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PhD. THESIS

2019

DEVELOPING A COMBINED QUALITATIVE SHIP VALUATION ESTIMATION MODEL

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PİRİ REİS UNIVERSITY

2019

DEVELOPING A COMBINED QUALITATIVE SHIP VALUATION ESTIMATION MODEL

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Science and Engineering in partial fulfilment of

the requirements for the degree of

Doctor of Philosophy

Graduate Program in Maritime Transportation and Management Engineering

Pîrî Reis University

2019

DEVELOPING A COMBINED QUALITATIVE

SHIP VALUATION ESTIMATION MODEL

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Date of Submission: 28 October 2019

Date of Defense : 03 January 2020

Date of Approval : 03 / January / 2020

ACKNOWLEDGEMENTS

I am honoured to be able to have completed the PhD program, something I had wanted to do for many years but which I could not carry out due to difficult professional circumstances. When asked by my thesis supervisor if I would like to study ‘ship valuation’, I immediately said ‘yes’ - without first thinking it over. Looking back at this multi-disciplinary subject, I am still astonished how I managed to wade through the crocodile-filled pool into which I had so unthinkingly jumped! The reason is that *worldwide* very few scientists have studied this issue. It is impossible to reach an absolutely correct determination regarding future estimation nor can these predictions be realized precisely. This is not just my opinion but one shared by other scientists working on this issue. I am happy to have completed this challenging journey through the encouragement and support of my thesis advisor, Asst. Prof. Dr. Oktay Çetin. I am grateful for his support and his patience.

Apart from my Supervisor, I must express my gratitude to the other members of the thesis progress committee: Prof. Dr. Metin Çelik and Assoc. Prof. Dr. Ergün Demirel, for giving unwavering guidance and encouragement, and for sharing their insightful suggestions. They have all played a major role in polishing my research writing skills. I am also pleased to say ‘thank you’ to Prof. Dr. Taner Berksoy, who made valuable criticisms and provided useful directions at every stage of the thesis. I would also like to extend my deepest gratitude to Prof. Dr. Cem Gazioğlu. In addition, I am honoured that the honourable committee approved the scientific nature of my thesis.

I would like to state my deepest appreciation to my family who have always supported me, and I would like to apologize to them at the same time. I have been working at a busy pace for more than 30 years while they patiently waited for the opportunity for us to enjoy each other’s company. We have sacrificed the best years of our lives for the sake of our country interests. I would like to thank them once again for providing the necessary love, patience and sacrifice in this work. Every job has hidden heroes. Finally, I would like to express my gratitude to my colleagues who have motivated and supported me, and also the crows and seagulls that inspire me under all circumstances.

TEXT OF OATH

I declare and honestly confirm that my study, titled "Developing A Combined Qualitative Ship Valuation Estimation Model" and presented as a Ph.D. Thesis, has been written without applying to any assistance inconsistent with scientific ethics and traditions. I declare, to the best of my knowledge and belief, that all content and ideas drawn directly or indirectly from external sources are indicated in the text and listed in the list of references.

Murat Koray

January 14, 2020

ABSTRACT

The concept of value is as old as the history of humanity and is being discussed on that every period. The complex structure of maritime trade, the high uncertainties, and the lack of transparency of commercial data make ship valuation difficult. There are three most preferred approaches in maritime market to determine ship's valuation. These are marketing approach, income approach and cost approach. However, these approaches do not provide the fair value of the ships. The fair value is depending on the economy of scales. Particularly, determining of the fair value becomes more difficult in times of crisis. The determination of the direction in which supply-demand balance will occur due to instability in periods of economic crisis, and the volatility of the market, necessitate the use of combined mathematical methods. Brokers experience difficulty in determining a ship's real value because of the lack of instant and unbiased data that can be accessed at anytime and anyplace in the world. Mostly, brokers use a marketing approach to determine a ship's value. However, a marketing approach does not give an accurate solution under all conditions. Ships, especially those ranging in age from 6-25, that is, more than five years old, need to be evaluated with a combined method which differs from marketing approaches.

There is no systematic and standard mechanism to determine a ship's value worldwide. The aim of this study is to develop a reliable ship valuation mechanism using namely the ***"Combined Qualitative Ship Valuation Estimation Model (CQSVEM)"*** to validate the ship's actual price. Within this model, the ship's fair value can be calculated more accurately. According to concrete result of analysis, on average the second-hand price of bulk carriers' sales from 2014 to 2017 in the range of 18,233 dwt -172,549 dwt increases by $17.313 per 1 DWT while it loses $671.278 in value per 1 AGE annually. Hence, analysis indicated that the depreciations of these bulk carriers suffer from 5.2% to 7.2% per year. As a result of the analysis, it was found that a price difference in the range of $ 2.68M to (-) $ 2.49M was reasonable, while transactions outside this range were subject to excessive or low pricing. However, reasonable prices that are 40% of whole transactions are realised in the high volatile market. By running CQSVEM, the reasonable value of a ship can be calculated more accurately. This model, composed of eleven stages, will be useful in determining the fair value and to provide decision making support for willing buyers, willing sellers and other related third parties.

ÖZET

Değer kavramı, insanlık tarihi kadar eskidir ve her devirde bu konu tartışılmaktadır. Deniz ticaretinin karmaşık yapısı, belirsizliklerin çokluğu ve ticari verilerin transparan olmaması gemi değerlemesini güçleştirmektedir. Gemilerin değerini belirlemek için denizcilik piyasasında en çok tercih edilen üç yaklaşım bulunmaktadır. Bunlar emsal karşılaştırma yaklaşımı, gelir indirgeme yaklaşımı ve maliyet yaklaşımıdır. Ancak, bu yaklaşımlar adil fiyat veya makul fiyat değerini karşılamamaktadır. Makul fiyatın değeri ölçek ekonomisine bağlıdır. Özellikle kriz dönemlerinde makul fiyatın belirlenmesi daha da zorlaşmaktadır. Ekonomik kriz dönemlerinde meydana gelen istikrarsızlıklar ve piyasanın kırılgan olması nedeniyle arz-talep dengesinin hangi yönde olacağının belirlenmesi, birleşik matematiksel yöntemlerin kullanılmasını gerektirmektedir. Brokerler, herhangi bir zamanda ve dünyanın herhangi bir yerinde erişilebilen anlık ve tarafsız verilere ulaşamamasından dolayı bir geminin cari değerini belirlemekte güçlük çekmektedirler. Brokerler, çoğunlukla bir geminin değerini belirlemek için emsal karşılaştırma yaklaşımını tercih ederler. Bununla birlikte, emsal karşılaştırma yaklaşımı her koşulda doğru bir çözüm olmamaktadır. Özellikle, beş yaşından büyük olan gemilerin (6-25 yaş) değerlemesinde brokerlerin tercih ettiği emsal karşılaştırma yerine kombine bir metoda ihtiyaç duyulmaktadır. Dünya genelinde bir geminin değerlemesi için belirlenmiş sistematik ve standart bir yöntem bulunmamaktadır. Bu çalışmanın amacı, geminin cari fiyatını teyit etmek için "Birleşik Nitel Gemi Değerleme Tahmin Modeli" kullanarak güvenilir bir gemi değerleme mekanizması geliştirmektir. Analiz sonucunda elde edilen sonuçlara göre 2014 ile 2017 yılları arasında, 18,233 dwt -172,549 dwt aralığında satışı gerçekleştirilen kuru yük gemilerinin her 1 DWT için 17.313$ fiyat artışı olurken, her 1 YAŞ arttığında 671.278$ fiyat kaybı oluştuğu hesaplanmıştır. Bu analize göre, %5.2 ile %7.2 arasında yıl başına değer kaybı oluştuğu tespit edilmiştir. Bu dönemdeki kuru yük gemilerinin satışlarında (+) 2.68 milyon $ ile (-) 2.68 milyon $ arasında kalanların makul olduğu, bu değerlerin dışında kalanlarda ise aşırı fiyatlama olduğu görülmüştür. Tüm satışların %40'ının değerinde satıldığı hesaplanmıştır. Bu model sayesinde bir geminin makul değeri daha doğru hesaplanabilecektir. Bu nedenle bahse konu model, alıcılar, satıcılar ve diğer ilgili üçüncü taraflara adil olan gemi değerini belirlemek için faydalı bir karar desteği sağlayacaktır.

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LIST OF SYMBOLS

β: Beta Factor

Bt: Average Operational Expenditures (OPEX)

C_1: Current Net-Time Charter (TC) Rate in Running Year,

C_2: Average net-TC Rate

Ct: Charter Income

E: Market value of the ship's equity

F: Market value of the ship's debt

G: Total market value of ship's assets,

i: Discount Rate

r_D: Cost of debt capital

r_E: Cost of equity capital E

r_{Rf}: Risk Free Basic Rate of Interest

r_{wacc}: weighted average cost of capital (WACC)

RWt: Lightweight Displacement-LDT

t: Period,

t_1: current year,

t_2-T: Period End

T 20/25: Remaining period and

LIST OF ACRONYMS/ABBREVIATIONS

CQSVEM: Combined Qualitative Ship Valuation Estimation Model

DCF: Discounted Cash Flow

FMV: Fair Market Value

GDP: Global Domestic Product

HSES: The Hamburg Ship Evaluation Standard

ISTFIX: Istanbul Freight Index

LTAV: Long Term Asset Value

MRP: Market Risk Premium

OLV: Orderly Liquidation Value

OPEX: Operational Expenditures

PwC: Price Waterhouse Coopers

S&P: Sale and Purchase

TCE: Time Charter Equivalent

TNR: Total Net Revenue

TVE: Total Voyage Expenses

UNCTAD: United Nations Conference on Trade and Development

VHBS: The Association of Hamburg and Bremen Shipbrokers (Verband Hamburger und Bremer Schiffsmakler)

VHSS: The Hamburg Shipbrokers' Association (Vereinigung Hamburger Schiffsmakler und Schiffsagenten)

1. INTRODUCTION

There are lots of academic studies to date which have been written about the subject of value. However only a few of them are written about the "Ship's Value". The main reason for this deficit in academic studies is that the future estimation of ship's value is very difficult to ascertain and needs complex methods to determine the value accurately. Brokers experience difficulty in determining a ship's real value because of the lack of instant and unbiased data that can be accessed at any time or anywhere in the world. Mostly, brokers use a marketing approach to determine a ship's value. However, a marketing approach doesn't give an accurate solution under all conditions.

1.1 Definition of the Problem

Ships, especially those from the age range 6-25 which are more than five years old, need to be evaluated with a combined method which differs from marketing approaches. In addition, there is no official or authorized institution which provides official services on newbuilding prices, scrap prices, second-hand prices and forward valuations except well-known authorized research companies and some expertized institutions on valuations in the world.

Shipping companies in their estimations also need to take into account reasonable valuation companies globally. These companies follow the actual economic situations and evaluate all anomalies of the asset's values. Generally, willing buyers and willing sellers have no need for systematic rules to make ship valuation. But ship valuation depending on systematic rules are vitally important for Sales and Purchase Brokers (S&P) in terms of long-term asset values (LTAV). Reduced income (freight) cash flows, covering the next 10 to 15 years with accounts projections are made by them. However, it is very hard to estimate net asset values precisely. Moreover, ship values vary from country to country and time to time. For example, in accordance with US bankruptcy codes, US courts do not accept discounted cash flow methods. In this study, the ship's valuation as well as other valuation methods, such as shipyard and real estate have been scrutinized in all aspects.

1.2 Motivation to Study on Ship's Valuation

The concept of value is almost as old as the history of humanity. However, there has never been a complete understanding of this concept. The invention of money or the existence of money-like exchange tools shaped the concept of value. Geographical distinction and cultural differences affected the valuation methods, and as the international trade developed, the concept of value began to become concrete. Since maritime trade has directed all civilizations in the world to establish relations with each other, it has been instrumental in the development of the value of goods relatively through the exchange of goods produced. Catastrophic wars in the world, technological leaps, scarcity of the goods produced, surface and underground sources of the world that is not evenly distributed, the energy and transportation requirements for producing goods from country A to country B has triggered the economy of scale. As the economic events in the world change the equilibrium of supply and demand on production dynamically, the equilibrium of supply and demand on merchant ships is changing correspondingly.

For that reason, it becomes almost impossible to act with strategic foresight in the highly volatile maritime market. Scientific studies to date have often failed to estimate the future precisely. Although short-term forecasts are reasonable in the shipping market, the accuracy of long-term forecasts is controversial. The ship's valuations such as second-hands, newbuildings, casualties, modernization, renovation or scrap requires a correct calculation. In fact, there is a sudden decline in ship values due to the economies of scale, although the depreciation of a ship used in normal conditions is evident unless there is an unusual development with the cost of production of a ship. It is relatively easy to estimate the market value of a single ship during sale and purchase of second-hands or newbuildings. In addition, extensive research should be made on the freight market, shipbuilding market, sale and purchase market and demolition market and should be monitored day by day.

The sale and purchase prices of the same class of ships should be monitored and price quotes received from various shipyards should be taken into consideration for newbuildings. Since the options of two or three standard models of ships, as Chinese Shipbuilders suggested to the buyers, are cheaper than unique designs, it may be possible to reduce costs with a similar approach to mass production and hence a ship with the optimum size would be preferred by the shipowners.

The shipowners who intend to buy newbuildings or second-hand ships should make an attempt to sign a contract of affreightment with their customers before purchasing a ship. Because the agreement is an evidence to ensure that they will pay their loan debts to creditors. In addition, if the shipowners attempt to find charterers after purchasing, risky payment cycle might be occurred, and it might be late to earn money. It is vital to estimate freight rates at this stage. The valuation process determines how much the ship is at a certain point and usually has five common uses. Stopford stated that

> "The first is to establish the current market value of a vessel being purchased or offered as collateral against a loan. When drawing up a loan agreement, bankers seek an independent collateral value of the ship. Second, loan documentation often includes a clause requiring the borrower to maintain collateral at a prescribed level. If a merchant ship is held as part of the collateral package, it is necessary to update the market value of the vessel to establish whether the collateral conditions are being met. A third use is to establish the market value of the fleet owned by a company making a public offering or issuing a bond, and the values will appear in the related documentation, for example the prospectus. Fourth, companies publishing their accounts may include a current market value of the fleet. Finally, an investor buying a second-hand ship may obtain a valuation as a check against the price, especially if there is not much else on the market" (Stopford, 2003).

Shipbrokers evaluate the ship taking into account the type, the age, the size, the construction year and technical characteristics of the ship. The inspection of a ship is difficult to do by brokers as it requires special technical knowledge. Specialists can prepare inspection and survey reports only. For that reason, brokers first assume that the ship has to be proper for seaworthiness & cargoworthiness and then a price reduction will occur according to the technical condition of the ship. There are three most preferred approaches to determine ship's valuation. These are marketing approach, income approach and cost approach. Marketing approach is very practical for ship brokers. However, marketing approach does not always give concrete results to estimate the correct price of a ship. Why brokers prefer marketing approach instead of others? Because, it is very easy, and brokers have to be fast for the best option and have to decide buying or selling to willing buyers or willing sellers as soon as possible. Since the competition in the maritime market is rather stiff, there is often no possibility to conduct an in-depth investigation. Due to the free market (laissez faire) conditions, lead to volatility in ship prices. Because of this situation, there are even large fluctuations in ships of the same type and age. The problem area was detailed in the thesis and large-scale anomalies were revealed. In this case, based on the most recent buying and selling prices in the market, no matter what approach is used, all calculations will result in incorrect results. Since the maritime market is not transparent, data collection for brokers always requires a challenging struggle and laborious efforts are made to predict the future with incomplete information. Some private research companies around the world have been collecting market data regularly for a long time and have created a data repository to perform big data management. These companies generate indices in various methods and provide their users to predict the future course of actions. Whichever method is applied, the net present value used in estimating the future should be calculated correctly. In order to calculate net present value of ship prices, adjustment price should be matched. Within the scope of the study some limitations related with valuation have been applied because of the very different types of ships in shipping trade. Because of the major and minor commodities of world production cover more than thirty percent of the world trade, dry bulk carriers have been preferred in the study. Since each type of merchant ship has different characteristics, there are some differences from the valuation methods. For example, if there are reefer in container ships, especially attribute adjustment should be done.

In order to improve **"Combined Qualitative Ship Valuation Estimation Model"** previous valuation methods were scrutinized. The differences and deficiencies of these valuation methods have been interpreted. In order to develop a new hybrid method to eliminate the gaps of the valuation methods, a field study was conducted to collect the appropriate data. These data were collected by reviewing official web sites such as Clarkson Research, Lloyd's List, Baltic Exchange, Shanghai Shipping Exchange, Hellenic Shipping News etc. This data shows the years of construction, sales year, tonnage, sales price of the ships, the shipyard where it was built, and which shipowner company was sold. In the literature review, a comprehensive study was carried out on which factors affect ships' value. Although there are many factors affecting the value of a product subject to world trade, it is understood that the most important factors that determine the ship price are ship type, age, tonnage and specific feature according to the findings obtained from previous studies. In the estimation of the future, it has been determined that the income approach is more accurate, but it is understood that this is utmost important to predict the future by calculating the net present value correctly or by adjusting the price before valuation.

1.3. Research Objective

The aim of this study is to develop a ship's valuation mechanism using the **"Combined Qualitative Ship Valuation Estimation Model"**. Within this model the ship's value can be calculated more accurately. On the other hand, the objective of the study is the model a reliable evaluation method to validate the ship price. However, there is no systematic and standard mechanism to determine a ship's value worldwide. In this context, it is considered that authorized vessel value system is necessary for making future estimation and providing decision-making data to ship owners, investors, banks, insurance companies and other public or private institutions. In the light of the aforementioned above research objectives have been following steps;

- **STEP-1:** Analysing methods and approaches for valuation have been scrutinized.
- **STEP-2:** A critical analysis of these methods has been undertaken to determine the gaps.
- **STEP-3:** These methods have been combined to overcome their shortcomings.
- **STEP-4:** A new model to determine ship's value more accurately has been developed.

2. LITERATURE REVIEW

Due to the comprehensive thesis study, the literature review was explained in five steps. Firstly, it was intended to understand the term of value in the economic sense. Secondly, Lloyd’s of London Press Ltd. Publications and VesselValue.com Ltd. Web Site were considered and reviewed as a guide document. Thirdly, some important issues were scrutinised such as “Shipping Innovation”, “Investment Philosophies”, “Financial Modeling & Valuation”, and “Value Capture for Transportation Finance” Forthly, appropriate mathematical models were investigated how to calculate the adjusted value of the ships. In addition, Institute of Chartered Shipbrokers (ICS) publications have been used to understand the nature of shipping trade.

2.1 Theoretical Background: The Term of Value

The first thinkers of the economic theories that existed in the world have generally been men of theology and philosophy. Therefore, the concept of value has been basically built on ethical values firstly (Hirose & Olson., 2015). The term of axiology defined by Britannica or Mariam-Webster etc. means “Value Theories” and that is associated with economy such as “Catallactic”, “Political Economy”, or “Science of Exchanges” (Mill, 1965). As far as is known, the first thinker to articulate the concept of value has been Plato. Plato adopts his opinion, “where property is owned by all and labour is specialized” (Mohun & Warren, 2012). Aristotle is the first to put forward the concept of "value in use" and "value exchange" (Fogarty, 2018). In order to enlighten the concept of value, the "justum pretium" doctrine was developed by Saint Thomas Aquinas. Saint Thomas Aquinas' thought about the economy (trade, wages, division of labour, usury etc.) has led to the development of the "justum pretium" doctrine and has made an important contribution to comprehensive understanding of the value concept. Aquinas put forward that the just price occurred at the point of equilibrium where economic fluctuations stabilized (Rekhi, 2018). He claimed that “the justum pretium" doctrine plays an important role on wage arbitrations among the parties such as unions and corporations, employees, and employers, etc. (Frings, 1987). Even though the concept of value had been understood on the time of Aquinas (1225-1274), the concept of intrinsic value could not be perceived. Thomas Aquinas had been stated that the price of a product will be fair unless there is no deception or over pricing in the market (Mohun & Warren, 2012). John Duns Scotus (1265-1308) emphasized that supply and demand are not unlimited and that production costs are an important factor in this limitation. Scotus also articulated that a fair price could occur when a willing buyer and willing seller were to buy a product on the market (Mochrie, 2005).

Scotus expressed that:

> "The value equivalence must always be maintained by using fairness, insofar as it is possible to accomplish this without fraud…….However, at all times value equivalence ought to be determined not only naturally, on the basis of the thing itself, but on the basis of sound and fair judgment" (Scotus, Wolter, & Bychkov, 2016).

Similarly, Ibn Khaldun (1332-1406) stated that the value of a product is directly proportional to the labour given to it (Ibn Khaldun, 1978). He also emphasized that "labour is the real basis of profit" Ibn Khaldun thought on production, value, price, wage and profit that are in accordance with the balance of supply and demand. In the view of Jean Buridan's Philosophy of Logic (1300-1358); it can't be rational selection between two equidistant and equally tempting things (Bruidan, 1985). He emphasized that the importance of valuing by making comparisons and revealing differences**.** William of Occam (1285-1347) and Gabriel Biel (1420-1495) are the pioneers of nominalism. They developed arguments against the realist philosophy that Thomas Aquinas and John Duns Scotus put forward. They claimed that the value of a good depends on its usefulness in meeting needs. Realism and nominalism approaches have begun to leave their place to mercantilism in the 16^{th} or 17^{th} century. Mercantilism is the economic order of the new world that is the result of renaissance, reform and geographical discoveries. Following the discovery of the America started gold transfer from America to Europe. Due to the fact that maritime shipping made attractive in seven oceans under the auspices of Navy (sequentially; Portugal, Spain, Netherland and UK) increased the exchange of freight between the East and the West. Bernardo Davanzati (1529–1606) concentrated on the determinants of the demand for goods (utility), since the merchants' profits depended on the exploiting of the difference between the market buying and the selling prices rather than controlling the production process. Davanzati thought that value depends on any intrinsic value instead of depending on utility and scarcity. Davanzati distinguished "value-in-exchange" from "value-in-use", identifying the "paradox of value" in the process (Fonseca, 2017). From Mercantilist economists, Sir William Petty (1623-1687) interpreted the concept of value, considering the factor of labour and nature and he determined how the economy can be measured (Aspromourgos, 1995). Petty's view was to apply the new empirical methods of science to financial and political affair using real world data rather than relying on logical reasoning. English Economist Sir William Petty introduced the concepts of national income and expenditure. Petty also argued that the value of a product comes from the effort needed to make it (Mohun & Warren, 2012). At that times, English Philosopher John Locke defended contrary opinions of William Petty's theories. He argued that commodity prices are directly influenced by the ratio of buyers to sellers. In the seventeenth century John Locke built on Aristotle's ideas when he attributed the corruption of human nature to the introduction of money (Wood, 2004). John Locke claimed that supply and demand are only affecting value in the short term. The value attributed to the usage of the goods, not by benefits of them, varies according to the amount of demanded goods. However, in the long run, labour is the only factor that determines value. Thanks to the work of the French economist Anne Robert Jacques Turgot (1727-1781), the measure of value has been transformed into the concept of utility again. Even if Turgot accept that there are several factors create value, the most important factor among them is the other person's need. In other words, he thought the value concept as a providing benefit to a consumer of goods. Turgot expresses his ideas about the concept of value as follows;

> "The only means of expressing value is then, as we have said, to express that one thing is equal in value to another; or, if you like, in other words to present one value as equal to a required value. Value, like size, has no other measure than itself, and if values are measured by comparison with other values, as length is measured by comparison with other lengths, then, in both means of comparison, there is no fundamental unit given by nature, there is only an arbitrary unit given by convention" (Groenewegen, 1977).

Richard Cantillon (1680-1734) was accepted utmost important figure in the early development of economics. He tried to explain the inter-connected economy how it worked and became the first to present a coherent theory of prices and income distribution (Brewer, 1992). Cantillon distinguished between market prices and intrinsic values. He thought that

> "Market prices are, the actual prices paid in the market on any particular occasion. Intrinsic values are the center of gravity around which market prices fluctuate and are relatively unchanging" (Brewer, 1992).

Cantillon's theory can be summarized that market prices depend on supply and demand. The intrinsic value of a good does not always equal the market price. However, the market value of the goods that are sought and whose prices are stable can be at the same level as the market value. Buyers' preferences and value judgments, sellers' mastery, and supply-demand quantities play a role in price formation. The market price often occurs at a different level of intrinsic value. Cantillon defined the term of intrinsic value which it can be measured by the quantity of land and labourers, considering the quality of land and labour. Cantillon's construction of "intrinsic value" mean that the concept of opportunity cost, not the essential nature of a thin. There is never variation in the intrinsic value of things, but the impossibility of proportioning the production of goods and products in a state, to their consumption, causes a daily variation, and a perpetual ebb and flow in market prices (Cantillon, 2010).

Cantillon dictated that:

> "There is no such 'par value' between land and labour, only money a 'most certain measure' can be used for income measurements and comparisons" (Cantillon, 2010).

Adam Smith (1723-1790) was a Scottish philosopher and economist who is the best known as the author of "An Inquiry into the Nature and Causes of the Wealth of Nations", who was influenced by Richard Cantillon's essay on economic theory (Essai sur la Nature du Commerce en Général) (Butler, 2011). According to view of the Adam Smith Institute, themes of The Wealth of Nations are as follows;

“The first theme in The Wealth of Nations is that regulations on commerce are ill-founded and counter-productive. Another central theme is that this productive capacity rests on the division of labour and the accumulation of capital that it makes possible. Smith’s third theme is that a country’s future income depends upon this capital accumulation. A fourth theme is that this system is automatic. Where things are scarce, people are prepared to pay more for them: there is more profit in supplying them, so producers invest more capital to produce them. Where there is a glut, prices and profits are low, producers switch their capital and enterprise elsewhere” (Adam Smith Institute, 2019).

Adam Smith distinguished the value concept in two different meanings. The one may be called “value in use”; the other, “value in exchange”. The things which have the greatest value in use have frequently little or no value in exchange; and, on the contrary, those which have the greatest value in exchange have frequently little or no value in use. Nothing is more useful than water: but it will purchase scarce anything; scarce anything can be had in exchange for it. A diamond, on the contrary, has scarce any value in use; but a very great quantity of other goods may frequently be had in exchange for it (Smith, 1976). David Ricardo (1772-1823) criticized Smith's conception of the labour that is to be compared because different types and amounts of labour are spent for different products. He realized that value depended upon the quantity of labour necessary for production which would be calculated by time (Fogarty, 2018). Ricardo stated that:

“Possessing utility, commodities derive their exchangeable value from two sources: from their scarcity and from the quantity of labour required to obtain them.” (Ricardo, 2001).

David Ricardo also claimed that:

“The diminution of money in one country, and its increase in another, do not operate on the price of one commodity only, but on the prices of all”

Ricardo's labour theory of value constituted the basis for Karl Marx's theories of surplus value (Mohun & Warren, 2012). Karl Marx (1813-1883) wrote described the circulation of capital using a model inspired by Quesnay. Quesnay produced his Economic Table, the first analysis for the workings of a whole economy (macro economy). He tried to show that:

“Market competition allows the existence of a value surplus, over costs, in the prices of primary commodities, while the market value of the products of industry is always equal to the expenses incurred in their production” (Vaggi, 1987).

Adam Smith saw society as perfectly functional, and the entire economy as a successful system, an imaginary machine that worked. Smith described how his system of “perfect liberty” could have positive outcomes. However, Karl Marx believed that:

“A commodity’s value is based on the labour needed to produce it, capitalists must price the finished goods by first adding the price of labour to the initial commodity cost, then adding profit” (Mohun & Warren, 2012).

Karl Marx distinguished the concept of capital into two part. He described the concept of capital as unchanging capital invested in the means of production, and variable capital invested in the means of labour force. According to Marx's theory (Bilgi, 2016), surplus value is equal to the new value created by workers in excess of their own labour-cost, which is appropriated by the capitalist as profit when products are sold. Karl Marx has not rejected the views of John Locke and Ricardo who claimed that the capital is the accumulated labour. Marx thought that the raw materials and machine assets were equal to the wages he had spent to obtain them. The cost of capital and raw materials are not included to surplus value. The concept of surplus is limited to the unpaid amount of labour, especially if it is the right to labour. John Stuart Mill (1806-1873) claimed that:

“The value which a commodity will bring in any market is no other than the value which, in that market, gives a demand just sufficient to carry off the existing supply” (Mill, 1965).

William Stanley Jevons (1835-1882) challenged the classical model that cost determines value. He noted that labour (or capital) once spent has no influence on the future value of an article; bygones are forever bygones. In this context, Jevons stated that:

“Cost of production determines supply, supply determines final degree of utility, final degree of utility determines value” (Jevons, 1888).

