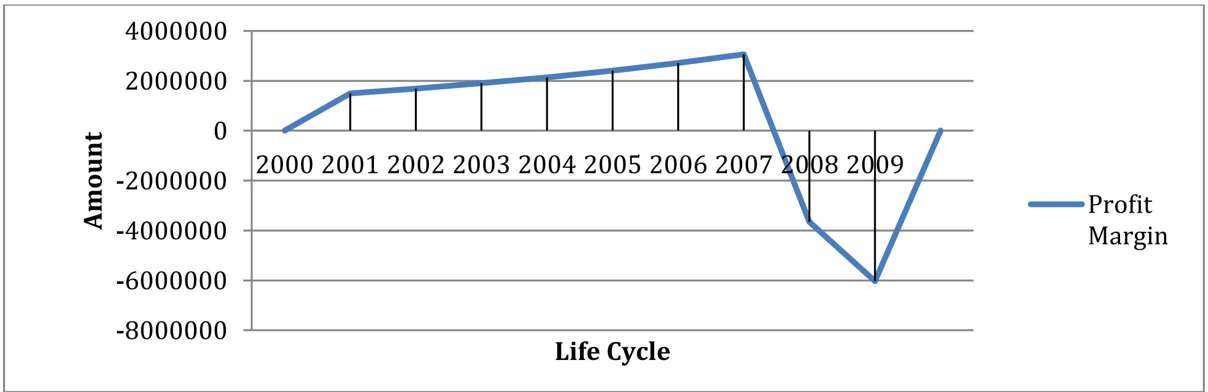
Cost of the vessel has an upward trend in the beginning of the period estimated and after the first year there is a obvious decline starting to taking place, until it reaches zero in 2006. Cost declines in such a high ratio, because of the boom in the time charter rates at this period, which actually manage to eliminate the initial cost, before the vessel is finally sold.

Finally, the value of the vessel follows the trend of cost, but the margin between the prices of these two is always too high. The value of the asset at the end of the period is significantly higher than the initial price of the vessel, suggesting that the reselling price in this case is actually higher

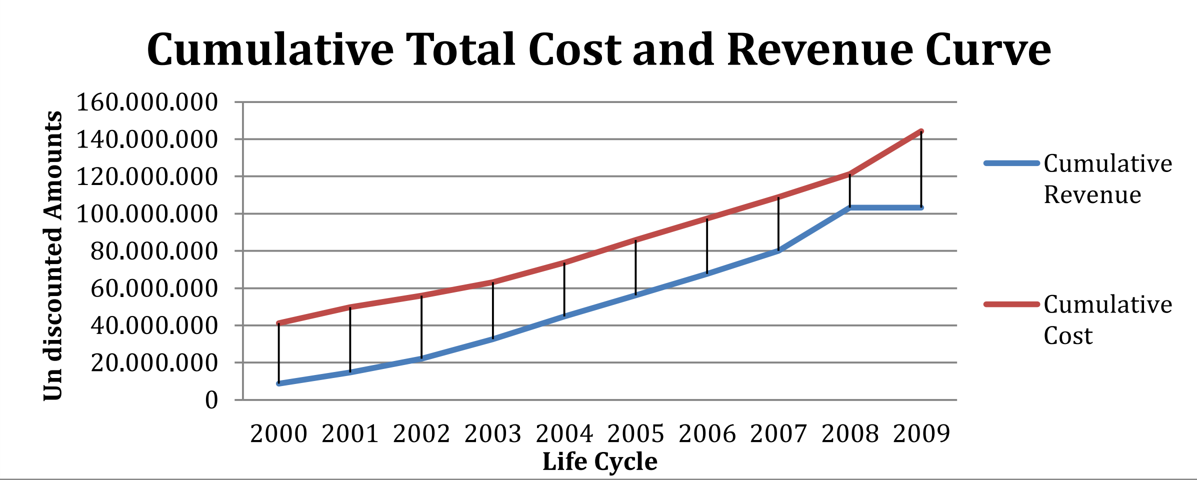


Graph 6.3.2.1.: Cost-Value-Profit curves in present values at any time of life-cycle for a five years old Aframax tanker.

Profit margins have a stable upward trend from the beginning of the investment until the 2007, where a significant drop is taking place. This change again, is contributed to the financial instability at this period, which affected the shipping market in a high degree and resulted in the significant reduction of the time charter rates. Time charter rates after the financial crisis bottomed and sometimes contributed to the lay-up of the vessel, because there were no cargoes to be transported.



Graph 6.3.2.2.: Profit Margin curve in present values at any time of life cycle for a five years old Aframax tanker.



Graph 6.3.2.3.: Undiscounted Cumulative Cost and Revenue at any time of life-cycle of a five years old Aframax tanker.

The final graph(6.3.2.3.) provides interesting outcomes for the investment on a second hand vessel. The cumulative revenue is following the same trend with the cumulative cost and the margin between them is always high. As it seams from the graph in 2008 the cumulative revenue tries to reach the cumulative cost but because of the financial crisis this never happened.

General Outcomes

WLCC model manage to capture in a very well manner the investment on Aframax. The empirical results suggest that for the period investigated, a five years old Aframax vessel provides cash flows, which actually repay the initial price of the vessel.

