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Thesis

"Comparing among different Vessel Valuation Methods: The case of a dry bulk carrier."

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Special Thanks-Dedication.

"I dedicate this Dissertation to my family and friends.
Also, I devote this thesis to Advanced Shipping & Trading S.A.,
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Abstract

This thesis statement intends to depict and analyze the major valuation methods used in the shipping market sector. These methods are the Market Method, Income Method, and Replacement Cost Approach Valuation. Valuation in shipping has a vital role in the industry as it relates to an asset investment. Every valuer and investor has to take into consideration that the Vessel is an asset its value changes at a radical pace, depending on market conditions each time. That's why, every valuer says that valuations are made based on their commercial value and not on their construction worth. Depending on trustworthy and reputable information sources, to display the simulations with accurate and reliable results, three main completely different outcomes emerge, dependent on various parameters. It is remarkable to remember that there is no "wrong" estimation result, as the valuer is appraising a vessel considering different parameters each time and following instructions from the person or company who wants the vessel valuation.

Key Words

Market Approach, Income Approach, Replacement Cost Method, Valuation, Asset Play.

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Abbreviations

1. **ARR** Accounting Rate of Return
2. **b** Beta Factor
3. **b_e** Beta
4. **BC** Bulk Carrier
5. **BDI** Baltic Dry Index
6. **BPI** Baltic Panamax Index
7. **CAPM** Capital Asset Pricing Model
8. **Cov** Covariance
9. **CQSVEM** Combined Qualitative Ship Valuation Estimation Model
10. **DD** Dry Dock
11. **D/E** Dept/Equity
12. **DFC** Discounted Cash Flow
13. **D/V** Dept/Value
14. **DWT** Dead Weight Tons
15. **E/V** Equity/Value
16. **FCF** Free Cash Flows
17. **FMV** Fair Market Value
18. **HSES** Hamburg Ship Evaluation Standard
19. **IRR** Internal Rate of Return
20. **KPMG** Klynveld Peat Marwick Goerdeler
21. **LPG** Liquified Petroleum Gas
22. **LT** Long Tons
23. **LTAV** Long-Term Asset Value
24. **MCDM** multi-criteria Decision-Making
25. **MRP** Market Risk Premium
26. **NPV** Net Present Value
27. **OLS** Ordinary Least Squares
28. **PV** Present Value
29. **PwC** Price Waterhouse Coopers
30. **RCM** Replacement Cost Method
31. **R_D** Cost of Dept

32. **R_E** Cost of Equity
33. **Rf** Risk-Free
34. **ROA** Real Options Analysis
35. **S&P** Sales & Purchase
36. **TP** Transaction Price
37. **USD** US Dollars
38. **Var** Variance
39. **WACC** Weighted Average Cost of Capital
40. **YOB** Year of Built

1. Introduction

This Dissertation presents thoroughly the three major valuation methods that prevail in the shipping market, to make comparisons among them and come to a clear conclusion about their distinctive characteristics.

Vessel Valuation in shipping has become very substantial in recent days, as the shipping market has been more volatile than in the past. Considering that until 2008 there was mainly used Market Approach, since then new methods of asset appraisal have been created to cover shipping needs and demands. In contrast to periods of economic increase, vessels are relatively easy to value as the new build and sale & purchase markets are liquid and transactions frequent enough to permit accurate comparisons, which subsequently facilitate asset valuations.

The most important point that has to be noted is that the valuers have to comprehend what defines the value of a vessel and how to appraise that value because it is a significant requirement for making appropriate decisions that enhance the shipping market industry.

1.1. Subject and Goals

The main subject of this thesis statement is to describe Vessel Valuation methods, such as Market, Income, and Replacement Cost Approach, with their simulations and their pros and cons to make the final comparisons of their results. Through these results, valuers will be able to determine the factors that influence the outcome of every method used.

1.2. Research and Purpose

It is noteworthy to mention that the valuation of a vessel is not only for a shipping company but also for other sectors, such as banking companies and accounting firms. The major reason why a ship needs valuation is vessel owners. It plays a crucial role for a shipowner to have the acknowledgment of his ship's value, as the vessel is appraised commercially, something that can't be predicted, due to the highly volatile freight market. Vessel valuation refers always to a willing buyer and a willing seller, as they need to know the appropriate information before investing in the asset.

1.3. Problems and Obstacles

Even though Valuation is a significant measure for every company, regardless of the domain, shipping valuation is still minimal and "niche". Therefore, there were restricted sources of information and very scattered references throughout the web, scientific databases, articles, and electronic books.

At the same time, the Vessel Valuation thesis is a very difficult task for a valuer, as estimating a ship's future value is very complicated to verify. That's why, combined methods are needed to define the ship's value accurately. This may happen due to the lack of unbiased data that can't be accessed at any time or anywhere in the world.

1.4. Methodology and Techniques

The theoretical part of this dissertation was based on miscellaneous electronic books and articles on Google Scholar, Investopedia, Springer, Financial Times, and other sources via the Internet. As for the practical part of models' application, various sources of information were used via Marine Traffic and from the main electronic book for the depiction of every model and more particularly "The International Handbook of Shipping Finance: Theory and Practice" by Kavussanos and Visvikis (2016).

The data, which were used in simulations, were based on secondary information and research using approximate prices and diversified names on Vessels and freight for the order of good sake. The main techniques, which are utilized in this specific dissertation, are the OLS regression for the Market Value Method, Capital Asset Pricing Model (CAPM), Present Value (PV), Weighted Average Cost of Capital (WACC), and Free Cash Flows (FCF) for Income Method and Depreciation life factor for the Replacement Cost Approach Method. As far as it can be observed, the Income Approach or else the LTAV method displays a complex of techniques and calculations that will be explained further in the methodology and result section.

1.5. Thesis Structure

This Dissertation presents a comprehensive analysis of vessel valuation and its significance in the shipping market. The study is divided into six parts, with the section being the introduction. This chapter will describe the main subject and the goals that this thesis aims at, as well, as the research and its purpose of it. It, also, highlights the research and its purpose, while discussing any occasional issues that occurred during its conduction.

The second chapter of the thesis is devoted to a literature review that presents different aspects of the topic through diverse opinions from researchers, authors, organizations, and alumni dissertations from other universities. More specifically, there are displayed distinct opinions and explanations for "What vessel valuation?" and "What categories there are in the shipping market?" major questions and matters of ship appraisals.

In the third part of the thesis, the methodology used in the research is analyzed. The section begins with a general explanation of what vessel valuation is and why it is significant in the shipping market. Then follows a thorough analysis of the three main valuation methods - Market Method, Income Method, and Replacement Cost Approach Valuation. The section provides a comprehensive overview of each method, including their simulations, benefits, and drawbacks. This information is crucial for anyone involved in vessel valuation, as it helps them understand the factors that influence the outcome of each method and make informed decisions accordingly.

The fourth part of the thesis statement focuses on the results of the performance of these approaches, where a common example is provided to compare the methods and fit a specific model of a vessel. Drawing on reliable information sources, the impact of beta on the income Method is analyzed and concluded by comparing the results of all the methods presented in the thesis. referred to the results of the performance of these approaches.

In the last section of conclusions, a comprehensive analysis of the research's findings and their implications for the shipping industry is provided. Objective difficulties encountered during the prosecution of the thesis will, also, be discussed. Lastly, there will be recommendations for further research and the author's conclusions referred to this topic.

2. Literature Review

The present literature review aims to provide a comprehensive overview of the Vessel Valuation Approaches, which are a critical aspect of the shipping industry. Through an in-depth analysis of various sources of information, this review seeks to elucidate the key features and underlying principles of these approaches from diverse perspectives. By emphasizing their relevance and applicability to the shipping sector, this study has the major aim of contributing to a more nuanced understanding of the Vessel Valuation Approaches and their implications for the industry.

Market Investments and asset play in the shipping sector have a vital role in the maritime market trajectory. That's why, in the last decades many Researchers have drawn their attention to developing Vessel Valuation Approaches that help them assess every asset. The present thesis has the intention to show the main Valuation Approaches which are the Market Approach, Income Approach, and Replacement Cost Method. Furthermore, they will be presented by simulations with related cases and respective estimations comparing among these methods and choosing which one is the best way to follow.

Many valuation researchers and thesis statements express their view of evaluating a Vessel. One of them is the Company McQuilling Services (2009), which are Marine Transport Advisors and supports that Valuation Methods are the market, income, and cost approach, respectively. Comparable transactions typically inform the valuation of ships. Consequently, the "Last Done" methodology has emerged as the most widely used approach to determine the value of vessels. Both new-build and second-hand ships are valued using this technique, which relies on the most recent transaction data available.

Every Vessel is categorized by factors such as age, size, and structure, for example, single hull, double hull, coated, uncoated, and other characteristics based on the type of the ship. This allows vessels to be compared to similar ones to have an equivalent market rate within a given asset type at any time.

The prices of second-hand and newbuilding vessels are highly connected and influenced by market conditions, according to Nam et al. (2022). Age, size, and freight are the most determining factors, mainly for second-hand ship value. The sale and purchase market enables shipowners to buy

secondhand ships immediately, as opposed to waiting for up to two years for a new building. Freight rates are subject to high volatility throughout the stages of the shipping cycle, with a typical business cycle lasting around eight years. Thus, ship valuation is considered very important for the shipping domain.

Based on the Hamburg Ship Evaluation standard (n.d.) (HSES), asset valuation approaches have been a debate of controversy regarding the accuracy of the comparable sales system.

The intention of the Valuation methods, as the McQuilling Services support, is to aid accounting, balance sheet, and loan-to-value purposes and not to render the industry's standard for sale and purchase deals (S&P).

The three main methods for determining the "Fair Market Value" of assets are the Market Approach, Income Approach, and Cost Approach. The Market Approach involves analyzing historical data of prices paid in actual sale transactions to estimate the Fair Market Value of the asset. The Income Approach projects the Fair Market Value based on the net revenue that the property is predicted to generate over its useful life. Lastly, the Cost Approach considers the current cost of rebuilding the entire unit to determine the value of the asset based on the basic rule of substitution.

To value an asset, the valuator must consider that the market at a specific time is the crossing point of supply and demand from buyers and sellers. In many cases, such as lending, accounting, maintenance, demolition, insurance, and other fields, justify specific valuation considerations, that's why, appropriate valuation methods should be further used.

Koray and Çetin (2020) give their explanation for vessel valuation approaches. They consider that combined mathematical methods are needed to appraise a vessel's value, as the supply and demand balance is influenced by many factors, such as the economic crisis and the high volatility of the market. Most of the Brokers utilize the Market Approach method to define a ship's value, even though this method does not provide a precise estimation, due to the lack of immediate and unbiased data. Ships, especially those between 6 and 25 years old, because they are more than five years old, need to be evaluated with more than one approach, that's why there is no standard mechanism in a ship's valuation projection.

The appraisal of a ship is a complex process that takes into consideration several significant factors. One of the most crucial elements is the time factor, which plays a pivotal role in determining the vessel's value. Other equally important factors include the year of the ship's construction and sale, its tonnage, the sale price of comparable vessels in the market, the shipyard where it was built, the ship type, and its age. Each of these factors contributes significantly to the overall appraisal process and aids in determining the fair market value of the ship. A thorough understanding of these factors is necessary to ensure an accurate and reliable appraisal of the vessel.

The research methodology utilized by the organization entails the usage of three distinct approaches in the estimation of future outcomes. These approaches include a comprehensive market report, a reliable forecasting model, and a scenario analysis. In this case, these Regression Models confirm these coefficients for almost every period.

According to Karatzas (2009), the price of a vessel is what a buyer would pay to acquire the asset from a well-informed seller, given that markets are efficient and normal. In passive markets, there are unusual transactions to maintain a clearly defined asset price curve, while several other variables may continue to fluctuate and in uncertain high levels, such as freight rates, the ability of debt financing, and other reasons. Valuing a vessel in a less active environment can trigger numerous arguments, though. Moreover, Vessel Valuations have been mainly used for accounting and financial intentions, thus professional standards and well-established practices have been implied to define assets' valuation.

There have been both commercial and academic guidelines that provide an assessment of the fair Market Value of a Vessel. In active markets, the commercial and academic values often converge to the purchase price that a well-informed investor-buyer would pay for the acquisition of the Vessel. On the other hand, high volatility, and uncertainty, which are related to shipping rates, future estimates of earnings, financial inputs, and reality, dominate in the real world.

It's worth referring to Karatzas (2009) who summarized the three main valuation methods: Market Approach, Replacement Cost, and Income Approach. These methods contribute to making informed decisions regarding purchasing, selling, or investing in Vessels. In the realm of asset

valuation, different methods can provide distinct perspectives and insights regarding the worth of an asset. Each method, however, has its own set of advantages and disadvantages.

The Market Approach, for instance, is a method that involves valuing a vessel by comparing it to the most recent sale or "last done" of a comparable vessel. Adjustments are made for factors such as age, cargo-carrying capacity, and miscellaneous vessel specifications. This method can offer a reliable guide for valuing a similar vessel in efficient and liquid markets. Nonetheless, there are instances where the Market Approach may be less useful in determining an asset's value.