Carl Menger (1840-1921) obtained five main principles about economics related with value as follows;

"The value of a particular good or of a given portion of the whole quantity of a good at the disposal of an economizing individual is thus for him equal to the importance of the least important of the satisfactions assured by the whole available quantity and achieved with any equal portion. For it is with respect to these least important satisfactions that the economizing individual concerned is dependent on the availability of the particular good or given quantity of a good." (Menger, 2004)

Marie Esprit Leon Walras (1834-1910) discovered the concept of marginal utility. Walras created a theoretical model of "General Equilibrium" related with means of integrating both the effects of the demand and supply side forces in the whole economy (Daal & Jolink, 1993). This mathematical model of simultaneous equations concluded that "In general equilibrium everything depends upon everything else." Léon Walras tried to analyse the concept of value from the approach of demand (Okamoto & Ihara, 2005). Based on the equations covering the entire exchange mechanism, he considered that a good could arrive at an individual value criterion. It aims to reach the subjective side benefit of a single commodity by moving from the macro equilibrium measure. Alfred Marshall (1842-1924) was also merging the classical analysis with the new tools in order to determine value concept considering supply and demand. He found the time effects on value. Marshall explained his study within four time periods shown in Table-2.1

Table-2.1 Time Effects on Value

Market Period	Time	Supply	Demand	Value Determined By
1	Too short	Production Fixed	Variable	Demand
2	Short-run	Production Variable, Plant Size Fixed	Variable	Supply and Demand
3	Long-run	Production Constant, Plant Size Altered	Variable	Economy of Scale
4	Secular	Technology and Population Variable	Variable	Supply

Source: Compiled by author considering the book of "Principle of Economics" which is written by Alfred Marshall) (Marshall, 2013)**.**

Marshall emphasized as a general rule:

> "The shorter the period which it is considered, the greater must be the share of attention which is given to the influence of demand on value; and the longer the period, the more important will be the influence of cost of production on value" (Mukherjee & Kanwar, 1990).

While the value is determined by the effect of demand instead of supply in the market in the short term, the effect of the supply on the value is higher than demand due to the late reaction of the production costs to the market in the long term (Medema and Samuels 2003). Two theories of Karl Marx, "Capital and Interest" had been criticized by Austrian Economist Eugen Böhm-Bawerk (1851-1914). He found two point of rebuttal. Eugen Böhm-Bawerk has two arguments. First, waiting argument means that business people, capitalists etc. have to be wait for manufacturing process, selling productions to the customers and second always business people take risks but workers don't (Skousen, 2007). He thought that value presupposes scarcity, valuelessness presupposes superabundance. Because he understood that the superabundance must be sufficiently large to permit the loss of the very goods which are being subjected to a valuation, without converting the superfluity into an insufficiency. Keynes, thought on two fundamental postulates about:

> "The wage is equal to the marginal product of labour", and "The utility of the wage when a given volume of labour is employed is equal to the marginal disutility of that amount of employment" (Keynes, 2013).

Friedman's theory is based on the distinction between the positive and the normative economy. He stated that:

> "Positive economics is in principle independent of any particular ethical position or normative judgments. As Keynes says, it deals with "what is," and not with "what ought to be".

Its task is to provide a system of generalizations that can be used to make correct predictions about the consequences of any change in circumstances. (Friedman, 1953). Its performance is to be judged by the precision, scope, and conformity with experience of the predictions it yields.

In short, positive economics is, or can be, an **"objective"** science, in precisely the same sense as any of the physical sciences. He concludes that making progress in positive economics is of more importance than making progress in normative economics proper (Hammond, 2009).

2.2 Definitions Attributed to the Concept of Value in Shipping Markets

Definitions attributed to the concept of value in shipping markets were explained following subheadings.

2.2.1 The Most Accepted Term of Value in Shipping Market

In general, the term value represents an amount, as of goods, services, or money, which is considered to be a fair and suitable equivalent.

2.2.2 Market Value

Ship values are available in open sources. Brokers make an evaluation based on the data obtained from these sources. The "International Valuation Standards" defines market value as;

"the estimated amount for which an asset or liability should exchange on the valuation date between a willing buyer and a willing seller in an arm's length transaction, after proper marketing and where the parties had each acted knowledgeably, prudently and without compulsion" (IVS, 2016).

2.2.3 Equitable Value

Equitable Value is the estimated price for the transfer of an asset or liability.

2.2.4 Investment Value

Investment Value is the value of an asset to an owner for investment or operational objectives.

2.2.5 Synergistic Value

Synergistic Value is the result of a combination of two or more assets or interests where the combined value is more than the sum of the separate values.

2.2.6 Liquidation Value

Liquidation Value is the amount that would be realised when an asset or group of assets are sold on a piecemeal basis, that is without consideration of detriments related with a going-concern business.

2.2.7 Replacement Value

Replacement Value is the total cost of replacing an asset, generally in its present form and in accordance with appropriate regulations and legal requirements.

2.2.8 Fair Value

Fair Value would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date (IFRS, 2019).

2.3 Previous Ship Valuation Methods and Approaches

When the previous ship valuation methods and approaches are examined, it is seen that there is a distinction on newbuilding, second-hand and scrap values. Shipyard owners want to estimate new ship prices in order to increase shipbuilding production capacities by taking the economies of scale into consideration. There is a need for the determination of second-hand ship values for the purpose of buying and selling ships, ordering new ships and making long-term lease agreements. The two most important factors affecting ship supply and demand are ship prices and freight rates. Other than that, cargo owners, banks, insurance companies, bankers, governments, port authorities, machinery manufacturers, international organizations, oil companies, steel producers and sellers, that they want to examine the maritime market and to make a prediction for the future.

The decision makers have to make a prediction for various reasons. Majority of these are trading on the spot market, time-charter market, sale and purchase market, budget planning, strategic and institutional planning, product development, international negotiations, government policies, establishment of industrial relations, bank credit analysis and expert reports for courts.

Time element is very important factor for ships' valuation. The estimates to be made in accordance with instantaneous, short term, medium term or long term, change the methods to be applied. Since brokers exposure to deal with instant data under the time-pressure, they have no option other than snap decision-making processes and methods. The short term generally includes 18 months of data. Therefore, the future estimation in short-term can be calculated more accurate than long term. Mid-term forecasting include 5-10 years' time-span. Bankers who provide capital to the maritime sector describe the medium term as 4-12 years time-span in general (Stopford, 2009).

Shipbuilders are agree on the time-span (4-12 years) articulated too. Since the estimates after 10-12 years are accepted as long term, it is vital that shipowners survive in crisis periods and risk factors can be determined. Therefore, it is seen that supply-demand models and econometric models are used in forecasting the future. Since the economic life of the vessels is in the range of 20-25 years, the long-term estimations between 10 and 25 years should be done carefully. Uncertainties regarding the stagnation or crisis in the economy due to technological leaps, standards, and criteria promulgated by regulations are increase the risk and make the estimations more difficult. There are three different approaches to predicting the future. These are market report, forecasting model and scenario analysis. As a result of market forecasting, market research data and applied methods, new shipbuilding prices, second hand prices, freight rates and shipbuilding orders are estimated. However, because the world economy, product trade, the presence of existing trade fleets, ship prices and freight rates in relation to the investment sensitivity of shipowners, determining the ship supply and demand, in the estimation of ship prices, the difficulty of collecting data and the diffusion of these data due to the large number of dependent variables, make the estimations difficult to process correctly. Macro-level variables are divided into sub-groups, a very large increase in the number of variables occurs, but the effect of each variable is discounted to a negligible level as the weight coefficient decreases. In previous models, the factors affecting ship supply and demand have been determined that the type, age and tonnage of the vessels are the most effective factors on ship price. However, the age of the ship has a multiplier effect of over 60% compared to the others. Regression models confirm these coefficients almost every period. By regression or multiple regression analysis, it is possible to calculate the main variables such as the type, the age and the tonnage or secondary variables such as the discount rates, the interest rates, the indexes, the steel prices. Besides, whether the effect of each unit increase these variables, and there is a correlation or not between these variables on the ship price are also predicted. In addition, it can also be determined whether the result obtained by performing simulation analysis is reliable or not. Analytical researchs, models and techniques are as in Table-2.2

Tablo-2.2 Analytical Research / Model / Analysis / Techniques Used in Maritime Trade

Analytical Research / Model / Analysis	Analytical Techniques
Opinion Survey	DELPHI technique Opinion Surveys
Trend analysis	Naïve (Bayes) Analysis Trend extrapolation Smoothing Decomposition Filters Autoregressive (ARMA, ARIMA, GARCH) Box-Jenkins Model
Mathematical Model	Single Regresyon Multiple Regresyon Econometric Models Supply-Demand Models Sensitivity Analysis
Probability Analysis	Monte Carlo Analysis

Source: “Analytical Researchs / Models / Analysis / Techniques Used in Maritime Trade” (Stopford, 2009)

Major determinants of newbuilding prices are determined as shipbuilding cost, shipyard capacity, vessel orderbook, freight rates and secondhand prices by the following authors as in Table-2.3

Table-2.3 Distinguished Models/Approaches Related with Vessel Prices

AUTHORS	MODELS/APPROACHES	EXPLANATION
Beenstock and Vergottis	a. An econometric model of the world shipping market for dry cargo, freight and shipping. b. An Asset Pricing Approach c. A Capital Asset Allocation Model	Newbuilding and Secondhand Ship Prices
Tinbergen	A Cyclical Model for Shipbuilding Cycles	Newbuilding Prices
Koopmans	Cobweb Model for determining cyclical supply and demand in a shipping market	Newbuilding Prices
Jin	Supply and Demand Approach	Newbuilding Prices
Hawdon	Tankship Building Model	Newbuilding Prices
Volk	Asset Pricing Model with The Cost-Based Model Approach	Newbuilding Prices
Charemza and Gronicki	An econometric model of world shipping and shipbuilding (Ship prices adjust to freight and activity rates)	Secondhand Ship Prices
Strandenes	Secondhand Values as a Weighted Average of A Short and Long-term Profits	Secondhand Ship Prices
Kavussanos and Alizadeh	Weighted Sum of Current and Future Expected Long-Term Earnings	Secondhand Ship Prices
Kavussanos and Veenstra	A Theoretical Models (Vector Autoregressive (VAR), Autoregressive Conditional Heteroscedasticity (ARCH), and Autoregressive (Integrated) Moving Average (AR(I)MA) models) for the estimation of secondhand ship prices.	Secondhand Ship Prices
Kavussanos	Time-series modelling (atheoretical) ARCH models	Secondhand Ship Prices
Veenstra	a. Quantitative analysis of shipping markets. b. Cointegration Methodology	Secondhand Ship Prices
Glen and Martin	Tanker Market Risk	Secondhand Ship Prices
Hale and Vanags	Johanssen method of testing for cointegration	Secondhand Ship Prices
H. E. Haralambides, S. D. Tsolakis and C. Cridland	Econometric Modelling of Newbuilding and Secondhand Ship Prices (a Theoretical Error Correction model and an Atheoretical Autoregressive (AR) model)	Newbuilding and Secondhand Ship Prices

2.3.1 Newbuilding Prices

Tinbergen and Koopmans were the first economists to put forward the economic theory of maritime transport in the 1930s. Tinbergen is the first scientist to explain the cyclicality of maritime transport markets. Tinbergen is of the opinion that the sector's demand is completely inelastic versus the freight rate (Veenstra & Fosse, 2006). The fluctuations of freight rate in the sector is usually created short-term booms after the following long-term declines or decreases (Brooks, 2010). Chrzanowski has determined the factors that affect the service demand in the market as the volume, quantity and transportation distance of the cargo carried. It is stated that meeting the demand depends on the amount of fleet in the rental market (Chrzanowski, 1985). Koopmans has divided the supply curve for maritime transport into two phases. The first curve is a horizontal, elastic, but not full-capacity period, the second curve is vertical, inelastic, and full-capacity period.

Koopmans thought that the supply of per ton-mile, as in Figure-2.1, was related to the fleet size. He defined the request as a function of the rate of freight / fuel prices and the other rate of operating expenses as shown in formula 2.1 (Tsolakis S. , 2005).

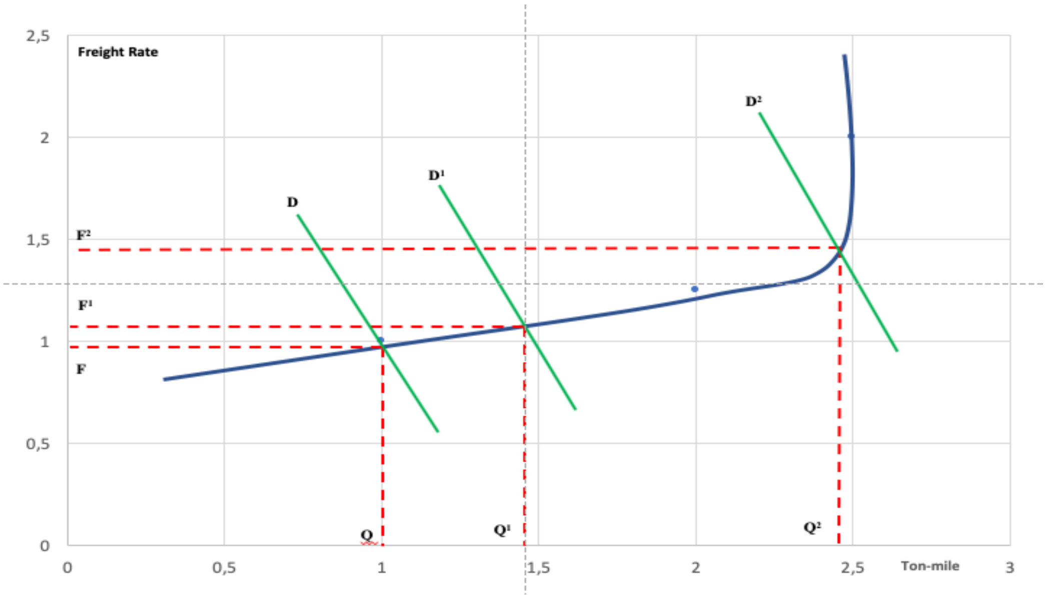

Figure 2.1 Maritime Shipping Spot Market Supply-Demand Model (Stopford, 2009)

$$Q^{D} = f \left[\frac{FR}{P_{B}}\right]^{\lambda} \qquad (2.1)$$

The term "λ" was calculated by Koopmans as 0.15. This number shows that the supply curve is more inelastic as the laid-up ratio decreases. This is an indication of the inelastic structure as the fleet moves towards the full capacity operating level. As seen in Figure 2.1, an increase in demand shifts the demand curve from D to D1, which leads to an increase in the freight rates from F to F1. This small increase in freight rates leads to a significant increase in the quantity of tanker tonnage from Q to Q1. Because the supply curve in this range has an elastic structure and is sensitive to the price. At the point of Q1, world tanker tonnage is operating in almost full capacity market. At the point of Q2, active and full capacity service is provided for all tanker tonnages in the market. A small increase in demand from D1 to D2 in the model will result in a very large increase in freight rates from F1 to F2. However, compared to the increase in freight rates, there will be a slight raise in the amount of tonnage from Q1 to Q2. The reason for this is that the tonnage supply curve, which gradually approaches to full capacity, moves towards an inelastic structure and becomes desensitized against the price. At full capacity level, the supply curve is fully inelastic. Although, the demand for services continues even at very high freight rates in the market, which exhibits an inelastic demand structure (Adland & Strandenes, 2007). According to the study of Zenon S. Zannetos (1966) on the tanker maritime transport market, after the use of capacity of 97.2%, the degree of elasticity is zero. Zannetos (1966) was the first to investigate the factors determining the freight rates on time basis (Zannetos, 2006). The variables that affect marginal costs, ship size and spot freight rates are time-based freight rates. Marginal costs are the most influential factor in time-based freight rates. When the ship markets are looked at in general, the activities in the newly built and scrapping markets determine the current capacity of overseas trade. In this way, it represents the markets that make up the capital asset in production and the service process. In addition, the second-hand ship market does not alter the current capacity but alters the ownership. For this reason, while the new construction and scrapping markets are seen as real markets, the second hand ship markets are seen as an auxiliary (secondary) market. In other words, while it is the newbuilding and scrapping markets that determine the actual capacity in the maritime transport sector, it is the second-hand ship markets in a secondary market where this capacity is traded (Strandenes, 2010). As in the freight market, in the new shipbuilding market, due to the fact that the free market conditions are valid, the prices are determined according to demand. However, cost elements are more prominent here.

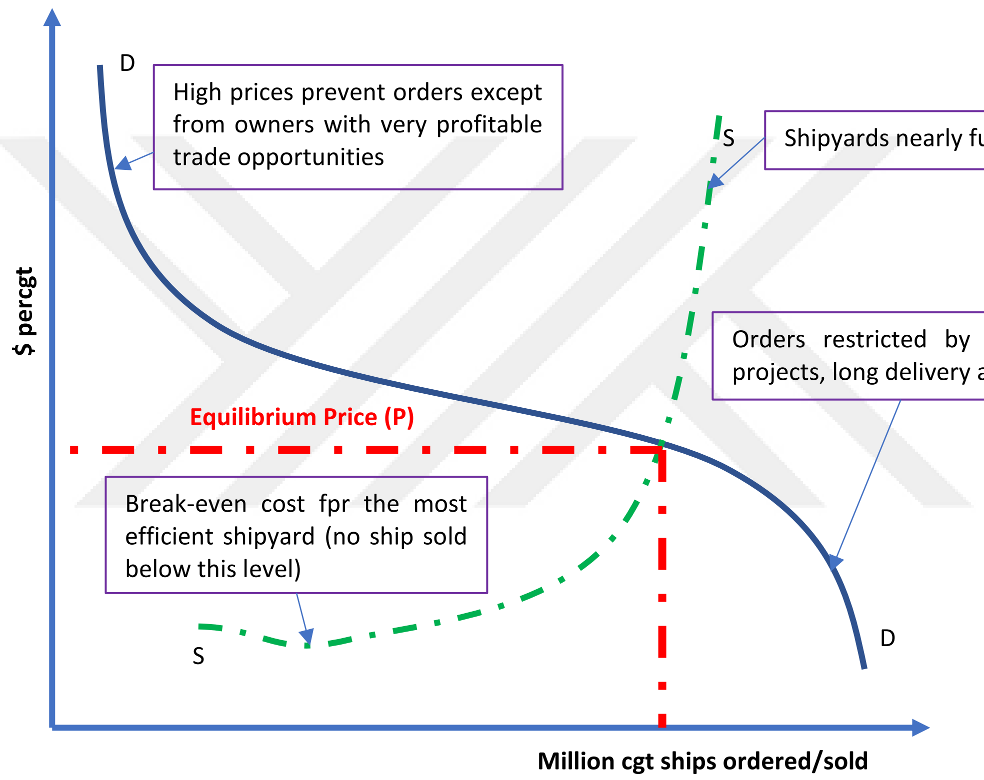

Figure 2.2 Shipbuilding supply and demand functions (Stopford, 2009)

Shipyards with a competitive advantage are the only shipyards that can receive shipbuilding orders at low price levels and these shipyards are few in numbers. Over time, as the prices start to rise, existing shipyards will reach full capacity and after this point more shipyards will start to enter the market. Such a supply curve is defined as a short-term supply curve. In the short term, the capacities and performances of the shipyards are fixed. However, in cases of any state aid to the shipyards, they can receive shipbuilding orders at lower prices. Examples of such external effects can be amplified and in such cases the shape of the supply curve will change (See in Figure-2.2). However, in general terms, there are many plausible reasons why the industry's short-term supply curve is as it is. Even though the shipbuilding industry would want to sell ships at high prices in fact the reverse would be true for the shipowners. According to the demand curve, when ship prices are very high, companies with low operating expenses and the most profitable companies will be able to meet these high prices. However, the quantity of ships ordered is very low at this point. When ship prices begin to decline over time, the number of shipowners who will be able to finance them will increase and the demand for new build ships will increase. Due to financial constraints and concerns over market expectations, this demand will only continue to a certain extent. After this point, more ship orders will not be placed although ship prices decrease (Stopford, 2009). In an open market, the supply and demand functions mentioned above will result in the price of equilibrium. In this way the price will be determined after the results of the negotiations between investors and shipyards (Alizadeh & Nomikos, 2009). When the supply and demand balance is taken into consideration, it is seen that if the shipyards increase their prices, there will be a decrease in demand and the idle capacity in the shipyards. On the contrary, in the region where the demand curve is very steep, ship demands will be more than ship supply at that price level even if shipyards decrease their prices by a small amount. However, at this stage, the capacity of the shipyards will be insufficient to meet the orders. In the long run, the production capacity of these shipyards may change; new shipyards may be set up, or existing shipyards may be shut down. Therefore, each shipyard capacity has its own supply function. Naturally, if there is an increase in the demand for newbuildings during the period in which the shipyards are working full capacity, the prices of ships will rise sharply. The price increase will continue until new shipyards enter the market. At the same time, due to the events that cause changes in the supply-demand balance in the industry, different equilibrium prices are formed, and this causes fluctuations in prices. However, the fluctuations in ship prices is not as high as the freight market. The main reason for this is the cyclical structure in the sector. Within this structure, ship prices cannot increase continuously, and high burst of price do not occur.

There are six key factors affecting commercial fleet supply and demand. Factors affecting demand; freight rates, market expectations and the existence of loans. Factors affecting supply; the capacity of the shipyards, unit costs of the shipyards and production subsidies. (Stopford, 2009).

Ship owners tend to order more ships because of the high rate of returns achieved in the period when the freight rates are high. This way they will increase their profitability. In cases where high freight rates continue for a long time, there is a natural increase in ship demand, as financing will be ready for new ship order. Rise in freight will result in increased demand for ships. The increase in ship demand brings about an increase in shipbuilding prices and ship orders. While the ship deliveries are realized, the supply of ships increases and hence the freights fall. As a result of this, new ship orders fall and second-hand ship demands will be reduced, and also ship dismantling will increase. As a result of ship dismantling, the supply of ships will decrease, and the freight rates will raise. This leads to an increase in ship demand, which is the beginning of the cycle. In this way, the balance of supply and demand in maritime transport continues with fluctuations and determines shipbuilding prices and shipbuilding orders. In a market where high freight transportation is practised, the shipyard capacities will be fully loaded, and the ship will be built at high prices. On the other hand, in a market where low freight rates are dominant, shipyards will not be able to use their capacities and they will build ships at low prices to maintain their existence (Alizadeh & Nomikos, 2009).

The fact that there is a long period between orders and deliveries of vessels and the long economic life after the delivery of a ship limits the impact of the freight rates in the spot market on the new construction demand.

Market expectations are the second biggest factor after spot freight rates on the new construction demand. According to market expectations, one of the two options which are, ordering new ships or buying second hand ships will be chosen. The third biggest factor affecting the new construction demand is the availability of credit facilities and the presence of credit.

2.3.2 Second-Hand Prices

The economic conditions of the second-hand ship market are different from the newbuilding market. The newbuilding market is cost-based. The market, which has an extremely cyclical and fluctuating structure, offers investors the opportunity to make huge profits from trades. Timing for investment is very important at this stage (Tsolakis, Sridland, & Haralambides, 2003). A second-hand ship market, which is so active, is often referred to as a sale & purchase market. The second-hand ship market is one of the world's most competitive markets. Because it is an open economy and there is no entry-exit barrier to the market. There are four basic factors that determine the prices of second-hand vessels at any particular moment. These are freight rates, age of the ship, inflation and future expectations of ship owners (Stopford, 2009). Second-hand ship prices significantly depend on the profitability of the market (Alizadeh & Nomikos, 2009, s. 58). The other variable that affects second-hand ship prices is the age of the ship. It is normal for a 10-year-old ship of the same type and tonnage to have a lower price than a 5-year-old one. In general accounting practices, it is recognized that a merchant ship is subject to depreciation for 15-20 years and then scrapped. Brokers, which determine the prices of second-hand vessels, assume that ships lose their value about 5-6% each year. (Stopford, 2009). Inflation in the long term is an effective factor on second-hand vessel prices. While the age of the ship is effective on the price of the second-hand vessel, the freight rate levels may sometimes make the impact of age insignificant. Although a newbuilding has newer and better technology under normal circumstances, the second-hands can be sold at higher prices when the freight rates are very high in the market. When a ship owner wants to purchase a ship, an older ship may be preferrable to a newer one due to the rate of return. The fourth and the most important variable affecting second hand ship prices is the expectations. Expectations accelerate the change in market cycles. Expected freight rates, expected trading volumes, expected fuel prices and, other market-related expectations affect the second-hand market. Determining the value of vessels traded in the second hand market is important for ship owners, sellers, buyers and brokers. Thus, it is possible to have an idea whether the ship is cheap or expensive by determining the value according to market conditions and the real value. Ship valuation is a continuous routine activity carried out by the S&P brokers. There are many reasons why an appraisal is needed. Banks would like to know the value of the asset for which they provide a long-term credit for and probably will track the value of the ships until the loan is paid off. In addition, the company's fleet value should be determined in order to be declared in annual accounts of publicly traded companies. Finally, with leasing type finance the residual value of the ship needs to be known at the end of the loan term. Kavussanos and Alizadeh claimed that the discounted cash flow analysis of the second-hand ships could be used for valuation as second-hand ships have short life spans (Kavussanos & Alizadeh, 2002). In the markets where the "effective markets hypothesis" is valid, capital asset pricing of a ship is calculated by the following formula 2.2.

$$\mathbf{P_{new}} = \sum_{t=1}^{n} \frac{E(CF_t)}{[1+E(r_t)]^t} + \frac{E(P_{n,secondhand,scrap})}{[1+E(r_n)]^n} \qquad (2.2)$$

CF: Expected Cash Flows, **P:** Ship Price, **r:** discount rate

The present value of the cash flows expected to be generated as a result of the ship's future activities is equal to the present value of the final value (**terminal value**-the second-hand price or the scrap price of the ship). **Terminal value is the value of a company's expected free cash flow beyond the period of explicit projected financial model** (WallStreetMojo, 2019). Terminal value formula 2.3 is as follows;

$$\textbf{Terminal Value} = \sum_{i=1}^{\infty} \frac{FCFF_t}{(1+WACC)^t} \qquad (2.3)$$

FCFF: Free Cash Flow to Firm, WACC: Weighted Average Cost of Capital (discount rate), t: time

High volatility of the cash flows depending on revenues will cause the price of the ship to fluctuate. One of the main points to be considered in the present value approach is to determine the discount rate accurately. The discount rate (expected return) consists of the sum of the operating gain / loss and the capital gain / loss on a percentage basis. This equality may be impaired when markets are inactive (Kavussanos & Visvikis, 2006) who, in this context, have investigated the effectiveness of the markets by comparing the price with the market price. The results showed that the market structure of second-hand ships did not comply with the effective markets hypothesis. This necessitates the consideration of other factors in second-hand valuations. In practice, there are many factors that affect asset prices and returns.As Campell and Mei stated, the main problem in asset pricing is that these factors are often unobservable (Campbell & Mei, 1993). Therefore, determining the value of a ship is a very difficult issue. The valuation of a merchant ship is based on many procedures and market information. Brokers first look at the physical condition of this ship in their records and the price at which the same type of ship was sold on the market. In particular, the type, size, age of the ship, the shipyard where it was built, the equipment it has and the characteristics of its attributes are important factors in determining the value. Large-volume vessels are generally more valuable than small-volume vessels. However, this is also determined by cycles in freight rates. (Stopford, 2009). Shipyards are also important factors to be considered in the valuation. Some shipyards may have better technologies. Attributes of the ships are also a factor affecting value. Some ship owners might prefer standard outfittings and non-standard outfitted ships can be sold at discounted prices. Some vessels have better outfittings than the standard ones in the market and the owners can request these to be added onto the price. Double-skinned, tankers high-speed ships or ships with automatic machine rooms are generally more valuable. Lastly, based on the concept of bringing willing buyers and willing sellers together, the value of the ship also depends on the judgements of the broker. Because a ship with nominal value can be discounted to a lower price if there is not a willing buyer in the market. In a rising market, ships can be sold above the nominal price. These depend on the broker's judgment at that time. The determination of the net present value of the ship is as important as determining the residual / scrap value. There are three main determining factors in this regard. These are the depreciation rate, inflation rate and market cycles. For example, assuming the rate of depreciation for a ship with an initial cost of $ 28 million is 5%, the ship's book value will drop to $ 14 million after 10 years. However, considering the 3% increase in newbuilding prices in this period, the value of the ship will be $ 18.2 million.

This price is the most likely one that the ship should have after 10 years. The depreciation rate and inflation rate is also not easy to estimate to some extent. However, the main difficulty in calculating residual values is to estimate market cycles. These uncertainties are the risks in maritime transport and the level of risk to be taken totally belongs to the investor.