6.3.3. Aframax 15 Years Old

15 YEARS OLD AFRAMAX TANKER				
	%	**values**	**Finance**	
			D	**S**
R(TC*365*95%)	159.89%	9,502,443	35.00%	65.00%
CONSTRUCTION VALUE		10,834,444	**life-cycle (yrs)**	10.00
			WACC	36.02%
OPEX	48.97%	2,910,145	**Credit Spread**	4.39%
			Inflation Rate	2.57%
			Depreciation, a	4.00%
RV(SH PRICE)		-	**Free risk rate**	6.97%
DC(SCRAP VALUE)		7,537,500	**Risk Premium Λ**	3.33%
			Growth Rate g	1.81%
			Free risk rate i*	4.39%

Table 6.3.3.1.: Description of the model's input-output figures for a fifteen years old Aframax tanker

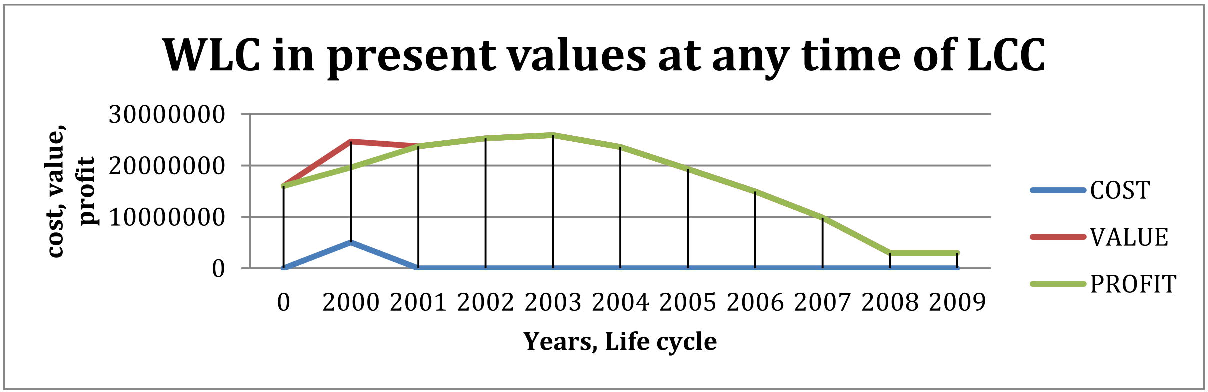
Empirical Results

Graph(6.3.3.1.) suggests that the profit from the operation of the vessel has an upward trend starting from the first year of operation, reaching the highest levels in 2003 and then has a stable downward trend until 2008, where is stabilized until the end of the operation of the vessel. The downward trend is related with OPA 90, because the oil mayors during the years, progressively stopped charter single hull vessels.

Cost of the vessel has an upward trend in the beginning of the period estimated and after the first year there is a obvious decline starting to taking place, until it reaches zero in 2001. Cost declines in such a high ratio, because of the boom in the time charter rates at this period, which actually manage to eliminate the initial cost, before the vessel is finally sold.

Finally, the value of the vessel follows the trend of cost, but the margin between the prices of these two is always too high. The asset has lost all of its value until the end of the operating period.

the reselling price in this case is actually higher



Graph 6.3.3.1.: Cost-Value-Profit curves in present values at any time of life-cycle for a fifteen years old Aframax tanker.

Profit margin has an upward trend in the first semester of the investment and then, a significant drop is taking place in the second semester reaching zero.. After that the profit margin increased but only for a year, until 2002 and then is dropping progressively reaching in 2008 the lowest price. The downward trend is related with OPA 90, because the oil mayors during the years, progressively stopped charter single hull vessels.

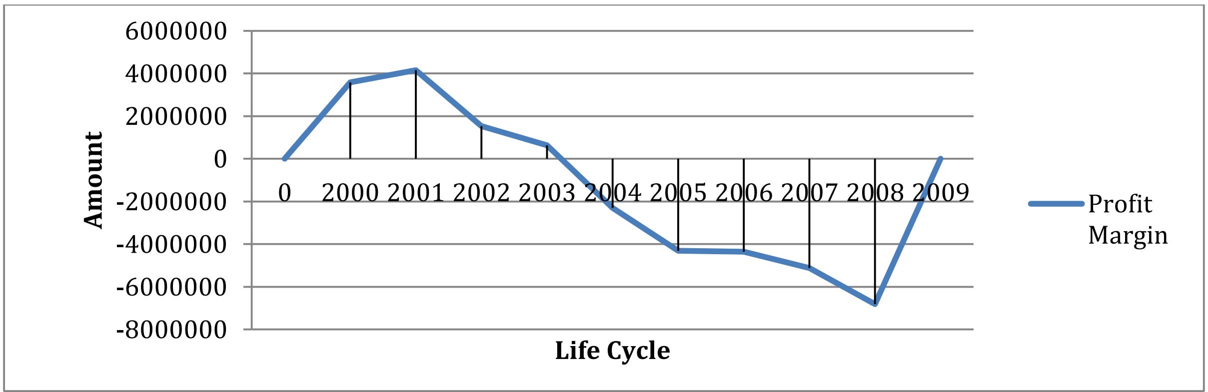


Chart 6.3.3.2.: Profit Margin curve in present values at any time of life cycle for a fifteen years old Aframax tanker.

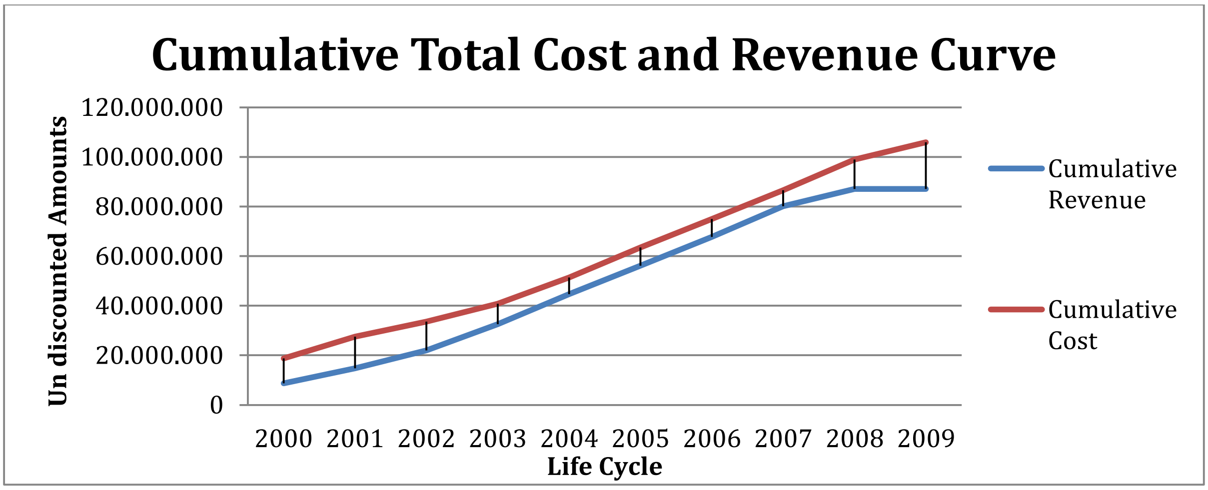


Chart 6.3.3.3.: Undiscounted Cumulative Cost and Revenue at any time of life-cycle of a fifteen years old Aframax tanker.