For example, in the case of Aframaxes, which are vessels that partake in the crude oil trade, there are often many similar sales that can guide asset pricing and valuation using the Market Approach. On the contrary, LPG carriers are not transacted as frequently as they are part of a niche market. This market segment has a relatively small fleet, a small number of buyers and sellers, higher entry barriers for buyers, and operates based on long-term relationships. As a result, the Market Approach may not be the most effective method for valuing LPG carriers. Throughout idle markets, the market Approach tackles further restrictions due to constant uncertainty in the market, despite the "last done" that this method follows.

The Income approach is the most interesting valuation method according to Karatzas (2009), because it is the most academically demanding method and widely accepted, as the appropriate method of determining the value of assets may impact the value of the asset on a high. The income Approach is the value or more specifically the net present value of all the net earnings the vessel is supposed to create throughout her remaining commercial life plus her residual value itself or else "salvage" value.

The Replacement Cost Method (RCM) is mainly useable for Vessels that are specifically destined for certain trades. Regularly, it refers to vessels that are excessively customized for such trades and therefore there is a small demand in the event of a sale. The author gives a remarkable instance of ships that have been valued based on the replacement method, which has to do with quarter-deck ramps to load vehicles and tanks, helipads, containership capacity, heavy lift and steel-reinforced, humified cargo holds or Vessels that are on long-term bareboat charter to an operator.

With the method of Replacement Cost, the Vessel is valued on the assumption of the value of the Vessel of replacing ship in the present market environment. The evident view of this valuation method is that the cost to replace the vessel is not necessarily the price that a third-party buyer would pay, which means that the historical cost is not inevitably a market number.

Generally, it is supported that most of the existing valuation techniques take into consideration the future cash flows generated by the vessel that investors expect to receive starting from the valuation date. The results from the widely applied methods, which are the market approach, the income approach, and the cost approach, are mainly based on the market conditions during valuation. For instance, when markets have low volatility in the short period and investors' expectations of future events are resemble, all the methods reach similar results.

On the contrary, when the market environment is depicted by doubt, as investors have different expectations concerning future events, these methods end up with different results and are mainly used as supporting approaches to assess the value from different aspects of view, more specifically to describe a pessimistic or a more optimistic opinion. Under the thesis statement of Xaviaras (2016), the market approach is a method that considers the value of the vessel to be equal to the market price of comparable vessels in recently completed transactions among willing and knowledgeable buyers and sellers.

The market approach, also known as the "Last Done," "Mark to Market," or "Comparative Valuation" method, is a widely adopted vessel valuation method in the shipping industry. It involves analyzing historical data of prices paid in actual sale transactions to estimate the fair market value of the asset.

To predict the value of the vessel with the Market Method, the first step is to search the most recent completed vessel transactions which are nearly the same as the one examined. The following four key factors are essential in determining the comparability of vessels: size, type, age, and condition. These factors play a crucial role in the evaluation of vessels and are often used as the primary criteria for comparison.

Market Approach Valuation is a complex process that considers several factors to determine the value of a ship. In addition to the primary factors, such as the ship's age, size, and condition, several

other secondary factors can significantly influence the final valuation. These secondary factors include the type of the main engine, confirmed charter contacts with creditworthy counterparties, loading equipment (such as derricks and cranes), the shipyard where the ship was originally built, and its location at the time of sale.

It is noteworthy that while these factors may be considered secondary, they play a crucial role in the overall valuation of the ship. For instance, the type of main engine can affect the ship's operating costs, which can, in turn, influence its overall value. Similarly, confirmed charter contracts with creditworthy counterparties can provide a level of stability and predictability to the ship's income stream, and therefore, positively impact its valuation.

In conclusion, the Market Approach Valuation of a ship is a complex process that requires careful consideration of several factors. While the primary factors of age, size, and condition are critical, the secondary factors, such as the type of main engine, confirmed charter contracts, loading equipment, shipyard, and location at the time of sale, should not be overlooked, as they can significantly impact the final valuation.

In his view of the income approach, the vessel is determined by discounting all future cash flows that the vessel is predicted to generate during its remaining economic useful life containing residual scrap value on maturity. This method is the most demanding approach and is widely accepted for estimating the value of asset vessels, as there must be a forecast for future charter rates. This makes the income approach difficult as future charter rates are usually estimated depending on historical data.

The income approach is also called the "mark-to-model" method or LTAV (Long Term Asset Value) and generally requires a financial model with the cash flow forecast. The Long-Term Asset value Method, first introduced by the German Shipbroker's Association (HSES) and Price Waterhouse Coopers (PwC), basically utilizes a Discounted Cash Flow (DFC) formula and the concept of weighted average cost of capital (WACC) to define the vessel's capability to generate "Financial Surpluses" for the suppliers of capital referring to equity and debt.

The cause for the appearance of this approach was the main depreciation of the secondhand ship prices. Concerning the Replacement Cost Method, the vessel is valued depending on how much it

would cost to build a precise identical vessel in the same condition. The replacement cost requires adjustments for depreciation caused by physical worsening and functional obsolescence. The method of replacement cost is principally used to forecast the value of vessels with unique features that can't be grouped in a wider list and focuses on the fact that it does not account future cash-generating ability of the vessel. Some of the most common examples are the types of "maintenance" and "research" vessels.

KPMG (2020), a worldwide consultant company, presents its aspect of the LTAV approach for valuing ships. There are various reasons to value a ship, therefore companies can choose how to value a ship among three specific methods. As KPMG states, one of these methods is the Long-Term Asset Value (LTAV), a ship valuation method based on a discounted cash flow model (DFC), which has been established since 2009, when economic times were under pressure and such a method encouraged shipping companies to make amendments to their fleets.

The LTAV approach is a discounted cash flow weighted average cost of capital method based on the future free cash flows that the valuing ship can generate via use. The future free cash flows are discounted to the valuation date using a risk-equivalent discount rate. The major intention of the LTAV method is to provide an accurate estimation that is independent of price fluctuations and oriented to a ship's long-term earning potential. This specific method is commonly accepted by the shipping field, as it is a decisive perception that leads to substantial results even in times of crisis.

The WACC is usually used for discounting. The Capital Asset Pricing Model (CAPM) is made up of the Cost of equity and the cost of debt. The cost of equity is composed of a risk-free basic interest rate, the risk premium, and the beta factor. It aids investors define the expected return on investment. Furthermore, the Cost of debt is calculated by adding the risk-free interest rate to the risk premium rate, which represents the compensation required to offset the risk associated with the prices of second-hand and new building vessels that are highly connected and influenced by market conditions. Single-value planning models are not considered as they do not include the fluctuation margins of the value drivers and distribution curves within these fluctuation margins. The latter-mentioned method, the multi-value planning model, is a method that should be preferred more in ship valuation, instead of a single-value model.

The Monte Carlo simulation, a versatile modeling technique, is particularly effective in mathematically charting the fluctuating margins of value drivers. The primary value drivers that must be considered for this purpose are transport volumes, charter rates, bunker prices, and exchange rates. When employing a multi-value planning model, it is imperative to factor in the uncertainty of valuation and establish a value range for the ship based on this.

It can be challenging to operate in the Shipping Market due to its volatility, high cyclicity, and seasonality. The future cash flow can also be difficult to forecast accurately due to uncertainties. Financing an active ship market is also a tough task as there is no ship financing available with low interest rates because of low cash flows, freight rates, and low return rates. Additionally, there are some limitations in IRR, NPV, and ARR methods. The DFC method does not consider non-financial factors, such as managerial or behavioral effects, while the Weighted Average Cost of Capital (WACC) method requires many assumptions and predictions for a range of inputs. However, multiple Decision Support Models based on Multi-Criteria Decision-Making (MCDM) and Real Options Analysis (ROA) can overcome these limitations.

The CQSVEM model (Combined Qualitative Ship Valuation Estimation Model) has the main intention of defining the variations between nominal and real sale prices. The "combined quantitative ship valuation estimation model" centers around the idea that price margin is determined by variations in prices. As a result, the model calculates an adjusted price to aid in investment or disinvestment decisions. This is accomplished through a series of steps, including data collection, classification, and benchmarking, as well as determining fair value, age, and attribute adjustment, and ultimately, making a sale or purchase.

At the same time, Kavussanos and Visvikis (2016) describe the two major valuation approaches, the market and LTAV method in their way. They consider that the fundamental value of a vessel is based on the expected future financial advantages that equity and debt investors simultaneously can predict. The valuation method that offers the most credibility in results is the income approach or the discounted cash flow (DFC) valuation method. In the latter method (DFC), the principal value of a ship is the present value of its projected cash flows, discounted at a rate that mirrors its risk value. Thus, the DFC method is also called as "mark-to-model" method. It must be noted that

the DFC approach is mainly used for the valuation of companies and long-lasting assets, such as the real estate sector.

Nonetheless, the market approach is the most prevailing valuation method in the shipping field, which helps valuators and investors make the right decisions and estimate the ship's value. Vessel valuations are very significant for the shipping industry as shipbrokers use valuations when they want to advise their clients on fulfilling a purchase decision and determine borrower's compliance with existing loan contracts and bank's compliance with capital sufficiency standards and predictions for potential credit losses.

It is important to note that vessel valuations are not only requested for financial planning purposes but also demanded in a variety of other scenarios. For instance, it is used as a maintained price in court sales, in a broad range of legal disputes, and by insurance agents to define coverage levels. When determining the market price of a vessel, auction pricing is commonly used. The transaction price is accepted as the "clearing" price between willing and well-informed buyers and sellers. The market method is also called the "relative valuation approach", "mark-to-market" or "last-done" method and is dependent on similar vessels' pricing.

On the other hand, DFC valuation relates the value of an asset to the present value of expected future cash flows on that asset. Correspondingly, under a DFC approach, the value of an asset is a function of the expected cash flows occurring at some point in the future. The value of a vessel is obtained by discounting free cash flows at the weighted average cost of capital (WACC). Integrated into this method are the tax benefits of dept and the expected additional financial risk associated with dept.

Hence, this section has the intention to present and briefly mention the major ship valuation methods and why each one is important to the estimation and decision-making in the shipping industry among different aspects of different authors and organizations.

2.1 What Vessel Valuation is

Generally, Vessel Valuation is the estimation of an asset based on its "commercial" price and not on its building value, which can be conducted in several ways and methods. For example, a Panamax, which was built in China in 2021, has a building price of around $18 million, while it has a commercial value of around $15 million today, as the shipping market at that moment was bearish or in a bullish market the same vessel would overcome its initial price of $18 million. This is why, the shipping market has high volatility and is dependent on many factors at the same time. It has, also, been mentioned that according to the economic theory, price differs from value.

On the one hand, price is the quantity of payment or reimbursement given by one party to another in return for goods or services. At the same time, value is a measure of the advantage that an economic factor can gain from either a good or service. Eventually, it can be observed that the price constantly fluctuates with the value.

This phenomenon occurs as the price is driven by demand and supply of the market and more specifically in shipping markets (Wenrui, 2014, p.10). Until the global financial crisis in 2008, the valuation of the vessels was conducted with the Market Approach, using the price of comparable vessels in recent purchases. Thereafter the beginning of the crisis, when prices in the secondhand market fell to very low levels and the general market volatility recorded historically bearish prices, new valuation methods turned up.

One of the most reputed methods is the LTAV method, or else the Income Approach, which was first proposed by the Hamburg Shipbrokers Association in conjunction with PwC and is dependent on Discounted Cash Flow (DFC). Then, replacement cost appeared in the scene, as there was ambiguity after the financial crisis whether the market prices reflected the real values of the ships or they were inflated priced, which created a "bubble" consecutively going to "explode". (Xaviaras, (2016) p.8)

2.2. Reasons why Vessel Valuation is significant

It must be noted that Asset Valuation is initially very important for the shipping sector, for banking field, and accounting companies, too. Vessel owners require vessel valuations to estimate if it is the right time for a vessel's purchase. Other main reasons for valuation appraisals are accounting, planning, and controlling purposes.

Willing sellers and buyers utilize valuations to have a basic idea before deciding where to invest. Usually, shipbrokers have adequate experience in ship valuations as they are well-informed about the market trajectory and they can advise their potential clients, on which investments are the best. Furthermore, banks are highly influenced by the changes in shipping market values.

Vessel valuations play a crucial role in the banking sector as they enable banks to make informed lending decisions, determine whether borrowers are complying with existing loan covenants, provision for potential credit losses, and conform with capital adequacy standards. Without accurate vessel valuations, banks would not be able to make sound financial decisions and would be at risk of incurring significant losses. Nonetheless, valuation estimations are considered vital when market conditions commence to become unstable and unpredictable. (Xaviaras, (2016) p.8)

The following segments that will proceed in this thesis, are to describe thoroughly these approaches and depict them with respective simulations comparing the results between these valuation methods.

3. Methodology

This section will briefly mention Vessel Valuation in general and how it was developed throughout the years. Moreover, there will be a description of the three most common valuation methods, with their simulations and their pros and cons respectively. The three simulations were adjusted on a Panamax Vessel, as it is widely recognized and used in the S&P (Sales and Purchase) market.

The acquisition of this Research is mainly secondary, and it was based on obtaining adequate knowledge of the subject, identification of the prevailing aspects regarding the topic, and formation of the goal and objectives.