2.3.3 Demolition Markets and Factors

Scrapping means reducing the total tonnage supply of second-hand ships. The supply function of the demolition market is related to the scrapping decision. Scrapping decision depends on long-term market expectations (Stopford, 2009). Factors affecting the scrapping decision; the ship owner's financial performance, ship age and size, freight market expectations, high operating expenses due to the use of old technology, scrap prices, market conditions, scrap value and the second-hand price of the vessel according to the book value, cash flows of the ship served, specific characteristics of the sector in which the ship operates, management policies and attitudes (Stopford, 2009).

Scrapping decision is based on the calculation of the total cost incurred while the ship is in service and the cash flow capacity that the ship will generate in the future. The cash flows generated by the ship will be significantly dependent on the freight rates. Therefore, the amount of tonnage that will be scrapped will increase when the freight rates decrease. The decrease in freight rates implies an increase in the amount of tonnage allocated to scrap and a decrease in scrap prices. The increase in freight rates means that the vessels that had been decided to be scrapped but have not yet demolished to be put back in service resulting in an increase of scrap prices. It is understood that there is an inverse relationship between the declared scrap tonnage amount and the scrap prices. The relationship between the freight market and the demolition market is expressed by the following formula 2.4 (McConville, 1999).

$$P_0 - P_t > \sum \frac{(Y_t - C_t)}{(1+r)^t} \qquad (2.4)$$

P_0: Current Sale Price of The Vessel, Pt: Expected Value of The Vessel, t: The Time Perod, t: Period of time, Y_t: Anticipated Income or Earning at Time t, C_t: Anticipated Cost at time t, r: rate of interest.

If the ship's present value is greater than its future value, the shipowner will tend to sell this ship for disposal. If a profit is made when the costs are deducted from the expected return and when an appropriate discount rate is calculated from the future to today and this is discounted from the mentioned profit, the remaining value will be the determinating factor in the ship owner's decision to scrap the ship or not. Therefore, considering the difference between selling the ship today and selling it in the future, if the total profit is greater than its present value, the owner will decide to dispose of his ship (McConville, 1999). Therefore, the current state of the freight market and future market expectations are the main determinants of the tonnage to be scrapped. In the scrapping market, fluctuations in prices can be very large due to state interventions such as tax restrictions at customs and reductions in income tax. The rate of increase of the world merchant fleet depends on the balance of new ship deliveries, scrapped and lost at sea fleets. In a period when the freight market is bad, the profitability of the vessels decreases and the second hand prices also decreases. In cases where the market gets worse, the inactive or the second hand prices of old ships will be reduced to their scrap values. In such a case, these vessels will be scrapped and this will cause the existing fleet capacity to decrease. So the price mechanism automatically reduces the fleet excess. In contrast, if the fleet is constrained or raised demand increases freight rates; either shipowners will be willing to expand their fleets, or leasing shipowners will create their own fleets to meet their needs, or new investors who notice high returns will enter the market. Thus, scrapping procedures will be postponed. In this case, in a market where there are more buyers & sellers, ship prices will increase, and scrapping prices will decrease (Grammenos & Xilas, 1996). The further revival of the market can even allow the second-hand prices to be ahead of the newbuilding prices. There is also a relationship between scrapped vessels tonnage and the tonnage of newbuildings. For example, in 2017, the total tonnage of the vessels that were demolished was 22,916 dwt while the total tonnage of the newbuildings were 64,899 dwt (UNCTAD, 2018). However, these tonnage changes are cyclic. When planning for the future, the balance between these two tonnages should be considered. In general, the scrap market is in inverse relation to both the freight market and the newbuilding market.

Hawdon worked to model the scrap market in his study. However, he modelled not the scrap prices, but the scrap volumes. According to Hawdon's model; scrap volumes are related to current and, future freight rates as a function of fleet size and vessel demand (Hawdon, 1978). Neither were scrap prices referenced from Beenstock and Bergottis' studies based on DWD. It is understood that in the light of these explanations above, the most important factors determining the scrap volumes are second-hand ship prices and scrap prices. Shipowners decide to sell or scrapping their vessels depending on second-hand or scrap prices (Beenstock & Vergottis, 1993).

2.3.4 Analytical Techniques

The most popular forecasting techniques are listed in Table-2.3. These are opinion surveys, trend analysis, mathematical models and probability analysis.

2.3.4.1 Opinion Surveys

Delphi technique is the most preferred method among the opinion surveys used for future estimations in shipping (Stopford, Maritime Economics, 2009, s. 724). The classical technique proceeds in well-defined sequence. Another method is resource review within the opinion surveys. Resource review is divided into two methods, literature review and the evaluation of sector reports.

2.3.4.2 Trend analysis

Naïve (Bayes) Analysis, Trend extrapolation, Smoothing, Decomposition, Filters, Autoregressive (ARMA, ARIMA, GARCH), Box-Jenkins Model are used in trend analysis.

2.3.4.2.1 Naïve (Bayes) Analysis

The Bayes's Theorem has so far been proven to be a coherent method of mathematically expressing a decrease in uncertainty gained by (or proportional) an increase in knowledge (Carrier, 2012).

The Bayes theorem 2.5 is:

$$P(A \mid B) = \frac{P(B \mid A) * P(A)}{p\ (B)} \qquad (2.5)$$

Using Bayes theorem, it can be found the probability of A happening, given that B has occurred. Here, B is the evidence and A is the hypothesis. The assumption made here is that the predictors/features are independent. That is presence of one particular feature does not affect the other. Hence it is called naive. Generally Bayes's rule can be considered for the problem of estimating values of k parameters (causes), A = (A1,….., Ak), using n observations (effects), B = (B1,….., Bn). In the rule then, given the observations B = (B1,….., Bn), the posterior probability distribution of A can be computed as formula 2.6:

$$p(A|(B1,\ldots, Bn) = \frac{p(B_1,\ldots,B_n\ |A)_* p(A)}{P(B_1,\ldots,B_n)} \qquad (2.6)$$

2.3.4.2 Logistic Regression and Bayesian Network (BN)

Logistic regression is used to provide the conditional probability table (CPT) for a discrete BN. There are two types of logistic regression: binary logistic regression and multinomial regression. The discrete-dependent variable specified in the form of unobserved but continuous variable y*, where y* ε (-∞, +∞). Consider an independent variable set X = (x1, x2,………. xn) leading to dependent variable y, as a function of X,

$$y = \sum_{i=1}^{n} 1 \sum_{j=1}^{m-1} 1\ \text{ßij xij} + \varepsilon \qquad (2.7)$$

Rijman get the conditional probability of y under a configuration of independent variable set X^0 through multinomial regression (Rijmen, 2008).

$$P\ (y = y_1) = \frac{e^{\beta_i X^0 + \varepsilon}}{1+\Sigma_{i=1}^{m-1} e^{\beta_i X^0 + \varepsilon}} \qquad (2.8)$$

2.3.4.3 Trend extrapolation

According to Business Dictionary, trend extrapolation is a “forecasting technique which uses statistical methods (such as exponential smoothing or moving averages) to project the future pattern of a time series data” (Business Dictionary, 2019). These methods examine trends and cycles in historical data, and then use mathematical techniques to extrapolate to the future. The assumption of all these techniques is that the forces responsible for creating the past, will continue to operate in the future. This is often a valid assumption when forecasting short term horizons, but it falls short when creating medium- and long-term forecasts (Walonick, 1993).

There are many mathematical models for forecasting trends and cycles. Choosing an appropriate model for a particular forecasting application depends on the historical data. The study of the historical data is called exploratory data analysis. Its purpose is to identify the trends and cycles in the data so that appropriate model can be chosen. The most common mathematical models involve various forms of weighted smoothing methods. Another type of model is known as decomposition. This technique mathematically separates the historical data into trend, seasonal and random components. A process known as a “turning point analysis” is used to produce forecasts. ARIMA models such as adaptive filtering and Box-Jenkins analysis constitute a third class of mathematical model, while simple linear regression and curve fitting is a fourth.

2.3.4.4 Smoothing Techniques

When data collected over time displays random variation, smoothing techniques can be used to reduce or cancel the effect of these variations. When properly applied, these techniques smooth out the random variation in the time series data to reveal underlying trends (FrontlineSolvers, 2019). There are four different smoothing techniques: Exponential, Moving Average, Double Exponential, and Holt-Winters. Exponential and Moving Average are relatively simple smoothing techniques and should not be performed on data sets involving seasonality.

Double Exponential and Holt-Winters are more advanced techniques that can be used on data sets involving seasonality (Daniels Trading, 2019). There are some smoothing techniques related with ship's valuation shown in Table-2.4

Table-2.4 Smoothing Techniques

Smoothing Techniques	Explanation
Exponential	$S_0 = X_0$ $S_t = \alpha X_{t-1} + (1-\alpha) S_{t-1}$, t > 0 where: • original observations are denoted by {xt} starting at t = 0 • α is the smoothing factor which lies between 0 and 1
Moving Average	Using the time series X1, X2, X3, ..., Xt, this smoothing technique predicts Xt+k as follows : St = Average (xt-k+1, xt-k+2, ..., xt), t= k, k+1, k+2, ...N where, k is the smoothing parameter. The parameter value between 2 and t-1 where t is the number of observations in the data set.
Double Exponential	St = At + Bt , t = 1,2,3,..., N Where, At = axt + (1- a) St-1 0< a <= 1 Bt = b (At - At-1) + (1 - b) Bt-1 0< b <= 1 The forecast equation is: Xt+k = At + K Bt , K = 1, 2, 3, ... where, a denotes the Alpha parameter, and b denotes the trend parameters.
Holt-Winters	$S_t = \alpha \frac{y_t}{I_{t-L}} + (1-\alpha)(S_t + b_{t-1})$ Overall Smoothing $b_t = \gamma (S_t - S_{t-1}) + (1-\gamma) b_{t-1}$ *Trend Smoothing* $I_t = \beta \frac{y_t}{S_t} + (1-\beta) I_{t-L}$ Seasonal Smoothing $F_{t+m} = (S_t + m_{bt}) I_{t-L+m}$ Forecast. y is the observation, S is the smoothed observation, b is the trend factor, I is the seasonal index, F is the forecast at m periods ahead, t is an index denoting a time period. and α, β, and γ are constants that must be estimated in such a way that the MSE of the error is minimized.

There are some error measures related with smoothing techniques. These are Mean Absolute Percentage Error (MAPE), Mean Absolute Deviation (MAD) and Mean Square Error (MSE) (Swamidass, 2000). The forecast errors refer to the calculation of the difference between the expected value and the observed value. Comparing the two computed error, which is the difference between observed and expected and is an indispensable indication of the accuracy of the method.

For a whole series the squared errors are typically summed resulting in **Sum of Squared Errors (SSE)**. Sometimes it might be come across **Mean Squared Error (MSE)** which is simply $\sqrt{\boldsymbol{SSE}}$.

The mean absolute percentage error (MAPE) as shown in formula 2.9 is a statistical measure of how accurate a forecast system is.

$$\textbf{Mean Absolute Percentage Error (MAPE)} = \frac{\sum_{t=1}^{n} |(x_t - \hat{x}_t)/\,x_t|}{n} * \mathbf{100} \quad (2.9)$$

Mean absolute deviation (MAD) of a data set is the average distance between each data value and the mean. Mean absolute deviation is a way to describe variation in a data set. MAD helps to get a sense of how "spread out" the values in a data set are.

$$\textbf{Mean Absolute Deviation (MAD)} = \frac{\sum_{t=1}^{n} |(x_t - \hat{x}_t)|}{n} \quad (2.10)$$

Mean Square Error (MSE) simply refers to the mean of the squared difference between the predicted parameter and the observed parameter.

$$\textbf{Mean Square Error (MSE)} = \frac{\sum_{t=1}^{n} (x_t - \hat{x}_t)^2}{n} \quad (2.11)$$

2.3.4.5 Decomposition Models

Decomposition procedures are used in time series to describe the trend and seasonal factors in a time series. More extensive decompositions might also include long-run cycles, holiday effects, day of week effects and so on (PennState, 2019).

The following two structures are considered for basic decomposition models:

- Additive: xt = Trend + Seasonal + Random
- Multiplicative: xt = Trend * Seasonal * Random

The decomposition model (Hyndman & Athanasopoulos, 2018) assumes that sales are affected by four factors: the general trend in the data, general economic cycles, seasonality, and irregular or random occurrences. The forecast is made by considering each of these components separately and then combining them together. A time series using an additive model can be thought of as

$$y_t = T_t + C_t + S_t + I_t \quad (2.12)$$

Whereas a multiplicative model would be

$$y_t = T_t \times C_t \times S_t \times I_t \quad (2.13)$$

T_t, the trend component at time t, which reflects the long-term progression of the series (secular variation). **C_t**, the cyclical component at time t, which reflects repeated but non-periodic fluctuations. The duration of these fluctuations is usually of at least two years.**S_t**, the seasonal component at time t, reflecting seasonality (seasonal variation). **I_t**, the irregular component at time t, which describes random, irregular influences.

2.3.4.6 Filtering

Filtering refers to estimating what is happening currently, whereas prediction is concerned with hazarding a guess about what might happen next. The basics of smoothing, filtering and prediction were worked out by Norbert Wiener, Rudolf E. Kalman and Richard S. Bucy over half a century ago (Einicke, 2012). In statistics and economics, a filter is simply a term used to describe an algorithm that allows recursive estimation of unobserved, time varying parameters, or variables in the system (Pasricha, 2010).

2.3.4.7 Autoregressive Models

A common approach for modeling univariate time series is the autoregressive (AR) model (Box, Jenkins, & Riensel, 1994):

$$X_t = \delta + \emptyset_1 X_{t-1} + \emptyset_2 X_{t-2} + \cdots + \emptyset_p X_{t-1} + At \quad (2.14)$$

Where X_t is the time series, A_t is white noise, and

$$\delta = \left(1 - \sum_{i=1}^{p} \emptyset_i\right) \mu \quad (2.15)$$

With μ denoting the process mean.

An autoregressive model is simply a linear regression of the current value of the series against one or more prior values of the series. The value of p is called the order of the AR model. AR models can be analyzed with one of various methods, including standard linear least squares techniques.

An **autoregressive (AR) model** is when a value from a time series is regressed on previous values from that same time series. For example, y_t on y_{t-1}:

$$y_t = \beta_0+\beta_1 y_{t-1} + \epsilon_t \quad (2.16)$$

A k_{th}-order autoregression is a multiple linear regression in which the value of the series at any time t is a (linear) function of the values at times t−1,t−2,…,t−kt−1,t−2,…,t−k.

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 y_{t-2} \ldots\ldots\ldots + \beta_k y_{t-k} + \epsilon_t \quad (2.17)$$

Another common approach for modeling univariate time series models is the moving average (MA) model:

$$X_t = \mu + A_t - \theta_1 A_{t-1} - \theta_2 A_{t-2} - \cdots - \theta_q A_{t-q} \ (2.18)$$

Where X_t is the time series, μ is the mean of the series, A_{t-i} are white noise terms, and $\theta_1,\ldots,\theta_q$ are the parameters of the model. The value of q is called the order of the MA model.

The Box-Jenkins ARMA model is a combination of the AR and MA models. In order to apply the Box-Jenkins method, the series must be free of trents and seasonal fluctuations, in other words, the series must be stationary.

$$X_t = \delta + \emptyset_1 X_{t-1} + \emptyset_2 X_{t-2} +\cdots+ \emptyset_p X_{t-p} + A_t - \theta_1 A_{t-1} - \theta_2 A_{t-2} - \cdots - \theta_q A_{t-q} \ (2.19)$$

The Box-Jenkins model assumes that the time series is stationary.

2.3.4.8 Mathematical Models

There are mathematical models related with ship valuation such as simple regression, multiple regression, econometric models, supply-demand models and sensitivity analysis.

"Regression analysis is the process of constructing a mathematical model or function that can be used to predict or determine one variable by another variable or other variables." (Cortinhas & Black, 2012).

The deterministic regression model is

$$y = \beta_0 + \beta_1 x \qquad (2.20)$$

The probabilistic regression model is

$$y = \beta_0 + \beta_1 x + \epsilon \qquad (2.21)$$

Simple linear regression analysis determines the line that best fits a collection of X-Y data points.

"That line minimizes the sum of the squared distances from the points to the line as measured in the vertical, or Y, direction" (Hanke & Wichern, 1989).

This line is known as the regression line and its equation is called the regression equation as follows.

Y= b + aX (b is called Y intercept. **a** the slope of the straight line)

$$b = \frac{n\Sigma XY - \sum X \sum Y}{n\sum X^2 - (\sum X)^2} \qquad a = \frac{\sum Y}{n} - \frac{b\Sigma X}{n} \qquad (2.22)$$

The standard error of estimate measures the typical amount by which the actual Y values differ from the estimated values (Hanke & Wichern, 1989).

$$Sy.x = \sqrt{\frac{\sum (Y - Y_R)^2}{n-2}} \qquad (2.23)$$

A residual is the difference between an actual Y value and its predicted value (Hanke & Wichern). Since there are both positive and negative residuals, the some of residuals is always zero. One method which has been devised to measure the errors generated by the forecasting is the mean absolute error (MAE).

MAE is the average value of the absolute residuals. Residual is $\mathbf{Y_f - Y}$

$$\boldsymbol{MAE = \frac{\sum|Y_f - Y|}{n}} \qquad (2.24)$$

Y_f is the forecasted value. Y is an actual value.

The interpretation starts by investigating whether there is enough evidence to conclude that there is a linear relationship between each independent variable and a dependent one among all the population data points. As a result, the following hypothesis is tested

Ho : β = 0,

H1 : β ≠ 0

where **β** is the slope of the true population regression line **(Y=β + βX 0)**. In this dissertation the hypothesis is tested at the significant level equal to **5%**. Consequently, for the coefficient that p-value is bigger than **5%**, the null hypothesis is satisfied and for the coefficient that p-value less than **5%** the alternative hypothesis is satisfied. (ISIXSIGMA, 2019).

$$\mathbf{R^2} = \frac{a\sum b - c\sum - \bar{y}}{\sum \pi - a} \quad (2.25)$$

Another parameter used for evaluating the model is the coefficient of determination (R^2). R^2 measures the extent to which the variability of Y and X are related.

In other words, this statistic illustrates the percentage of variation of dependent variables that is explained by the variation of the independent variable. R^2 is calculated by following equation:

$$\boldsymbol{R^2} = \frac{\boldsymbol{b\sum Y - a\sum XY - n\bar{Y}}}{\boldsymbol{\sum Y^2 - n\bar{Y}^2}} \quad (2.26)$$

$\hat{Y}$ is the average of all **Y** values .

The basic concept of multiple regression remains the same compared to simple regression, but more than one independent variable is used to forecast the dependent variable. In multiple regression analysis the dependent variable is also represented by Y and the independent variables are represented by X1, X2, X3,..., Xn. The regression equation is as follows:

$$\mathbf{Y = b_0 + b\ _1X_1 + b_2\ X_2 + b_3\ X_3 + ... + b_nX_n} \quad (2.27)$$

3. RESEARCH METHODOLOGY

Thesis studies have been carried out in seven phases. These phases are defining the research problem, literature review, formulating the hypothesis of the dissertation, designing the research, collecting data, analyzing the data, interpreting the data and report.

3.1. Defining the Research Problem

Generally accepted methodology of thesis is shown as following Figure-3.1.

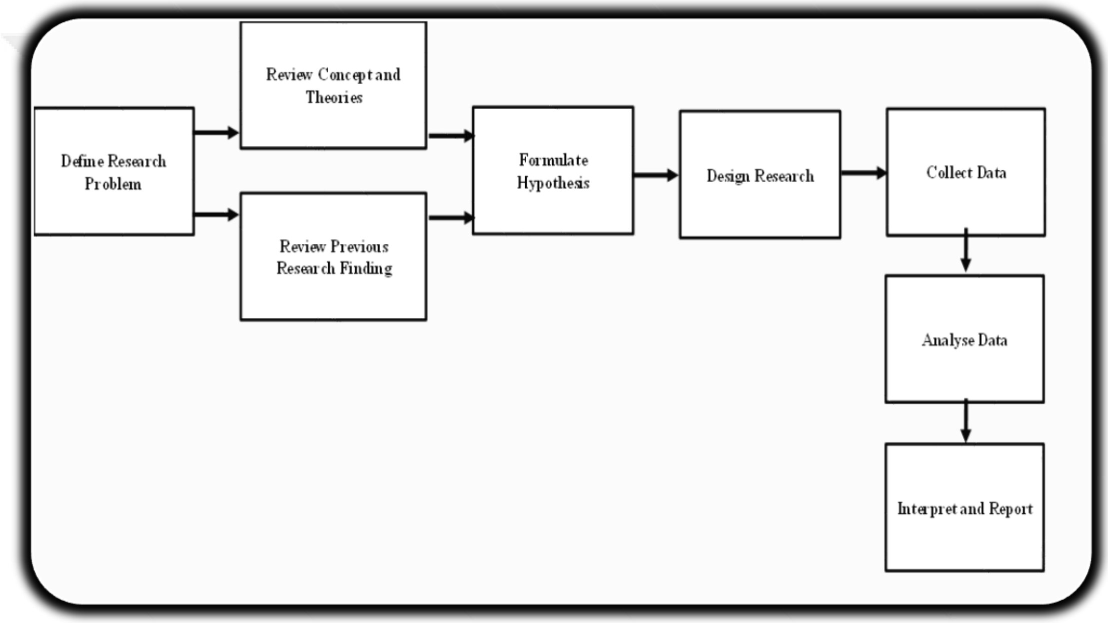

Figure-3.1 Generally Accepted Methodology of Thesis.

The study is commenced at defining research, and then reviewed concepts, theories and previous methods related with valuation in Chapter-1 and Chapter-2. After formulating hypothesis, design research has been occurred. In order to determine the deficiencies of reasonable methods, Lloyds' List data and Clarkson's Data have been used. As well as all these efforts, more than 500 articles, documents were downloaded from Scientific Database of Mendeley, ScienceDirect, Elsevier, Scopus and National and Council of Higher Education Thesis Center.

Collected and analysed data have been compared to these documents's findings. And also, it was struggled to obtain current ship data from Baltic Exchange Information Services, Clarksons Integrated Shipping Services, Shanghay Shipping Exchange Information Services, VesselValue Ltd. etc.

The problems related with ship valuation to be researched can be listed as follows:

- Can a combined qualitative model complement the gap of the current ship valuation methods?
- Can the existing methods, especially the Hamburg Ship Valuation Method, be calculated at reasonable prices for all parties?
- Can the determination of a fair value serve as a reference point for buying and selling ships at a reasonable price?

3.2 Literature Review

In addition to explain problem area of the thesis in Chapter-1, the methodology of literature review is shown in Figure-3.2.

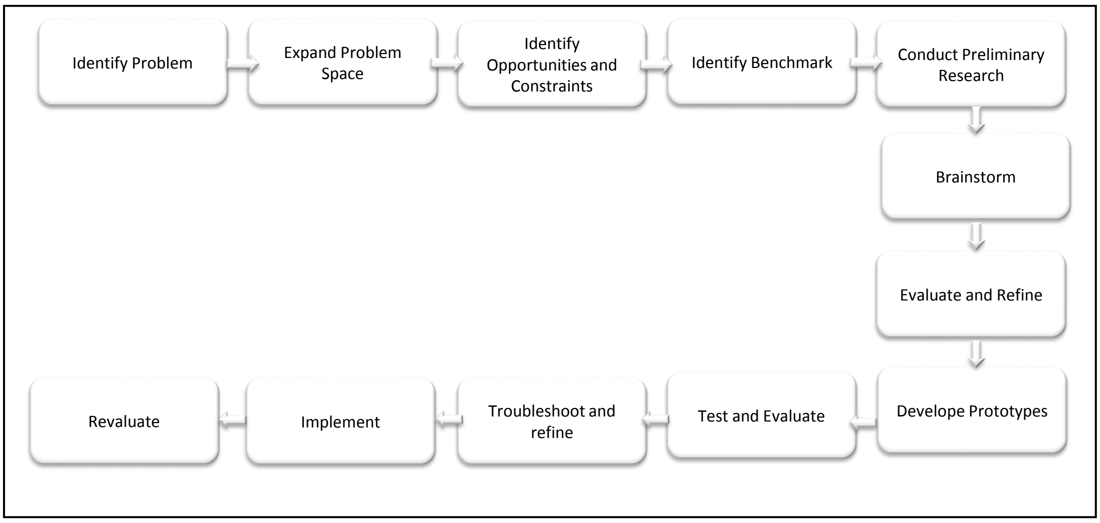

Figure-3.2 The Methodology of Literature Review

There are many few scientific literatures related with Ship's valuation directly. However, there are a lot of primary and secondary relevant resources and methods. In that reason, it has been utilized shipping finance and valuation methods. Besides of them, it has been paid visits to Revalua Consulting Company, ESKO Marine Trading Ltd Co., Kıran Holding and Istanbul Denizcilik AR-GE Yayincilik ve Danismanlik A.Ş. (Istanbul Freight Index-ISTFIX). In addition, it has been distance interviewed by Skype with VesselValue Ltd. about methodology of vessel valuation. In order to improve current methodologies of vessel value, it has been also distance interviewed by internet with Lloyd's Maritime Academy about Ship's Valuation Distant Learning Course.

Within these efforts, it is understood that marketing valuation of vessels is the most preferable calculation method. As a sample, VesselValue Ltd. described the mathematical model behind VesselsValue automated online valuations (Adamou, 2019).

VesselValue Ltd. focused on market value. However, they also considered discounted cash flow value for accountancy. Because discounted cash flow value is the present value of the vessel's future cash flows such as revenues, operating costs, maintenance, and demolition.

According to literatures, and VesselValue Ltd.'s view are indicated that five main factors of vessels are determined to calculate vessel values. These factors are type, featıre, age, size and earning sentiments. In literature, these factors are accepted especially by the Association of Hamburg and Bremen Shipbrokers (VHBS).

3.3 Formulating the Hypothesis of the Thesis

Ship valuation is an important process for the parties involved in making investment decisions. The hypothesis that the research grounds is formulated as stated below:

"If a fair value of merchant ships can be determined, overpricing at the moment of buying or selling can be avoided, even under free market conditions".

3.4 Designing the Research

The design of the research were explained in following subheadings.

3.4.1 Designing an Appropriate Methodology

As a result of the literature review about the ship valuation and the examination of the previous methodologies, it was seen that the methods used to determine the ship valuation and the future estimation of ship prices were almost close with some diferencies. It is concluded that the present methods are not enough byself but complementary each other. It is thought that a hybrid approach should be created in order to calculate the ships' values more accurately than previous methods.

In this context, research will be composed of two surveys. (See in Figure-3.3). These are industrial survey and scientific survey.

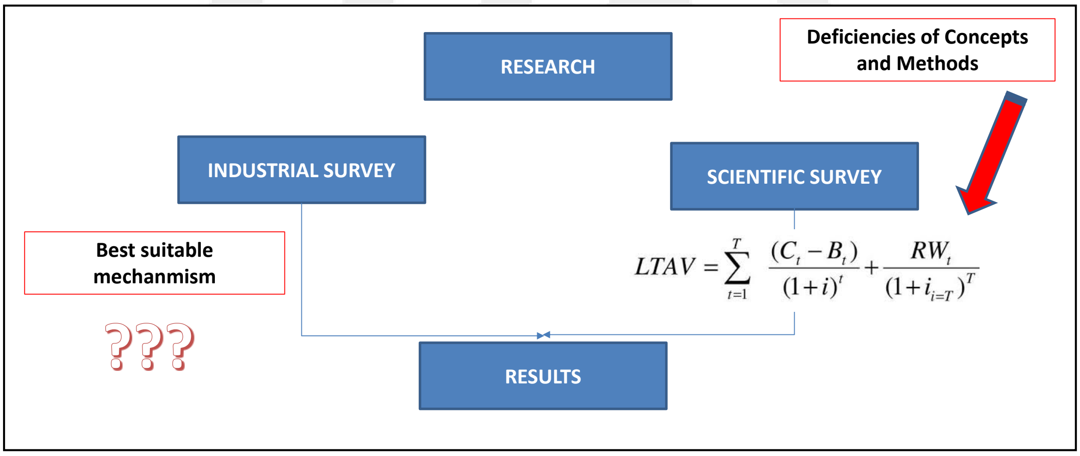

Figure-3.3 Design Research

In this research study, literature have been scrutinized in four main sections to find gaps related with ship's valuation. These are capital markets, legislation issues, shipping finance, marine insurance and valuation methods. Selective issues such as investors (special funds), institutions (real estate appraisal, brokerage, portfolio management, banks (credits), investment trusts, independent audit firms, funds (KG, KS, Islamic), rating agencies, integrated shipping services (Baltic Information Services, VesselValue Information Services, Clarkson Integrated Shipping Services, Shanghay Shipping

Exchange) and companies (small to medium enterprises-SMEs, wealth funds, publicly held companies) are investigated related with capital markets.