The final graph(6.3.3.3) provides interesting outcomes for the investment on a second hand vessel. The cumulative revenue is following the same trend with the cumulative cost. As it seams from the graph in 2004 the cumulative revenue overcome the cumulative cost for three years, until 2007.

General Outcomes

WLCC model manage to capture in a very well manner the investment on Aframax vessel. The empirical results suggest that for the period investigated, a fifteen years old Aframax vessel provides cash flows, which actually repay the initial price of the vessel.

6.4. Suezmax

6.4.1. Suezmax New Building

NEW BUILDING SUEZMAX TANKER				
	%	values	Finance	
			D	S
R(TC*365*95%)	25.77%	12,531,453	35.00%	65.00%
CONSTRUCTION VALUE		48,625,000	life-cycle (yrs)	10.00
			WACC	11.20%
OPEX	5.98%	2,910,145	Credit Spread	4.39%
			Inflation Rate	2.57%
			Depreciation, a	4.00%
RV(SH PRICE)		46,000,000	Free risk rate	6.97%
DC(SCRAP VALUE)		-	Risk Premium Λ	3.33%
			Growth Rate g	1.81%
			Free risk rate i*	4.39%

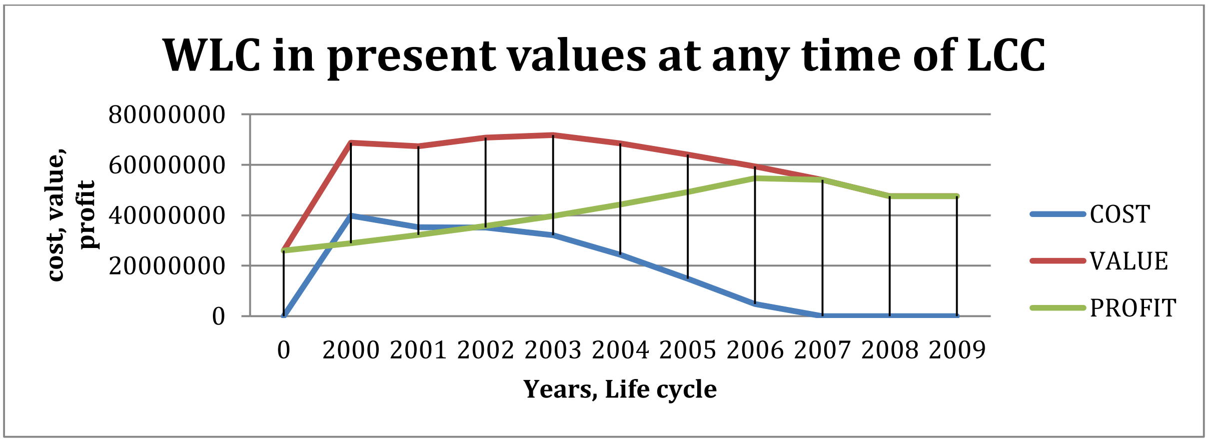
Table 6.4.1.1.: Description of the model's input-output figures for a new building Suezmax tanker

Empirical Results

Graph(6.4.1.1.) suggests that the profit from the operation of the vessel has an upward trend starting from the first year of operation, reaching the highest levels in 2007 and then is following a stable trend until the end of the operation life for the period estimate.

Cost of the vessel has an upward trend in the beginning of the period estimated and after the first year there is a obvious decline starting to taking place, until it reaches zero in 2007. Cost declines in such a high ratio, because of the boom in the time charter rates at this period, which actually manage to eliminate the initial cost, before the vessel is finally sold.

Finally, the value of the vessel follows the trend of cost, but the margin between the prices of these two is always too high. The value of the asset at the end of the period is significantly higher than the initial price of the vessel, suggesting that the reselling price in this case is actually higher.



Graph 6.4.1.1.: Cost-Value-Profit curves in present values at any time of life-cycle for a new building Suezmax tanker.

Profit margins have a stable upward trend from the beginning of the investment until the 2006, where a significant drop is taking place. This change again, is contributed to the financial instability at this period, which affected the shipping market in a high degree and resulted in the significant reduction of the time charter rates. Time charter rates after the financial crisis bottomed and sometimes contributed to the lay-up of the vessel, because there were no cargoes to be transported.