The information utilized was provided mainly from various shipping-related articles analyzing the topic, books, and market analyses either from shipbroking firms or global financial websites with Market Information, such as Financial Times. Furthermore, some information was attained from university dissertations of MSc and PhD levels, such as Wenrui (2014), and Xaviaras, (2016), in which many aspects of the shipping markets and various opinions on Vessel Valuation Methods were analyzed.

Various Secondary sources of information were used to collect information for creating the Ship Valuation Methods in Excel and to comprehend the philosophy behind the concept of valuations. During the procedure, the focus was on gathering topic-related scientific papers, published in recognized journals.

Thus, papers from researchers, such as Kavussanos and Visvikis (2016), Hitchner (2017), and Financial Times were mainly used for the conduction of this dissertation. After these major aspects were accredited, the thesis's main topic was shaped. This research thesis depended on secondary research, as primary data were unavailable or very limited to be used.

3.1. Methods of Valuation

Most of the valuation approaches take into consideration the future cash flows produced by the vessel, which investors forecast to receive as of the valuation date. The most accepted approaches can be summarized into three:

- The market approach.
- The income approach.
- The replacement cost approach.

The results of these methods mainly depended on the market conditions throughout the valuation. When the market has low volatility in the short term and investors' expectations of future events are similar, all the approaches mentioned above have similar close results.

On the contrary, when the market is uncertain with different investors' expectations about the future, these methods deviate from each other. That's why, supporting techniques are used to appraise the value from different aspects, such as an optimistic and a pessimistic view (Xaviaras, (2016) p.9).

3.2. Market Approach

The first valuation method, which is going to be presented, is the Market Approach which is the most common among the other ones. The market price of a vessel is defined by auction price, which is the fair value, where the purchase price is accepted between willing buyers and sellers. According to Hitchner (2017), Fair market value can be determined "as the price at which the property would change hands between a willing buyer and a willing seller, neither being at force to purchase or sell and both parts have knowledge of relevant facts".

The Market Approach, which is one of the most used valuation methods, involves a three-step process. Firstly, the buyer must identify the factors that determine comparability and value, which is a crucial element in the valuation process. Secondly, the buyer must search for an appropriate number of purchases that can act as a reference to find the most recent transaction that matches the vessel, they are interested in. The last step refers to vessel price adjustment concerning the

comparable transactions. This approach has been extensively studied in academic research and has been proven to be an effective way to determine the fair market value of a vessel.

A stochastic implication of the Market Approach will follow above, to be comprehended in a better way. A Panamax vessel is to be appraised on 1st December 2023, so a sample of thirty random Vessels was created, to compare with the main ship. These ships should have similar characteristics to the estimated one, such as age, size, and freight market. Age has a major role in vessel valuation, as newer vessels with more developed technology may produce lower costs, such as maintenance costs. Furthermore, larger vessels can carry more cargo, thus there is a positive relationship with the price.

As freight rates increase, vessel prices will rise, because a strong positive relationship between the state of the freight market and the vessel price exists. This occurs as freight rates are the cash flows a ship can produce. Transaction date has, also, a vital role, because more recent transaction prices are more relevant and adequate than older ones. For instance, a more recent transaction price might reflect a new use for a vessel or a new industry environment.

It is crucial to consider various factors that may influence the valuation of a vessel. These factors include the particulars of the main engine, any confirmed time charter contracts with creditworthy counterparties, loading equipment such as derricks and cranes, the original shipyard, and the location of the vessel at the time of sale. A thorough analysis of these factors is necessary to determine the precise value of a vessel in the market.

BLUE MALUE, which is the vessel to be estimated on 1st December 2023, is a decade Panamax bulk carrier with a capacity of 71,121 Dwt (Dead Weight Tons) and 2011 YOB (Year of Build). The below table summarizes a list of Panamax Bulker sales, between July 2023 and December 2023, five-month data transactions. The table provides information on the age, the size of vessels sold, and the state of the freight market at the time of purchase. BPI (Baltic Panamax Index) is the measure that represents the freight market for Panamax, reflecting the supply and demand balance in the dry bulk shipping markets.

Table 1: Thirty Vessels Data to Estimate with Market Approach Valuation.

$TP_i = a + b_1 \cdot Age_i + b_2 \cdot Size_i + b_3 \cdot Freight_i + e_i$

SALE DATE	VESSEL NAME	SALE PRICE $	YOB	AGE AT SALE	DWT	BALTIC PANAMAX INDEX
Dec-23	**BLUE MALU**	**15,600,000**	**2011**	**12**	**71,121**	**2,154**
Dec-23	ANTHOUSA	9,400,000	1994	29	69,893	2,899
Dec-23	CAPE GLORY	13,200,000	2006	17	81,003	2,554
Dec-23	CL PACIFIC	12,900,000	2005	18	74,544	2,354
Nov-23	QUEEN	12,600,000	2000	23	76,825	2,879
Nov-23	ALPHA VISION	10,500,000	1999	24	73,457	2,444
Nov-23	LORAS DREAM	14,700,000	2003	20	70,045	2,334
Nov-23	SOPHOCLES	13,100,000	2005	18	68,799	2,245
Nov-23	SEMIRAMIS	18,900,000	2014	9	76,555	2,654
Nov-23	CM SHANGHAI	15,100,000	2009	14	79,123	2,154
Oct-23	TITANAS	11,300,000	1998	25	82,123	2,365
Oct-23	SUPERSTAR	10,100,000	1997	26	83,124	2,178
Oct-23	SALAMIS	13,600,000	2000	23	71,245	2,567
Oct-23	IOLI	14,500,000	2001	22	75,897	2,145
Oct-23	APEX 202	17,600,000	2013	10	77,895	2,113
Sep-23	SEA STAR	14,800,000	2005	18	71,556	2,004
Sep-23	RED ROSE	12,100,000	1996	27	76,887	2,015
Sep-23	YASA 367	10,400,000	1995	28	74,569	1,995
Sep-23	SUCCESS	14,800,000	2007	16	72,345	1,989
Sep-23	SL CHINA	16,200,000	2010	13	71,254	1,879
Aug-23	MAX 32	17,900,000	2015	8	80,154	1,923
Aug-23	CAPTAIN P	14,285,000	2006	17	79,125	2,001
Aug-23	SEA WAY	18,200,000	2017	6	78,426	2,010
Aug-23	BLUE STAR	19,150,000	2019	4	76,425	2,145
Aug-23	SUPER STAR	14,250,000	2003	20	72,254	2,457
Jul-23	GREAT	12,156,000	2001	22	70,142	2,222
Jul-23	NEW WAY	15,750,000	2011	12	75,452	2,105
Jul-23	NEA ELPIS	13,750,000	2000	23	70,123	2,094
Jul-23	PARIS	11,890,000	1998	25	68,512	2,057
Jul-23	ATHENS	16,100,000	2012	11	73,457	2,000

Source: Author based on Kavussanos and Visvikis (2016).

As the estimation of the Vessel is affected by many aspects, such as age, size, and freight, the Ordinary Least Squares (OLS) regression analysis can be implemented to appraise a purchase price. Using all the information provided in the table above, the estimation is the following multivariate regression to examine the relationship between the vessel price and the pricing factors.

$$TP_i = a + b_1 \cdot Age_i + b_2 \cdot Size_i + b_3 \cdot Freight_i + e_i$$

Where:

- $\boldsymbol{TP_i}$ is the paid purchase price for the vessel i, (i is the running index, refers to each of the 30 transactions to the table above).

- $\boldsymbol{a}$ is a (constant) intercept term.
- $\boldsymbol{b_1}$ is the sensitivity coefficient for Age.
- $\boldsymbol{Age_i}$ is the age of the vessel BLUE MALUE at the date of the transaction.
- $\boldsymbol{b_2}$ is the sensitivity coefficient for Size.
- $\boldsymbol{Size_i}$ is the vessel size measured in thousand DWT of the appraised BLUE MALU.
- $\boldsymbol{b_3}$ is the sensitivity coefficient for Freight.
- $\boldsymbol{Freight_i}$ is the average monthly BPI at the date of the transaction of BLUE MALU.
- $\boldsymbol{e_i}$ is an error term.

Applying OLS Regression methodology to appraise the intercept term and the sensitivity coefficients via Excel, the below results arose.

Table 2: Data Analysis.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.94
R Square	0.88
Adjusted R Square	0.87
Standard Error	947,291.26
Observations	30.00

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	1.75654E+14	5.85514E+13	65.24850229	3.12714E-12
Residual	26	2.33314E+13	8.97361E+11		
Total	29	1.98986E+14			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	24,121,155.10	3,612,850.28	6.68	0.00	16,694,835.00	31,547,475.21	16,694,835.00	31,547,475.21
AGE AT SALE	-359,529.32	27,682.72	-12.99	0.00	-416,431.96	-302,626.67	-416,431.96	-302,626.67
DWT	-39.98	43.43	-0.92	0.37	-129.25	49.30	-129.25	49.30
BALTIC PANAMAX INDEX	-224.28	692.41	-0.32	0.75	-1,647.55	1,198.99	-1,647.55	1,198.99

The equation that derives from solver in Excel, after applying OLS is: $TP_i = 24{,}121{,}155 - 359{,}529.32 \cdot Age_i - 39.98 \cdot Size_i - 224.28 \cdot Freight_i$. Depending on the adjusted R-squared, which is the standard measure of data fitting in the regression model, justifies that 88% of the variability observed is explained by the regression model, and the rest of them, 12%, is appraised by unexpected variables. After creating the formula to estimate the value of BLUE MALU, is

taken into consideration the numbers of age, size, and freight from the first table. Thus, the following estimation emerges upon rounding results:

$$TP_i = 24{,}121{,}155 - 359{,}529.32 \cdot 12 - 39.98 \cdot 71{,}121 - 224.28 \cdot 2{,}154$$

= 24,121,155 – 4,314,351.84 – 2,843,417.58 – 483,099.12= **16,480,372.59 $ USD.**

The table below is the same estimation through Excel calculations, which were analytically presented above.

Table 3: Market Approach Valuation Results.

MARKET APPROACH VALUATION for Vessel BLUE MALUE 71,121/2011	
$TP_i = 24{,}121{,}155 - 359{,}529.32 \cdot Age_i - 39.98 \cdot Size_i - 224.28 \cdot Freight_i$	
a	24,121,155
b_1	-359,529.32
Age_i	**12**
b_2	-39.98
$Size_i$	**71,121**
b_3	-224.28
$Freight_i$	**2,154**
TOTAL	**$** **16,480,372.59**

3.2.1. Benefits of Market Approach Method

The major advantage of the Market Valuation Method is that is the most applicable and usual method in valuing a vessel. Moreover, this approach depends on the shipping price of recent real transactions because the market shows less volatility in the short term. Therefore, the market depicts the real market status.

3.2.2. Drawbacks of the Market Approach Method

The Market Approach method is a widely used valuation technique in the maritime industry, which considers various marketing and technical factors that can affect the ship's price. These factors include the age of the ship, deadweight tonnage (DWT), the country of origin, the type of main engine, fuel consumption, and a range of other parameters. However, the process of contemporary ship valuation has become increasingly complex, and there is a growing need to incorporate additional parameters to depict a ship's market value more accurately. As such, maritime industry

professionals must stay up to date on the latest developments in the field to ensure that their valuations are comprehensive and reliable (Wenrui, 2014, p.22).

3.3. Income Approach

The income approach is a more complex valuation method, which combines many valuation techniques. DFC valuation relates the value of an asset to the present value of expected cash flows on that asset. More specifically, this approach is a function of the expected cash flows occurring at some time in the future. To make appraisals with this estimation model, a row of steps and calculations must be followed.

STEP 1

The first step is to estimate the beta factor. Beta factor (b) is a measure of the volatility or else systematic risk of a portfolio compared to the market. Depending on how much is the beta factor, there are different scenarios. The calculation can be estimated with the following formula:

$$b_e = \frac{Cov(r_{BPI}, r_{BDI})}{Var(r_{BDI})}$$

Where:

- $\boldsymbol{r_{BPI}}$ is the return on the market which the main vessel is subject to, in this case, is data of BPI (Baltic Panamax Index).
- $\boldsymbol{r_{BDI}}$ is the return on the overall market, which is the BDI (Baltic Dry Index).
- $\boldsymbol{Covariance}$ shows how changes in the main vessel's returns are related to changes in the market's returns.
- **Variance** depicts how far the market's data spread from their average value.

The types of Beta Factors that can be estimated are the following:

Table 4: Beta factor types.

BETA VALUES	EXPLANATION
Beta=1	This case indicates that its price activity is strongly correlated with the market. This means that it has systematic risk.
Beta>1	This indicates that the main vessel's price is more volatile than the whole market. For instance, if the beta is 1.3, it is supposed to be 30% more volatile than the market, which means that risk is increased as well as the expected return.
Beta<1	A beta value that is less than one means that the main vessel is less volatile than the entire market. This means that makes a less risky portfolio and moves more slowly than the market averages.

Source: Author based on Kenton (2022).

In the table below, there are data on BPI Asset Prices, which are related to the Baltic Panamax Index and BDI market prices, which are referred to as the Baltic Dry Index in the entire market.

Table 5: Historical Data of Random Market Prices.