Within the legal issues; taxation, shipbuilding contract and disputes, bankruptcy and forclosure, collision at sea, salvage, limitation of liability and charterparty are also examined. In addition, ship valuation methods are effect the all aspects of marine insurance (e.g. insurance & reinsurance markets, cost insurance & freight, hull insurance, associations, cargo interests, hull interests, contracts of sale, warranties, time & voyage insurance, statutory exclusions, perils, insurance values, facultative cargo insurance and time & cargo clauses). There are three widely accepted asset valuation methods such as Market Approach, Replacement Cost and Income Approach (Karatzas, 2009).

These methods provide a different perspective and insight into the value of a vessel, and each one of these methods has its own strengths and intrinsic limitations at the same time. Besides of them there are some valuation approaches such as dividend value, expectation value, utility value, liquidation value etc. In order to value of ships, valuers are generally providing the following types of vessel valuations;

- Fair Market Value (FMV),
- Orderly Liquidation Value (OLV),
- Income approach,
- Discounted Cash Flow Analysis (DCF),
- Replacement cost method
- Long Term Asset Value (LTAV) under Hamburg Shipbrokers Association Rules.

Methods and approaches aferomentioned above are necessary for shipping finance issues such as The Analysis of Market Cycles, Loans and Risk Management, Equity Financing, Asset Pricing, Institutional Framework, Ship Leasing, Islamic Finance, Newbuildings, Second-hands, Scrapping, Ship Sale and Purchase (S&P). In the light of this research, it is understood that there is no robust infrastructure of vessel’s valuation system and systematic mechanism of vessel's appraisal especially in developing countries. Insomuch that it is not clear whether vessels are real estate or securities.

In this context, Hamburg Ship Evaluation Standards and Capital Asset Pricing Model (CAPM) are reviewed and discussed. Because these standards and models were a milestones of vessels value system. These standards and models are published by The Association Hamburg Shipbrokers and Ship Agents Association (Vereinigung Hamburger Schiffsmakler und Schiffsagenten-VHSS)'s auditing firm Price waterhouse Coopers (PwC). The Long-Term Asset Value (LTAV) has been available to the maritime industry since 2009. It is a newly developed ship evaluation method based on a Discounted Cash Flow model (DCF), supplementing the previously existing evaluation methods (VHSS, 2009).

Today, after the merger of the brokers and agents in Bremen and Hamburg to the Association of Hamburg and Bremen Shipbrokers e.V. (VHBS), the Association is a voluntary association of settled in and around Bremen and Hamburg shipbrokers and ship agents (VHBS, 2019). There are two methods have been used for determining casual link among market value and others within this study (See in Figure-3.4).

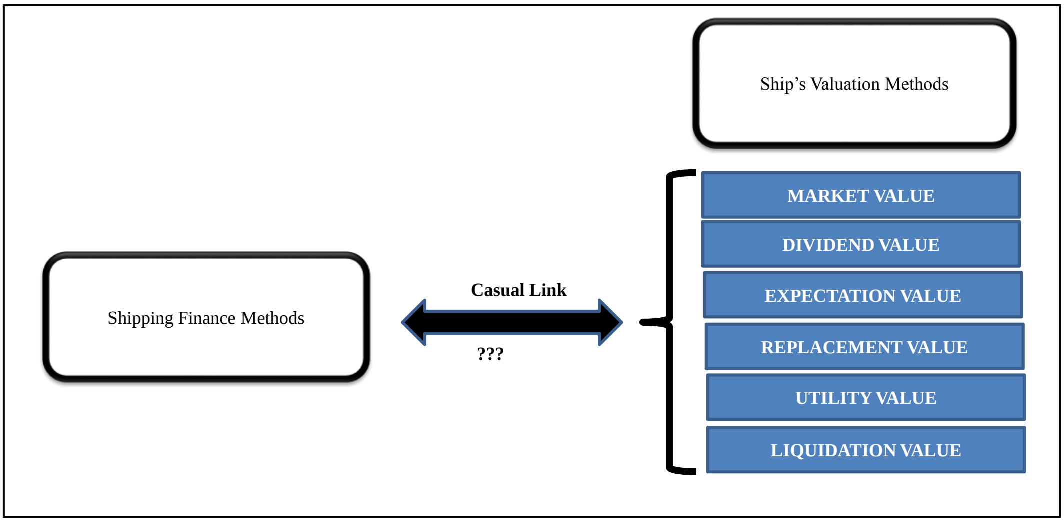

Figure-3.4 Casual Link between Shipping Finance Method and Ship's Valuation Methods

Ship’s Valuation Methods are scrutinised and struggled for determining the deficiencies of them. In order to fill the gap of these methods in Figure-3.4, it is decided to improve hybrid methods considering with ship finace methods as in Figure-3.5

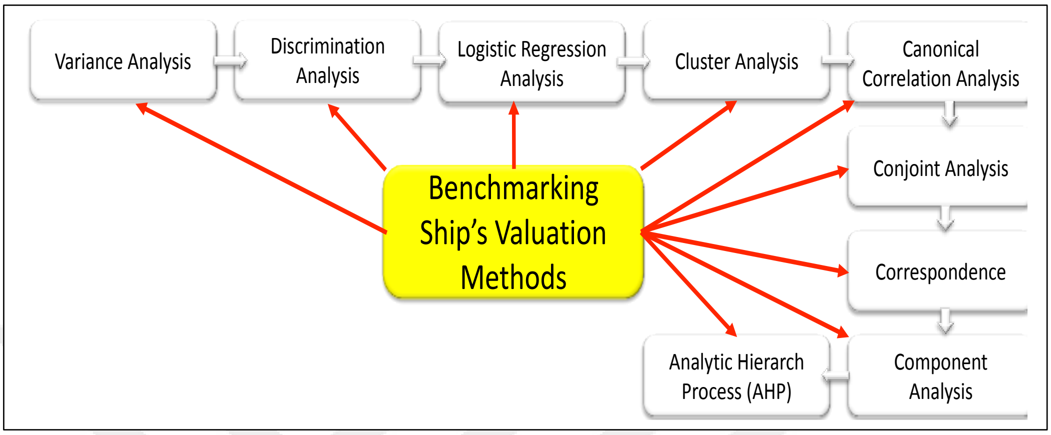

Figure-3.5 Benchmarking Ship’s Valuation Methods with Shipping Finance Methods

The aim of the hybrid methods is to create “Combined Multi-Regression Analysis and Qualitative Estimation Model”. The objective of this model is to calculate the ship’s value more accurately than other methods. Methods and techniques have been divided into five categories. Firstly, main methodology of thesis, secondly method for literature review, thirdly methods for problem solving, fourthly method for shipping finance and lastly method for ship’s valuations are explained. Main methodology of the thesis is shown in Figure-3.6.

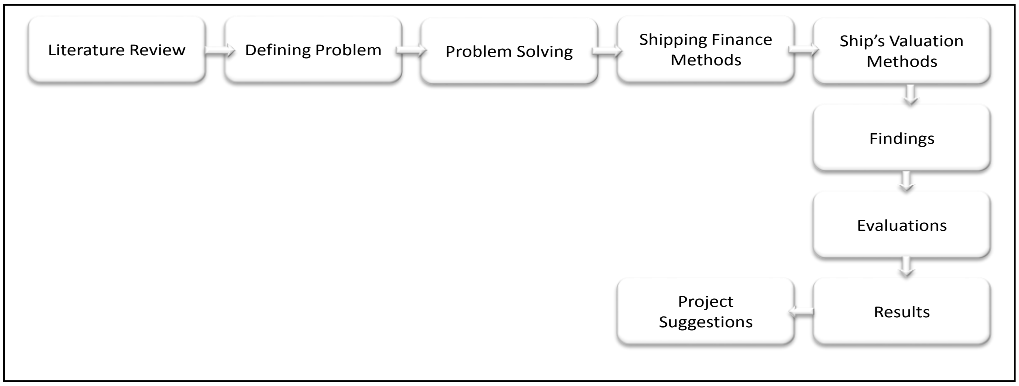

Figure-3.6 Main Methodology of The Thesis

3.4.2 Problem Solving

It is articulated before there are four shipping market to collect data. The most accessible data is belonging to ship sale and purchase market.

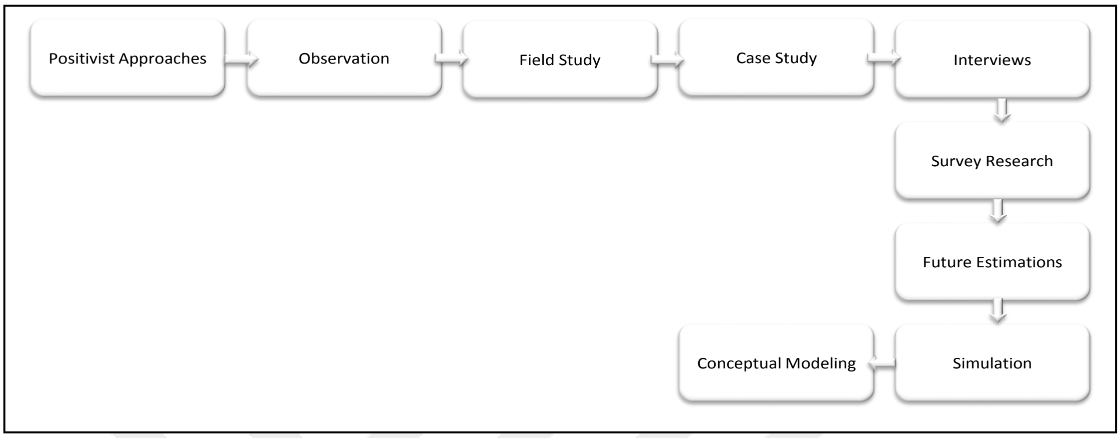

Figure-3.7 The Method of Problem Solving

In this study, real sale and purchase prices of vessels have been collected from integrated shipping services (Baltic Infırmation Services, VesselValue Information Services, Clarkson Integrated Shipping Services, and Shanghay Shipping Exchange etc.). The method of problem solving is shown in Figure-3.7. In order to problem solving, different aspects of ship valuation are searched. the research studies in Chapter-4 to support improving a new model are completed within the preliminary phase of the thesis. The findings of these studies are discussed in Chapter-4 and the results of them are utilized as an argument for the model to be applied in Chapter-5.

In the light of Chapter-1 (Introduction), Chapter-2 (Literature Review), Chapter-3 (Methodology) and, Chapter-4 (Research Studies), "Combined Qualitative Ship Valuation Estimation Model" has been improved.

3.5 Collecting and Analysing Data

In this study, real sale and purchase prices of vessels have been collected from integrated shipping services (Baltic Infırmation Services, VesselValue Information Services, Clarkson Integrated Shipping Services, and Shanghay Shipping Exchange etc.).

Within these data, regression analysis, multi-regression analysis, long term asset value on discounted cash flow analysis and market analysis are conducted to determine fair value of bulk carriers.

3.6 Interpreting the Data and Report

The results obtained through the application of mathematical methods within the scientific research were interpreted and reflected in the results and proposals section of the thesis study. As a result of the implementation of a new combined qualitative model and the analysis of the data, it was understood that fair value would also be a referance factor to compromise between sellers and buyers, as well as related parties such as banks, creditors, insurance companies etc.

4. RESEARCH STUDIES FOR IMPROVING A NEW MODEL

In order to improve “Cobined Qualitative Ship Valuation Estimation Model (CQSVEM)”, differences and deficiencies of previous valuation methods have been scrutinised. Hence, it is aimed to develop a new hybrid method to eliminate the gaps in the valuation methods. Therefore, following research studies were carried out.

4.1 Evaluation of the Impact of Freight Rates on Ship Valuation

The maritime industry, which has an important place in the world trade, has a very fragile market. Freight rates are one of the most influential factors in the maritime market. The operation of Merchant Vessels is directly related to freight rates. In some periods of economic crisis, maritime companies have to work to the detriment because of low freight rates, they resort to methods such as laid-up or scrapping. The economic crisis can sometimes be caused by excessive increases in oil prices, and sometimes can be caused by a financial crisis. This leads to a decrease in new shipbuilding activities, a drop in second-hand ship values, lack of availability of bank credits, an increase in ship insurance and funding costs, and changes in the routes on which vessels are operated. Ship valuation is directly related to ship supply and demand subject to maritime trade. While the world trade volume increases, freight rates are increasing, and the value of ships have been rising. Due to the fact that customers demand decreases in times of crisis, the high supply of ships could not find a sufficient load for many ships. Because of the ship’s being forced to operate at a loss, irrespective of whether owner companies have got ships which they are new or old, they may have to be constrained in **"out of service"** or **"laid-up"**. Since there is a huge number of variables affecting non-transparent maritime trade and in addition it is not possible to follow all of them on a one-by one basis at the same time, there is a need for future estimation models based on some statistical methods on time series. Because the high volatility of the shipping market has many future unforeseen grey areas, regression models need to be used for risk analysis. The decision support systems will be of the utmost importantance for strategic managers to provide simultaneous decisions. Since the highly volatile shipping market has unpredictable grey areas, multi-regression models will be used to determine risk factors and decision support systems will stand out. These systems are of the utmost importance for strategic managers to provide simultaneous decisions. Global Domestic Product (GDP) for 2015 is approximately $ 74.152 trillion (The World Bank, 2015). Ceteris paribus, 90% of these goods are transported via maritime trade (UNCTAD, 2016). In times of crisis, the shrinkage of production, the large number of ships, cause the freight rates to fall. Thus, maritime trade declines to 75% of GDP. Considering that the border trade with neighbouring countries is approximately 23% of world trade, it is highly likely that maritime trade will maintain its importance for many years and maintain its superiority over other modes of transport. Currently, there are more than 50,000 merchant ships used in international maritime trade in the world. These vessels, which are registered to the world trade fleets and belong to over 150 flag states, employ more than a million seafarers (ICS, 2017). In 2017, this figure increased to 58331 ton-miles (Clarkson Research, 2017). In the total of world trade fleet, bulk dry cargo ships are 43.11%, tankers are 27.86%, general cargo ships receive 4.17%, container ships are 13.52% and other ships have a share of 11.34% (UNCTADSTAT, 2017). It is evaluated that the dry bulk market contains the most needed major loads (Iron Ore, Coal and Grain) in world trade. The main reason is that ship construction and the demolition industries create ship supply-demand equilibrium and economy of scales. The most important element of ship construction is the steel in the framework of today's technology. Iron, coal and limestone are mainly used in steel production (D.J.Eyres, 2012). In order to determine the effect of freight rates on maritime transport which are very large and complex when considered in parallel with the aforementioned statistical values, it would be more accurate to concentrate on especially the bulk dry cargo market to narrow this issue down.

4.1.1 The Relationship between Ship Assessment Approaches and Freight Rates

In order to determine the relationship between ship assessment approaches and freight rates following issues are scrutinised.

4.1.1.1 The Concept of Value and The Meaning of Ship Valuation

Trade is almost as old as the history of humanity. The relative value of a commodity relative to the other depends on the need for it, its supply to the market and the quantity of demand. The exchange of commodities that are not identical to each other requires the determination of the value of each one relative to the other.

With the ideal state of Plato and the claim of Aristotle's private property to the present day, the concept of value has been associated with the concept of morality since the first philosophers who attempted to add normative meanings to the economy are engaged in theology.

According to Albertus Magnus and Thomas Aquinas, the value of a commodity is merely the sum of the effort to produce it and the effort made to transport this product until it reaches the buyer and the risks involved. Thomas Aquinas, with this motive, pushed forward the thesis of **"Fair Price"** and argued that the traders could not act with the motive of excessive profit and find the value of the commodity provided that they behave in a moral manner. Almost 400 years later, philosophers such as John Locke and Immanuel Kant advocated the concept of private property, while Karl Marx rejected these theses and he claimed that if private property was allowed, workers' labour would be stolen and that workers would be enslaved.

Valuation methods to determine fair price should minimize grey areas, prevent over pricing and optimize risk factors. Ship valuation mechanism has very complex structure. Before purchasing a ship, initial investment cost and long-term asset value should be compared by brokers or valuers. The difference between the two values will help to decide them whether to invest in this vessel. Thus, the operating expenses, the residual value of the ship and the discount rates that will change throughout the life cycle period will enable the determination of the long-term asset value based on a discounted cash flow.

The economic life cycle of the vessels has decreased from 40 years to 30 years and now to 20 years due to the advancement of innovative technology and the legal regulations of national / international regulatory agencies, classification societies and related official institutions. If technological advances are so fast, it will be an inevitable fact that ship life cycles will further reduce to 10 years. Therefore, according to the ship life cycle, dock repairs and maintenance, unexpected breakdown removals, modifications and modernizations, mandatory or optional maintenance applications, spare material expenses within the scope of inventory control management, personnel expenditures and operational expenses (OPEX-Operational Expenditures), insurance expenses, bank charges and the sum of all the expense items are lower than the revenue obtained; the value obtained as a result of collecting the income from the value of the scrap in addition to the remaining total income should be higher than the cost of the ship. There is a supply-demand imbalance due to the shrinkage of the production in the world and the supply of goods that are to be transported by maritime trade.

The long-term continuation of this situation leads to the scrapping of the ships before the expiration of their economic life-cycle, sales of the second-hands at low prices or be decide to the laid-up mode of the ships. There are two general tendencies in the world. One of them due to speculation is to buy second-hand ships, a second one is to remove older ships from merchant fleets, and instead of them, to order newbuildings. The first course of action is made through speculation. In order to achieve first course of action, the ship owner should keep some of his second-hand ships out of service (laid-up) until the crisis period is over, and should also be willing for a time to operate their ships at a loss. The second case, when the number of vessels decreases in the shipowner's fleet, means the carrying capacity decreases. Before the ship life cycle is completed, some of the vessels are sold at low value and some of them are taken out of service in the early period. To compensate for such loss, ships with relatively low operational costs compared to second-hand vessels are preferred. Thus, they can be maintained with low operation costs for a minimum of 5 years. In this case, the carrying capacity of newbuildings will need to be increased. Otherwise, the greater number of newbuildings with a lower carrying capacity to carry required load capacity will have to be constructed.

The strategic decisions to be taken here depend on the course of freight prices. For that reason, there is a need for various valuation approaches for determining the current and future estimations of ships.

The basic ship valuation concepts that determine the ship valuation approaches are shown in Figure-4.1.

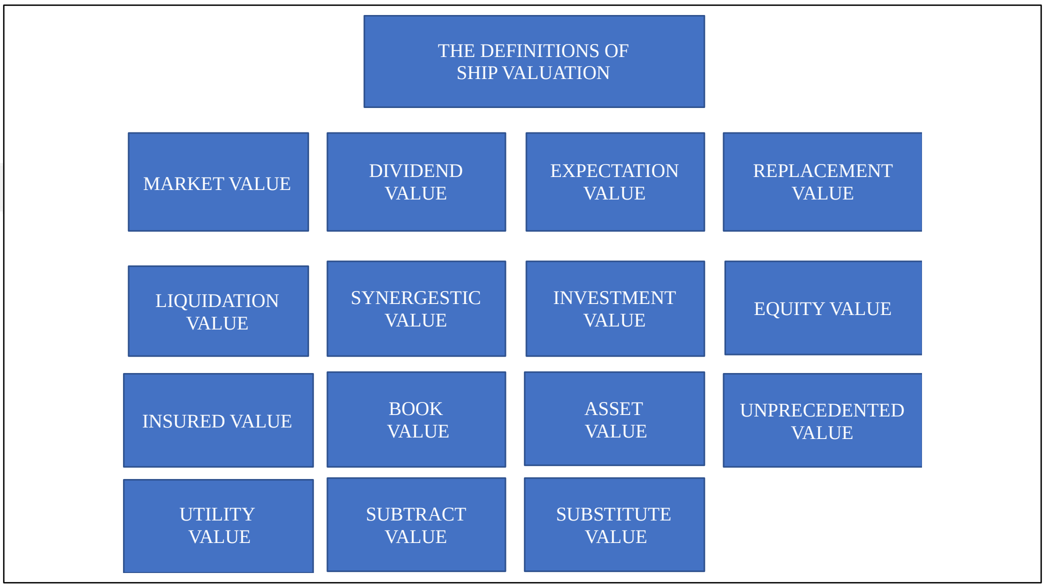

Figure-4.1 The Definitions of Ship Valuation

As it can be seen in Figure-4.1, there are many definitions about ship valuation. However, commonly used term of value is **"Market Value"**. In the sale of commercial goods, the seller wants to sell the goods with the highest possible value by a classical approach, while the buyer tends to purchase these goods at the lowest possible price with the most suitable condition. This also applies to the ships. However, in an extremely volatile market, it is not always possible to find a willing seller or buyer for the sale or purchase of a ship of low or high value required by the market. To give an example for dry bulk carriers, these ships are named on the type of cargo they are able to carry such as dry bulk, container, multipurpose, Ro-Ro, frigorific and livestock.

The maritime companies produce instant execution services through multi-buyers and multi-seller in shipping market. Shipping trade in freight prices which are dynamically variable in a wide range of products from iron ore to grain, coal, livestock, electronic goods, cement, is profitable in some periods, but in some periods, it is at a loss. Profit or loss is calculated on the basis of Time Charter Equivalent (TCE).

The TCE is calculated on the basis of standard ship types by deducting from the total net revenues, the total voyage expenses and divided by the total voyage days. The calculations do not include allowance for unforeseen expenses, waiting time at port and off-hire time. However, they do account for the ballast trips in the estimation of the total voyage days (ICS, 2006), (Tsioumas, 2016), (Clarkson Research Services, 2019).

$$TCE = \frac{TNR - TVE}{TVD} \tag{4.1}$$

Total Net Revenue (TNR) = (Freight Rate * Cargo Intake) * (1-Commision)

Total Voyage Expenses (TVE) = (Bunker Cost+Port Charges+Canal Dues+ …..+)

TC Rate indicated in the above formula is on a US dollar basis and the daily time-rent is paid. The daily rental price obtained above this value will make shipping trade profitable. Baltic Dry Index (BDI) is widely used for dry cargo ships. By comparing the daily economic indicators published by the London-based Baltic Exchange organization with the TCE ratios; future estimations, a decision can be made to selling and purchasing, laid-up, out of-service or scrapping.

Shipping prices for various sea routes are reported daily by shipping agencies to the Baltic Stock Exchange in London and various indices are calculated here. Although the BDI shows the demand for the current dry cargo carrying capacity in the world, it is still necessary to carry out a risk analysis for future-oriented inference because of the fact that profit ratios are not known due to the lack of notification pursuant to the brokering agreement or the TCE values on 26 different routes already determined. For example, when Lloyd’s List Market Data (24 February 2017) is examined, it is seen that Baltic Dry Bulk Index is at 875 level. (See in Table 4.1).

According to the daily market report published by Dry Ships Incorporated Company; An index multiplier was calculated by utilizing the Spot TC Average (TCavg) values and the Baltic Dry Index dated February 24, 2017, BCI (Cape Index), BPI (Panamax Index) and BSI (Supramax Index) for 21 January 2017. This value varies according to the total DWT (Deadweight Tonnage) of the same type ships engaged in similar commercial activity. With this predicted coefficient, it is possible to calculate the Spot TC Average value when the average index is multiplied. Hence, this value is compared with TCE, it can be seen that the freight earned from revenues is profit or loss.

Table-4.1 The Calculation Sample of Baltic Dry Index Multiplier

Baltic Dry Index-BDI				
	BCI (Capesize) 24.02.2017	**BPI (Panamax)** 24.02.2017	**BSI (Supramax)** 24.02.2017	**BHI (Handysize)** 21.01.2017
Spot TC Average **(A)**	9358 USD	7613 USD	8461 USD	6088 USD
Average of Indices	9358 + 7613 + 8461+6088 / 4 = 8477 USD			
Daily Indices **(B)**	1165 **(C)**	947 **(D)**	809 **(E)**	428 **(F)**
Daily Indices Multiplier **(A/B)**	0,1244924129 **(G)**	0,1243924865 **(H)**	0,0956151755 **(I)**	0,0703022339 **(J)**
Average Daily Index (ADI) **C+D+E+F/4**	**875**			
Index Multiplier (IM) **G+H+I+J/4**	**0,1037005772**			
ADI * IM	**OVERALL AVERAGE VALUE = 90,73800505 = 9074 USD**			

The ratio of the annual Spot TC Averages to the duration of the ship's life-cycle is equal to the overall average value on a $ / day basis (9074 USD, 24.02.2017). The difference between the annual average and the general average is that the standard deviation is determined in $ by the ship during the service period by calculating annually.

The ratio of this standard deviation to the average of general rent will determine the risk coefficient. However, the risk factor will vary depending on the DWT of the vessels. Risk calculation can be calculated separately for different routes, different ship tonnages, different age intervals new shipbuilding prices, second hand prices.

In this context, risk coefficient can be calculated according to the annual ship rents by using the formula given below (Karagoz, 2015).

$$\text{Standard Deviation } (\sigma) = \sqrt{\frac{\sum(X_i - \mu)^2}{N}} \qquad (4.2)$$

X1: 1st Year Daily Rent (Annually), **X2:** 2nd Year Daily Rent (Annually), **μ:** N Years's Daily Rent, **N:** Total Year.

Standart Deviation (σ) / General Rent Average (μ) = coefficient of variation (4.3)

The formula gives the value of standard deviation. The coefficient of variation determines the percentage of risk. Using this formula, the daily rental rates can be determined by multiplying the Baltic Dry Index Multiplier and The Average of Daily Indexes.

Additionally, the overall average value can be calculated on the basis of $ / day for Handysize, Supramax, Panamax or Capesize using Clarkson SIN data. Using Deval's Clarkson SIN 2010 data, the general average of rent values for 1 year $ / day for a 23-year period between 1989 and 2011 was calculated as 11.035 for Handysize, 15.359 for Supramax, 17.611 for Panamax and 30.774 for Capesize (Deval, 2015). When these values are compared with the Baltic Dry Index multiplier, in the first quarter of 2017 respectively; It is observed that for Capesize it is 9358 USD, Panamax is 7613 USD, Supramax is 8461 USD, Handysize is 6088 USD and since 2011, TC Average values have decreased considerably. The following Figure-4.2 shows that the Baltic Dry Index is 934 in 2012, the highest index value is 2113 in December 2013, the lowest index value is 317 in January 2016 and the index is 875 in February 24, 2017.

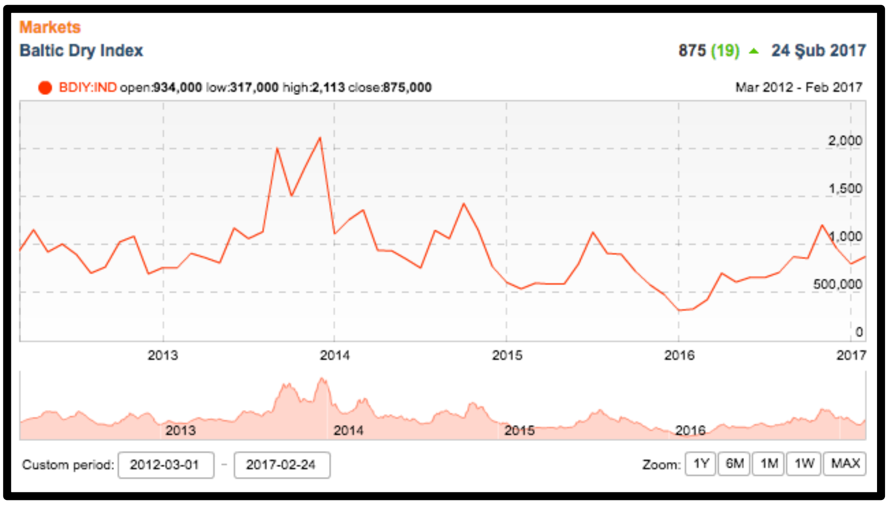

Figure-4.2 Baltic Dry Indexes 2012-2017 Source: (Lloyd's List, 2017)

When the Baltic Dry Indexes between 2012-2017 are compared with the data of 1989-2011, it can be seen that the percentage of risk is high and the market's volatility is increasing. As the requirements of the International Maritime Organization, ships should be subject to modernization or modification. Therefore, according to the evaluation the destiny of vessels exceeding 20 years of service may be taken out of service or laid-up.

4.1.1.2 Other Concepts Considered in Ship Valuation

The market value of ships is not sufficient by itself for future risk analysis. In addition to the market value as shown in Figure-3.8, concepts such as Dividend Value, Substitute Value, Subtract Value, Synergistic Value, Investment Value and Utility Value must be taken into consideration (IVSC, 2016). The dividend value is generally the average of the ship's market values. In this appraisal, the present value is taken into account after deducting the expenses from the gains of the ship today and in the future. Interest rates play a decisive role in the determination of the net present value.

In the Expectation Value concept, potential customers in the future are considered. Replacement value is the value of an economic asset in the case of re-supply on the valuation day.