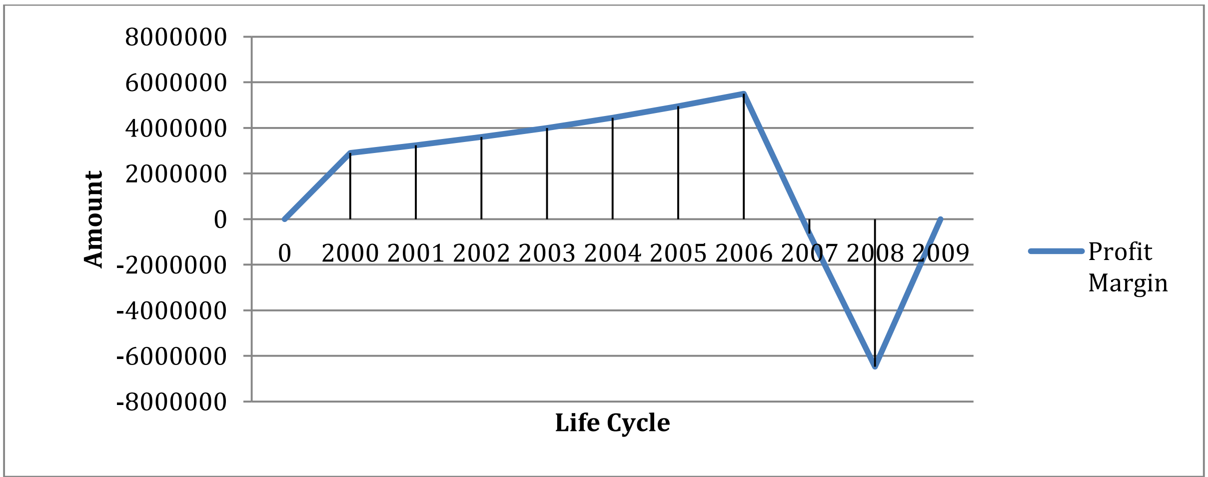


Chart 6.4.1.2.: Profit Margin curve in present values at any time of life cycle for a new building Suezmax tanker.

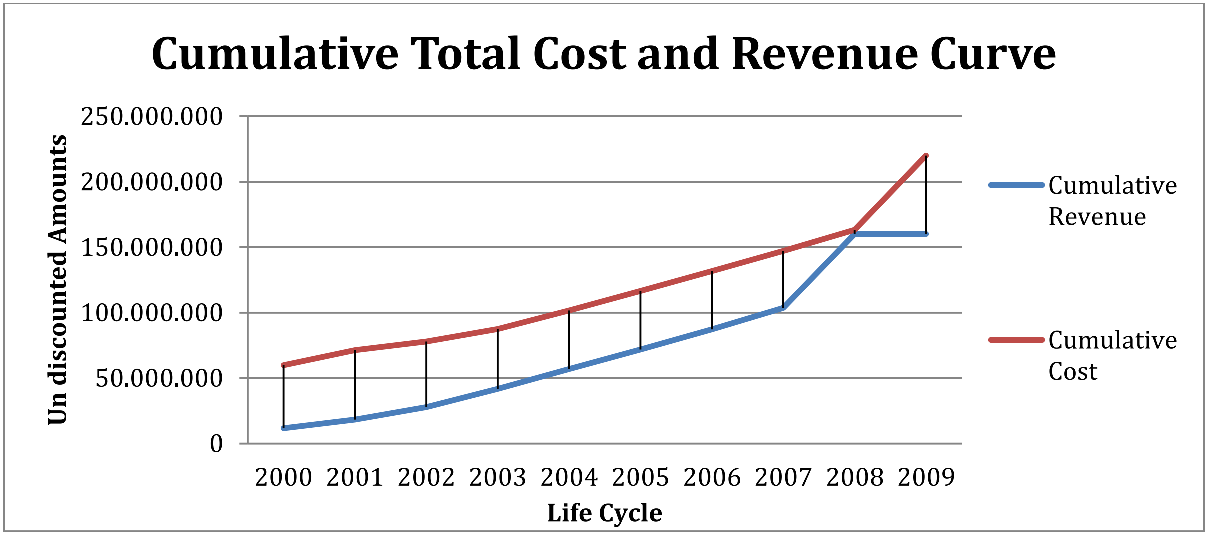


Chart 6.4.1.3.: Undiscounted Cumulative Cost and Revenue at any time of life-cycle of a newbuilding Suezmax tanker.

The final graph(6.2.1.3.) provides interesting outcomes for the investment on a second hand vessel. The cumulative revenue is following the same trend with the cumulative cost and the margin between them is always high. As it seams from the graph in 2008 the cumulative revenue tries to reach the cumulative cost but because of the financial crisis this never happened.

General Outcomes

WLCC model manage to capture in a very well manner the investment on a Suezmax vessel. The empirical results suggest that for the period investigated, a new building Suezmax vessel provides cash flows, which actually repay the initial price of the vessel.

6.4.2. Suezmax 5 Years Old

5 YEARS OLD SUEZMAX TANKER				
	%	**values**	**Finance**	
			D	**S**
R(TC*365*95%)	28.24%	12,531,453	35.00%	65.00%
CONSTRUCTION VALUE		44,375,000	**life-cycle (yrs)**	10.00
			WACC	11.49%
OPEX	6.56%	2,910,145	**Credit Spread**	4.39%
			Inflation Rate	2.57%
			Depreciation, a	4.00%
RV(SH PRICE)		26,750,000	**Free risk rate**	6.97%
DC(SCRAP VALUE)		-	**Risk Premium Λ**	3.33%
			Growth Rate g	1.81%
			Free risk rate i*	4.39%

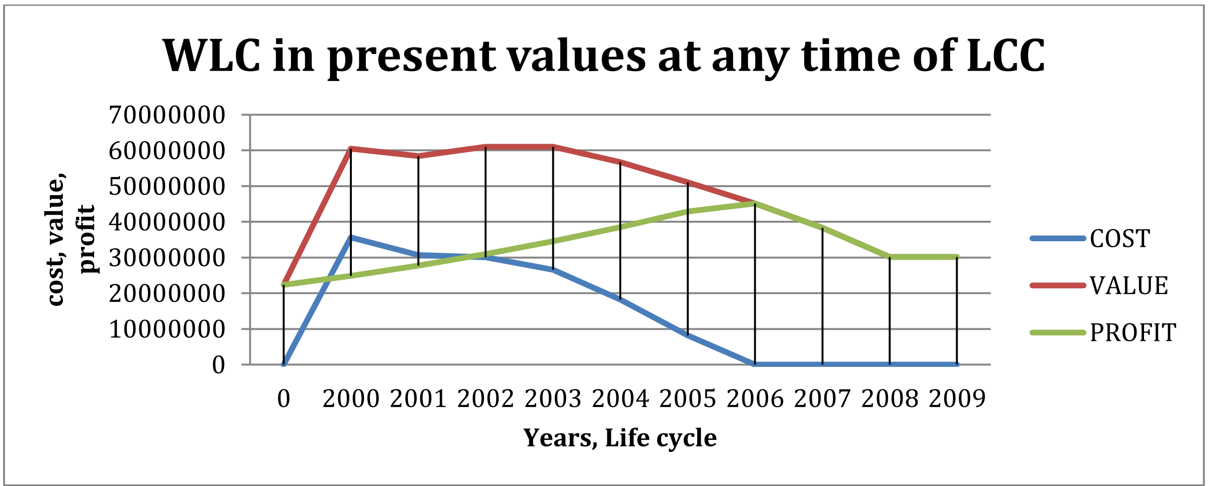
Table 6.4.2.1.: Description of the model's input-output figures for a five years old Suezmax tanker.