Historical Data		
Date	BPI Asset Price	BDI Market Prices
2/1/2023	1,012	1,255
9/1/2023	983	1,001
16/1/2023	897	997
23/1/2023	852	985
30/1/2023	900	1,005
6/2/2023	931	1,120
13/2/2023	952	1,250
20/2/2023	987	1,325
27/2/2023	1,000	1,428
6/3/2023	1,025	1,306
13/3/2023	1,780	1,955
20/3/2023	1,105	1,356
27/3/2023	1,150	1,235
3/4/2023	1,206	1,700
10/4/2023	1,225	1,789
17/4/2023	1,198	1,654
24/4/2023	1,174	1,635
1/5/2023	1,149	1,604
8/5/2023	1,201	1,784
18/5/2023	1,345	1,925
22/5/2023	1,406	1,998
29/5/2023	1,510	2,150
5/6/2023	1,604	2,540
12/6/2023	1,655	2,763
19/6/2023	1,740	2,900
26/6/2023	1,802	3,002
3/7/2023	1,845	3,157
10/7/2023	1,896	3,345
17/7/2023	1,945	3,521
24/7/2023	1,978	3,652
31/7/2023	2,001	3,602
7/8/2023	2,015	3,789
14/8/2023	2,069	3,801
21/8/2023	2,107	3,897
28/8/2023	2,159	3,924
4/9/2023	2,222	3,956
11/9/2023	2,189	3,894
18/9/2023	2,307	3,955
25/9/2023	2,458	3,988
2/10/2023	2,598	4,003
9/10/2023	2,320	3,807
16/10/2023	2,227	3,735
23/10/2023	2,124	3,502
30/10/2023	2,541	3,708
6/11/2023	2,789	3,889
13/11/2023	2,412	3,771
20/11/2023	2,321	3,542
27/11/2023	2,652	3,689

Source: Author based on Kavussanos and Visvikis (2016).

With the aid of Excel formulas, the covariance (COVARIANCE.P(B3:B50, C3:C50)) and variance (VAR.P(B3:B50, C3:C50)) are calculated. Then, Covariance is divided with Variance to calculate the beta factor as it can be observed below, b_e= 0.61. In this case, beta<1, therefore it is a low-risk investment for valuation.

Table 6: Beta Calculation.

COVARIANCE	615,093.59
VARIANCE	1,008,169.66
BETA $b_e = \frac{Cov(r_p, r_b)}{Var(r_b)}$	**0.61**

STEP 2

Afterward, the calculation of the WACC (Weighted Average Cost of Capital) will follow up to calculate the LTAV on DFC.

$$WACC = R_E * \left(\frac{E}{V}\right) + R_D * (1 - t) * \left(\frac{D}{V}\right)$$

Where:

- **E** Market Value of the asset's equity
- **D** Market Value of the asset's dept
- **V= E+D** (Value=Equity+Dept)
- **R_E** cost of equity
- **R_D** cost of dept
- **T** is tax rate

In shipping cases are considered that there are no taxes, as it is not necessary to take them into account, therefore T=0 (General Law, 2015) (Marshall Hargrave,2023). More specifically, R_E is

the cost of equity which equals the risk-free rate plus the product of the expected market return deducting the risk-free rate and the beta of the market.

The risk-free interest rate depicts the rate of return of an investment that has no or little risk in the capital market. Investors often use government bonds as risk-free rates, because of their minimal risk in the capital market. Cost of debt R_D represents the cost of financing a project, such as buying a new building vessel, using external finance, or from financial institutions. More especially, the cost of debt in shipping depicts the interest rate that banks charge prospective investors to acquire external capital.

As for capital structure (D/E), investors use a combination of external and internal financing for a large investment. It depicts the amount of the weighted average cost of capital, as a higher level of debt leads on the one hand to a higher beta and at the same time to an increased rate for the cost of equity accordingly, as, on the other hand, the relative weight of equity capital in WACC formula is lower (Xaviaras, 2016, p.11).

The WACC approach is dependent on the free cash flows available for distribution between equity and debt holders. Also, the expected flows must be discounted using a weighted average of the required rates of return for both equity and debt.

Table 7: WACC calculation.

WACC CALCULATION	
U.S. treasuries 10 Year 3 Jan	3.80%
U.S. treasuries 10 Year Current Yield = Rf	4.21%
Coupon Rate	6%
Credit Spread (bond) = Corporate Bond Yield (Coupon Rate) - Treasury Bond Yield	1.79%
Rd	5.59%
be	0.61
Re = Rf + be x MRP where MRP=Market Risk Premium	5.05%
D/V (Dept/(Dept+Equity))	60%
E/V (Equity/(Dept+Equity))	40%
WACC = (D/V)*Rd + (E/V)*Re	**5.37%**

Source: based on Financial Times.

The annual expected free cash flows must be discounted to present values using the WACC. To calculate WACC, the US 10-year Treasury at the beginning of 2023 is found via Financial Times,

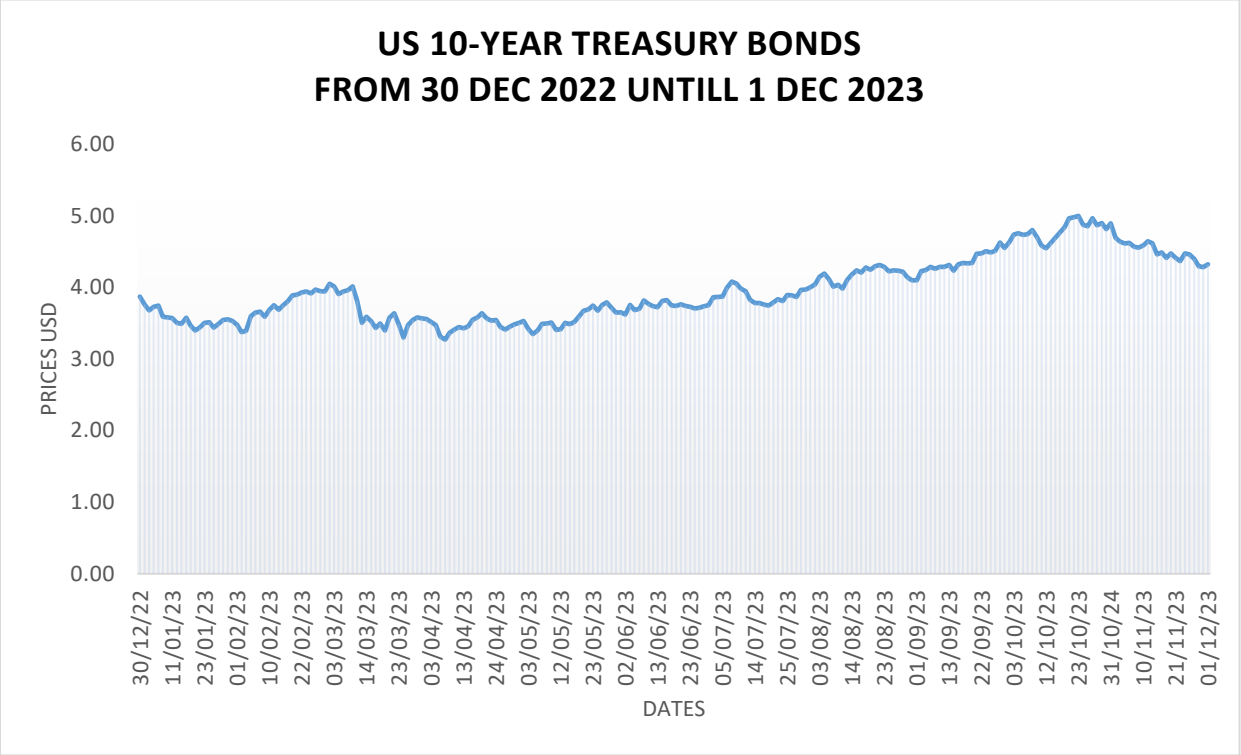
which is 3.80% (Chatham Financial, 2023). US 10-year Treasury rates are used for a fixed rate payer in USD in return for receiving a three-month LIBOR. Also, the US treasury's 10-year Current Yield is used for a risk-free rate.

Table 8: US 10-Year Treasury by Financial Times.

BONDS 1 DECEMBER 2023		
US 10-YEAR TREASURY US10YT		
YIELD	TODAY'S CHANGE	1 YEAR CHANGE
4.21	**↓ -0.015 / -0.36%**	**↑ + 19.86%**

Source: based on Financial Times.

Figure 1: Daily prices of 10-year treasury bonds for 2023.



Source: based on Financial Times.

The high-yield index has an average coupon rate of almost 6% according to a financial source (Martin, 2023). Thus, credit spread (bond) is calculated if the treasury bond yield (Rf) is deducted

from the Corporate Bond Yield 6%, which is equivalent to 1.79%. Credit spread refers to the disparity of yield or returns between two same-maturity Treasury Bonds by possessing different credit ratings (5paisa Research Team, 2023). After estimating Credit Spread (bond), R_D is calculated which is the sum of US treasuries at the start of the year at 3.8% and Credit Spread at 1.79%. Therefore, the cost of debt R_D is equal to 5.59%. Having calculated beta at the first step the cost of equity R_E is calculated based on the CAPM formula:

Re = Rf + be x MRP,

Where MRP=Market Risk Premium is equal to R_D-R_F.

Consequently, R_E = 4.21%+ 0.61*(5.59%-4.21%) = 5.05%. For this case is assumed, a rational proportion of Dept and Equity at 60%/40%. The final step is to calculate WACC based on the last estimations. Using the formula of WACC the following result arose:

$$WACC = R_E * \left(\frac{E}{V}\right) + R_D * \left(\frac{D}{V}\right) = 5.05\%*40\% + 5.59\%*60\% = 5.37\%.$$

Table 9: Income Approach Data.

DATA				DD PER 5 YEARS
VALUATION DATE	1/12/2023			2011
VESSEL TYPE	BC			2016
YEAR OF BUILT	2011			2021
SIZE	78,010	DWT		2026
AGE	12	YEARS		2031
LIGHT DISPLACEMENT	25,000	LT		2036
ECONOMIC USEFUL LIFE	22	YEARS		
OPERATING DAYS	355	DAYS		
ACTUAL BOOKING DAYS	95%			
OPERATING DAYS WITH DD	340	DAYS		
GROSS CHARTER RATE PER DAY	17,050	$		
AGE DISCOUNT	4%			
FEES & COMMISSIONS	5%			
ANNUAL OPEX				
MANNING COSTS	745,000	$		
STORES	277,000	$		
ROUTINE, REPAIR & MAINTENANCE	164,000	$		
INSURANCE	290,000	$		
ADMINISTRATION	150,000	$		
TOTAL ANNUAL OPEX	1,626,000	$		
INFLATION RATE PER YEAR	2%			
EXPECTED INCREASE OPEX PER YEAR	2.50%			
SCRAP PRICE PER LONG TON AT VALUATION DAY	250	$		
WACC	5.37%			

In the table above, a case of Panamax Dry Bulk Carrier is assumed, which was built in 2011 and the appraisal is considered on 1st January 2023. The gross charter rate is considered at 17,050 $ USD per day adjusted linearly to the historical average for a year. The following year daily gross

charter rates are supposed to increase only with the expected inflation rate of 2% per year. The results of net annual charter revenues are based on:

- the number of available running days adding one more parameter, whether it is a year with dry docking services or without,
- the vessel's utilization rate,
- the amount of paid fees and commissions.

Annual Operating expenses include tonnage taxes and are, also, estimated to increase with the expected inflation rate of 2% per year. At the end of economic life, which is in 2035, the vessel's scrap value will be obtained, based on the number of lightweight tons and the steel price per light ton, depending on net actual charter rates, annual operating expenses, and the scrap value, the free cash flows can be appraised in each calendar year for the vessel's remaining lifetime (Kavussanos, Visvikis, 2016, pp.299-302).

The last step is to calculate the Present Value of the Vessel (PV) which is the current value of a future total of money of cash flows given a specified rate of return. The formula of Present Value (PV) is the following:

$$\text{PV} = \frac{CF_t}{(1+r)^t}$$

Where:

- **PV** is the Present Value of Cash Flow at time t,
- $\boldsymbol{CF_t}$ is the expected cash flow at time t,
- **r** is the discount rate
- **t** is the time.

This means that future cash flows are discounted at the discount rate of 2%, and the higher discount rate leads to a lower present value of future cash flows (Fernando, 2023). After estimating the Present Value for each year, a summary emerges, which depicts the value of the vessel with the

Income Approach method, or else the LTAV approach. Depending on the table below, the appropriate calculations are made to reach the result of the LTAV value.

Table 10: Income Approach equations for Calculation.

Income Approach Equations	
1.	Actual Booking Days=Operating days x %Actual Booking Days
2.	Daily Gross Charter Rate = Gross Charter Rate per day x Inflation Rate
3.	Charter Rate After Age Discount = Daily Gross Charter rate x (1-Age Discount)
4.	Daily Net Charter Revenue = Charter rate After Age Discount x (1 - Fees & Commissions)
5.	Annual Net Charter Revenue = Daily Net Charter Revenue x Actual Booking Days
6.	Annual Operating expenses = Total Annual OPEX x Expected increase OPEX per year
7.	Scrap Value=Light Displacement in LT x Scrap Price x (1+ Inf Rate)^(Economic Useful Life-Vessel's Age)
8.	FCF (Free Cash Flow) = Annual Net Charter Revenue - Annual Operating Expenses (+ Scrap Value)
9.	PV Factor = 1/((1+WACC)^No Years)
10.	PV = PV Factor x FCF

Table 11: Income Approach Method.