The replacement value is used to estimate the value of a ship which may be substituted for a displaced ship, in other words the value of a ship that may replace it. The liquidation value can be explained with the concepts of scrapping and waste. Scrapping refers to the reprocessing parts of the ship, which can be recycled into the ship industry, however, waste is the non-commercial disposals.

The long-term asset value (Long Term Asset Value-LTAV) can be found after the initial investment in a ship and after the costs are deducted during the life cycle, and then discounted cash flow analysis can be made. Therefore, the liquidation value is the value that will occur if an asset or an asset group is sold on a piece-by-piece basis, regardless of an ongoing business-related benefit (or loss).

The synergistic value is the combination of two separate values (assets and liabilities), resulting in a value greater than the sum of the two separate asset values. For this, a single specific receptor is required. The synergistic value is always more than the market value.

Synergistic Value may be consistent with market value, since the asset will be the price that will be exchanged on the value date between a willing buyer and a willing seller, but it will probably be a surplus as it reflects the value of the synergies offered to multiple market participants. For example, synergies in the niche markets such as military ships, mega yachts, or super yachts can be said to result in increased value. Considering that the war ships delivered to third countries through foreign military assistance or grants can cost up to 2-3 times the value they have during the life cycle of approximately 40 years, it can be stated that it can provide a serious income.

The value of this income is considerably higher than the market value of the ship. Investment Value is the added value that the owner or prospective owner provides for the individual investment or operational purposes.

The investment value reflects the conditions and financial targets of the asset. It is often used to measure investment performance. Utility Value is a reasonable value for both the buyer and the seller.

This value comes out as an appropriate value for bank loans. The utility value has an approach similar to the dividend value. The rate of return and the risks of the investment to be made are evaluated and added to the market value.

4.1.1.3 The Evaluation of The Hamburg Ship Valuation Standard in The Context of Freight Rate

The Hamburg Ship Evaluation Standard (HSES) is a ship valuation method based on the Discounted Cash Flow (DCF) model. Long-term asset value formula is developed by the Hamburg Ship Brokers Association (Hamburg Shipbrokers' Association-VHSS). This formula is as follows.

$$LTAV = \sum_{t=1}^{T} \frac{Ct-Bt}{(1+i)^t} + \frac{RWt}{(1+i)^T} \quad (4.4)$$

Ct: Charter Income), **C_1** : Current Net-TC Rate in Running Year, **C_2** : Average net-TC Rate), **Bt**: Average OPEX), **i**: Discount Rate), **t**: Period, [**t_1** : current year, **t_2-T** : Period End)], **T 20/25:** Remaining period and **RWt**: Lightweight Displacement-LDT)

The table below gives a generic overview of the parameters of the above formula for calculating the Long-Term Asset Value of a dry cargo vessel (Handysize, 16 Million USD, 30.000 DWT, and 5 years old). When the parameters in Table-3.1 are applied to the LTAV formula, the present value of the LTAV specified in Table-3.2 is obtained for 15 years.

The following calculations can be made with the calculation module of Long Term Asset Value-Ship Options on the official website (http://www.long-term-asset-value.de/ltav.php) of the Hamburg Ship Brokers Association. In addition, same calculations can be applied with MATLAB, EXCELL or SPSS programme.

Table-4.2 Net Present Value of the Generic 30000 DWT Handysize Dry Cargo Ship

t	Age	Running days	Gross-TC Income p.d ($)	Net-TC Income p.a (C) ($)	OPEX p.a (B) ($)	(C-B)/(1+i)^t ($)
1	6	358	6084	2.036.497	1.095.000	870.512
2	7	358	6084	2.036.497	1.116.900	786.157
3	8	358	6084	2.036.497	1.139.238	709.227
4	9	358	7000	2.343.110	1.162.023	863.188
5	10	343	7140	2.289.834	1.185.263	746.401
6	11	358	7283	2.437.772	1.208.968	767.745
7	12	358	7428	2.486.527	1.233.148	724.058
8	13	358	7577	2.536.258	1.257.811	682.856
9	14	358	7729	2.586.983	1.282.967	643.999
10	15	343	7883	2.528.161	1.308.626	556.868
11	16	358	8041	2.691.497	1.334.799	572.792
12	17	358	8202	2.745.327	1.361.495	540.198
13	18	358	8366	2.800.233	1.388.725	509.459
14	19	358	8533	2.856.238	1.416.499	480.469
15	20	343	8704	2.791.295	1.444.829	415.463
				SUB-TOTAL		9.869.392 ($)
				RESIDUAL SCRAPVALUE t=15		240.545 ($)
				PRESENT VALUE		**10.109.937 ($)**

Source: Present Value is calculated by author using Hamburg Ship Brokers Association official web site "Long Term Asset Value - Ship Options" Module. (http://www.long-term-asset-value.de/ltav.php).

In the LTAV formula determined by the Hamburg Ship Valuation Standards, the discount rate plays an important role. Discount rate formula (4.5) is as follows;

$$r_{WACC} = r_E * \frac{E}{G} + r_D * \frac{F}{2G} \qquad (4.5)$$

r_{wacc}: weighted average cost of capital (WACC), **E:** Market value of the ship's equity, **F:** Market value of the ship's debt, **G:** Total market value of ship's assets, **r_E:** Cost of equity capital E, **r_D:** Cost of debt capital.

Equity cost **(r_E)** formula (4.6) as follows;

$$r_E = r_f + \text{MRP} * \beta \qquad (4.6)$$

r_E: Cost of Equity Capital, **r_{Rf}:** Risk Free Basic Rate of Interest, **MRP:** Market Risk Premium, **β:** Beta Coefficient.

The coefficient has been accepted as 3.4 for dry cargo vessels according to Hamburg Ship Valuation Standards. In addition, Market Risk Premium (MRP) has been determined as 4% - 6%. Depending on the econometric time series, risk analysis with the Bayesian approach and the use of logistic regression methods to prepare conditional probability tables and determination of constant coefficients are required in markets with high volatility. Therefore, it was concluded that the Hamburg approach had a complementary role for courts, banks, insurance or finance companies.

4.1.2 Discussions

Due to the variety of products carried by dry cargo ships, it is considered that a ship valuation approach which is independent of the freight rates will not be possible considering the change in the commodity values in the major loads, the balance of supply and demand of these goods and the inelastic structure of the shipbuilding sector. However, the use of methods such as market values, prior sales or income approach alone will not be sufficient for ship valuation. Currently, the most commonly used method is the analysis of various indices. It is concluded that the constant coefficient of "**0.110345333"**, which is generally accepted for the Baltic Dry Index Multiplier, may vary according to the DWT supply. While the freight rates are high, the difference due to this coefficient may seem negligible and the loss of income due to the index multiplier for the low freight rates during the crisis periods should be taken into account and not be overlooked. Similarly, when the generally accepted Hamburg Ship Valuation Standards are reviewed, discount rates play a key role in a long-term ship valuation based on discounted cash flow (DCF) model. In calculating the discount rate, the cost of equity capital is the determinant factor, while the cost of the equity cost for Dry Cargo Ships is calculated by using a β coefficient of 3.4. This constant should be recalculated depending on the DWT supply. Depending on the econometric time series, risk analysis with the Bayesian approach to estimation errors and the use of logistic regression methods to prepare conditional probability or contingency tables and determination of constant coefficients are required in markets with high volatility. Therefore, it was concluded that the Hamburg approach had a complementary role for courts, banks, insurance or financial companies.

If the daily freight rates and other parameters of all merchant vessels in service are collected in a data pool, future estimations can be calculated by various quantitative and qualitative methods and indices of these parameters. For that reason, it is important that the data of all ships subject to maritime trade should be entered correctly, one by one and simultaneously. Recently, many open sources recommend that the Baltic Dry Index has been no longer covered by the whole world and should be considered together with other indices. The differences of tax rates, interest rates and exchange rates, geopolitic circumstances related to the war risks, rapid growths of technology, regulations put forward by international organizations, flag and port state applications force multi-variable and non-linear data to be merged in order to provide big data management. Therefore, the establishment of a global maritime cooperation is gaining importance to ensure the effective big data management. The existence of a correlation between indices must be taken into account. The institutions making strategic planning for the future will need not only expert consultants but also decision support systems. Assuming that the average ship life cycle is 20-30 years, it can be seen that in critical periods such as war risks, oil crisis, financial crisis or extraordinarily bankruptcies, the ship supply and demand will have the maximum change. In these situations, a decrease in ship supply and freight prices can be experienced. Therefore, it is important that decision support systems work in an integrated data repository where big data can be stored, taking into account every possible parameter. Thus, within the 20-year period, the time interval between which the crisis may occur is predicted, and with various simulations it will be possible to take appropriate positions for the crisis and post-crisis opportunity period. As a result, each country needs to create its own data repository and these data pools should be integrated with the service-oriented architecture and the indices should be calculated more accurately. While service providers such as Clarkson, Baltic Dry Index and VesselValue have come a long way, close their systems and provide an important service to the whole world, it is a fact that grey areas are formed in the future forecasting and modelling.In addition to aforementioned recommendation, touching upon the subject of securitisation will also be beneficial. The asset value of the vessels is affected positively or negatively by the freight rates. It would be helpful to evaluate the asset values of the ships as real estate. However, securitisation of the assets is also of utmost importance too. In order to prevent the excessive decrease in asset values of vessels from construction to demolition, securitisation plays a critical role in keeping the asset values of ships.

4.2 The Effects of Long-Wave Economic Cycles to The Ship Valuation

Since it is necessary to use different mathematical methods to estimate the supply-demand balance in times of the economic crisis leading to an increase in instability and volatility of the market, it is misleading to determine the ship valuation solely by the market approach.

In this study; considering the short-wave theorem of Kitchins, Juglars and Kuznets and the long-wave theory of Kondratieff, the effect of long-waves in predicting ship's Long-Term Asset Value (LTAV) has been evaluated. In this context, in the process of deciding on new shipbuilding and second-hand vessel sales, laid-up and scrapping operations, floating points have been considered on swinging long waves at the economic cycles and how much deviations are between the calculated values and the actual sales values of the ships have tried to be determined. In this framework, some suggestions are presented to maritime companies about the strategies they can implement in terms of strategic management.

4.2.1 Nikolai Dmitrievich Kondratieff and the Long-Wave Economic Cycles

Nikolai Dmitrievich Kondratieff, who wrote The Theory of Long Waves, studied history and statistics in the city of St. Petersburg, where he was born in 1892. In 1920, he assumed the task of founding the Conjuncture Institute and was appointed as the Director of the Institute (Kondratieff, 2010). Although Kondratieff had previously issued various publications on the subject, he succeeded in putting his work on long waves into a systematic basis in his 1928 article **“The Dynamics of Industrial and Agricultural Prices"**. Kondratieff demonstrated the fact that the long wave theory, which he had been able to develop before the economic crisis of 1929, could not destroy the capitalist system. Kondratieff's analysis clarifies how long-term business cycles called Kondratieff or "K waves", and how capitalism operates in the world's major international economic crises. The K waves are based on 60 years +/- 1-year periods (cycles) and the fluctuations in the economy are seen seasonally. According to this (Kale, 2014; Karagöz, 2015);

- The spring period shows that the economy is getting better, the inflation is only one digit, but the existence of a new production factor exists.

- Summer inflation has risen to double digits, and the uncertain environment created by the competition of global actors, which play a leading role in the economy, increased the suspicion created in the society.

- The financial problems caused by the double-digit inflation in the autumn period are tried to be repaired, there is a credit boom and the foam economy is carried out in an artificial welfare environment.

- The winter period shows that the debts have arisen due to the excessive capacity caused by the economic crisis and commodity deflation.

According to the Kondratieff waves (Kondratieff cycle / long waves / long economic cycles), the recurrent fluctuations of important economic variables for a characteristic period range from 40 to 60 years. While they tend to accelerate in growth rates in upswing periods, they tend to slow down in other downswings (Grinin, Korotayev, & Tausch, 2016).

Kondratieff found that the British economy expanded from 1792 to 1825 and shrank from 1825 to 1847; he stated that the temporary overproduction capacity in the products such as iron, steam engine and textile production increased the economic competition but the prices were lowered due to the economic recession. Subsequently, after the second economic expansion in the UK from 1847 to 1873, he found that there was another economic contraction from 1873 to 1893 due to excessive investments in the fields of railways, steam ships and telegraph industry.

He then stated that the third economic expansion that took place between 1893 and 1903 was interrupted during the World War I, followed by an expansion in North America and Japan. However, he identified that the decline in the US stock market and the excessive inflation in Germany in 1929 led to the world economic crisis. While long waves provide a very important strategic prediction, macroeconomic approaches that examine shorter cycles should also be taken into account. The determination of how short waves are emitted at the stage of long waves will shed light on the economic decisions to be taken before the collapse and stagnation periods. In this context, the short and / or medium-wave theorems of Kitchins, Juglars and Kuznets, Akamatsu and others are discussed together with Kondratieff's long-wave theorem. When the Juglar cycle (or "business cycle") was examined, it was seen that 7 to 11-year characteristic periods were discussed (Grinin, Korotayev, & Tausch, 2016). It is a medium-term economic cycle.

The economic growth and burst are considered as macro-economic fluctuations, with the Juglar cycle describing the situation in which a new economic crisis following a new period of economic growth is regularly introduced. The Juglar cycle is divided into four stages (See in Figure 4.3). These are;

- **Phase 1:** Recovery,
- **Phase 2:** Expansion,
- **Phase 3:** Recession,
- **Phase 4:** Depression,

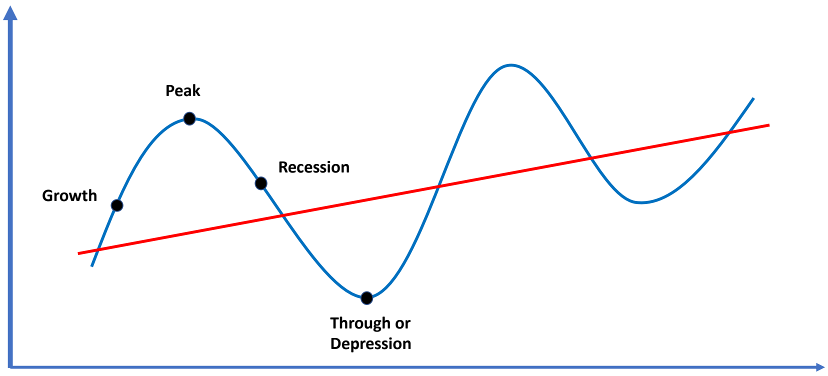

Figure-4.3 Juglar Cycle (Business Cycle) (Stopford, 2009)

In 1922, when Kondratieff formulated the long-wave theorem, he called 7 to 11-year's cycles as Short Waves or Short Cycles. Later, Kondratieff thought these conjunctural cycles as medium-term cycles. During this period, it was found that the characteristic cycles of the 3 to 4 years that Joseph Kitchins had discovered were in fact a fluctuation due to the stocks of the enterprises from 40 to 59 months. These fluctuations are called Short Waves or Short Cycles. Due to today's computer-aided logistic information systems, Kitchins cycles are losing their importance. Nevertheless, surplus stock accumulation continues to cause prices to fall. Kuznets' cyclical oscillations of 15-25 years cover infrastructure investments and other changes in the economy. However, the reasons for such economic changes cannot be defined precisely because they can be linked to long-term investments in technology, emissions, construction or other areas (Stopford, 2009). In 1937, Japanese economist Kaname Akamatsu discovered special ties between developed countries and developing countries in relation to the Kondratieff cycle. The oscillations that show upward rises and downward falls in the economy are called the Akamatsu Waves. Akamatsu's flying gees model is different from neoclassical approaches and theories. This theory has attempted to explain the process of developing economies converted into a developed economy (Schröppeland & Mariko, 2005). The theory developed by Akamatsu was revisited by Raymond Vernon in 1966 in the western style. Vernon's Product Cycle Model is mainly production-oriented. It does not focus on consumer-oriented sociocultural and behavioural variables.

Vernon's approach is based on industrial goods in manufacturing sectors, ignoring intangible assets such as services or brands. It provides information at the macro level to develop national policies rather than micro-level and short-term management decisions. The basic view of Vernon's hypothesis is that some countries specialize in goods which already exist in the market, yet some countries are specialized in new goods. The critical point is to understand in stages how a commodity becomes a new commodity and ends up in a position of belonging to the market. Countries such as the US specialize in the production of new goods, especially as a result of the high costs of highly trained labour force and Research - Development (Vernon, 2009). Joseph Schumpeter has been the first to use the term of long-cycles for Kondratieff's studies (Barnett, 1998).

The first studies of Kondratieff are about time series. First of all, all data (exceptions and price series) are divided into population. Subsequently, per capita income curves were addressed by using the least squares method. 9-year work cycles, short cycles and random fluctuations have been extracted from long waves. When the curves were examined, it was determined that the deviations from the general trend were related to long cycles yet the other curves were determined not to be related (Garvy, 1943). From Adam Smith to Karl Marx, economists have sought to understand the causes of productivity and productivity growth. Until the end of the Second World War, the reason for growth was not fully understood (The Economist, 2014). In 1956, Robert Solow, a lecturer at the Massachusetts Institute of Technology (MIT), introduced the Production Function Model. Solow was awarded the Nobel Prize in Economics in 1987 (MIT, 2018). In this theory, it is stated that the output of the economy depends on capital and labour inputs. In accordance with the law of diminishing returns, increasing the amount of a production factor has an effect of raising the total production; however, the effect of each additional unit variable input decreases gradually. After a while, it affects the production amount negatively. Although the law of diminishing returns does so, if the capital is increased when there is a certain labour, or if the labour force is increased when there is a certain capital, it is seen that this negative effect is replaced by a small increase. The law of diminishing returns is a condition that must take place in an ideal economic system. However, when the long waves are examined, it is actually seen that the theoretical laws of economics work differently from what is actually stated in theory. While the capital stocks of the countries which succeeded in industrialization after the industrial revolution increased relatively compared to the labour force. It is expected that the return on each unit of capital would decrease according to the law of diminishing returns. However, contrary to expectations, the increase on capital return demonstrates that there is an economical structure different from the ideal situation. This cannot be explained by economic inputs such as increasing or decreasing, capital or labour force. According to the law of diminishing return, investment need to be reduced as capital increases. Nevertheless, the slowdown in economic growth through technological progress and innovation cannot be compensated and this cycle does not function in favour of poor countries. Intellectual property stemming from technological knowledge, experience of production based on market research, are in a sense trade secrets. As trade secrets can only be purchased for a large cost and are protected by patent rights or intellectual property rights, the factor of trade secrets is ignored during the evaluations. However, despite the principle of the law of diminishing returns, trade secrets are still the most important factor explaining why it is growing the rich states. Austrian economist Joseph Schumpeter's these views on technological progress explain the cycles of industrial mutations that have annihilated the previous one and been continuously renewed (creative destruction) for a period of 50-60 years. While looking at Kondratieff's long-wave theorem, it should be considered that technological leaps are also an important factor. Kondratieff has taken into account the wages, interest rates, industrial production and consumption in the US, France and the United Kingdom, while Schumpeter has examined the issue further. The periods in which there are important technological leaps in the world history and the long waves mentioned by Kondratieff overlap.

Parallel to the industrial revolution new products such as;

- The use of steam vehicles and railways (since 1829),
- The use of steel, electricity and engineering activities (since 1875),
- The use of automotive, oil and mass production vehicles (since 1908),
- The use of IT technologies (since 1970),

have revived the market and created an upward trend (Yegorov, 2011). On the other hand, it is seen that wars, financial crises, supply-demand imbalances related to oil or alternative energy resources have turned the market to a downward trend, and holding strategies have been formed in the interim periods between instability and equilibrium. In addition to technology, which is an important factor in the Kondratieff cycle, credit and banking also play a very important role. Because the new technology is forced to grow, so is initiative and risk taking. This mentality encourages investment and lending. Thus, when multiplier effect begins, economies expand rapidly.

The basis of long-term economic expansion is the interaction between science-technology and economy. Excess production capacity occurs in the normal business cycle after economic expansion periods. This new technology-based industry reduces prices as it matures, and many competitors enter the new market. Even in this relatively new industry always reduces profits. The high-tech industry will not be a high-profit industry for a long time. Because after the maturation of technology, competition will also intensify. The third industrial cycle ended after the 1950s, and after the fourth cycle where oil, aviation and mass production reached maturity, the fifth cycle with semiconductors, fibre optics, genetics and software related technologies approached the maturity phase after the 1990s. Schumpeter's cycling of 50-60 years is reduced to 30-40 years due to the rapid development of technology. The waves of Kondratieff that Joseph Schumpeter analysed are as in Figure-4.4.

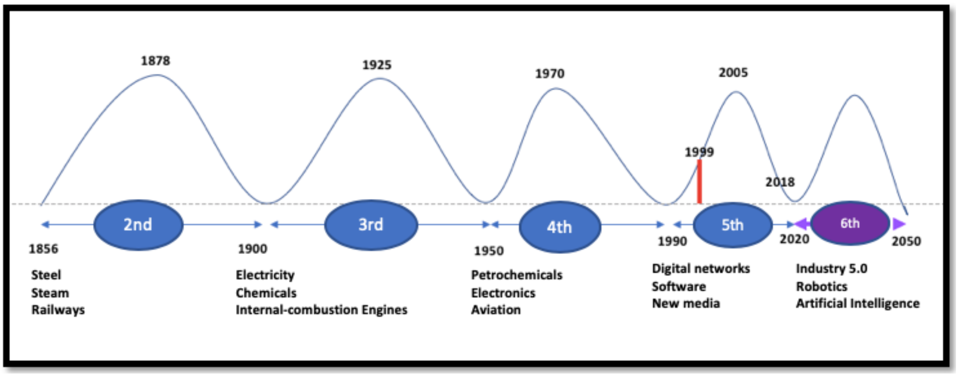

Figure-4.4. The waves of Kondratieff that Joseph Schumpeter worked (It is revised by author).

Schumpeter made a prediction by 2020. A simulation was made until 2050, since it is highly probable that it would be a 30-year cycle due to technological leap. In this case, as in 1856, 1900, 1950 and 1990, long waves are expected to reach the deepist point at the beginning of 2020. Next, it is thought that advanced technology products such as plasma technology, artificial sun, thorium-based nuclear energy, energy storage systems, alternative energy sources, space technologies, robotics and artificial intelligence applications will cause a new technological leap. However, It is speculative when new technologies will be supplied to the world markets. Also, the fact that new technologies will shorten cycles and reduce them to 20 years should be taken into consideration.

4.2.2 Long Waves and Shipping Market Cycles

Maritime trade, one of the locomotive actors of global development for more than 5000 years, is carried out in a highly competitive, high-risk market with strict economic rules. In addition, economies of scale force shipowners, shipbuilders, buyers and sellers, banks and financial companies, insurance companies and many other actors to take strategic decisions. The most suitable means of transportation in the transfer of goods produced in the world from point A to point B is undoubtedly the ships. As the production increases, the carrying capacity of the vessels is also increasing in order to reduce the freight rates. However, when there is a contraction in production, very large or ultra large carrier capacities will not be filled.

In such a case, because of the excessive ship supplies, shipowners are at a loss. In this case, the shipowners can decide to take their ships out of service or laid-up. Very few companies in the market believe that with the motive of speculation, they can buy second hand ships that fall in price during the crisis and increase their profits by placing them on the market in the future when ship supply is needed. Especially, the Greek shipowners have sometimes made such choices. An important centre of economic power was formed in this region due to the maritime trade concentrated in Phoenicia during 2000-3000 BC. Over time, these power centers continued to shift westward as shown in Figure-4.5

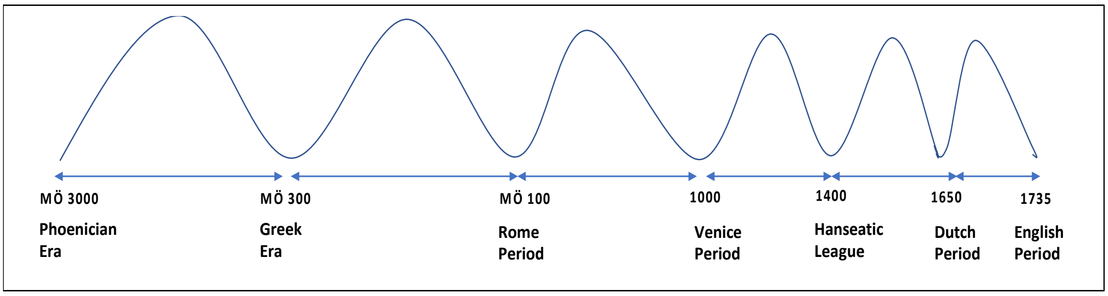

Figure-4.5 Power Centers in History from 3000 BC to 1735

Economy power centers are moved from Phoenicia to East Asia through 5000 years. These are respectively; Greek (MÖ 300), Rome (MÖ 100), Venice (MS 1000), Hanseatic League (MS 1400) Antwerp and Amsterdam (1650), London (1735), North America (1880-1950), Japan (1950-1970), South Korea (1973-1986) and China. This issue coincides with Kondratieff's long wave theorem. When the paradigm changed, the strategic centre of gravity shifted to the west, and finally China's outstanding performance led the country to become the centre of attraction in East Asia. As the maritime cycles cannot be explained soley by using the long-wave theorem, it would be more accurate to interpret the short waves which are superimposed on the long waves. In this context, maritime trade has shifted westward in four phases. The first phase is the Mediterranean / Indian Ocean, the second phase is the North Atlantic, the third phase is the Pacific and the fourth phase is the South and East China Seas.

Taking into consideration Figure-4.5, from the 3000 BC until the period of 1650-1735, it is seen that the range of long waves for trade centres is quite wide. The technological leap is quite slow until the 16th century. After this date, a rapid change process has been entered. From the 1800s, the long waves became more frequent and narrowed to 50-60 years. Nowadays, it is estimated that intervals of long-waves will shrink until 20-30 years in the near future.

According to the predictions of the scientists, it is highly likely that new maritime trade routes will emerge from the North Pole due to global warming. This situation will be felt as a new factor from 2050 onwards. Since the ice will completely melt after 2070, the sea trade routes will be reduced by 1 to 3. In the 2100s, perhaps long waves will be synchronized with short waves. All this depends on the factors that will create a paradigm shift. Re-expansion of the intervals of these cycles may emerge with the result of a worldwide catastrophe. Sir William Petty noticed that in 1660 there were seven-year cycles in corn prices (Murphy, 2009). Subsequently, other economists used decomposition techniques (Nerlove, Grether, & Carvalho, 1976) over time. Thus, they have found that the cycles are composed by the components of different parts statistically.

In 1838, the French economist and philosopher Antoine Augustin Cournot (1801-1877) discovered that periodic changes should be distinguished from the long-term changes (Kukushkin, 2016). Cycles are not unique to the maritime market. Some economists, historians, and statisticians have analysed and categorized cycles in many industries. Usually, these categories are focused on the length of the cycles when they are determined. Kitchens; 3-4 years, Juglar; 6-8 years, Labrousse; 10 to 12 years, Kuznets; 20 years and Kondratieff; They have detected cycles that lasted 50 years or longer (Stopford, 2003). Cycles are defined in three main groups as long term, short term (cyclical) and seasonal. The short-term cycles and seasonal cycles of Martin Stopford on long-term cycles based on the freight value collected from a wide variety of sources are shown in Figure-4.6

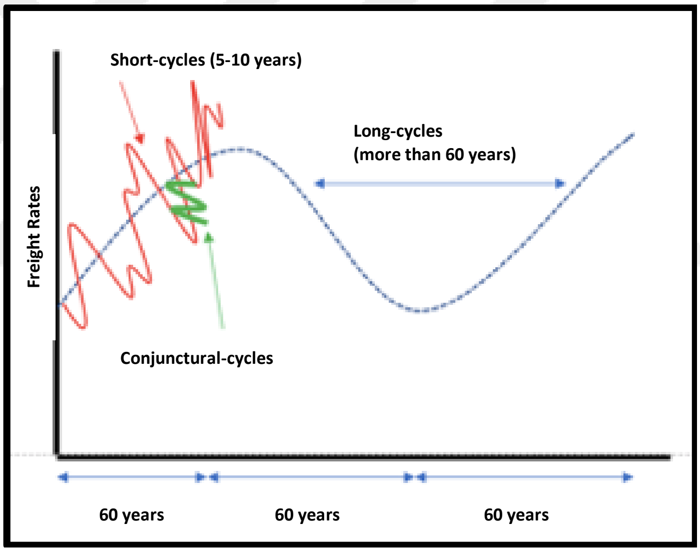

Figure 4.6 Short, Long and Conjunctural (Seasonal) Cycles (compiled by Martin Stopford)

When the long cycles are revised as indicated in Figure-4.5 and Figure-4.6, it is understood that short cycles and conjunctural (seasonal) cycles show different trends in trough, recovery, peak and collapse stages. It is seen that freight rates and the independent and dependent variables related with freight rates are very important factors. At trough phase, idle capacity of ships occurs, ships wait in the queue at the ports' mouth and with slow-steaming for fuel saving.