Empirical Results

Graph(6.4.2.1.) suggests that the profit from the operation of the vessel has an upward trend starting from the first year of operation, reaching the highest levels in 2006 and then has downward trend until 2008. From 2008 until the end of the operation period has a stable trend. The downward trend is related with the conditions of the market, which change after 2008 and have significant relation with the beginning of the subprime crisis and the financial instability started at this period.

Cost of the vessel has an upward trend in the beginning of the period estimated and after the first year there is a obvious decline starting to taking place, until it reaches zero in 2006. Cost declines in such a high ratio, because of the boom in the time charter rates at this period, which actually manage to eliminate the initial cost, before the vessel is finally sold.

Finally, the value of the vessel follows the trend of cost, but the margin between the prices of these two is always too high. The value of the asset at the end of the period is significantly higher than the initial price of the vessel, suggesting that the reselling price in this case is actually higher.



Graph 6.4.2.1.: Cost-Value-Profit curves in present values at any time of life-cycle for a five years old Suezmax tanker.

Profit margins have a stable upward trend from the beginning of the investment until the 2005, where a significant drop is taking place. This change again, is contributed to the financial instability at this period, which affected the shipping market in a high degree and resulted in the significant reduction of the time charter rates.

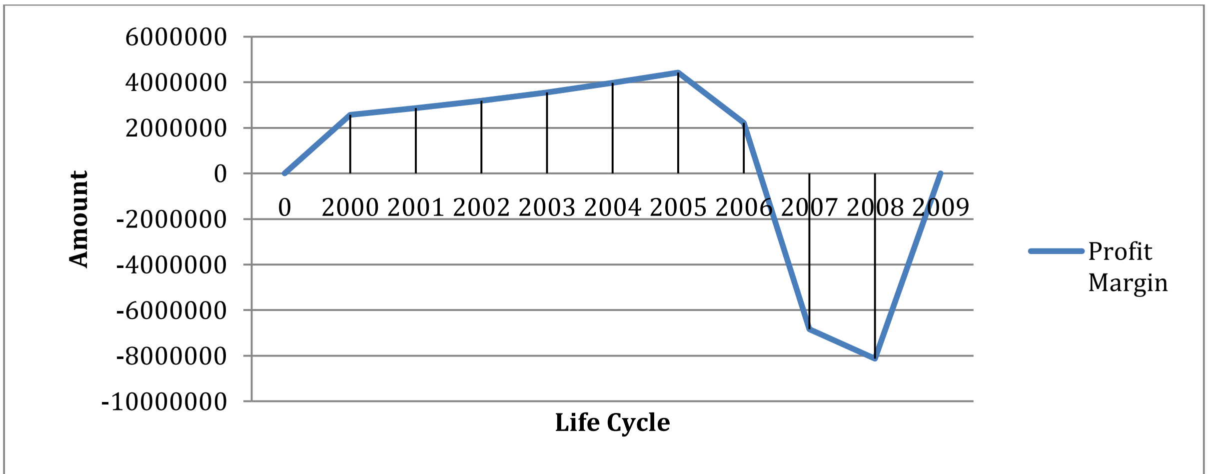


Chart 6.4.2.2.: Profit Margin curve in present values at any time of life cycle for a five years old Suezmax tanker.

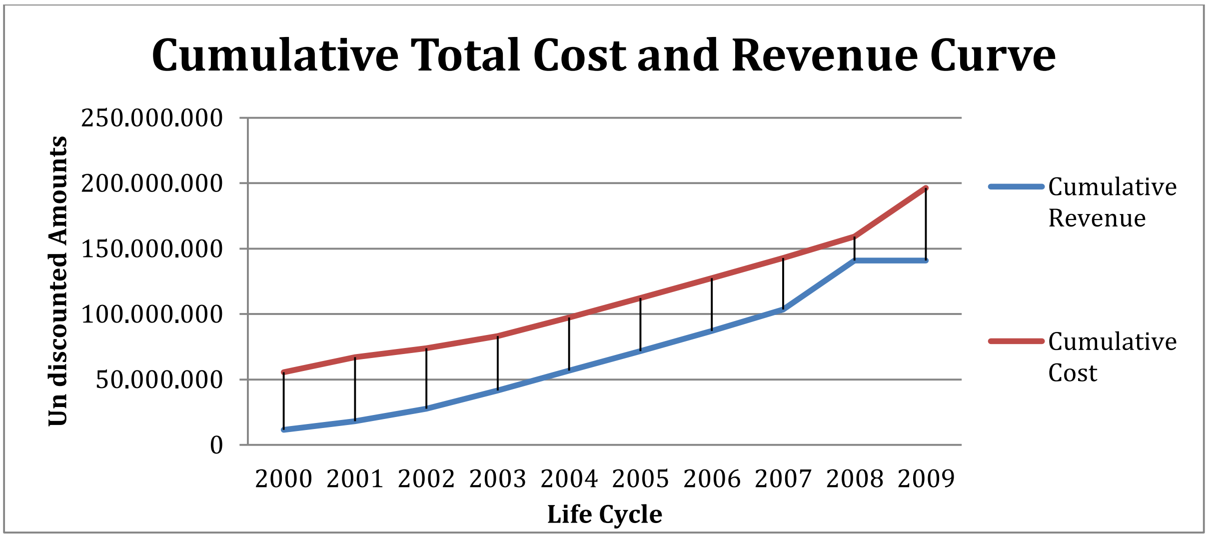


Chart 6.4.2.3.: Undiscounted Cumulative Cost and Revenue at any time of life-cycle of a five years old Suezmax tanker.