YEAR	NO YEAR	VESSEL AGE	OPERATING DAYS	ACTUAL BOOKING DAYS (95%)	DAILY GROSS CHARTER RATE	AGE DISCOUNT	CHARTER RATE AFTER AGE DISCOUNT	FEES & COMMISSIONS	DAILY NET CHARTER REVENUE	ANNUAL NET CHARTER REVENUE	ANNUAL OPEX	SCRAP VALUE	FCF	WACC	PV FACTOR	PV
2023	1	12	355	337	17,050		17,050	5%	16,198	5,462,607	1,626,000		3,836,607	5.37%	0.95	3,640,916
2024	2	13	355	337	17,391	4%	16,695	5%	15,861	5,348,985	1,666,650		3,682,335	5.37%	0.90	3,316,270
2025	3	14	355	337	17,739	4%	17,029	5%	16,178	5,455,964	1,708,316		3,747,648	5.37%	0.85	3,202,940
2026	4	15	340	323	18,094	4%	17,370	5%	16,501	5,329,939	1,751,024		3,578,915	5.37%	0.81	2,902,717
2027	5	16	355	337	18,455	4%	17,717	5%	16,831	5,676,385	1,794,800		3,881,586	5.37%	0.77	2,987,623
2028	6	17	355	337	18,825	4%	18,072	5%	17,168	5,789,913	1,839,670		3,950,243	5.37%	0.73	2,885,385
2029	7	18	355	337	19,201	4%	18,433	5%	17,511	5,905,711	1,885,661		4,020,050	5.37%	0.69	2,786,600
2030	8	19	355	337	19,585	4%	18,802	5%	17,862	6,023,825	1,932,803		4,091,022	5.37%	0.66	2,691,153
2031	9	20	340	323	19,977	4%	19,178	5%	18,219	5,884,684	1,981,123		3,903,561	5.37%	0.62	2,436,861
2032	10	21	355	337	20,376	4%	19,561	5%	18,583	6,267,188	2,030,651		4,236,537	5.37%	0.59	2,509,829
2033	11	22	355	337	20,784	4%	19,953	5%	18,955	6,392,532	2,081,417		4,311,114	5.37%	0.56	2,423,740
2034	12	23	355	337	21,200	4%	20,352	5%	19,334	6,520,382	2,133,453		4,386,930	5.37%	0.53	2,340,564
2035	13	24	355	337	21,624	4%	20,759	5%	19,721	6,650,790	2,186,789	7,618,715	12,082,716	5.37%	0.51	6,117,693
															LTAV	$ 40,242,290

Using the data above, eventually, the result is 40,242,290 $ USD for the valuation date 1st December 2023, which will be discussed later.

3.3.1. Advantages of Income Approach

The Income valuation method has been widely acknowledged for its ability to provide a comprehensive assessment of the future earnings potential of a ship. The method enables an in-depth analysis of the vessel's capacity to generate profits and its overall profitability. This, in turn, facilitates informed decision-making when considering the purchase or sale of a ship. The Income valuation method, therefore, represents a valuable tool for investors and stakeholders in the maritime industry, offering a reliable means of assessing the financial viability of vessel investments.

3.3.2. Disadvantages of Income Approach

Even Though, the important advantages, there are crucial disadvantages that must be referred to. It must be mentioned that is a more complex valuation method than the other ones, which is why it makes it difficult to understand. Additionally, it is complicated to predict future income, as the market presents high volatility. Thus, the results are not always accurate. Influenced by all these factors, it is concluded that the number of future earnings can't be controlled (Wenrui, 2014, p.20).

3.4. Replacement Cost Approach

The Replacement Cost Method (RCM) is an approach to valuing an asset, in this case, a vessel, which takes under consideration the vessel's depreciation or loss of value over time and the cost of replacing the asset if it were damaged or demolished (Equitest, 2023). In the shipping section, to apply the Replacement Cost Approach, the valuation must be implied between two similar vessels from the same category and the same year of build.

In this instance, two Panamax Vessels are assumed which were built in 2010, LADY L and ANTHOUSA, to evaluate LADY L (Main Vessel) with ANTHOUSA (Subject Vessel) on 1st December 2023. It, also, considered that the sale price of the main vessel is 8.9 million USD $ and 9.1 million USD $ for the subject vessel respectively.

The economic useful life of the vessel must be taken into consideration, which is the time throughout an asset that remains useful and has not depreciated to the point (Chen, 2020). On this occasion, economic useful life is assumed at 25 years. With this significant element, the depreciation life is estimated, which is determined by dividing one by economic useful life. The result that occurs is equal to 4%.

Thus, the current value of the main vessel LADY L is equivalent to (Sale Price – (Sale Price x Depreciation Rate x Age)) which leads to USD 4,628,000. Subsequently, with the same method, the replacement value of the subject vessel ANTHOUSA is calculated, which is equal to USD 4,732,000. Summarizing the two values of the main and subsequent vessel, the result that emerges is equal to USD 9,360,000, which is the final value for the asset.

Table 12: Cost Approach Calculation.

DATA	MAIN VESSEL	SUBJECT VESSEL
VALUATION DATE	1/12/2023	
NAME OF VESSELS	LADY L	ANTHOUSA
VESSEL TYPE	BC	BC
SALE PRICE	$ 8,900,000	$ 9,100,000
YEAR OF BUILT	2010	
SIZE	75,095 DWT	79,010 DWT
AGE	12 YEARS	12 YEARS
ECONOMIC USEFUL LIFE	25	
DEPRECIATION LIFE **(1/ economic useful life)**	4%	
CURRENT VALUE OF MAIN VESSEL **(Sale Price-(Sale Price x Depreciation Rate x Age)**	**$ 4,628,000**	
REPLACEMENT VALUE OF SUBJECT VESSEL **(Sale Price-(Sale Price x Depreciation Rate x Age)**		**$ 4,732,000**
DEPRECIATED REPLACEMENT COST (Current Value of Main Vessel+Replacement Value of Subject Vessel)	**$**	**9,360,000**

3.4.1. Benefits of Replacement Cost Approach

The Replacement Cost Approach is a widely accepted valuation method in the shipping industry due to its numerous benefits. The sale price is used as a benchmark price in this approach, which is a significant advantage when determining the vessel's value. Moreover, this method also considers depreciation, which reflects the ship's substantial, functional, and economic losses. This ensures that the valuation is based on the current condition of the vessel, providing a more accurate and reliable estimate of its worth. These benefits make the Replacement Cost Approach a crucial tool for investors and analysts when making informed decisions about vessel investments.

3.4.2. Drawbacks of Replacement Cost Approach

The valuation method under discussion seems to have certain limitations that could restrict its application in practical scenarios. Firstly, it does not account for the impact of the shipping market on ship prices, which is a crucial factor to consider since secondhand prices can sometimes exceed new building prices. Secondly, assessing the substantive loss, functional loss, and economic loss of a ship through this method requires extensive calculations, related to the complex composition of the vessel. Finally, utilizing future prices in the evaluation of current vessels may not be a fitting approach, as it could lead to inaccurate estimations and judgments (Wenrui, 2014, p.18).

3.5. Pros and Cons of all Valuation Methods

Table 13: Comparison between each method's pros and cons.

METHODS	BENEFITS	DRAWBACKS
1. MARKET APPROACH	1. The most applicable Valuation method. 2. This approach depends on the shipping price of recent price transactions.	1. The Market Approach method assesses a ship's market value by considering marketing and technical factors, ex. age, DWT, etc.
2. INCOME APPROACH	1. Considers the future earnings of the ship. 2. It depicts the capability of the vessel to make a profit.	1. More complex valuation method. 2. Difficult to comprehend. 3. It is complicated to predict future income, due to the market's high volatility. 4. Not always accuracy.

		5. Future earnings can't be controlled.
3. COST APPROACH	1. The sale price is used as a benchmark price. 2. It reflects depreciation measuring the ship's substantial, functional, and economic losses.	1. Not able to depict the influence on shipping prices. 2. Takes only into consideration the sale price and the depreciation of the ship. 3. The secondhand price will sometimes be higher than the new building price, which can't happen in the replacement cost method. 4. The evaluation of substantive loss, functional loss, and economic loss of the ship needs a lot of calculations. 5. Using a future price in the appraisal of a current vessel is not appropriate.

As can be observed above, the Valuation method with the least drawbacks is the Market Approach. This is the major reason that is the most preferable method used by shipping firms. Moreover, it

appears to vital benefit from the other methods, which renders this method very usable and comprehensive for valuers. On the other hand, the method with the most disadvantages is the Replacement Cost Approach method, which is not very reputable in comparison to the other ones, as it leads to inaccurate and unreliable results.

Upon presenting an overview of the main valuation methods, the subsequent section will provide a detailed and systematic analysis of a fitted case study involving a dry bulk ship. This examination will be undertaken with the objective of comparing the results obtained from the various valuation techniques. The comprehensive evaluation of the dry bulk ship case study will enable a thorough understanding of the practical application of the theoretical valuation methods mentioned earlier.

4. Results

In this part, it will be presented a fitted case study of a specific vessel, using the three valuation methods that were analyzed earlier in the methodology section, to compare the results among them and observe, which is the most suitable and appropriate approach. The three aforementioned methods were applied to Panamax Vessels, which are Dry Bulk Carriers, as is the most prevalent and preferable category of a ship in the maritime industry, particularly for Sales and Purchase (S&P) transactions. In this case, BC PANAMAX OSTRIA, a Panamax dry bulk vessel, which is 76,444 DWT, built in 2008 is chosen to be presented with each method. According to Marine Traffic (2023), the following information about this vessel can be drawn.

Table 14: Vessel information for Panamax Ostria.

VESSEL INFORMATION	
IMO	9399557
Name	PANAMAX OSTRIA
General Vessel Type	Cargo
Detailed Vessel Type	Bulk Carrier
Navigational Status	Active
MMSI	636021875
Call Sign	5LGC8
Flag	LIBERIA (LR)
Gross Tonnage	41115
Summer DWT	76444 t
Length Overall X Breadth Extreme	225 x 32.26 m
Year Built	2008

Source: based on Marine Traffic.

Table 15: Vessel Valuation of Panamax Ostria.

CURRENT VALUATION	
Current Valuation	Demolition Value
$11.8 Million	**$5.9 Million**

Source: based on Marine Traffic.

The valuation date is 1st December of 2023 is assumed for all the following valuations that will be conducted in the fitting. Beyond using the same valuation date, the same economic useful life and sale price will be utilized in every method.

4.1. Fitting the Model with the Market Approach

Firstly, BC PANAMAX OSTRIA 2008 will be evaluated with Market Method appraisal, as it is the most common method among the others and the most acceptable in the shipping sector. In the table below, there is a list of thirty numbers of five-month data of purchases of Panamax Bulk Carriers, providing information about vessel names, sale prices, year of build, age at sale, DWT, and the state of the freight market at the time of purchase, which can be depicted from Baltic Panamax Index. As a Panamax vessel is evaluated, the BPI index must be utilized, which reflects the supply and demand balance for the Panamax shipping market.

Table 16: Vessel data for Market Valuation of PANAMAX OSTRIA.

$TP_i = a + b_1 \cdot Age_i + b_2 \cdot Size_i + b_3 \cdot Freight_i + e_i$

SALE DATE	VESSEL NAME	SALE PRICE $	YOB	AGE AT SALE	DWT	BALTIC PANAMAX INDEX
Dec-23	**PANAMAX OSTRIA**	**11,800,000**	**2008**	**15**	**76,444**	**2,250**
Dec-23	METAL	6,800,000	2004	19	73,610	2,001
Dec-23	LADY E	14,500,000	2006	17	74,115	1,998
Dec-23	KING G	7,580,000	2004	19	75,700	1,978
Nov-23	DOLPHIN	16,870,000	2010	13	76,770	1,925
Nov-23	SANTA ANNA	12,450,000	2009	14	76,098	1,905
Nov-23	RIO 2	15,630,000	2012	11	70,128	1,899
Nov-23	BC EXPRESS	12,980,000	2007	16	69,915	1,890
Nov-23	SHAO SIN	15,700,000	2007	16	71,125	1,800
Nov-23	BC CRYSTAL	16,740,000	2011	12	74,655	1,785
Oct-23	GREAT 2000	4,500,000	2001	22	70,257	1,755
Oct-23	AMBITION	6,900,000	2005	18	80,512	1,730
Oct-23	CL NAVIOS	5,780,000	2000	23	73,256	1,700
Oct-23	SEA 23	6,230,000	2002	21	74,354	1,689
Oct-23	HUAN SHI	18,125,000	2014	9	71,376	1,678
Sep-23	NEFELI G	19,700,000	2018	5	72,219	1,650
Sep-23	DOLPHIN	9,200,000	2004	19	75,136	1,643
Sep-23	EUROPE	4,123,000	1999	24	70,102	1,601
Sep-23	MG PANAMAX	4,200,000	1997	26	68,897	1,587
Sep-23	COGH	12,460,000	2011	12	69,807	1,502
Aug-23	BRILIANT	16,410,000	2015	8	79,125	1,487
Aug-23	CAPTAIN A	12,520,000	2006	17	78,876	1,470
Aug-23	OCEANIC	18,200,000	2017	6	77,546	1,406
Aug-23	YELLOW STAR	19,150,000	2019	4	74,259	1,302
Aug-23	SUPER BULK	5,240,000	2003	20	73,587	1,324
Jul-23	GREAT 34	4,980,000	2001	22	69,989	1,299
Jul-23	NEW SEAS	15,750,000	2011	12	75,452	1,274
Jul-23	ELPIS	6,100,000	2000	23	70,123	1,203
Jul-23	ATHENA	11,890,000	2015	8	68,512	1,101
Jul-23	DELOS STAR	11,230,000	2012	11	73,457	1,007

Using OLS (Ordinary Least Squares) Regression Analysis with the data above, it can be defined the following relationship between vessel price and pricing factors.

$$TP_i = a + b_1 \cdot Age_i + b_2 \cdot Size_i + b_3 \cdot Freight_i + e_i$$

Where:

- $\boldsymbol{TP_i}$ is the paid purchase price for the vessel PANAMAX OSTRIA based on the 30 transactions according to the table above),
- $\boldsymbol{a}$ is a (constant) intercept term,
- $\boldsymbol{b_1}$ is the sensitivity coefficient for Age,
- $\boldsymbol{Age_i}$ is the age of the vessel PANAMAX OSTRIA on 1st December 2023,

- b_2 is the sensitivity coefficient for Size,
- $Size_i$ is the vessel size measured in thousand DWT of the appraised PANAMAX OSTRIA,
- b_3 is the sensitivity coefficient for Freight,
- $Freight_i$ is the average monthly BPI on 1st December 2023 of PANAMAX OSTRIA.