Freight rates are almost equal to the Operating Expenses (OPEX) of companies. In this case, the vessels are kept in a laid-up (temporarily out of use) or out-of-service condition. The credit crunch and financial crisis are revealed. Freight charges decrease to bottom. Recession occurs. Radical decisions are shifted. For cash flow, companies sell their ships. With market pressure, new ships fall well below book value. The price of old vessels is almost as low as scrap value. The recycling market commence to revive. In the end, the bottom waves alleviate, and a potential capacity occur for the production of newbuildings. In the recovery phase, the balance of supply-demand begins to form; freight rates exceed the OPEX. When the peak point is reached, the equilibrium of supply and demand is completely stabilised. Second-hand ship prices rise and newbuildings cannot be supplied to the market simultaneously. It can be seen that second-hand ships are sold at higher prices than new ships. Shipyards' order books reach almost full capacity.

The old ships can be tried to be released without supervision. Modern ships can be sold far above their value-based price. Freight rates increase at least 2-3 times or much more naturally. Banks are reluctant to lend credit. As for the collapse stage, the supply exceeds demand and the freight rates begin to fall rapidly. This rapid decline is usually the result of big shocks, such as the scarcity of oil or the financial crisis. There is a certain resistance in second-hand prices since the decline has just started. However, the gradual decline in price begins. A number of vessels are kept under laid-up condition, and other vessels are chartered with low freight charges. The length of crisis periods causes strong actors to hold on to the market and others to disappear. It is evident that in the long term, both the buyers (Shipowners) and the sellers (Shipbuilders) can maintain profitability if they earned sufficient money between recovery and peak periods to overcome the crisis period. Even maritime companies that are too weak to be able to survive short cycles should be more cautious when making strategic decisions. In order to overcome the obstacles of these companies, merging is the best way to make a profit in the long-run. As the supply of ships can be increased through production contraction or when the freight rates are high, the current ship supply may increase by additional newbuildings. While every threat is also an opportunity, although there is a contraction in the volume of regular liner trade, there will be a great competition environment in line with the opportunities in tramp trade. Hence, It will be possible to shipping trade with the extraordinary freight rates by the firms that assume the trade risk for the war zones with high risk. When the supply of ships to these regions is increased, the freight rates will also decrease after a period of time within the increase in competition. The fluctuation of the market in times of crisis triggers as much the profit as the risk it brings. Since this is also an opportunity, there is a contraction of the volume in regular line transportation. In the case of a large competition environment in proportion to the opportunities that will arise in tramp trade, the firms that take the commercial risk in the war zones are trading with extraordinary freight rates. British economist Sir Henry Roy Forbes Harrod's determinations regarding commercial cycles are similar (Harrod, 1965). Ship supply in the freight market is a very important factor in the formation of prices.

High fluctuated shipping market considering for the maritime trade cycles within the short-term or the long-term is an unprecedented market when it is compared to any other specific market such as textile market relatively. Cyril Frederick Hardy Cufley stated that due to these uncertainties, it was necessary to create a space for unforeseen cargo, to meet the marginal tonnage requirement, to respond to the need for ships due to seasonal or other fluctuations, to offer lower prices than tariffs and to create a pool for emergency situations (Cufley, 1966). Cufley claimed that the estimation of the freight value would fail, the fluctuation of the open market as a result of the upswing and downswing movements, and therefore the impossibility of making a precise prediction (Cufley, 1972). Freight rates and ship prices are among the most important factors in predicting the future and making investment decisions. Ship orders increase when freight rates increase. When freight rates fall, ship orders decrease. Thus, there is an increase in ship breaking, ship scrapping, ship dismantling, ship demolition or ship recycling. Investors do not act rationally, they do not avoid extremism because of fear or ambitious. Instead of scrapping the ships, they stay in the market for a while and reduce the cash flow. Weak opponents are withdrawn from the market. The length and duration of short and long waves are different. This makes the sea trade attractive or risky and causes each cycle to have different characteristics (Hampton, 1991). Martin Stopford states that the peak point in long cycles brings a risk to the shipper and the bottom point to the carrier.

In addition, he emphasized that the supply-demand imbalance will be disadvantageous against the other side, but on the break-even point will be in favour of both sides. Because of the impossibility of staying at a break-even point, both parties act in a way that exceeds the cost, and this negatively affects the cash flow. However, the situation becomes more volatile as different actors provide input to this market. For example, factors such as China's preservation of inventories for ship steel production or the reduction of oil supply by oil refineries can lead to unexpected crises. For example, factors such as increasing its inventories related with China's ship steel production or the reduction of oil supply by oil refineries in the worldwide can lead to unexpected crises. Such crises can overwhelm new shipbuilding plans or influence the value of vessels in the second-hand market.

At this stage, shippers or ship-owners may take different positions to eliminate or mitigate the risk. Freighters can carry commodities with their own ships or ship-owners can charter their ships for short-term or long-term holders of cargo. Long-term charter may be the preferred option for shipowners, especially in the dry cargo market. Trade routes are evident, and demand is permanent. As long as circulation can be maintained, supply and demand continue. Cargo owners (shipper) may also prefer to be shipowners in such a case. However, no matter what the shipowners do, they face the risks of increasing inflation, fluctuating exchange rates, failure to maintain the performance of the ship in the contract and not pay chartering. Instead of time charters, shippers may prefer to tramp markets. In this case, the shipowner may not find fully load (deadweight tonnage) for appropriate carrier. Thus, there is a risk that the vessel cannot be filled maximum stowage capacity. As a result of the compilations made by Martin Stopford and his team from a variety of sources, 22 maritime trade cycles were determined considering the freight indices between 1741 and 2007. The average life of these cycles is 10 years. Cycles were completed between 3-20 years. As technology progresses, it is seen that cycles are narrowed. There are different numbers of short-cycles swinging on the long-cycles. However, the bottom cycle (trough) shows a very interesting behaviour. In some cases, there is a return without reaching trough. In some cases there is stand on trough period between 1 and 3 years. However, in some cases, the trough period is much longer.

A correct estimation model is needed as it can directly affect the strategic investments, as well as to determine the correct moment of return. Since wars often peak before the cycles, and then lead to sharp declines, the global peace indices should be carefully monitored and predicted how areas of war-risk can affect the cycles. The new shipbuilding supply will not be able to meet the demand in this period, as the major wars raise the freight indices out of the ordinary. The trade routes in the naval blockade zones or in the maritime embargo areas can be shifted or diverted as a result of military sanctions such as boarding operations or submarines torpedo attack. It is observed that the periods of recession and recovery have been prolonged since the increase in oil prices depending on oil supply constraints affected the costs in these periods. The most typical example of this is that the recession, which started in 1869, lasted until 1921.

This period coincides with a period of collapse of the empires and the establishment of state organizations, due to the ongoing economic recession all over the world. There is a great transformation and the economic crisis continues. This stagnation combined with the technological leap of the World War I broke out in an instant. While the freight index was 100 in the 1870s, the index reached to 160 in 1921, and in 15 years, the index fallen back to 100. In this short cycle, many actors have taken a new position. Those who could not hold on the market have disappeared. This hard fall caused the Second World War to be triggered. Alexandros M. Goulielmos examined the behavior of time series with respect to the period between 1745 and 2015 and found that the advancement of technology reduced the freight rates and did not create long waves. This view of Alexandros M. Goulielmos is against Martin Stopford's idea that technological leaps constituted the K waves (The Kondratieff Long Waves) (Goulielmos, 2017). Despite the employee’s income have increased thanks to the war industry of United States after the World War II, economic crises have occurred again. According to the classical approach, three main factors affecting the long waves were determined. These are globalization, maritime law (Exclusive Economic Zones, Continental Shelves etc.) and the risks posed by the economies of scale. Due to the economies of scale, the companies that are strengthened by merging in the maritime market increase their capacities while eliminating their competitors.

Kondratieff was able to predict the 1929 world economic crisis with the long-wave's theorem. Hampton has made a similar prediction using chaos theory. Accordingly, the crisis was predicted in 2004, but the expected crisis occurred in 2008. It is estimated that the freight rates will be low between 2016 and 2036. Thus, following the theories of Joan Robinson (Robinson, 1960) and Kondratieff, the post-crisis recovery is estimated to be 27 years. In the 275 years between 1741 and 2016, two major waves, 136 years and 79 years, were identified. One of these long-waves started in 1919 and ended in 2008 (89 years). If the World War II (taking into consideration for a long time such as 7 years) is not taken into consideration in the calculation, the duration of the long wave can be considered as 82 years. When the 82-year period has been added since 2009, it is assumed that the new long wave will end in 2091. The 266-year maritime economics freight index from 1741 to 2015 was reviewed by Alexandros M. Goulielmos. In this context, Mandelbrot Clusters found by Benoit Mandelbrot, who perceived mathematical harmony and clustered repetitive similarities in months, weeks, days, hours, minutes and seconds in time series, were taken into account. According to the findings made by the Clarkson Research team, 6 Noah Effects (seven bad years) and 7 Joseph Effects (seven good years) were identified during the 266 years (Goulielmos, The Kondratieff Cycles in Shipping Economy since 1741 and till 2016, 2017). As a result of many years of research, it was determined that economies of scale constitute risk and reveal the possibility of depression. In the measurement of risk, the volatility of the market and the degree of change in the freight rates emerge as two effective factors. These two factors directly affect the valuation of the ship and often lead to the inability to buy and sell the ships at the ideal market value. According to the Hamburg Ship Valuation Standards, which were determined by the Hamburg Ship Brokers and Ship Agencies Association, the long-term asset value of a ship has been developed considering with discounted cash flow analysis.

Long Term Asset Value Formula (4.7);

$$\text{LTAV}=\sum_{t=1}^{T}\left(1\,\frac{(Ct-Bt)}{(1+i)^{t}}+1\,\frac{RVT}{(1+i)^{T}}\right) \qquad (4.7)$$

Long Term Asset Value Formula on discounted cash flows (4.8);

$$DCFV = \sum_{t=1}^{T} \left(1 \frac{(Ct-Bt)}{(1+i)^{t-p}} + 1 \frac{RVT}{(1+i)^{T-p}}\right) \qquad (4.8)$$

C_t = Charter Income, **C_1**= Current Net-TC Rate in running year, **$C_{2\text{-}T}$**= Average Net-TC Rate of the past 8-10 years, **Bt**= Average OPEX of the last 8-10 years, **i** = Discount Rate, **t** = period, **t_1:** current year, **$t_{2\text{-}T}$:** period end, **T** = Remaining period until Age 20/25, **RV_T** = Residual Value, **p =** time after construction.

These formulae are created by Hamburg Shipbrokers Association (Vereinigung Hamburger Schiffsmakler und Schiffsagenten e.V., VHSS) collaborating with ship appraisers, shipping banks, ship owners, issuing houses and auditing companies (VHSS, 2019). The discount rate expressed by the letter "i" in the formulae (LTAV and DCFV) is a very effective factor for estimation of vessels with a commercial life of about 20-25 years. The discount rate (r_{wacc}) based on the weighted average cost of capital (WACC) is as follows (4.9);

$$r_{wacc} = r_E * \frac{E}{G} + rD * \frac{F}{2G} \qquad (4.9)$$

E: Market Value of The Ship's Equity, **F:**Market Value of The Ship's Debt, **G:** Total market value of ship's assets, **rE**: Cost of equity capital E, r**D**: Cost of debt capital.

When calculating the discount rate, the market risk premium and the coefficient included in the vessel's cost of equity capital (r_E) vary according to the length of the long waves and short waves. Since these two factors affect the volatility of the market and the degree of change in the freight rate, the risk environment created by the economies of scale allows the estimate more accurately. For this reason, these two factors have been tried to be calculated by scientists using many different methods.

Cost of Equity Capital (r_E) (4.10);

$$r_E = rRf + MRP * \beta \qquad (4.10)$$

r_E: Cost of Equity Capital, **r_{Rf}:** Risk Free Basic Rate of Interest, **MRP:** Market Risk Premium, **β:** Beta Coefficient.

The β (Beta) coefficient in the formula (3.10) (Treynor Measurement: Reward-to-Volatility Ratio or The Ratio of Excess Return to Non-Diversified Risk) indicates the specific risk of a ship in proportion to market risk. The fact that the beta coefficient is greater than 1 indicates that the mean value of the object is disproportionate response to the fluctuations in the markets. A Beta coefficient below 1 is disproportionately changing the value of the equation to a smaller extent. Alpha (α), Beta (β), Standard Deviation, Coefficient of Determination (R^2) and the average return earned in excess of the risk-free rate per unit of volatility (Sharpe Ratio) are taken into account in risk calculations (Treynor & Mazuy, 1996).

Sharpe Ratio (4.11);

$$Sharpe\ Ratio = \frac{rx - Rf}{StdDev\ (x)} \qquad (4.11)$$

x: Investment, rx: The Average Rate of Return, Rf: The Best Available Rate of Return of a Risk-free Security, StdDev: The Standard Deviation of The Return.

The effectiveness of the regression analysis is determined by the coefficient of determination (R^2). Because the systematic error decreases as the sample size increases, the R^2 value gives more meaningful results. However, since the value of R^2 is not only the determining factor. Hence, The Least Squares Method is used to calculate the coefficients of the regression equation α and β. Hence, the coefficients of the regression equation, α and β are calculate using The Least Squares Method. Thus, the best linear values are obtained, which is the least of the systematic error. In this way, the variance of the regression equation is found as smaller than the other methods.

Thanks to the R^2 value, it can be concluded that the regression equation is successful or not and the reliability of the estimation is high or low. Sharpe rate is the average return earned in excess of the risk-free rate per unit of volatility. Elimination of the risk-free rate from the average return may isolate performance related to risk-taking activities. In a Capital Asset Pricing Model (CAPM), the alpha (α) value is the rate of return that exceeds the model's estimated value. Investors generally prefer to invest with the high value of α. If the CAPM analysis (according to risk, economic conditions and other factors) should have earned 5%, but instead only shows 3% profit, the α value will be -2%. The CAPM analysis can also be used to calculate the β coefficient. The beta coefficient measures the volatility of a given collateral by comparing it with a corresponding benchmark performance over a period of time, and investors try to predict how much an investment cost can be deducted. The reference value taken for the alpha is zero (the investment is exactly based on the market expectations). However, the reference value taken for β is 1. When the beta coefficient is 1, the collateral value moves with the market mobilisation. If the Beta coefficient is less than 1, the collateral value is subject to lower price fluctuation than the market value. Conversely, a Beta coefficient greater than 1 means that the volatility of the collateral value is higher than the market. The alpha value shows the systematic risks involving the internal dynamics of the company, while the Beta value reveals external systematic risks such as market conditions. Another feature of the alpha value is that the sum of the alpha coefficients of the collateral values is equal to zero. In the calculations made by Alexandros M. Goulielmos, Alpha values were found between 1741 and 2015 and Alpha value was found to be 2 for normal risk value.

Theoretically, the alpha value is based on zero. However, due to the risky nature of the freight market, the Alpha value was accepted as 2. In the 261-year period, the average of Alpha values, except for the exceptional 13-year period, was calculated to be 2. If the alpha value is accepted 2 as a reasonable reference, it can be determined the direction of the risk high or low. The alpha was generally swinging between 1.91 and 1.95 from 1741 to 2015. However, the alpha value has decreased from 1.99 to 1.46 between the years of 1982 and 2015. Mandelbrot & Hudson calculated that there was a strong variation in freight values when the alpha value was 1.70. Therefore, the value of 1.46 posed a much greater risk. However, the period of depression between 1981 and 1987 and the crisis period between 2008 and 2015 has been an exceptional period from 1741 until today. The fact that the alpha value is around 1.50 causes the economies of scale to pose risks and the possibility of depression. In this case, it can be thought that a fluctuation process that adversely affects the maritime market will continue.

4.2.3 The Sales of Dry Bulkers in The Trough Period

The ships are worn out over the years after they have been built and delivered to the shipowner. The estimated economic life for ships is 25 years. Ships are almost equivalent to scrap value at the age of 25 years. This shows that a ship with an average life expectancy of 20-25 years has a loss of 4-5% with an optimistic estimate each year. According to the regression analysis of the market value and the age of Panamax type dry cargo carriers as specified in Figure-4.7 by Clarkson Research Studies, the sales value of the dependent variable is;

y = -0.7337x + 18.803 and R2 was calculated as 0.93

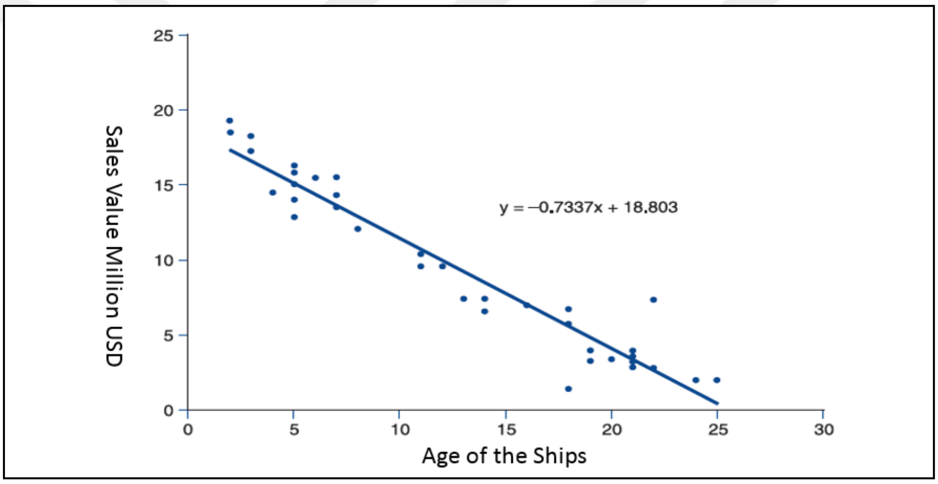

Figure-4.7 The value of Panamax bulk carriers in the first nine months of 2002.
(It is calculated by Clarkson Research)

Based on Clarkson data, the relationship between ship age and sales prices was determined by examining the sales of 1144 bulk cargo ships between the years 1985 and 2016 between the years 2014-2017 and compared with the 2002 data given in Figure-4.8.

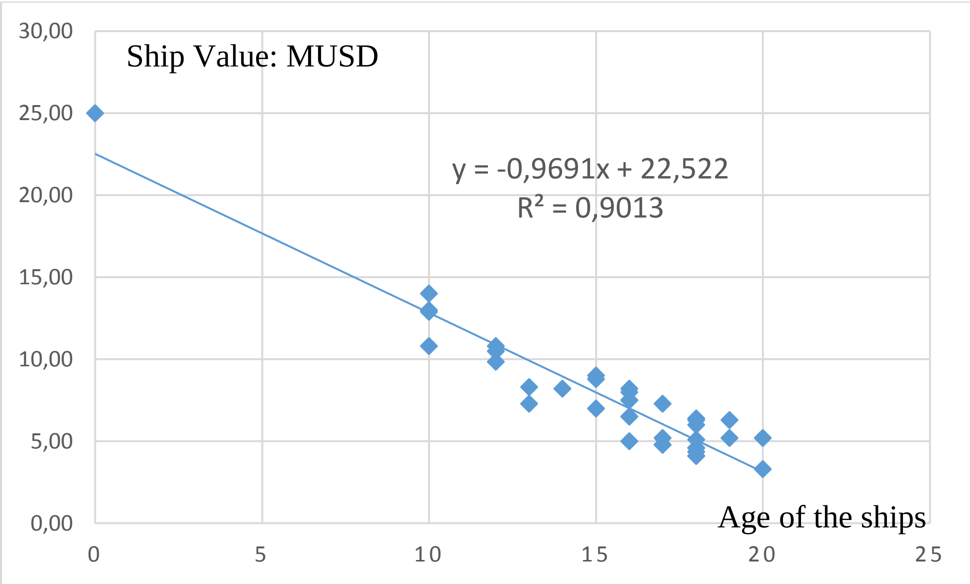

Figure-4.8 The value of Panamax bulk carriers between the ages of 10-20 in the year 2017 (It is calculated by author considering Clarkson Research Data using regression analysis)

First of all, in the year 2017, Panamax type bulk ships between the ages of 10-20 were examined and the results indicated in Figure-4.8 were reached. In this study, the calculated sales value of the dependent variable y and the value of R^2 are;

$$y = -0{,}9691x + 22{,}522,\ R^2 = 0{,}9013$$

In 2017, the sales values and the actual values of 10-20 years old Panamax ships were between +2.2 and -2.62 Million USD. Secondly, Panamax type bulk carriers, aged between 0 and 27 years, whose sales operations were performed in 2017, were examined. The results indicated in Figure-4.9 were reached. The sales value of the dependent variable is:

$$y = -0{,}8808x + 21{,}392 \text{ and } R^2 = 0.9014.$$

In 2017, the difference between sales values and actual values of vessels that are in 0-27 ages, are calculated as +/- 3.5 Million USD. Considering that the newbuilding cost for 2017 is 25 million USD, it is worth about 15 million USD in 10 years and up to 20 million USD in 20 years. After 20 years, it is close to the scrap value.

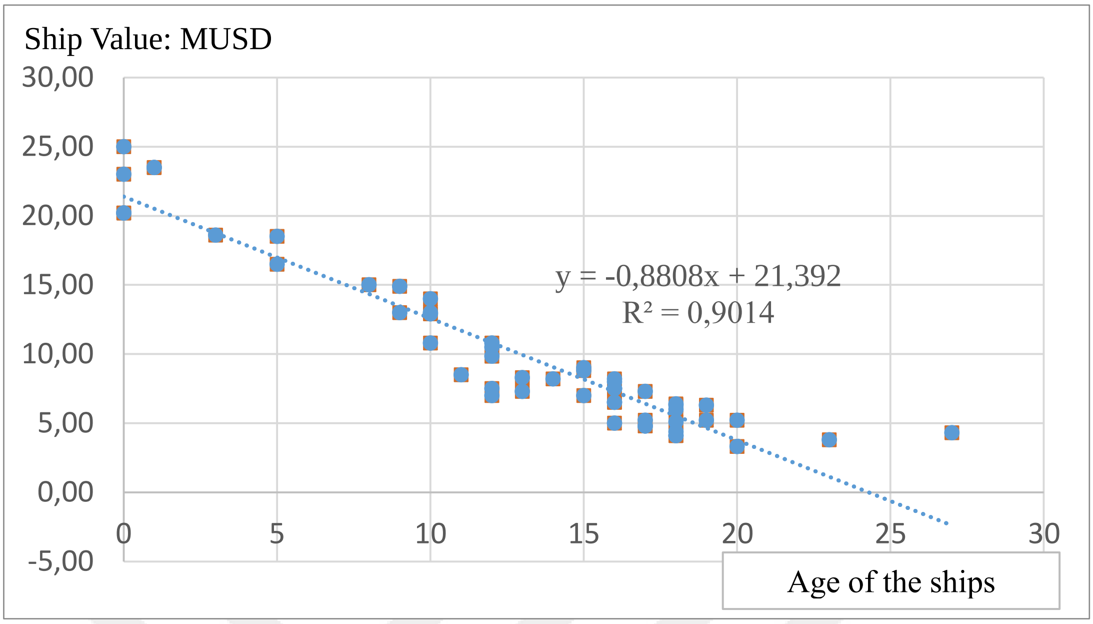

Figure-4.9 Sales Price for 0-27 years old Panamax in 2017

(Calculated by Regression Analysis using Clarkson Research Data)

While there is an average 11% difference between the ship values calculated with the sales values as seen in Figure-4.9, there is a difference between +/- 3.7 Million USD in the sales of some ships. As seen on Figure-4.9, there is an average value of 11%. When the sales value of the dependent variable (**y = -0,8808x + 21,392**) is taken into consideration, it is calculated that there is a difference of +/- 3.7 million USD between the sales value and the actual values. It will be possible to reduce these differences as a result of taking necessary measures after drawing up the reports of seaworthiness and cargo-worthiness reports as well as survey and inspection reports by classification societies. For this reason, in each country, the state accredited ship valuation mechanism should be established, and the valuation reports prepared before the sale should be kept under control.

4.2.4 Findings

The short- and medium-term cyclical and seasonal fluctuations take on different characteristics depending on the trough, recovery, peak, and collapse of the long waves described by Kondratieff.

It is imperative for decision makers to take into account the character of cyclical and seasonal waves, especially at the jumping points and at the points where each cycle of long waves begins to contract or expand. In the following 50 years, it is estimated that artificial intelligence and robotic applications will reduce the economic life cycles of ships by 10-15 years with industry 4.0 and 5.0 applications. Scientists who develop their research on Kondratieff theories emphasized that the mistakes in strategic decisions on shipping market will be cause going into administration. The largest shipyards around the world that provide new ship supplies are 150-250 years old shipyards. In general, shipbuilding approaches are conservative. The reason for this is not the fact that the investments are not open to innovation, but they do not have the return rates in the short term. Therefore, rapid technological leaps, the necessity of shipbuilding to comply with international rules, the dissemination of environmentally friendly new technologies, the need to adapt rapidly to the new conditions of shipyards will reduce the amplitude of long waves. Shipowners who have to operate their ships at the trough of Kondratieff's long waves are forced to choose one of their options to sell their vessels well below their actual values, to laid-up or to take them out of service. Those who the powerful companies or merging companies are waiting for the rise of long waves by working at the loss in times of crisis. It is not important that the corporate shipyards, which can preserve their assets for 200 years, are damaged during a 20-year recession. Because in the long run, these shipyards will be seen to be mostly in a profitable process. Since many companies without strong capital cannot hold on to the maritime market for a long time, they need to develop decision support systems and make big data management. It is vital that the statistical institutions of the States obtain relevant data from the maritime sector and share them with accredited organizations. It is very difficult to detect long waves unless a large picture is seen. The foundation of The Institute of Conjuncture in the USSR in the 1920s was a very important strategic decision. The establishment of similar institutions in Turkey will be also beneficial in terms of risk management. The Baltic Dry Index, Clarkson and Shanghai Shipping Index have been collecting data on the maritime sector for many years and sharing with their members. These institutions have big pictures related with the maritime industry and provide information support their states to facilitate their decision-making process. In order to analyse ship valuation, there is need to provide instant and unbiased data that can be accessed from anywhere in the world, at any time. For this purpose, all data providers should be integrated into an authorized institution in Turkey. Especially, Turkish Chamber of Shipping, Turkish Shipbuilders Association, Turkish Shipowners' Association, Maritime Universities and related institutions should be able to meet the information exchange requirements with computer aided and service-oriented, decision making systems. Thus, the establishment of an authorized integrated operation centre will ensure the estimation of vessel valuation more precisely. If the ship valuation is made precisely, it will be possible to provide realistic service to banking and financial institutions, insurance companies, arbitration courts or all relevant units. The contraction in world production and trade volume, changes in interest rates and discount rates and the increase in risk factors will affect long-term asset values negatively. There are basically two approaches in the world. The first is the approach of Norwegian shipowners. Norwegian shipowners prefer high tonnage, new and few ships. Thus, they can make more effective liner trade with high speed. The second is the approach of Greek shipowners. Greek shipowners prefer to have several second-hand ships, which are low-priced but functional. They aim to plan suitable voyage for some ships, to laid-up some of them, and to gain high earnings by placing laid-up ships on the market when ship supply is needed. Both approaches are profitable styles in the long run. However, in times of crisis in which technological leaps occur, the risk of being idle of the ships in the inventory reveals the fact that long waves should be carefully monitored. The next 20-year process is expected to be a period of high risk of war with technological leaps. In that reason, it should be essential to take the right position, not to be in a hurry to invest and to catch up without delaying peak stage of growth and making a good preparation for the turning point in strategic decision-making process. It can be misled to estimate ship value comparing market value and ship sales in the past 5 years due to these transactions can be result at a loss. Therefore, taking into account the Hamburg Valuation Standards, the long-term asset value depending on the discounted cash flow should be calculated and subsequent dynamic ship valuation methods should be used.

In addition, the price should be adjusted according to the age and features of the ship and these prices should be compared with the multiple regression method. In order to estimate ships Valuations, following factors should be considered.

- Convenient flag state or national flag state,
- Builder, quality assurance, guarantee, classification society,
- Accident or event,
- Replacement value,
- Currency risk, Inflation, Discount Rate, Interest Rate,
- Stock Markets and share value of shipping company.

Failure to calculate the realistic valuation of the ship will result in the problem of financial lending institutions giving an excess loan to a low-cost ship. The low freight rates will lead to a rate of return over 36 months for the loans granted. If interest rates increase, ship mortgage system will not be functioned due to the high risk in payment of instalments. In order to share the risk in such crisis periods, the establishment of mechanisms for obtaining ship finance should be considered. Also, functional funds should be preferred such as Islamic funds instead of KG funds.