The final graph(6.4.2.3.) provides interesting outcomes for the investment on a second hand vessel. The cumulative revenue is following the same trend with the cumulative cost and the margin between them is always high. As it seams from the graph in 2008 the cumulative revenue tries to reach the cumulative cost but because of the financial crisis this never happened.

General Outcomes

WLCC model manage to capture in a very well manner the investment on Suezmax vessel. The empirical results suggest that for the period investigated, a five-year-old Suezmax vessel provides cash flows, which actually repay the initial price of the vessel.

6.5. VLCCs

6.5.1. VLCC New Building

NEW BUILDING VLCC TANKER				
	%	values	Finance	
			D	S
R(TC*365*95%)	22.65%	16,689,063	35.00%	65.00%
CONSTRUCTION VALUE		73,666,667	life-cycle (yrs)	10
			WACC	10.52%
OPEX	4.60%	3,388,697	Credit Spread	4.39%
			Inflation Rate	2.57%
			Depreciation, a	4.00%
RV(SH PRICE)		63,916,667	Free risk rate	6.97%
DC(SCRAP VALUE)		-	Risk Premium Λ	3.33%
			Growth Rate g	1.81%
			Free risk rate i*	4.39%

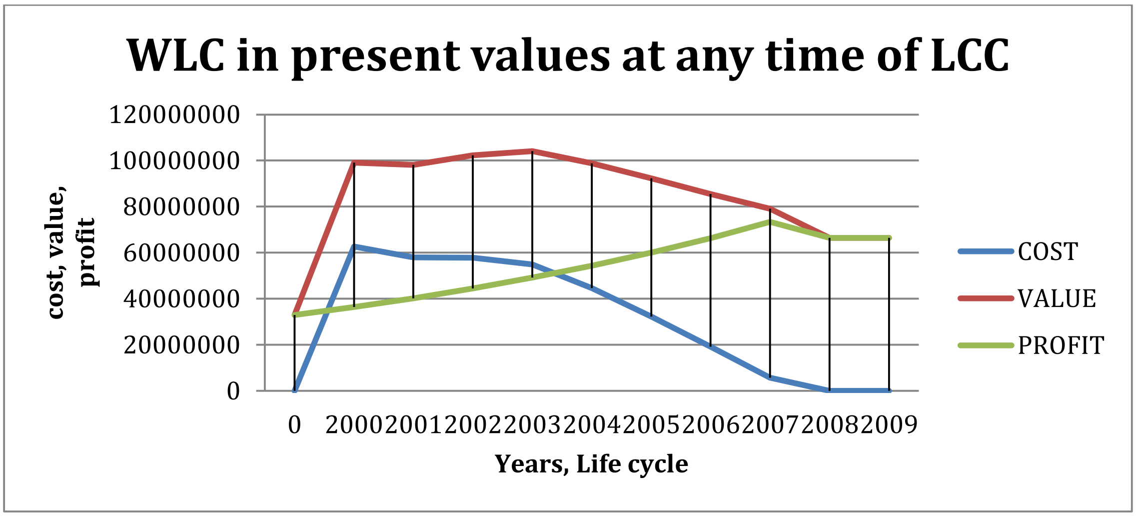
Table 6.5.1.1.: Description of the model's input-output figures for a new building VLCC tanker

Empirical Results

Graph(6.5.1.1.) suggests that the profit from the operation of the vessel has an upward trend starting from the first year of operation, reaching the highest levels in 2007 and then is following a stable trend until the end of the operation life for the period estimate.

Cost of the vessel has an upward trend in the beginning of the period estimated and after the first year there is a obvious decline starting to taking place, until it reaches zero in 2007. Cost declines in such a high ratio, because of the boom in the time charter rates at this period, which actually manage to eliminate the initial cost, before the vessel is finally sold.

Finally, the value of the vessel follows the trend of cost, but the margin between the prices of these two is always too high. The value of the asset at the end of the period is significantly higher than the initial price of the vessel, suggesting that the reselling price in this case is actually higher.



Graph 6.5.1.1.: Cost-Value-Profit curves in present values at any time of life-cycle for a new building VLCC tanker.

Profit margins have a stable upward trend from the beginning of the investment until the 2007, where a significant drop is taking place. This change again, is contributed to the financial instability at this period, which affected the shipping market in a high degree and resulted in the significant reduction of the time charter rates.

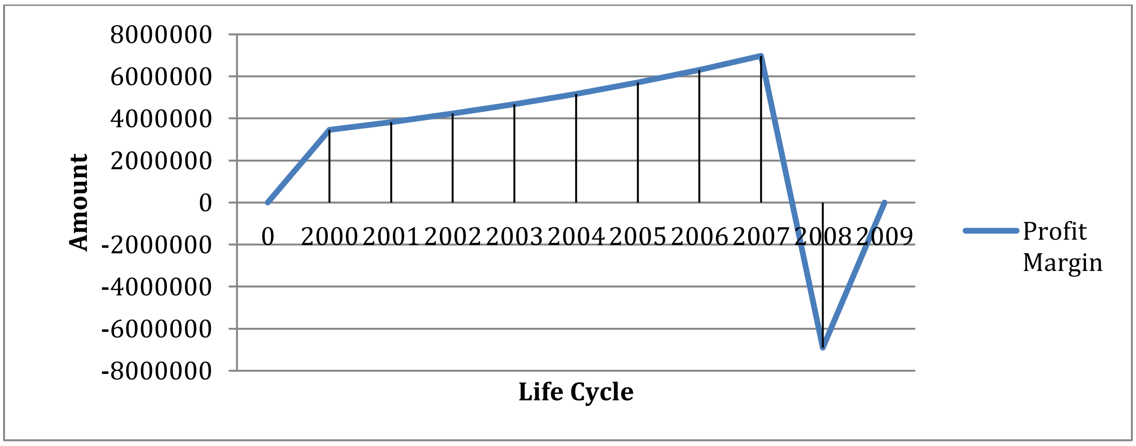


Chart 6.5.1.2.: Profit Margin curve in present values at any time of life cycle for a new building VLCC tanker.