Table 17: Regression Analysis for PANAMAX OSTRIA.

SUMMARY OUTPUT FOR PANAMAX OSTRIA								
Regression Statistics								
Multiple R	0.92							
R Square	**0.85**							
Adjusted R Square	0.83							
Standard Error	2,115,888.06							
Observations	30.00							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	6.37586E+14	2.12529E+14	47.47142784	1.09588E-10			
Residual	26	1.16402E+14	4.47698E+12					
Total	29	7.53988E+14						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	**18,108,413.96**	9,382,085.62	1.93	0.06	-1,176,739.22	37,393,567.14	-1,176,739.22	37,393,567.14
AGE AT SALE	**-791,180.59**	68,761.35	-11.51	0.00	-932,521.57	-649,839.60	-932,521.57	-649,839.60
DWT	**-3.55**	127.15	-0.03	0.98	-264.92	257.82	-264.92	257.82
BALTIC PANAMAX INDEX	**3,559.53**	1,378.41	2.58	0.02	726.16	6,392.90	726.16	6,392.90

After applying the OLS Regression model, the intercept term and the sensitivity coefficients are appraised, which are significant for the calculation with the Market Approach. Thus, the following results emerge:

Table 18: Valuation results for PANAMAX OSTRIA based on Market Approach.

MARKET APPROACH VALUATION for Vessel PANAMAX OSTRIA 76,444/2008	
$TP_{PO} = 18{,}108{,}414 - 791{,}180.59 \cdot Age_{PO} - 3.55 \cdot Size_{PO} + 3{,}559.53 \cdot Freight_{PO}$	
a	18,108,414
b_1	-791,180.59
Age_i	**15**
b_2	-3.55
$Size_i$	**76,444**
b_3	3,559.53
$Freight_i$	**2,250**
TOTAL	**$ 13,978,143.87**

The equation that derives from solver in Excel, applying regression model is:

$$TP_{PO} = 18{,}108{,}414 - 791{,}180.59 \cdot Age_{PO} - 3.55 \cdot Size_{PO} + 3{,}559.53 \cdot Freight_{PO}$$

Where PO is the appraised vessel of Panamax Ostria.

The adjusted R-square in **Table 17** which is equal to 0.85 justifies that 85% of the variability observed, is explained by the regression model and the rest 15% is estimated by unexpected variables. After creating the form to estimate the value of PANAMAX OSTRIA, the results of age, size, and freight are considered in **Table 18**.

Therefore, the following estimation arises with rounding results:

$$TP_{PO} = 18{,}108{,}414 - 791{,}180.59 \cdot 15 - 3.55 \cdot 76{,}444 + 3{,}559.53 \cdot 2{,}250$$

$$= 18{,}108{,}414 - 11{,}867{,}708.9 - 271{,}376.2 + 8{,}008{,}942.5$$

$$\approx \mathbf{13{,}978{,}143.87\ USD.}$$

4.2. Fitting the model with the Income Approach

In this section, the three occasions of beta (b=1, b>1, b<1) are considered, to compare the results between these cases. Using the equations that were analyzed in the methodology section, the next appraisals can be made.

Table 19: Income Approach Equations utilized in calculations.

Income Approach Equations	
1.	Actual Booking Days=Operating days x %Actual Booking Days
2.	Daily Gross Charter Rate = Gross Charter Rate per day x Inflation Rate
3.	Charter Rate After Age Discount = Daily Gross Charter rate x (1-Age Discount)
4.	Daily Net Charter Revenue = Charter rate After Age Discount x (1 - Fees & Commissions)
5.	Annual Net Charter Revenue = Daily Net Charter Revenue x Actual Booking Days
6.	Annual Operating expenses = Total Annual OPEX x Expected increase OPEX per year
7.	Scrap Value=Light Displacement in LT x Scrap Price x (1+ Inf Rate)^(Economic Useful Life-Vessel's Age)
8.	FCF (Free Cash Flow) = Annual Net Charter Revenue - Annual Operating Expenses (+ Scrap Value)
9.	PV Factor = 1/((1+WACC)^No Years)
10.	PV = PV Factor x FCF

The table presented above offers a comprehensive understanding of the equations used in LTAV calculations. Equation 1 defines the Actual booking days, which refers to the number of days that the vessel is active and is of paramount importance in the estimation of the Income Approach. Equation 2 represents the Daily Gross Charter Rate, which is the rate of hire inclusive of fees and

commissions. More specifically, the Gross Charter Rate is determined by multiplying the vessel's fixed value with an annual inflation rate.

In Equation 3, the Charter Rate after the age discount is calculated by multiplying the daily gross charter rate by an annual age depreciation. Equation 4 determines the Daily Net Charter Revenue by deducting the age discount and all fees and commissions from the daily gross charter rate. The Annual Net Charter Revenue is calculated by multiplying the Daily Net Charter Revenue by the actual booking days, as outlined in Equation 5. In Equation 6, the Annual Operating Expenses are defined as all the costs related to the vessel's operation, such as manning costs, stores, repair & maintenance, insurance, administration, etc.

Equation 7 outlines the computation of the Scrap value, which is based on the main factors of the remaining life of the vessel, light displacement, and scrap price. Equation 8 helps to determine the Free Cash Flow, which is derived by subtracting the Annual Operating Expenses from the Annual Charter Revenue. That's why, FCF is equal to **Annual Charter Revenue- Annual OPEX**. (Chris B. Murphy, 2023). Finally, Equation 9 represents the present Value Factor, which estimates the current value of money that will be received in the future, and Equation 10 is the Present Value, obtained by multiplying the present value factor with Free Cash Flows. The insights offered by these equations offer a comprehensive and nuanced understanding of the LTAV calculations.

4.2.1. Income Approach with b=1

The present analysis will commence with a thorough examination of the income approach, with a beta equal to one. This scenario is indicative of a strong correlation between the price activity and the market, thereby implying the presence of systematic risk.

Table 20: WACC calculation considering b=1.

WACC CALCULATION	
U.S. treasuries 10 Year 3 Jan	3.80%
U.S. treasuries 10 Year Current Yield = Rf	4.21%
Coupon Rate	6%
Credit Spread (bond) = Corporate Bond Yield (Coupon Rate) - Treasury Bond Yield	1.79%
Rd	5.59%
be	**1.00**
Re = Rf + be x MRP where MRP=Market Risk Premium	5.59%
D/V (Dept/(Dept+Equity))	60%
E/V (Equity/(Dept+Equity))	40%
WACC = (D/V)*Rd + (E/V)*Re	**5.59%**

Given the US treasuries 10-year data, R_f rate, Coupon Rate, Credit Spread, and debt & Equity proportions from the Methodology section in **Table 7**, b=1 is settled. From **Table 4**, when the beta value is equal to one, it means that the vessel's price, in this case, PANAMAX OSTRIA, is highly correlated with the market. This signifies that it has systematic risk, inherent to the whole shipping market.

Initially, the R_E is estimated through the CAPM model $R_E=R_F+b_E$ x MRP = 5.59%. Then, using the formula of Weighted Average Cost of Capital (WACC), the following result arises:

$WACC = R_E * \left(\frac{E}{V}\right) + R_D * (1-t) * \left(\frac{D}{V}\right)$ => WACC = 5.59%*40% + 5.59%*60% = 5.59%

Therefore, $R_D=R_E$=WACC=5.59%, because b=1.

Table 21: PANAMAX OSTRIA data with b=1.

DATA				DD PER 5 YEARS
				2008
VALUATION DATE	1/12/2023			2013
VESSEL TYPE	BC			2018
YEAR OF BUILT	2008			2023
SIZE	76,444	DWT		2028
AGE	18	YEARS		2033
LIGHT DISPLACEMENT	12,250	LT		
ECONOMIC USEFUL LIFE	18	YEARS		
OPERATING DAYS	355	DAYS		
ACTUAL BOOKING DAYS	95%			
OPERATING DAYS WITH DD	340	DAYS		
GROSS CHARTER RATE PER DAY	17,600	$		
AGE DISCOUNT	4%			
FEES & COMMISSIONS	5%			
ANNUAL OPEX				
MANNING COSTS	875,000	$		
STORES	258,000	$		
ROUTINE, REPAIR & MAINTENANCE	187,200	$		
INSURANCE	350,000	$		
ADMINISTRATION	154,300	$		
TOTAL ANNUAL OPEX	1,824,500	$		
INFLATION RATE PER YEAR	2%			
EXPECTED INCREASE OPEX PER YEAR	2.50%			
SCRAP PRICE PER LONG TON AT VALUATION DAY	250	$		
WACC	**5.59%**			

Upon careful examination of the table above, it is observed that the annual Operational Expenses (OPEX) for the PANAMAX OSTRIA have been comprehensively calculated, taking into account several key factors such as Manning costs, Stores, Routine, Repair and Maintenance expenses, Insurance costs, and Administration costs. Additionally, the table presents crucial information regarding the Vessel Type, Year of build, Size, Age, and Light Displacement of the vessel, which is pertinent to understanding the overall expenses incurred by the vessel.

It is important to note that several assumptions were made during the valuation process, which are fundamental to the outcome of the analysis. These include a specific valuation date of 1st December 2023, an estimated economic useful life of 18 years, operating days of 355, actual booking days of 95%, operating days with dry dock of 340, gross charter rate per day of 17,600$/day, age discount of 4%, fees and commissions of 5%, inflation rate per year of 2%, expected increase in OPEX per year of 2.5%, and a scrap price per long ton on the valuation date of 01/12/2023 of 250$.

Furthermore, Dry Docks have been appraised since the year of building that is in 2008. Thus, five more Dry Dock Surveys till 2035 must be expected (2008, 2013, 2018, 2023, 2028, and 2033 respectively). Finally, the appraised WACC is taken from **Table 20** equal to 5.59%, to continue with the calculations.

Table 22: PANAMAX OSTRIA Results based on b=1.

YEAR	NO YEAR	VESSEL AGE	OPERATING DAYS	ACTUAL BOOKING DAYS (95%	DAILY GROSS CHARTER RATE	AGE DISCOUNT	CHARTER RATE AFTER AGE DISCOUN	FEES & COMMISSIONS	DAILY NET CHARTER REVENUE	ANNUAL NET CHARTER REVENUE	ANNUAL OPEX	SCRAP VALUE	FCF	WACC	PV FACTOR	PV
2023	1	18	340	323	17,600		17,600	5%	16,720	5,400,560	1,824,500		3,576,060	5.59%	0.95	3,386,741
2024	2	19	355	337	17,952	4%	17,234	5%	16,372	5,521,533	1,870,113		3,651,420	5.59%	0.90	3,275,037
2025	3	20	355	337	18,311	4%	17,579	5%	16,700	5,631,963	1,916,865		3,715,098	5.59%	0.85	3,155,745
2026	4	21	355	337	18,677	4%	17,930	5%	17,034	5,744,602	1,964,787		3,779,816	5.59%	0.80	3,040,741
2027	5	22	355	337	19,051	4%	18,289	5%	17,374	5,859,495	2,013,907		3,845,588	5.59%	0.76	2,929,873
2028	6	23	340	323	19,432	4%	18,655	5%	17,722	5,724,148	2,064,254		3,659,894	5.59%	0.72	2,640,777
2029	7	24	355	337	19,820	4%	19,028	5%	18,076	6,096,218	2,115,861		3,980,357	5.59%	0.68	2,719,960
2030	8	25	355	337	20,217	4%	19,408	5%	18,438	6,218,142	2,168,757		4,049,385	5.59%	0.65	2,620,636
2031	9	26	355	337	20,621	4%	19,796	5%	18,807	6,342,505	2,222,976		4,119,529	5.59%	0.61	2,524,890
2032	10	27	355	337	21,034	4%	20,192	5%	19,183	6,469,355	2,278,550		4,190,805	5.59%	0.58	2,432,594
2033	11	28	340	323	21,454	4%	20,596	5%	19,566	6,319,922	2,335,514		3,984,408	5.59%	0.55	2,190,348
2034	12	29	355	337	21,883	4%	21,008	5%	19,958	6,730,717	2,393,902		4,336,815	5.59%	0.52	2,257,862
2035	13	30	355	337	22,321	4%	21,428	5%	20,357	6,865,332	2,453,750	3,062,500	7,474,082	5.59%	0.49	3,685,204
															LTAV	$ 36,860,410

The first column is the year that starts the valuation 2023 until the year is to be appraised. In this case, the appraisal is about to last till the year 2035. Thus, in the second column, there is the number of years, starting from year one for 2023 and ending up to the number 13 for the year 2035.