With the blockchain system which will eliminate many intermediary institutions, the ship valuation will be made more transparent and closer with the adaptation of Financial Technology Integration (FINTECH) to the whole maritime system because ship sales operations will make ship valuation transparent, reduce commissions and by-pass the tax system. In this way, the maritime sector will be protected from the risk of many traders manipulating the market. However, this option is directly proportional to the confidence in the blockchain system. As a result, it is necessary to create a structure to analyse long waves for an accurate ship evaluation. In this method, it is evaluated that all public and private sector institutions in the maritime sector will be able to trade in a controllable risk environment in the long term.

4.3 Dry Cargo Carriers' Valuation Considered within OPEX Parameters in the Context of Energetic and Environmental Performances

Depending on weather and sea conditions, all duty processes of dry cargo vessels consume energy depending on the device / system configuration that is either activated or deactivated. These processes affecting energy consumption can be defined as manoeuvring in the port with full load, in open coastal waters and narrow waters, on the open sea, while approaching the port of arrival, while piloting the ship, pocketing or hoisting by means of pushing and pulling means and finally in load handling. However, there is also a loss of energy wasted in direct proportion to the abilities of the ship's personnel. As a result of the development of environmentally sensitive systems and the regulations imposed by regulatory authorities such as the International Maritime Organization and Flag and Port State, shipping companies are under severe pressure to develop environmentally sensitive behaviour as well while coping with low freight rates.

The maritime industry is one of the most important players in the logistics sector and fulfils 90% of the potential for transportation. In this sector - basically a fossil fuel-based energy consumer, the limitations imposed by national and international standards have forced all stakeholders to work on energy-efficient management. In particular, fossil fuel-laden consumption can be seen as a major problem area that causes environmental pollution with CO_2, SO_x and NO_x. In addition to these pollutants, physical wastes, and various chemical wastes, polluted ballast water used to balance load effects can also be considered as subjects to be studied in this sector.

The International Maritime Organization (IMO) has developed a global approach based on the efficient use of energy and the reduction of emissions in fossil-based systems. The Energy Efficiency Design Index (EEDI), Energy Efficiency Operational Index (EEOI) and Ship Energy Efficiency Management Plan (SEEMP) management programs developed by the IMO sector in the context of sustainable energy efficiency policies can be seen as pioneering work in this respect.

In addition to these studies, market-based measures (MBMs) based on the marine industry and sectoral studies have been taken into consideration (Pike, Butt, Johnson, & Walmsley, 2011).

4.3.1 Materials and Methods

The maritime sector, together with its stakeholders, is considered an important element in the development of sustainable policies. In this respect, not only the investment costs but also the maintenance costs of the vessels are important as well as the operating and voyage costs of the vessel. As a matter of fact, in the sector, many cost functions that define valuation have been identified - basic components such as initial investment costs, fuel costs, repair and maintenance costs, personnel costs and insurance. Criteria assessed in this context greatly affect the vessel costs directly. In particular, it has been shown that fuel consumption is an important parameter for the measures considered in an economic appraisal.

The energy consumption of commercial ships using the same trade routes may vary depending on sea and weather conditions. Important reasons for varying fuel consumption are operational parameters and energy management. Technological features can be seen as a significant influence on valuation. Optimizations based on efficiency in energy consumption processes and conditions based on productivity in operational parameters, reveal the most efficient use of technology and affect the cycle of the ships' "life expectancy". Therefore, technological features affect the valuation costs positively. In studies related to cost analysis based on the valuation of a ship, the size of the ship, the fuel consumption performance and the operational maintenance costs can be seen as key components. In this study, the energy and environmental performance of a main propulsion system belonging to a bulk carrier in reference to parameters is examined. In this context, consideration of the performance data and the ship valuation process effects are also defined. At the end of the study, the relationship between shipbuilding processes and ship's appraisal will be considered by taking into account the cost of fuel, which has the biggest impact on operational expenditures.

4.3.2 The Shipping Industry and Energy Productivity

As a major component of world transport, shipping has reached a potential of 90% in the tanker and dry cargo trade. The distribution of world transport and sea transport since 2008 is displayed in Figure-4.10.

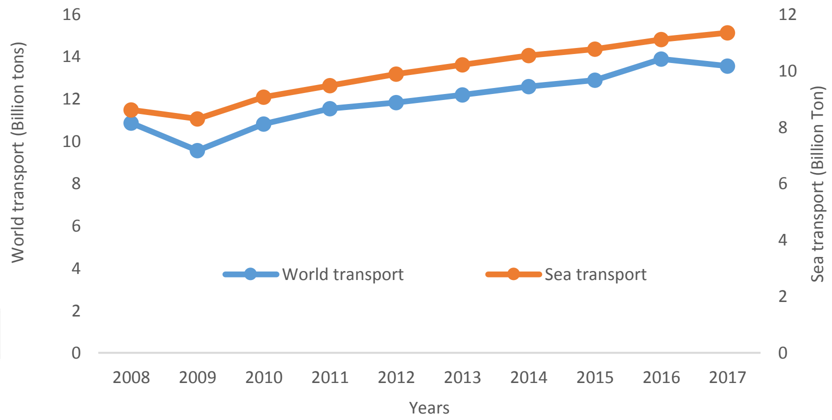

Figure-4.10: Changes in World and Sea Transport (TCS, 2017)

Seaborne trade represented an average of 83.02% of world trade between 2008-2017. Although it has ranged between 79% and 84% since 2008, it has since followed an upward trend of only 4.44% after the 2016 crisis. According to United Nations Trade and Development Organization (UNCTAD) reports (2017), the distribution of the world's maritime trade vessels over 100 gross tonnes is shown as in Figure-4.11 (TCS, 2017).

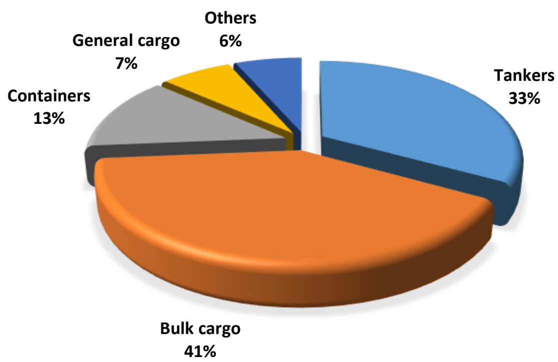

Figure-4.11: Distribution of World Merchant Fleet (TCS, 2017)

Dry bulk shipping has the largest share in maritime transportation and includes general cargo, bulk dry cargo, and container transportation. Dry Bulk Carriers have experienced a maximum tonnage increase from 27% to 40% according to UNCTAD's 30-year data. The share of container vessels has fallen from 17% to 6.5% due to their inability to compete with general cargo ships and freight carriers due to higher costs, although the proportion of container ships has increased from 1.6% to 13% (TCS, 2017). The maritime sector, which consumes about 10% of the world's energy, is a sector using mostly fossil fuel. In the sector where the individual load effect is quite high, the main engines are mainly diesel engines. As fuel consumption has increased since the 1970s, improvements towards lower fuel consumption have been seen. In diesel engines, stroke / bore ratio, peak pressure effects, low speed and average speed management, and reductions in oil consumption are at the top of these (GEA, 2012). The maritime industry is seeing specific reductions in average impact pressures in diesel engines and fuel injection technologies. In addition, in fuel systems, control mechanisms based on fuel injection direction, spray runs, injector nozzle improvements, and direct NOx and SOx reduction have become a priority.

4.3.3 Vessel Valuation

In the maritime sector, economy of scale is a decisive factor in the formation of ship supply and demand, while the excessive volatility of the freight market makes ship valuation difficult. It is not enough to know only the age, tonnage and market price of ships in order to make a vessel appraisal close to the correct value. Factors such as the amount of production, the supply and demand situation of these goods, the gross national product of the countries, and the amount of each item transported by sea, that is, the subjects of the trade, provide the predictability of the annual carrying capacity and the type of goods that these vessels can carry. These factors are taken into consideration when freight rates are calculated. However, freight rates also affect the profitability of trade, as the maritime market is subject to serious fluctuations and is extremely fragile. Freight rates provide important decision support data for the valuation of vessels. Current freight rates and estimated future freight rates provide a significant input in the choice of new shipbuilding purchases, second-hand ship purchase and hot / cold laid-up or out of service preferences. Operational costs are of utmost importance in periods when freight rates are low. Large size carriers are needed to transport long distances at once, and relatively small vessels should be used for short distances. Especially during such low freight rate periods, the high prices of fuel consumed by the vessels make them unprofitable. For dry cargo vessels, operation costs, periodic maintenance costs, voyage costs, cargo handling costs and capital costs are important variables in terms of operating costs. Energy efficiency emerges as a distinctive factor in determining the performance of variables affecting operating costs. In terms of operational costs, the quality of the lubricating oil used in the main and auxiliary machines affects the insurance values as well as the frequency of use of spare materials. Failure rates due to the age of the ship and the usage pattern, periodical or selected maintenance, repair and overhaul applications all affect the value of the vessels. In terms of voyage costs for a Capesize dry bulk carrier, the performance of the main and auxiliary machines and the speed-dependent fuel consumption (approximately 66% fuel oil and 10% diesel oil) have an important place in the total cost of the voyage (Stopford, 2009) Fuel consumption depending on the design of the ship, the ability of the ship's crew, and the type of freight all have different variables during the handling period in the port. Cargo handling of dry bulk carriers is much more laborious and costly than on a container ship or a Ro-Ro ship, since dry bulk carriers have heavy and large-scale bulk cargoes. According to Clarkson's data (Stopford, 2009) considering the capital costs, maintenance-repair costs, voyage and operation costs of vessels of 5, 10 and 20 years old, the cost of capital decreases as the ship age increases, complex faults arise and maintenance-repair costs rise. Voyage costs increase by approximately 7%, while operating costs rise by 13%. Operation and voyage costs for dry cargo vessels up to 10 years range from 2% to 4%, with a radical increase of 5% to 8% over the second decade. (Calculated by author taking into account Martin Stopford's "Maritime Economics" and using the Clarkson Research Official Web Site) (https://www.clarksons.com/services/research/). For vessels over 20 years old, there is no commercial profitability during periods when there are particularly low freight rates, and it is considered to be a suitable way of removing from service vessels in the 20-25 year age range. 20 years is a critical age for ships. During this period, options for renovation or modernization should be considered. However, the rapid progress of the technology reveals that the strict rules laid down by the regulatory authorities in particular for environmental protection are not a rational solution at the end of a ship's life cycle (maximum 10 years for high cost modernizations). As a result of the great advances in shipbuilding technology in the next 20-30 years, it may be possible to remove the vessels from service after, perhaps, 10 years (VHSS, 2009). Depending on the dwt tonnage of a dry bulk carrier, the total cost can be expressed by the following formula (4.12):

$$Ctm = \frac{OC+PM+VC+CHC+K}{DWT} \quad (4.12)$$

where: C_{tm}: Cost per dwt per annum (t: year, m: stands for the m^{th} ship), OC: Operational Cost per annum, PM: Periodic Maintenance per annum, CHC: Cargo Handling Cost per annum, K: The capital cost per annum. DWT: Deadweight tonnage. (Stopford, 2003).

As can be seen from the cost formula, fuel consumption plays a decisive role in total cost per deadweight because each cost item has a variable that affects fuel consumption. If the ship's valuation formula in the context of the "Discounted Cash Flow Method" developed by the Hamburg Ship Brokers Association is considered; the difference between revenues and expenditures, and the residual value of the ship, taking into consideration the year to year discount rate, the long- term value of the ship can be estimated. As can be understood from this formula (4.13), OPEX costs and the discount rates are at the forefront.

$$DCFV = \sum_{t=1}^{T} \left(\frac{(Ct-Bt)}{(1+i)^{t-p}} + \frac{RVT}{(1+i)^{T-p}} \right) \quad (4.13)$$

C_t = Charter Income, C_1 = Current Net-TC Rate in running year, $C_{2\text{-}T}$ = Average Net-TC Rate of the past 8-10 years (If possible, otherwise shorter), Bt = Average OPEX of the last 8-10 years, i = Discount Rate, t = period, t_1 : current year, $t_{2\text{-}T}$: period end, Average 10 year charter rate), T = Remaining period until Age 20/25, RV_{T} = Residual Value, In this formula the exponent t–p can be fractional, which enables the discount rate to correspond to the appropriate period (VHSS, 2009).

After dry cargo vessels have passed 10 years of age, it is now possible to articulate the residual value of these vessels. However, when it comes to ship valuation, due to the rising volatility of vessels' value, especially for ships older than 10 years, it can be seen that the same notation of vessels value can differ one from another in respect to cost-effectiveness. In this sense, comparing only the previous sales values of similar vessels, and looking only at market values could lead to miscalculation. The physical condition of the tanks' interior coatings, the deficiencies in the criteria of seaworthiness and cargoworthiness of the ships, the compatibility with the authorities newly published regulations, few purchasers (such as chemical tankers in that particular niche market), the presence of complex faults requiring high cost repairs or having the need to re-equip with new systems/ devices all require additional calculations to determine the value of these vessels. Therefore, as a ship ages, a more balanced and reasonable relationship can be established between freight rates and charter rates as a result of the reduction in total energy loss and in the prevention of the misuse of the ship. Given the high OPEX costs in older ships, it would be possible for the ship to operate with a profit margin above charter rates for vessels between 10 and 25 years of age with a holistic energy approach instead of laid-up or out of service options. In particular, reducing fuel consumption to a minimum during the periods at the cylical bottom (trough) of the economy could be an important part of holding strategies. As the tonnage of ships is reduced, the cargo capacity will also decrease, so Handysize-type dry cargo ships can only cover their operating costs in adverse economic conditions and may have been working unprofitably. In this situation, the owner's choice will be Aframax or Capesize Dry Bulk Carriers, but their carrying capacity will not be completely utilized with maximum freight because of the lessened production capacity of the world at any given time. Although it is possible to manning of a vessel with a qualified crew to ensure safety and security at sea, there is no difference between Handymax and the Capesize Dry Bulk Carriers in terms of personnel costs. The daily average fuel consumption of a dry cargo ship with a capacity of 30,000 DWT is around 21 ton / day. The fuel consumption of a dry cargo ship of 170,000 DWT is around 50 tons/day. The annual USD / DWT costs are reduced by 62% when the two dry bulk carriers are compared. This represents an approximately 2.5 times difference in fuel consumption. When the fuel cost is examined, Capesize Dry Bulk Carriers are 42% more economical than Handysize Dry Bulk Carriers (VHSS, 2019).

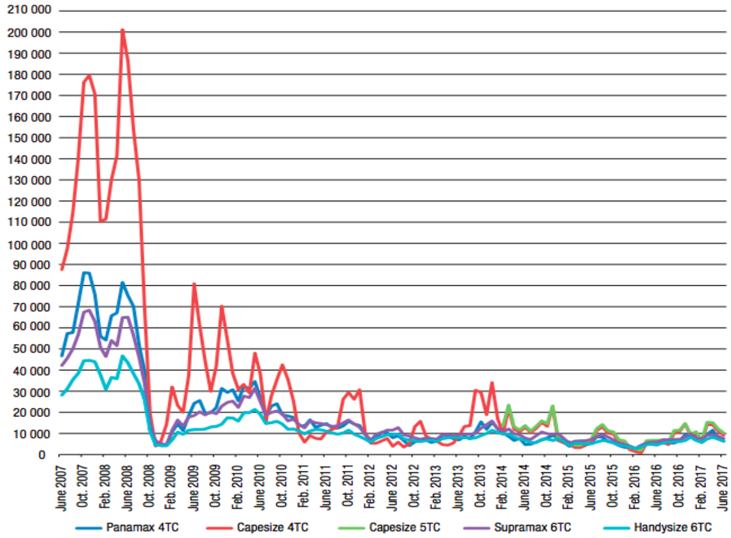

Figure-4.12: Distrubitions of world merchant fleet (UNCTAD, 2018)**.**

However, according to UNCTAD data (See in Figure 4-12), freight rates of \$200,000/pday for Capesize in 2008 fell to \$10,000/pday in June 2017 (UNCTAD, 2018). According to the estimation of 25th April of 2018 by the brokerage firm of Alibra Shipping Limited, the Time Charter Rate was calculated as \$19,750/pday. The highest volatility occurred was in \$160,000/pday in August 2008, at \$80,000/pday in September 2008, at \$15,000/pday in October 2008 and at \$5,000/pday in November 2008 (Kyong, 2013). Capesize Dry Bulk Carriers are used mainly to carry iron ore (70-80%), and to a lesser degree coal (30-40%) and a minor amount of grain (0-5%). Handysize Dry Bulk Carriers carry mainly grain loads. Hence, major maritime trade routes are determined by the supply and demand of major loads. According to the Baltic Dry Index (BDI), the index decreased from 3,000 in 2010 to 1363 on 28th April of 2018 (Malcome, 2017). This means that if the daily index multiplier is assumed to be 0.110345333, then the freight value can be calculated as 12,353 \$/day for the index of 1363. Assuming that the TCR values are 19,000 \$/day, there will be a loss of approximately 7,000 \$ / day for Capesize Dry Bulk Carriers. In this case, it may be necessary to take certain economic measures, such as changing major commercial routes, lowering crew salaries or reducing personnel numbers and thus lowering the quality of the provision. In addition, other options might be preferred such as being laid up or being put out of service. The most important consideration in the decision-making process is to focus on fuel consumption and energy efficiency, which have the greatest effect on voyage costs and operating costs. Measures such as lowering the ship's speed by 11 kts, adaptation of the integrated energy management system to the vessels, reconsideration of the concept of ship use, and the gradual reduction in the number of personnel before adding new, unmanned, technology to the ship will reduce fuel consumption. An important factor here is not using the recommended factory settings for the amount of lubricating oil consumption allowed in the tolerances fixed by law for main and auxiliary machines, but rather to ensure the lubricating oil consumption closer to the factory settings via selected maintenance-repair procedures, as much as possible, in a vessel with a daily consumption of 50 tons of fuel. While 0.1-0.2 grams of lubricating oil consumption per kilowatt is considered normal, every 1.5% savings in fuel consumption will cause the lubricating oil consumption to be reduced up to 50% (Latarche, 2017). If a Capesize Dry Bulk Carrier which consumes 17,000 kW/pday energy were to reduce her speed from 14.7 mil/hour to 13 mil/hour, the daily amount of fuel consumption can be reduced from 55 tonnes/pday to 45. Depending on the age of the ship, the economic fuel consumption should be determined by comparing the Energy Efficiency Design Index (EEDI) with the Energy Efficiency Operation Index (EEOI) to calculate the optimum speed. In order to prevent the overheating of main and auxiliary machines, prevent lubricating oil leaks and increase the quality of lubricating oil, maintenance and repair of cooling water systems, insulating and using protective oils should be considered. In such an economic environment, state subsidies for fuel and lubricating oil will be one of the relief measures for this sector.

4.3.4 Discussions

From vessel operating costs to valuation processes, energy consumption is one of the fundamental issues that must be managed in institutional strategies. Although climate conditions are prioritized within the scope of energy consumption strategies, freight distributions, ballast water management, economic speed of the ship and operating criteria for Dry Bulk Shipping should be considered. Holistic priority approaches are important for all these parameters. In this respect, sustainable energy management strategies are developed for each ship's business model. For dry bulk carriers, direct voyage traffic has been considered according to two criteria, namely unit load consumption and total distance. Analysis of consumption of a ship for thirty times distance by unit load provides effective ballast management with direct load. The energy consumption distribution of a freight ship with reference to this study is given in Figure 4-13.

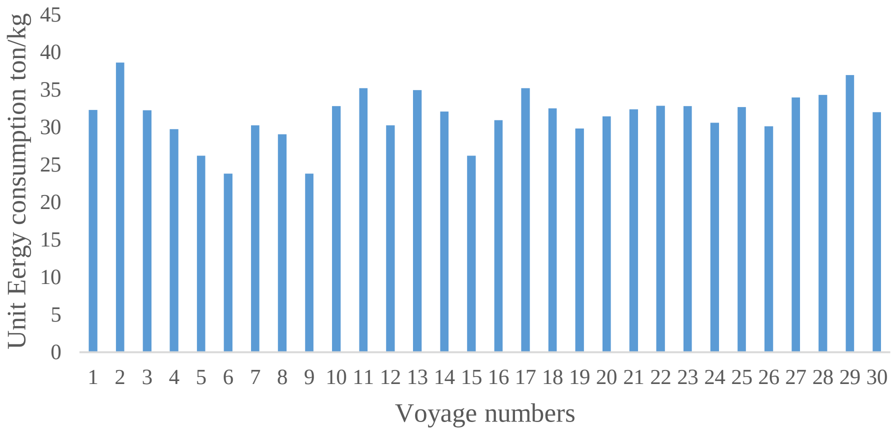

Figure-4.13: Unit energy consumption based on unit tonne

According to this distribution, it is seen that average consumption has been reduced by 31.57 kg / ton. The results are given in Figure-4.14.

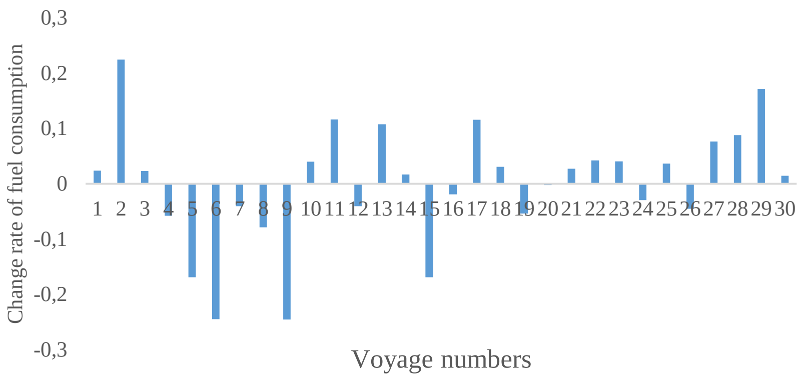

Figure 4.14: Unit energy consumption change rate considering unit load

However, it is seen that consumption distribution underwent a reduction of 14.85 kg / ton with minimums of 23.48 kg / tons and 38.67 kg / tons. Only in this way is the rate of change due to load examined according to average consumption. According to the distribution of consumption, there was a negative change of 24.49% and a positive change of 22.48%. In this respect, the consumption histogram of the ship was examined. The highest average consumption was 29.31 tons / kg for a value of 8 and 31.33 tons / kg for a value of 11. When 29.31 ton / kg is taken as a reference in all of this distribution, a saving potential of 7.17% in current consumption is determined. It was seen that the unit could achieve this consumption target in unit load. This means 625.18 tons of fuel savings when total travel loads and consumption are taken into consideration. Similarly, the current load values were fixed and evaluated based on the energy consumed per mile. Accordingly, the consumption distributions for unit miles are given in Figure-4.15

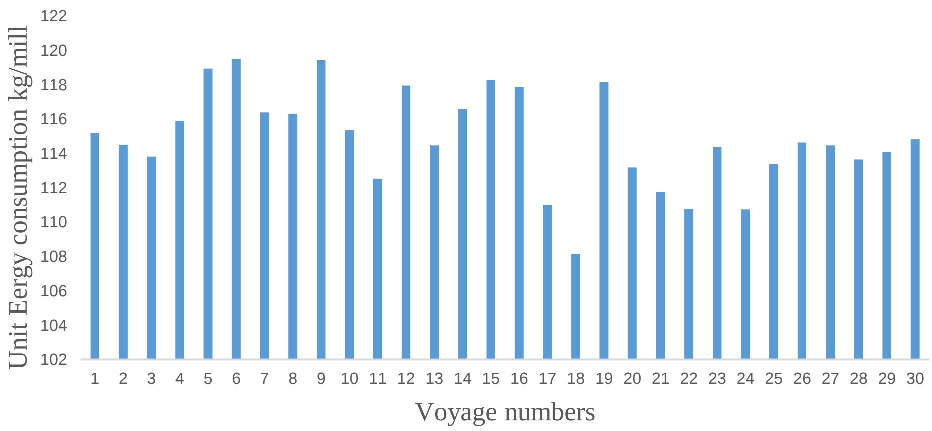

Figure-4.15: Unit energy consumption based on unit mile

Taking into account the voyage conditions, the energy consumption per mile was 114.89/kg/mile. The minimum energy consumption per mile in voyage conditions is 108.16 kg / mile, while the maximum consumption is 119.52 kg / mile. In this distribution, the difference between the peak values was found to be 11.36 kg / mile difference. Distribution of these mile changes according to voyage numbers were examined and the results are given in Figure-4.16.

Figure-4.16: Unit energy consumption change rate considering unit mile

When the peak differences due to mileage consumption were examined, a total of 9.89% is noticeable. When the general average consumption is taken into consideration, a distribution of 4.03% in the positive direction and 5.85% in the negative direction is observed. In this context, the distribution histograms were examined, and a specific value was determined for the unit mile. In this context, a total of 297.56 kg / mile savings potential draws attention when efficiency analyses are evaluated by accepting 111.25 kg / mile reference from the histogram. In this respect, it has been seen that significant savings can only be achieved in energy consumption by considering the two parameters.

The choice of diesel engines is most noticeable on ships. In this way, reasonable savings can be achieved in operating parameters for a diesel engine. Similarly, savings in main engine performance can be achieved. However, energy consumption should not be considered only in terms of fuel and other diesel fuels. For example, changing sea water temperature can be seen as a significant saving point. Sea water temperature is an important parameter for cooling the main engine. Sea water has a range of 5°C to 32°C. Above these temperature changes, the amounts of fuel consumption consumed for cooling a main motor at 12.6 MW power are given in Figure-4.17.

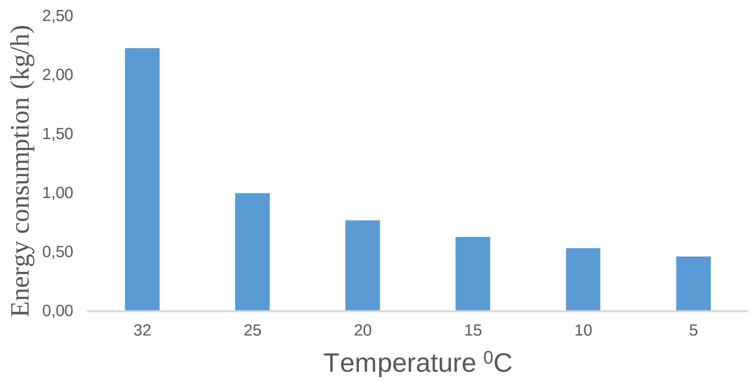

Figure-4.17: Energy consumption of cooling process

Cooling energy consumption to obtain an average cooling water temperature of 20°C has an effect of 0.77 kg/h. For each °C grade, the cooling savings potential has an effect of 2.68%. Only the total amount of savings that can be provided at 1°C temperature control when more than 30 voyages are examined. In this context, it has been found that the total amount of fuel at 20°C has a value of 31.54% when 30 voyages are considered. A one-degree savings rate in this load distribution has yielded a 5.27% savings, at 510.31 tons. Developing local solutions for energy efficiency in ships will not be accurate in terms of holistic strategies. In addition, planning or prioritization of management tools needs to be considered together with a process analysis. The energy efficiency analyses mentioned above are important processes for holistic strategies that need to be managed. Total energy management will be a very positive contribution to ship valuation. Although the vessels are equipped with environmentally sensitive and energy efficient technologies due to the new regulations, they are naturally affecting voyage and operating costs due to possible faults in the use of vessels. Since the freight rates and operating expenditures will increase in periods when the economy is volatile, it is estimated that this will seriously lower the value of the vessels. Until unmanned vessels are developed, studies to reduce misuse of ships will help to ensure energy efficiency and ship valuation.

5. COMBINED QUALITATIVE SHIP VALUATION ESTIMATION MODEL

The aim of this chapter is to introduce the“Combined Qualitative Ship Valuation Estimation Model” in the light of Chapter 1-3. In order to establish a model 1446 dry bulk carriers sold in 2014-2017 were analysed. The main objective of this model is to determine the variations between nominal and real sale prices. The price margin will be determined according to the price anomalies. Thus, an adjusted price will be calculated for investment or disinvestment decisions. If investment decisions are given, age and attribute adjustments of price will be calculated for reasonable sale or purchase prices of ships. The concept of the model is shown in Figure-5.1.