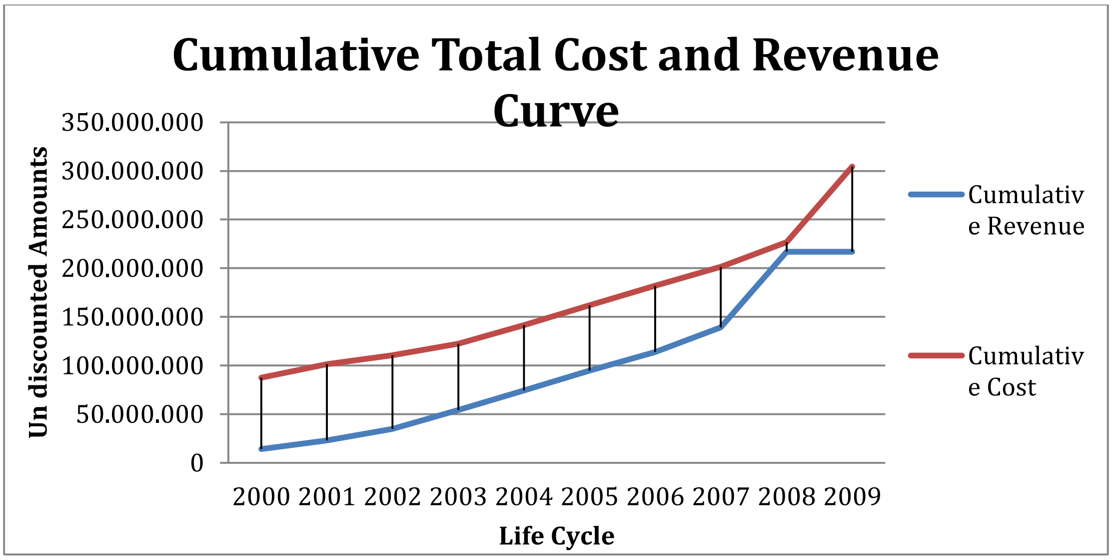


Chart 6.5.1.3: Undiscounted Cumulative Cost and Revenue at any time of life-cycle of a newbuilding VLCC tanker.

The final graph(6.5.1.3.) provides interesting outcomes for the investment on a second hand vessel. The cumulative revenue is following the same trend with the cumulative cost and the margin between them is always high. As it seams from the graph in 2008 the cumulative revenue tries to reach the cumulative cost but because of the financial crisis this never happened.

General Outcomes

WLCC model manage to capture in a very well manner the investment on VLCCs vessel. The empirical results suggest that for the period investigated, a new building VLCC vessel provides cash flows, which actually repay the initial price of the vessel.

Chapter 7

Conclusions

The dry bulk sector and the liquid bulk sector do not have significant differences. The same results derive for the different age vessels. As a general rule most of the vessels maintain high profits in the period investigated and they manage to diminish the cost interestingly fast, with the reselling value to have a major impact in NPV as a last outflow. Surely, the scrap value is lower than the reselling price, but since most of the vessels manage to diminish the cost at an early stage, scrap value lower prices than the reselling create additional value in the end of the investment period.

Bulk carrier's vessels seem to reflect the conditions in market in a very good manner. More specific, dry bulk vessels are correlated with the excessive liquidity and the general euphoria in economies in the period investigated. Profits are maintained in high levels until the end of 2008, when the financial bubble started to appear in the economy and drag the freight rates in lower rates. The loss from this period in terms of revenue is significant, but the reselling value of the vessel in the end of 2009 was significant higher than the initial prices in the beginning of the investment. The stability of the operating costs, which has a constant rate in the increase in operating expenses, adds further dynamics in the WLC valuation and manage to accelerate the absorption of the high capitals invested in the beginning of the investment. Undoubtedly, the best investing solution for this period investigated will be the operation of the vessel until the year 2007 and then sale of the asset. The results of such an investment approach will further accelerate the profits from the decision and the final outcome would be an NPV, higher than the one projected in our scenarios.

BULK CARRIERS						
VESSEL	AGE	INITIAL PRICE	RESELLING VALUE	CUMULATIVE COST	CUMULATIVE REVENUE	NPV
Handysize	New Building	15,104,167	22,000,000	88,879,259	71,310,393	9,652,806
	5 years old	12,000,000	15,125,000	78,900,092	64,435,393	8,913,453
	15 years old	4,441,456	3,200,000	56,216,548	49,310,393	5,300,471
Panamax	New Building	22,833,333	31,104,167	120,830,603	94,615,099	11,026,595
	5 years old	16,625,000	23,250,000	106,768,103	86,760,932	11,506,787
	15 years old	7,302,042	5,235,000	74,195,145	63,510,932	7,175,202
Capesize	New Building	38,541,667	47,908,333	255,080,709	210,612,940	53,096,799

Table 7.1. : Bulk Carries Results

***The reselling value, cumulative cost, cumulative revenue and NPV, are for the year 2010.**

The table above shows some interesting results from the analysis of the bulk carriers. As it seams from the analysis of the models, the reselling value of a vessel is always higher than the initial price, expect in cases where the vessel is going for scrap. As far as it concerns the Net Present Value of the vessel is always lower than the reselling value except again in the cases that the vessel goes for scrap. This means that the vessel has been sold with premium. The selling of the vessels in the right time yield in higher profits. Another exception is observed in Capesize vessels where the Net Present Value is higher than the reselling value. This happens, because in 2010 where the reselling of the vessel is taking place, the financial crisis has begun so the values of the vessels had already started to fall off.