In the third column, are the operating days that the vessel is working considering the Dry-Docking Years, which are calculated in **Table 21**. This means that 340 Operating Days will be placed for the years of Dry-Dock, which are 2023, 2028, and 2033 accordingly, and for the rest of them, 355 days will be set. Using the form **Actual Booking Days=Operating Days x %Actual Booking Days** from equations **Table 19**, the fourth column is calculated, which arises from Actual Booking Days in DD= 340 x 95% = 323 and Actual Booking Days= 355 x 95% = 337, respectively.

In the fifth column, the Daily Gross Charter Rate is calculated, which emerges from the equation **Daily Gross Charter rate per day x Inflation Rate**. In the first row of the column, the gross charter rate per day is set from the data in **Table 21** 17,600 $/day, as the inflation rate starts from the following year. In the second year, the Daily Gross Charter rate increases at (Gross Charter Rate= 17,600$/day x 1.02) 17,952 $/day. The same steps are followed to calculate the rest of the Daily Gross Charter Rates till 2035, reaching 22,321 $/day that year.

The next column is the **Age Discount** that starts from the second year of valuation and in this case is 4% given in **Table 21**. Then, Charter Rate After Age Discount is calculated based on the equation **Charter Rate After Age Discount Daily Gross Charter Rate x (1- Age Discount).** In the first row, the Charter Rate After Age Discount is equal to the Daily Gross Charter Rate of 17,600/day, as it is not discounted yet. In the second row, Charter Rate After Discount 17,952$/day x (1-4%) = 17,234$/day. The same steps are followed to calculate the rest rows till the year 2035.

In the next column, **Fees & Commissions** are equal to 5% given in **Table 21**, which will be used in the calculation of the Daily Net Charter Revenue. Daily Net Charter Revenue can be estimated from the equation **Charter Rate After Age Discount x (1- Fees & Commissions)**. The first row derives from 17,600 x (1-0.05) = 16,720$/day, the same method is applied for the rest rows till the year 2035.

The next column, Annual Net Charter Revenue which is equal to **Daily Net Charter Revenue x Actual Booking Days**, are the Net Charter Revenues that are calculated in the previous column multiplied by the actual booking days. For instance, 16,720 x 323 = 5,400,560 $/year.

Annual OPEX is the operational expenses per year. The first-year Operational Expenses are equal to 1,824,500 $/year, as per data in **Table 21**. The second year can be calculated by the form Annual **Operating Expenses=Total Annual OPEX x Expected increase in OPEX per year**, which is equivalent to 1,824,500 $/year x (1 + 0.025) = 1,870,113 $/year.

Scrap Value is estimated in the last year of valuation, and it is added up to Free Cash Flows. The form of Scrap Value is **Light Displacement in LT x Scrap Price x (1+ Inflation Rate) (Economic Useful Life-Vessel's Age)**. Thus, the value from data in **Table 21** is estimated at 12,250 LT x 250$ x (1+2%) $^{(18-18)}$ = 3,062,500$.

Free Cash Flows are determined by the equation **Annual Net Charter Revenue – Annual Operating Expenses** and Scrap Value only is added for the last row. Therefore, the equation becomes **Net Charter Revenue – Annual Operating Expenses + Scrap Value**. For example, the first row occurs by deducting 5,400,560$ – 1,824,500$ = 3,576,060$.

And for the last row, in which scrap value must be added, is FCF = 6,865,332$ - 2,453,750$ + 3,062,500$ = 7,474,082$ Then, the WACC with the considering b=1, to appraise the PV factor, which has the following formula: $\mathbf{PV = \frac{CF_t}{(1+r)^t}}$. The result for the first row by using the above formula occurs as follows PV = 1/((1+5.59%)^1) = 0.95. The final PV, which is utilized for LTAV valuation, derives from **PV = PV Factor x FCF** = 0.95 x 3,576,060$ = 3,386,741$. Following the same steps to calculate PV till 2035 and finally adding them, a result of **$36,860,410$** emerges with LTAV valuation, given b=1.

4.2.2. Income Approach with b<1

Table 23: WACC calculation considering b<1.

WACC CALCULATION	
U.S. treasuries 10 Year 3 Jan	3.80%
U.S. treasuries 10 Year Current Yield = Rf	4.21%
Coupon Rate	6%
Credit Spread (bond) = Corporate Bond Yield (Coupon Rate) - Treasury Bond Yield	1.79%
Rd	5.59%
be	**0.40**
Re = Rf + be x MRP where MRP=Market Risk Premium	4.76%
D/V (Dept/(Dept+Equity))	60%
E/V (Equity/(Dept+Equity))	40%
WACC = (D/V)*Rd + (E/V)*Re	**5.26%**

Similarly, from **Table 4**, when the beta value is less than one, means that the vessel, in this case, PANAMAX OSTRIA, is less volatile than the entire freight market. This leads to a less risky portfolio and moves gradually in comparison to the shipping market averages. Thus, a very low beta of 0.4 is assumed. Initially, the R_E is estimated through the CAPM model $R_E=R_F+b_E$ x MRP = 4.76%. Also, R_D remains the same and is equal to 5.59%. Then, using the formula of Weighted Average Cost of Capital, the following result arises:

$$WACC = R_E * \left(\frac{E}{V}\right) + R_D * (1-t) * \left(\frac{D}{V}\right) \Rightarrow \text{WACC} = 4.76\%*40\% + 5.59\%*60\% = 5.26\%$$

Therefore, R_E<WACC<R_D, supposing that beta is less than one.

Table 24: PANAMAX OSTRIA data with b<1.

DATA				DD PER 5 YEARS
VALUATION DATE	1/12/2023			2008
VESSEL TYPE	BC			2013
YEAR OF BUILT	2008			2018
SIZE	76,444	DWT		2023
AGE	18	YEARS		2028
LIGHT DISPLACEMENT	12,250	LT		2033
ECONOMIC USEFUL LIFE	18	YEARS		
OPERATING DAYS	355	DAYS		
ACTUAL BOOKING DAYS	95%			
OPERATING DAYS WITH DD	340	DAYS		
GROSS CHARTER RATE PER DAY	17,600	$		
AGE DISCOUNT	4%			
FEES & COMMISSIONS	5%			
ANNUAL OPEX				
MANNING COSTS	875,000	$		
STORES	258,000	$		
ROUTINE, REPAIR & MAINTENANCE	187,200	$		
INSURANCE	350,000	$		
ADMINISTRATION	154,300	$		
TOTAL ANNUAL OPEX	1,824,500	$		
INFLATION RATE PER YEAR	2%			
EXPECTED INCREASE OPEX PER YEAR	2.50%			
SCRAP PRICE PER LONG TON AT VALUATION DAY	250	$		
WACC	**5.26%**			

It is worth noting that to make comparisons between the three cases of beta, the same instance is utilized, with the only modification being the adjustment of the WACC factor. This approach ensures consistency and facilitates a more rigorous and systematic analysis of the data.

Table 25: PANAMAX OSTRIA Results based on b<1.

YEAR	NO YEAR	VESSEL AGE	OPERATING DAYS	ACTUAL BOOKING DAYS (95%)	DAILY GROSS CHARTER RAT	AGE DISCOUNT	CHARTER RATE AFTER AGE DISCOUN	FEES & COMMISSIONS	DAILY NET CHARTER REVENU	ANNUAL NET CHARTER REVENU	ANNUAL OPEX	SCRAP VALU	FCF	WACC	PV FACTOR	PV
2023	1	18	340	323	17,600		17,600	5%	16,720	5,400,560	1,824,500		3,576,060	5.26%	0.95	3,397,398
2024	2	19	355	337	17,952	4%	17,234	5%	16,372	5,521,533	1,870,113		3,651,420	5.26%	0.90	3,295,679
2025	3	20	355	337	18,311	4%	17,579	5%	16,700	5,631,963	1,916,865		3,715,098	5.26%	0.86	3,185,628
2026	4	21	355	337	18,677	4%	17,930	5%	17,034	5,744,602	1,964,787		3,779,816	5.26%	0.81	3,079,193
2027	5	22	355	337	19,051	4%	18,289	5%	17,374	5,859,495	2,013,907		3,845,588	5.26%	0.77	2,976,259
2028	6	23	340	323	19,432	4%	18,655	5%	17,722	5,724,148	2,064,254		3,659,894	5.26%	0.74	2,691,027
2029	7	24	355	337	19,820	4%	19,028	5%	18,076	6,096,218	2,115,861		3,980,357	5.26%	0.70	2,780,438
2030	8	25	355	337	20,217	4%	19,408	5%	18,438	6,218,142	2,168,757		4,049,385	5.26%	0.66	2,687,335
2031	9	26	355	337	20,621	4%	19,796	5%	18,807	6,342,505	2,222,976		4,119,529	5.26%	0.63	2,597,298
2032	10	27	355	337	21,034	4%	20,192	5%	19,183	6,469,355	2,278,550		4,190,805	5.26%	0.60	2,510,229
2033	11	28	340	323	21,454	4%	20,596	5%	19,566	6,319,922	2,335,514		3,984,408	5.26%	0.57	2,267,364
2034	12	29	355	337	21,883	4%	21,008	5%	19,958	6,730,717	2,393,902		4,336,815	5.26%	0.54	2,344,606
2035	13	30	355	337	22,321	4%	21,428	5%	20,357	6,865,332	2,453,750	3,062,500	7,474,082	5.26%	0.51	3,838,826
															LTAV	$ 37,651,280

According to the analysis, it has been observed that the columns that are subject to change due to b<1 are the Weighted Average Cost of Capital (WACC), Present Value (PV) Factor, and the PV itself. Observing that the PV Factor increases throughout the years, due to the smaller denominator, a higher LTAV value of **$ 37,651,280** is estimated than the previous result.

4.2.3. Income Approach with b>1

Table 26: WACC calculation considering b>1.

WACC CALCULATION	
U.S. treasuries 10 Year 3 Jan	3.80%
U.S. treasuries 10 Year Current Yield = Rf	4.21%
Coupon Rate	6%
Credit Spread (bond) = Corporate Bond Yield (Coupon Rate) - Treasury Bond Yield	1.79%
Rd	5.59%
be	**1.30**
Re = Rf + be x MRP where MRP=Market Risk Premium	6.00%
D/V (Dept/(Dept+Equity))	60%
E/V (Equity/(Dept+Equity))	40%
WACC = (D/V)*Rd + (E/V)*Re	**5.76%**

Similarly, **Table 4**, when the beta value is more than one, signifies that the vessel, in this case, PANAMAX OSTRIA, is more volatile than the entire freight market. This leads to a riskier portfolio and moves radically in comparison to the shipping market averages. Thus, a very high beta of 1.3 is assumed. Initially, R_E is estimated through the CAPM model $R_E=R_F+b_E$ x MRP = 6.00%. Also, R_D remains the same and is equal to 5.59%. Then, using the formula of Weighted Average Cost of Capital, the following result occurs:

$$WACC = R_E * \left(\frac{E}{V}\right) + R_D * (1-t) * \left(\frac{D}{V}\right) \Rightarrow \text{WACC} = 6.00\%*40\% + 5.59\%*60\% = 5.76\%$$

Therefore, R_D<WACC<R_E, supposing that beta is more than one.

Table 27: PANAMAX OSTRIA data with b>1.

DATA				DD PER 5 YEARS
				2008
VALUATION DATE	1/12/2023			2013
VESSEL TYPE	BC			2018
YEAR OF BUILT	2008			2023
SIZE	76,444	DWT		2028
AGE	18	YEARS		2033
LIGHT DISPLACEMENT	12,250	LT		
ECONOMIC USEFUL LIFE	18	YEARS		
OPERATING DAYS	355	DAYS		
ACTUAL BOOKING DAYS	95%			
OPERATING DAYS WITH DD	340	DAYS		
GROSS CHARTER RATE PER DAY	17,600	$		
AGE DISCOUNT	4%			
FEES & COMMISSIONS	5%			
ANNUAL OPEX				
MANNING COSTS	875,000	$		
STORES	258,000	$		
ROUTINE, REPAIR & MAINTENANCE	187,200	$		
INSURANCE	350,000	$		
ADMINISTRATION	154,300	$		
TOTAL ANNUAL OPEX	1,824,500	$		
INFLATION RATE PER YEAR	2%			
EXPECTED INCREASE OPEX PER YEAR	2.50%			
SCRAP PRICE PER LONG TON AT VALUATION DAY	250	$		
WACC	**5.76%**			

After adjusting the Weighted Average Cost of Capital (WACC) following the methodology, the subsequent step entails proceeding with the determination of the Long-Term Average Value (LTAV). This requires the determination of the discount rate, which provides the basis for determining the present value of the projected cash flows. Subsequently, dividing the present value by the number of outstanding shares yields the LTAV.

Table 28: PANAMAX OSTRIA Results based on b>1.

YEAR	NO YEAR	VESSEL AGE	OPERATING DAYS	ACTUAL BOOKING DAYS (95%)	DAILY GROSS CHARTER RAT	AGE DISCOUNT	CHARTER RATE AFTER AGE DISCOUN	FEES & COMMISSIONS	DAILY NET CHARTER REVENUE	ANNUAL NET CHARTER REVENU	ANNUAL OPEX	SCRAP VALUE	FCF	WACC	PV FACTOR	PV
2023	1	18	340	323	17,600		17,600	5%	16,720	5,400,560	1,824,500		3,576,060	5.76%	0.95	3,381,438
2024	2	19	355	337	17,952	4%	17,234	5%	16,372	5,521,533	1,870,113		3,651,420	5.76%	0.89	3,264,788
2025	3	20	355	337	18,311	4%	17,579	5%	16,700	5,631,963	1,916,865		3,715,098	5.76%	0.85	3,140,944
2026	4	21	355	337	18,677	4%	17,930	5%	17,034	5,744,602	1,964,787		3,779,816	5.76%	0.80	3,021,740
2027	5	22	355	337	19,051	4%	18,289	5%	17,374	5,859,495	2,013,907		3,845,588	5.76%	0.76	2,907,006
2028	6	23	340	323	19,432	4%	18,655	5%	17,722	5,724,148	2,064,254		3,659,894	5.76%	0.71	2,616,064
2029	7	24	355	337	19,820	4%	19,028	5%	18,076	6,096,218	2,115,861		3,980,357	5.76%	0.68	2,690,286
2030	8	25	355	337	20,217	4%	19,408	5%	18,438	6,218,142	2,168,757		4,049,385	5.76%	0.64	2,587,987
2031	9	26	355	337	20,621	4%	19,796	5%	18,807	6,342,505	2,222,976		4,119,529	5.76%	0.60	2,489,529
2032	10	27	355	337	21,034	4%	20,192	5%	19,183	6,469,355	2,278,550		4,190,805	5.76%	0.57	2,394,769
2033	11	28	340	323	21,454	4%	20,596	5%	19,566	6,319,922	2,335,514		3,984,408	5.76%	0.54	2,152,914
2034	12	29	355	337	21,883	4%	21,008	5%	19,958	6,730,717	2,393,902		4,336,815	5.76%	0.51	2,215,739
2035	13	30	355	337	22,321	4%	21,428	5%	20,357	6,865,332	2,453,750	3,062,500	7,474,082	5.76%	0.48	3,610,888
															LTAV	$ 36,474,153

Based on our analysis, it appears that when b>1, the only columns that exhibit a change are WACC, PV Factor, and PV. Observing that the PV Factor diminishes throughout the years, due to the bigger denominator, a lower LTAV value of **$ 36,474,153** occurs than the previous results.

4.2.4. Compare between different beta results in Income Approach Valuation

Table 29: LTAV Results Comparison.

Beta	WACC	LTAV Results
B=1	5.59%	36,860,410 $
B<1	5.26%	37,651,280 $
B>1	5.76%	36,474,153 $

In brief conclusion, Beta is analogous to WACC and vice versa with LTAV Results. Beta shows how risky is an investment, and so does the WACC. WACC represents the return of the asset to the investors. That's why, the higher the WACC, the higher volatility it has, as investors anticipate greater returns for compensation. LTAV has adverse results, as it is the value of the asset that the investor must pay. Thus, he prefers a riskier investment with low LTAV Results.

4.3. Fitting the model with the Replacement Cost Approach

This valuation method requires a comparable vessel with similar characteristics and demands the same type as the valuated one, as it is based on substitution cost. In this instance, information on Marine Traffic is found, one of the most useful and accurate websites providing vessel information for every ship. In this case, Vessel TORO is the subject ship that will be utilized, to appraise PANAMAX OSTRIA's value on 1st December 2023. Based on the information below TORO is an active Panamax Bulk Carrier of 76,636 DWT built in 2008, the same as the main vessel.

Table 30: Subject's vessel information.

VESSEL INFORMATION	
IMO	9443009
Name	TORO
General Vessel Type	Cargo
Detailed Vessel Type	Bulk Carrier
Navigational Status	Active
MMSI	538007174
Call Sign	V7NL4
Flag	MARSHALL IS (MH)
Gross Tonnage	39737
Summer DWT	76636 t
Length Overall x Breadth Extreme	224.94 x 32.26 m
Year Built	2008

Source: based on Marine Traffic.

Herein it can be observed the valuation estimation in the present market depends on data from Marine Traffic. The price of $14,6 million is used to make the appropriate calculation with the Replacement Cost Approach. Accordingly, the value of 11.8 million USD is used for PANAMAX OSTRIA, as in **Table 15**.

Table 31: Subject's Vessel Valuation for the use of RCM.

CURRENT VALUATION	
Current Valuation	Demolition Value
$14.6 Million	**$6.0 Million**

Source: based on Marine Traffic.

Table 32: Replacement Cost Results for Panamax Ostria.

DATA	MAIN VESSEL	SUBJECT VESSEL
VALUATION DATE	1/12/2023	
NAME OF VESSELS	PANAMAX OSTRIA	TORO
VESSEL TYPE	BC	BC
SALE PRICE	$ 11,800,000	$ 14,600,000
YEAR OF BUILT	2008	
SIZE	76,444 DWT	76,636 DWT
AGE	15 YEARS	15 YEARS
ECONOMIC USEFUL LIFE	18	
DEPRECIATION LIFE (1/ economic useful life)	6%	
CURRENT VALUE OF MAIN VESSEL (Sale Price-(Sale Price x Depreciation Rate x Age)	$ 1,966,667	
REPLACEMENT VALUE OF SUBJECT VESSEL (Sale Price-(Sale Price x Depreciation Rate x Age)		$ 2,433,333
DEPRECIATED REPLACEMENT COST (Current Value of Main Vessel+Replacement Value of Subject Vessel)	$	4,400,000

Given the valuation date of 1st December 2023, Vessels of PANAMAX OSTRIA 76,444 DWT/2008 YOB, which is the main ship, and TORO 76,636 DWT/2008 YOB, as the subject vessel, are considered. The economic useful life has been determined in 18 years, as in the previous valuation methods, to make adequate comparisons later.

Depreciation life can be estimated based on the economic useful life. It can be calculated by the form $\boldsymbol{Depreciation\ Life} = \frac{\mathbf{1}}{\boldsymbol{Economic\ Useful\ Life}}$, which is equal to 6%. The current value of the main ship and the replacement value of the subject vessel can be appraised from the following equation: **Sale Price - (Sale Price x Depreciation Rate x Age)**. For Vessel PANAMAX OSTRIA this value is equivalent to $11,800,000-($11,800,000 x 6% x 15) = $1,966,667 (a). Respectively for the subject vessel TORO, its value is equal to $14,600,000-($14,600,000 x 6% x 15) = $2,433,333 (b). Finally, by adding the relations (a) and (b) the Depreciated Replacement Cost Value reaches **$4,400,000**.

4.4. Comparing between different valuation methods.

Table 33. Valuation Methods' Results for vessel PANAMAX OSTRIA.

METHOD	RESULT
1. Market Method	13,978,143.87 $
2.1. Income Method with beta=1	36,860,410 $
2.2. Income Method with beta<1	37,651,280 $
2.3. Income Method with beta<1	36,474,153 $
3. Replacement Cost Method	4,400,000 $

As can be observed from the results, there is a large deviation among them. The major reason why this might become is that different criteria are taken for granted in each method. There is no mistaken valuation result, as every approach can be utilized for different uses and purposes.

For a Panamax vessel like PANAMAX OSTRIA, which is 76,444 Dead Weight Tons and was built in 2008, the most rational outcome for 1st December of 2023 would be with a Market Approach of 13,978,143.87 $, because it is based on the current shipping market conditions and is comparable to a sample of similar data of vessels.

Nonetheless, the Income approach takes into consideration more aspects, financial terminology, and more complicated calculations, to appraise an accurate result. As can be noticed, in the LTAV method, three scenarios of beta contribution are assumed, which is why there are three different results only in one method.

The Income Method, a widely used approach in finance, is influenced by several key measures that are critical to understanding the financial performance of a company. These measures include the Weighted Average Cost of Capital (WACC), Present Value (PV), and Free Cash Flows (FCF). Additionally, FCF is derived from various factors such as Charter Rate, Age Discount, Fees and Commissions, Charter Revenue, OPEX (Operational Expenses), and Scrap Value. A thorough understanding of these measures is essential for making informed financial decisions.

Finally, the result of the Replacement Cost Method is the lowest result of all with a value of 4.4 million USD. This occurs because this method takes under consideration only one vessel, which is not so indicative for the appraisal and it is based on the replacement value, which derives from a depreciation rate.

5. Conclusions

This dissertation has provided a thorough presentation of applied valuation methods that are used extensively in shipping investment and financial decision-making. Since appraising vessels plays a key role in finance, there is no surprise in developing new valuation approaches fitted to the demands of the shipping market.

Herein, the main three valuation approaches have been examined and have displayed how they can be utilized for asset play investment. First and foremost, the most common and widely accepted method in the shipping industry is the market approach, which estimates a ship's value compared to recent sales of similar vessels. This approach is also known as the "mark-to-market" method in shipping valuation. Secondly, the Income Approach, which is a more complex valuation appraisal, determines the principal value of a vessel by its future expected cash flows, discounted by using the cost of capital (WACC), also known with the name of "mark-to-model". Finally, the Replacement Cost Method takes place between two similar vessels and has as a key point the depreciation value of a subject ship.

The choice among the three approaches is not always easy and is mainly based on one's view about market efficiency. Market prices and value results will have "close" results in "normalized" markets. In contrary to "abnormal" market conditions, market prices can diverge from value results under an inevitable state. Thus, a valuation model is required to recognize and explain this deviation, as well as to compare the models' outcomes among them. The most preferable valuation model is the Market Approach as it is the most comprehensive and least complex method concerning the others.

Even though the Income Method uses more composite financial techniques and, therefore, has more accurate results, is still less understood. Moreover, the Income Approach has to take into consideration market risk, which is expressed by the beta factor. As for the Replacement Cost Approach, it is only dependent on a vessel, which is the indicative one for the shipping market. Thus, this method does not provide such an accurate outcome.

During the conduction of this thesis statement, many obstacles and difficulties must be mentioned and taken into consideration for further research. Although ship valuation models end up with satisfied outcomes, there is little experience and knowledge on this subject, so there might be deficiencies or divergences in the results. Moreover, Vessel Valuation is a

modern and developing topic in shipping market investment. That's why, there are limited sources of information concerning this vital issue.

The present dissertation is premised on an analysis of the major valuation methods that pertain to the shipping industry. The underlying research is based on the views and opinions that have been expressed and explicated in the Literature Review section. Through a comparative analysis of these methods, the dissertation seeks to offer a clear and incisive appraisal of their distinctive characteristics, while also shedding light on the broader implications of valuation in the shipping industry.

What makes vessel valuation a modern trend nowadays is the competitive shipping environment and the unpredictable market conditions that have led valuers to develop renewable methods of appraising an asset. The restricted information about vessel valuation, data finding, and the challenge of an intuitive depiction of the valuation fitting models, were the most crucial parts of this thesis statement. Another important issue is that it is hard to quantify all the technical factors, which influence vessel price.

The depiction of the model, particularly in the Market Approach method, was based on the age of the ship, dead weight tonnage, and freight market conditions. Other crucial factors such as the type of engine, flag, speed, and other elements are difficult to determine. For the main reasons above, there must be mentioned the below recommendations for vessel asset play investments.

First, vessel valuation appraisals must become widely known to the immediately interested parties, such as willing buyers, willing sellers, valuers, etc. At the same time, ship valuation companies should provide adequate information and updates to all parties concerned. Adoption of vessel valuation should be an integral part of the maritime industry and for shipping finance, too. Thus, there would be appropriate training for potential valuers to make precise estimations in appraising a vessel. Many organizations such as Lloyds offer seminars and certifications that acknowledge someone as an official valuer.

Is noteworthy to mention that Ship Valuation is a vital part of contemporary shipping to support the sales and purchase department and the shipping finance sector. That is why accurate results have significant meaning. Generally, shipping valuation is an upcoming trend for the shipping finance sector, as the shipping market volatility and the uncertain

conditions that dominate the sector make it appropriate for any interested party. Further research in developing the appraisal methods and finding more ways to make them more comprehensive, should be examined from shipping companies, which are interested in adopting such techniques in their valuing system.

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