On the other hand Liquid bulk carriers seem to be a more conservative investment option. The profits are usually conservative, with no extreme changes during this period investigated. Cumulative cost is usually higher than the cumulative profit and in the most cases the cumulative profit not even managed to reach the cumulative profits rates. By their own nature, Tanker vessels are more expensive vessels and the cost of operating them is higher than the bulk carriers. Tanker sector is a closed and limited market and the entrance of new players in this sector is limited. The same approach exists for any extra capacity entering into the sector. Therefore results in this sector do not have any relation with our initial expectations.
Surprisingly, the cost of the vessels is diminished by the revenues at a certain point around the end of the investment period. In contrast with bulk carriers,

where the rate of cost diminishes in the middle of the investment period and with a higher pace, tankers are stretching the cost for many years later. The same happens for the value of the tanker vessels, which does not have the excessive peak of the bulk carriers. Tanker vessels value follows an upward trend, but in a more conservative manner than the dry bulk carriers.

For the fifteen-year-old tanker vessel, the results are different than all the other ages of tanker vessels. In all approached the results are depicting the devaluation of the assets due to the new regulations in the maritime sector, regarding the single hull vessels. After the Marpol amendments and the phase out of single hull carriers, there was a significant drop in the freight rates for these vessels. They only manage to operate in areas where they did not adopt the Marpol regulations. This phase out for these types of vessels is the major reason for the abnormalities in the WLC model in contrast with the other age's vessels. However, we should highlight that even though the regulations, where into force and the ship owners were aware of these changes, the investment on a single hull vessel in early 2000 and the sale for scrap by 2005 could boost the profits from this type of investment.

TANKERS						
VESSEL	AGE	INITIAL PRICE	RESELLING VALUE	CUMULATIVE COST	CUMULATIVE REVENUE	NPV
Handysize	New Building	28,625,000	19,250,000	116,521,040	82,899,199	6,785,835
	5 years old	22,875,000	12,166,667	103,687,706	75,815,866	8,417,100
	15 years old	12,376,238	3,770,000	81,022,277	63,649,199	10,528,252
Panamax	New Building	34,583,333	28,125,000	146,337,195	105,524,801	9,759,627
	5 years old	28,005,000	13,750,000	125,383,862	91,149,801	9,642,525
	15 years old	9,469,697	5,235,000	93,098,559	77,399,801	12,194,841
Aframax	New Building	38,291,667	30,708,333	164,024,428	117,743,710	13,068,191
	5 years old	33,166,667	16,166,667	144,357,761	103,202,044	11,899,973
	15 years old	10,834,444	7,537,500	100,967,497	87,035,377	12,031,288
Suezmax	New Building	48,625,000	46,000,000	219,939,525	160,083,293	25,990,052
	5 years old	44,375,000	26,750,000	196,439,525	140,833,293	22,340,189
VLCC	New Building	73,666,667	63,916,667	304,473,964	217,029,041	32,933,649

Table 7.2. : Tankers Results

***The reselling value, cumulative cost, cumulative revenue and NPV, are for the year 2010.**

The table above shows some interesting results from the analysis of tankers. As it seams, the reselling value of a vessel is always lower than the initial price, expect in cases where the vessel is going for scrap. As far as it concerns the Net Present Value of the vessel is always lower than the reselling value except again in the cases that the vessel goes for scrap. This means that the vessel has been sold with premium. The selling of the vessels in the right time yield in higher profits.

Concluding for the tanker sector, there is a strong notion that this market is highly regulated and the profit from this segment is conservative, but is rather stable and does not have the great fluctuations of the dry bulk segment. The idea that the dry bulk sector is for the new ship owners and the tanker sector is for the experienced ship owners has surely a base in our research.

Impact in Industry

The empirical results and whole life cost model provide a solid basis for a ship-owner to estimate the decision to invest in a vessel. Ship owner must always project about five years forehead the trend of the market and gather all available information that will signal an entry exit strategy for a vessel. Profoundly, WLC provides good results for the investment outcomes for the entire investment plan, but it is better to estimate for certain periods and judge each time whether you should consider maintaining the investment or sale it in order to elevate the profits in higher levels.

The revenues of a vessel at this period investigated were very high and cost of the vessel diminished very fast. In the period that the cost is eliminated or the cumulative profit surpass the cumulative cost that is the time that the ship-owner must consider to sell the vessel and add to the profits from the operation the profit from the reselling price of the asset.

Furthermore, the differences between bulk carriers market and the tankers market are obvious compering the models. An inexperienced ship owner should rather invest in the bulk carriers market than in the tankers market which is more risky.

Limitations

Shipping data have several flows, since it is very difficult to gather them. There are a few data providers that they have managed to gather shipping data for a large period and they were several cases that observations were missing. Nevertheless, the evolution in the design of vessels, which has effect in their capacity, has a consequence the seizure of data gathering for these vessels designs. In addition to the prices on the shipyards are not the same. For example a shipyard in Japan is way more expensive than a shipyard in China and it is well known in the market that a Japanese ship is technologically superior to a Chinese ship and its lifespan is greater. Another problem is the lack of construction costs from the shipyards. Furthermore, the period analyzed includes the most difficult period the shipping industry has ever faced so some of the models faced extremely changes from the one year to an other.

To conclude, this model is rather difficult to be applied in container ships because the routes they have to follow are specific even if they do not load. Moreover, there is not stable freight rate, which is calculated on total load, but separate price for each container load. These data are so difficult to gather in order to proceed in an analysis with this model.

Further development of this research

As we have already outlined above, it would be of major importance to change the period investigated with more years and data. WLC models are designed to provide better results for the whole life cost of the vessel. In the same time different scenarios about the duration of the investments can provide fruitful information about the profitability of the asset by the operation and salvage value or the operation for a certain period and then to sale it in the second hand market. Furthermore it would be interesting to see how the tankers market is going to change the next years because of the LNG market. LNG is a new market, which is still taking for but competes the tankers market.

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