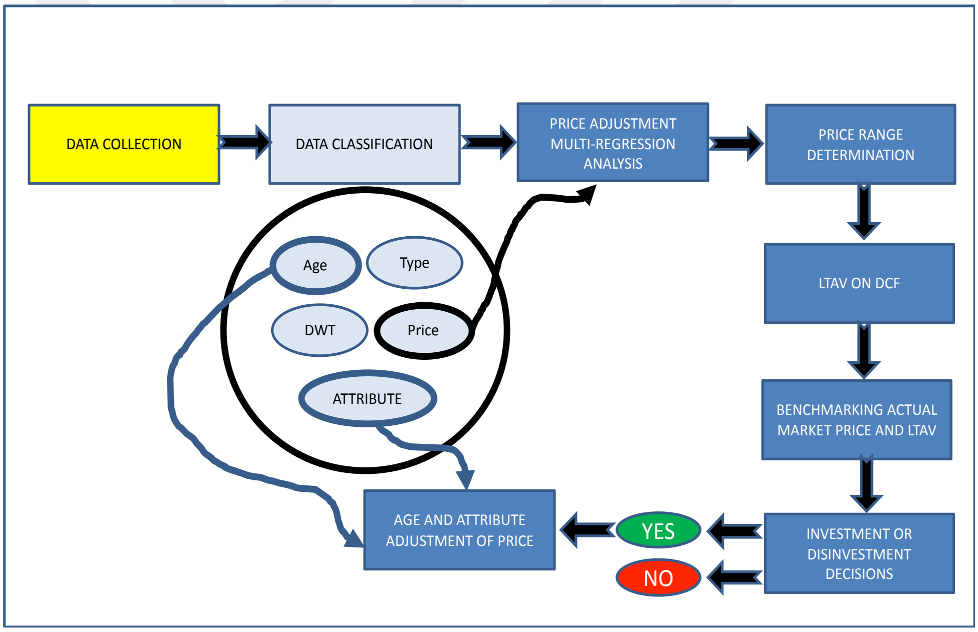

Figure-5.1 Combined Qualitative Ship Valuation Estimation Model

5.1 Data Collection and Data Classification

Collection of ship data from primary sources is not easy. According to the UNCTAD report, the top five countries in each segment are segregated according to building, ownership, registration and scrapping (UNCTAD, 2018).

The top five countries in each segment are shown in Table-5.1

Table-5.1 Top five countries in each segment

Countries	Building	Ownership	Registration	Scrapping
Bangladesh				
China				
Germany				
Greece				
Hong Kong				
India				
Japan				
Korea				
Liberia				
Marshall Islands				
Pakistan				
Panama				
Phillipines				
Romania				
Singapore				
Turkey				

Source: UNCTADstat (UNCTAD, 2018)**, Clarksons Research.**

The world commercial fleet consisted of 94,171 vessels, with a combined tonnage of 1.92 billion dwt. in 2018. Dry bulk carriers, which carry iron ore, coal, grain and other similar cargoes, account for the largest share of the world fleet in dead-weight tonnage and the largest share of total cargo-carrying capacity, at 42.5%. The percentage of dry bulk carriers in the world fleet between 1980 and 2018 were 27.2% in 1980, 35.6% in 1990, 34.6% in 2000, 35.8% in 2010 and 42.5% in 2018. The total deadweight tonnage of dry bulk carriers in 2018 is 818,612 dwt. UNCTAD analysis has found that deadweight tonnage is more relevant than seaborne trade and cargo-carrying capacity. According to UNCTAD secretariat calculations and, data from Clarksons Research, the dry bulk carriers' value in dollars is 22.2% of the world shipping fleet. However, the share of dry bulk carriers’ deadweight tonnage is 42.5%. The age distribution percentage of dry bulk carriers in total number of ships are 27.83% for 0-4 years, 41.32% for 5-9 years, 12.90%

for 10-14 years, 8.72% for 15-19 and 9.24% for 20+. The average deadweight tonnage of dry bulk carriers is 79,281 for 0-4 years, 76,618 for 5-9 years, 73,750 for 10-14 years, 60,907 for 15-19 years and 54,304 for 20+ in 2018. Their average age is approximately 9.1 years. According to UNCTAD secretariat calculations, based on data from the Baltic Exchange[1], the Baltic Dry Index averaged about 1,153 points, reaching a peak of 1,619 points in December 2017, the highest level since 2013, when it reached 2,178 points. Ships are grouped by size into four categories (Equasis Statistics, 2017):

- Small ships 100 GT to 499 GT
- Medium ships 500 GT to 24.999 GT
- Large ships 25.000 GT to 59.999 GT
- Very Large ships ≥ 60.000 GT

The Equasis data providers are France, the European Maritime Safety Agency (EMSA), the United Kingdom, Japan, the United States of America, Norway, Canada, the Republic of Korea, Brazil and, Spain. The total number of bulk carriers by type & size, and by age & size, are shown in Table-5.2.

Table-5.2 Classifications of bulk carriers, by type & size, and by age & size (Compiled by author from Equasis Statistics)

Bulk Carrier	Small (1)		Medium (2)		Large (3)		Very Large (4)		Total	
	Nu.	GT	Nu.	GT	Nu.	GT	Nu.	GT	Nu.	GT
Age										
0-4	20	9	593	11,103	1,495	56,421	386	40,410	2,494	107,943
5-14	12	5	1,941	31,631	3,430	129,556	1,124	110,165	6,507	271,357
15-24	65	28	634	8,731	916	31,016	161	15,291	1,776	55,066
+25	216	83	618	5,132	104	3,771	33	4,542	971	13,528
Total	313	125	3,786	56,597	5,945	220,764	1,704	170,408	11,748	447,894

Source: Equasis: (1) GT<500 - (2) 500≤GT<25.000GT - (3) 25.000≤GT<60.000 - (4) GT≥60.000

Nu: Number, GT: Gross Tonnage in 1000 gt. (Equasis Statistics, 2017)

[1] Baltic Exchange Index base: 1 November 1999 = 1,334 points.

The size of bulk carriers is often referred to one of the following classifications as in Table-5.3. (Eyres, 2010)

Table-5.3 Generally accepted types of bulk carriers

Classification	Size (DWT)	Length (m)	Draught (m)
Very Large Ore Carrier (VLOC) Very Large Bulk Carrier (VLBC)	200,000–400,000	> 310	> 20
Capesize	100,000–200,000	< 310	≅ 17
Panamax	65,000–100,000	< 240	≅ 12
Handymax	40,000–65,000	< 190	≅ 11-12
Handysize	10,000–40,000	< 160	≅ 10
Small Ships	<10.000	< 130	< 10

In addition to Table-5.3, there are a many types of bulk carriers worldwide (Duran & Martin, 2016). These are as follows;

- Supramax (50.000-60.000 dwt),
- Post-Panamax (80.000-125.000 dwt),
- Ultramax (ship-length 10 meters longer than Supramax),
- Kamsarmax (82.000 dwt, up to 225 m.),
- Newcastlemax (185.000 dwt, 300 m),
- Setouchmax (203,000 dwt, 299 m),
- Seawaymax (226 meters, draught 7,92 m),
- New Panamax (length 366 m, beam 49 m, draught 15,2 m)
- Malaccamax (300.000 dwt, 330 m, draught 20 m),
- Dunkirkmax (175,000 dwt, 289 m, max beam 45 m),
- Valemax or Chinamax (400.000 dwt, 360 m, beam 65 m, draught 23 m)

In this study, clusters are not classified by bulk carriers' categories. Initial calculations based on raw data show that 0-5 years old bulk carriers reflect market values, but 6-20 years old second-hand carriers are not in harmony with predicted values in sale and purchase market. More than 20-year-old bulk carriers prices approach scrapping values. Within this study, the vast majority of bulk carriers's data was obtained from Clarkson Research. It is generally accepted that Clarkson Research is the most authoritative provider of intelligence for global shipping. In addition, these data are enriched by considering Lloyd's List, Baltic Exchange, Shanghai Shipping Exchange, Hellenic Shipping News and Equais.

The raw data collected was classified as per Table-5.4 below.

Table-5.4 The Sample of Raw Data belongs to Dry Bulk Carriers

Type	Name	Built	Size (DWT)	Builder	Sold	Price USD	Sellers	Buyers
Bulk	Shandong Da De	2016	402.303	Daewoo (DSME)	2016	87,20	Vale	Clients of BoCom Leasing
…	…	…	…	…	…	…	…	…
…	…	…	…	…	…	…	…	…

The data of dry bulk carriers varying between 10.000 dwt and 400.000 dwt, respectively, are classified in a 10.000 dwt range. And then at the first stage, the age of the dry bulk carriers is calculated by the difference between the sales or purchases year and the construction year as in Table-5.5.

Table-5.5 A Sample of age calculations for Dry Bulk Carriers

Type	Name	Built	Size (DWT)	Builder	Sold	Age	Price (USD)	Sellers	Buyers
Bulk	Shandong Da De	2011	402.303	Daewoo (DSME)	2016	5	87,20	Vale	Clients of BoCom Leasing
Bulk	…		…	…	…	**…**	…	…	…
Bulk	Ore Jiangsu	2013	399.997	Jiangsu Rongsheng	2015	2	445,00	Vale S.A	Clients of China Ore Shipping

5.2 Price Adjustment and Price Range Determination

At the second stage, price anomalies were detected by applying regression analysis. In general, brokers calculate the market value of a ship by comparing other vessels in the same configuration. As a sample; due to the lack of time, a broker searches for the same category of ship on the Equasis web site or any other service provider located on open sources.

Table-5.6 Samples of Market Valuation for a Dry Bulk Carrier.

Ship Name	DWT	Built	Sold	Age	Price ($M)
Pacific Capella	180.346	2012	2017	5	27,00
Pacific Canopus	180.330	2012	2017	5	25,00
Shin-Zui	180.201	2007	2017	10	15,00
N Fos	179.294	2010	2017	7	21,80
IVS Cabernet	177.173	2007	2017	10	20,50
Portage	176.391	2002	2017	15	9,00
Teh May	175.085	2004	2017	13	10,00
Bulk Prosperity	172.964	2001	2017	16	8,00
Blue Island	152.398	2000	2017	17	7,50
True Frontier	179.294	2010	2017	7	?
				Mean Price:	**$15,98M**

For example, when it is intended to purchase the dry bulk carrier "True Frontier" when considering the mean price in Table-5.6, the reasonable value of the ship should be estimated. In order to calculate reasonable value, multi-regression analysis would be a satisfactory method to make any investment or disinvestment decision as in Table 5.7

Table-5.7 Multi-Regression Analysis Summary Output for Table-5.6

Regression Statistics								
Multiple R	0,95101755							
R Square	0,90443439							
Adjusted R Sq	0,87712993							
Standard Erro	2,57140092							
Observations	10							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	2	438,039281	219,01964	33,124053	0,00026981			
Residual	7	46,284719	6,61210272					
Total	9	484,324						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	50,6744909	27,2861671	1,85714947	0,10565266	-13,847042	115,196023	-13,847042	115,196023
DWT	-9,944E-05	0,00014392	-0,6909851	0,51183089	-0,0004398	0,00024086	-0,0004398	0,00024086
AGE	-1,633545	0,26424323	-6,1819746	0,00045315	-2,2583809	-1,008709	-2,2583809	-1,008709

Above is the multi-regression analysis summary output for the formula;

$$y = b_0 + b_1 * x_1 + b_2 * x_2 + \varepsilon \text{ (unprecedented value)} \quad (5.1)$$

According to coefficients in Table 5.7;

$$y = ((50{,}6744908789651) + (-0{,}000099444*A1) + (-1{,}63354497*B1)) + \varepsilon$$

Predicted value of True Frontier (y) = $ 21,40996355

Table-5.8 The Sample of Market Valuation for Dry Bulk Carrier "True Frontier"

Ship Name	DWT	Built	Sold	Age	Price ($M)	Predicted Price ($M)	Range
Pacific Capella	180.346	2012	2017	5	27,00	24,5724384	2,43
Pacific Canopus	180.330	2012	2017	5	25,00	24,5740295	0,43
Shin-Zui	180.201	2007	2017	10	15,00	16,4191329	-1,42
N Fos	179.294	2010	2017	7	21,80	21,4099636	0,39
IVS Cabernet	177.173	2007	2017	10	20,50	16,7202494	3,78
Portage	176.391	2002	2017	15	9,00	8,63028972	0,37
Teh May	175.085	2004	2017	13	10,00	12,0272535	-2,03
Bulk Prosperity	172.964	2001	2017	16	8,00	7,33753934	0,66
Blue Island	152.398	2000	2017	17	7,50	7,74915968	-0,25
True Frontier	**179.294**	**2010**	**2017**	**7**	**?**	**21,4099636**	**?**
				Mean Price:	**$15,98M**	**$16,086M**	

Source: Compiled data from Clarkson Research by author.

The Advanced Shipping and Trading S.A. weekly report (25th Aug to 1st Sept 2017, WEEK 35) articulates that:

> "In the Capesize sector, clients of H-Line purchased the 2010 Korean "True Frontier" (179.294 dwt), at $ 29.5 mil, a price quite similar to the last sale of 2010 178k Korean "Asterix" back in the beginning of August. In addition, we remind you that True Frontier was purchased during 2/2017 as "N Fos" at $ 20.75 mil. Another capesize that sold in a very firm price is the Korean 2000 Blt NPS Century (172.036 dwt) at rgn $ 15 mil. to undisclosed buyers, although rumored also at lower levels".

It is claimed that Capesize Bulkers of the same size and age were sold at very different prices (+/- $ 10 mil.). When it is looked at Baltic Dry indexes, they changed from February to August 2017. In week 21, the BDI was 1125 and, the BCI was 1790 (Advanced, 2017). However, the BDI and BCI were raised to 1183 and 2264 in week 35 (Advanced, 2017, Week 35).

According to the results of a regression analysis as in Table 4.8, it can be said that it would have been reasonable to sell the M/V True Frontier for 21 million dollars as in Table 5.8, but she was actually sold for $ 30 mil. by Global Maritime Investment to clients of H-Line Shipping in reality. Considering that the mean price was between $15,98 mil. and $16,086 mil. in 2017, it is clear that overpricing had occurred under free market conditions.

5.3 Long Term Asset Value on Discounted Cash Flow Analysis

At the third stage, before making Long Term Asset Value on Discounted Cash Flow (DCF) Analysis, the optimum adjusted value should be determined. If the current market value is accepted an initial data, the calculated net present value would be misleading. In particular, while making strategic investment decisions or calculating firm value, these misleading ship prices can cause irreversible losses. Under these conditions, if a company has a fleet composed of hundreds of ships, it would result in hundreds of miscalculated ship prices.

The result would be a deep trouble for the ship-owners. The process of determining optimum ship prices has been divided into three main methods. In this study, data on 1446 dry bulk carriers was collected and evaluated. Firstly, ships of different ages but similar tonnage were classified at approximately 10.000 dwt. intervals. Secondly, ships of different tonnages but same age and same-year-sold vessels have been clustered together.

Thirdly, selected vessels that are harmony with each other in terms of tonnages and ages are classified together. The third option for a meaningful multi-regression analysis is more favorable. As mentioned in section-2, there are trinity valuation methods. These are “The Market Comparable Method”, “The Income Valuation Method” and “The Replacement Cost Method”. In addition, the regression analysis approach can more accurately be called“The Range Pricing Method” (Karatzas, 2009). The approaches of these quadruple methods are shown in Table-5.9.

Table-5.9 The Valuation Methods' Approaches

Valuation Methods	Approaches
The Market Comparable Method	Marked to the Market or Last Done
The Income Valuation Method	Marked to The Model (present value of the stream of FOpCF (free operating cash flow)
The Replacement Cost Method	Marked to The Cost
The Range Pricing Method	The Mean Estimated Price.

The Range Pricing Method is based on the mean estimated price. There are six pricing method in the market. These are "Pricing at a Premium", "Pricing for Market Penetration", "Economy Pricing", "Price Skimming", Psychology Pricing" and "Bundle Pricing" (Maguire, 2019).

5.4 Calculation of Long-Term Asset Value on Discounted Cash Flow

Investment or disinvestment decisions depend benchmarking the actual market price of the ship and the LTAV on DCF. The LTAV indicates attractive selling prices. The criteria are shown related with decision making processes in Table-5.10

Table-5.10 Decision Making Process for Investment or Disinvestment

Actual Market Price	Vessel Owner	Potential buyer
> LTAV	**Sell**	**Don't buy**
< LTAV	**Don't Sell**	**Buy**

In order to determine attractive price of “M/V True Frontier” that is shown in Table-5.8, the LTAV on DCF will be calculated, and then the LTAV on DCF for M/V True Frontier in Table-5.11 will be compared with predicted value that is calculated by multi-regression analysis.

Table-5.11 Calculation of LTAV on DCF for M/V True Frontier

^ t	Year (Y)	Age (A)	ABD (%95)	OD	DGCR (%2 IR)	1_CRAAD (%30)	2_CRAAD (%15)	1_DNCR %6.5	2_DNCR %6.5	1_ANCR	2_ANCR	AOE	SV	1_FCF	2_FCF	WACC %	PVF	1_PV $	2_PV $
1	2017	7	326	343,00	18500,00	18500,00	18500,00	17297,50	17297,50	6031000,00	6031000,00	2184200,00		3846800,00	3846800,00	73,00	0,93	3585088,54	3585088,54
2	2018	8	340	358,00	22000,00	22000,00	22000,00	20570,00	20570,00	7480000,00	7480000,00	2249726,00		5230274,00	5230274,00	73,00	0,87	4542814,43	4542814,43
2	2019	9	340	358,00	16000,00	16000,00	16000,00	14960,00	14960,00	5440000,00	5440000,00	2318066,00		3121934,00	3121934,00	73,00	0,87	2711591,56	2711591,56
4	2020	10	340	358,00	17500,00	17500,00	17500,00	16362,50	16362,50	5950000,00	5950000,00	2386406,00		3563594,00	3563594,00	73,00	0,75	2688371,80	2688371,80
5	2021	11	340	358,00	16500,00	16500,00	16500,00	15427,50	15427,50	5610000,00	5610000,00	2454746,00		3155254,00	3155254,00	73,00	0,70	2218378,85	2218378,85
6	2022	12	326	343,00	16830,00	16830,00	16830,00	15736,05	15736,05	5486580,00	5486580,00	2523086,00		2963494,00	2963494,00	73,00	0,66	1941805,47	1941805,47
7	2023	13	340	358,00	17166,60	17166,60	17166,60	16050,77	16050,77	5836644,00	5836644,00	2588612,00		3248032,00	3248032,00	73,00	0,61	1983454,51	1983454,51
8	2024	14	340	358,00	17509,93	17509,93	17509,93	16371,79	16371,79	5953376,88	5953376,88	2656952,00		3296424,88	3296424,88	73,00	0,57	1876054,31	1876054,31
9	2025	15	326	343,00	17860,13	17860,13	17860,13	16699,22	16699,22	5822402,59	5822402,59	2725292,00		3097110,59	3097110,59	73,00	0,53	1642703,62	1642703,62
10	2026	16	340	358,00	18217,33	18217,33	18217,33	17033,21	17033,21	6193893,31	6193893,31	2790818,00		3403075,31	3403075,31	73,00	0,49	1682187,26	1682187,26
11	2027	17	340	358,00	18581,68	18581,68	18581,68	17373,87	17373,87	6317771,17	6317771,17	2859158,00		3458613,17	3458613,17	73,00	0,46	1593327,49	1593327,49
12	2028	18	326	343,00	18953,31	18953,31	18953,31	17721,35	17721,35	6178780,21	6178780,21	2927498,00		3251282,21	3251282,21	73,00	0,43	1395911,88	1395911,88
13	2029	19	340	358,00	19332,38	19332,38	19332,38	18075,78	18075,78	6573009,13	6573009,13	2993024,00		3579985,13	3579985,13	73,00	0,40	1432467,70	1432467,70
14	2030	20	340	358,00	19719,03	13007,18	15794,43	12161,71	14767,79	4422439,82	5370105,50	3061364,00		1361075,82	2308741,50	73,00	0,37	507558,62	860952,52
15	2031	21	326	343,00	20113,41	13267,32	16110,32	12404,94	15063,15	4325146,14	5251963,18	3129704,00		1195442,14	2122259,18	73,00	0,35	415463,36	737568,89
16	2032	22	340	358,00	20515,68	13532,67	16432,52	12653,04	15364,41	4601106,39	5587057,76	3195230,00		1405876,39	2391827,76	73,00	0,32	455356,55	774701,42
17	2033	23	340	358,00	20925,99	13803,32	16761,17	12906,10	15671,70	4693128,52	5698798,91	3263570,00		1429558,52	2435228,91	73,00	0,30	431525,70	735096,78
18	2034	24	340	358,00	21344,51	14079,39	17096,40	13164,23	15985,13	4786991,09	5812774,89	3331910,00		1455081,09	2480864,89	73,00	0,28	409347,55	697923,98
19	2035	25	340	358,00	21771,40	14360,97	17438,32	13427,51	16304,83	4882730,91	5929030,39	3400250,00	8165855,00	9648335,91	10694635,39	73,00	0,26	2529634,05	2803956,46
																		34043043,27	35904357,47

LTAV: Long Term Asset Value, **Y:** Year, SA: Ship Age, **OD:** Operation Days, AD: Age Discount, **DGCR:** Daily Gross Charter Rate, **ABD:** Actual Booked Days **AD:** Age Discount, **CRAAD:** Charter Rate After Age Discount, **F&C:** Fees and Commisions, **DNCR:** Daily Net Charter Revenue, **ANCR:** Annual Net Charter Revenue, **AOE:** Annual Operating Expenses, **SV:** Scrap Value, **FCF:** Free Cash Flow, **WACC:** Weighted Average Cost of Capital (Discount Rate), **PVF:** Present Value Factor, **PV:** Present Value.

Table-5.11 shows that the calculation of the LTAV on DCF for M/V True Frontier. The LTAV on DCF Formula (5.2) is as follows:

$$LTAV\ on\ DCF = \sum_{t=1}^{T} \left(1 \frac{(Ct-Bt)}{(1+i)^{t-p}} + 1 \frac{RVT}{(1+i)^{T-p}}\right) \qquad (5.2)$$

C_t = Charter Income, **C_1**= Current Net-TC Rate in running year, **$C_{2\text{-}T}$**= Average Net-TC Rate of the past 8-10 years, **Bt**= Average OPEX of the last 8-10 years, **i** = Discount Rate, **t** = period, **t_1:** current year, **$t_{2\text{-}T}$:** period end, **T** = Remaining period until Age 20/25, **RV_T** = Residual Value, **p =** time after construction.

It is assumed that there are 358 operating days (maximum number of available running days-charter days in a typical year) and, 343 operating days in years with dry docking (maximum number of available running days in years with dry docking-class renewal). The Gross Charter Rate per day for the Current Year and the next four-year estimations have been obtained from “Baltic Capesize Indexes” and “Advanced Shipping and Trading S.A. Weekly Reports”. In addition, “Actual Booked Days” are assumed to be 326 days that is 95% of the total available running days. Daily Gross Charter Rates (Current Charter Rates) were realized as $18,500 for 2017, $22,000 for 2018 and, $16,000 for 2019. The next two years' estimations are $17,500 for 2020 and $16,500 for 2021. The other estimations of Daily Gross Charter Rates from 2021 to 2035 are consecutively calculated by the next years' daily charter rates at 2.0% interest rates. However, the percentage of reduction rate in the daily gross charter rate for ships age more than 20 years old is assumed to be 30% for sample-1 and 15% for sample-2, because the percentage of reduction rates can alter the estimated ship prices. Ship prices can change by the approximately $ 1-2 M when reduction rates between 15% and 30% are added into the calculations. After these operations, “Daily Net Charter Revenues” of 6.5% (ship management fee and freight commissions as a percent of the gross daily charter rate) are calculated. In order to determine “Annual Net Charter Revenues-ANCR”, the equations (5.3) below are utilized.

ANCR = CRAAD (for 30% or 15%) * ABD (for 95%) (5.3)

The next operation is to calculate Annual Operating Expenses. According to Baltic Exchange data, the daily operating expenses for Capesizes was $6,700 as of August 2017. Annual Operating Expenses to year 2035 were consecutively calculated by the following years' daily operating expenses at 3.0% interest rates. According to Moore and Stevens "Future Operating Costs Report 2018", vessel operating costs were expected to rise by 2.7% in 2018 and by 3.1% in 2019.

The following formula (5.4) is used to determine residual or scrap value.

$$\text{SV} = \text{LD x SP} * (1+i)^{T-p} \qquad (5.4)$$

SV: Scrap Value, LD: Light Displacement (in lt.), SP: Scrap Price (per. lt), i: interest rate, T: Remaining period until Age 20/25, p = time after construction.

M/V True Frontier's lightweight tonnage is approximately 21.990 ltd. Scrap prices per long ton change worldwide. These prices may reduce depending on transportation needs. According to Advanced Shipping and Trading S.A. weekly report (WEEK 35, 25thAug to 1st Sept 2017), scrap prices were $295 (Turkey), $260 (China), $380 (Pakistan), $385 (Bangladesh), and $375 (India). The scrap value of True Frontier is as follows:

$$\text{SV} = 21.990 \text{ x } \$260 * (1 + 0{,}02)^{25-7} = \$8{,}165{,}855 \text{ in } 2035$$

Free Cash Flows (FCF) from 2017 to 2035 were calculated considering Annual Net Charter Revenue (ANCR), Annual Operating Expenses (AOE) and Scrap Value (SV).

FCF formula (5.5) is as follows;

$$\text{FCF} = (\text{ANCR} - \text{AOE}) + \text{SV} \qquad (5.5)$$

FCFs provide data to calculate the present value of True Frontier. In order to calculate the LTAV on DCF, Weighted Average Cost of Capital (WACC) and Present Value Factor should be determined.

The WACC formula (5.6) is as follows:

$$\text{WACC} = \frac{D}{V} * r_D + \frac{E}{V} * r_E \quad (5.6)$$

$\boldsymbol{r_D}$: the cost of debt, $\boldsymbol{r_E}$: the cost of equity, **D:** the market value of debt, **V:** the market value of equity **(V = D + E).**

The cost of equity r_E (5.7) is:

$$r_E = r_f + \beta_E * MRP \quad (5.7)$$

$\boldsymbol{r_f}$: $risk\ free\ rate$, $\boldsymbol{\beta_E}$: $beta\ coefficient, systematic\ risk\ factor\ of\ equity$, **MRP:** Market Risk Premium

In this study, it is assumed that the risk-free rate is 2.2%, equity beta is 1.2 and MRP is 4.1. These data were obtained from US Treasury bond yields over 10-years (http://www.federalreserve.gov/releases/h15/data.htm) for r_f , Drobetz's study for β_E (Drobetz, Menzel, & Schröder, 2014), and Dimson's study for MRP (Dimson, Marsh, & Staunton, 2002). Based on this, the cost of equity r_E is calculated as follows:

$$r_E = 2.2\% + 1.2 * 4.1\% = 7.4\%.$$

r_E will be used in the Weighted Average Cost of Capital formula (5.8):

$$\text{WACC} = \frac{\text{D}}{\text{V}} * \text{r}_\text{D} + \frac{\text{E}}{\text{V}} * \text{r}_\text{E} \quad (5.8)$$

V: Value (V=D + E), **D:** Debt, **E:** Equity, $\mathbf{r_D}$**:** cost of debt, $\mathbf{r_E}$: cost of equity,

Risk of debt (r_D) is composed of swap rate and credit spread. The US 10 Year Treasury Rate was 2.27% (August 2017, https://ycharts.com/indicators/10_year_treasury_rate).

It is assumed that credit spreads are 1.5-5.0% (Karatzas Marine Advisors & Co., 2018) and M/V True Frontier's financed debt is 70%, therefore D/V = 0.7 and, $r_D = 2.27 + 5 = 7.27\%$ or $2.27 + 1.5 = 3.57\%$.

In the light of these data the Weighted Average Cost of Capital (WACC) is calculated as follows:

$$\textbf{WACC 1= 0.7 * 7.27\% + 0.3 * 7.4\% = 5.089 + 2.22 = 7.3\%}$$

$$\textbf{WACC 2= 0.7 * 3.57\% + 0.3 * 7.4\% = 2.499 + 2.22 = 4.72\%}$$

In the study, the WACC1 is assumed to be 7.3% as discount rate. The next step is to determine the present value factor (PVF) (5.9) considering the WACC.

$$\text{PVF} = \frac{1}{(1+\text{WACC})^t} \qquad (5.9)$$

PVFs are used to determine Present Value (PV) of the ship considering Free Cash Flows (FCF). The LTAV on DCF is compared with actual market price, and then to invest or disinvest is decided. However, it is unsure whether this value is normal or is an excessive purchase or selling price for the ship. For that reason, the actual market price should be adjusted and then compared with the LTAV on DCF. In chapter 5, basic and multi-regression analysis for second-hand bulk carriers has been applied to determine their interval of optimum price. As a result of the case study, the LTAV of M/V Frontier was calculated as $34-35 M. However, the predicted value of the ship was $21,4 M. Once they have been compared with each other, an investment or disinvestment decision should be taken using the following criteria.

$21,4 M < $34-35 M → Don’t Sell for Vessel Owner, **Buy** for Willing Purchaser

In reality this ship was sold at $30M in 2017 (August) by Global Maritime Investment to Clients of H-Line Shipping. But M/V True Frontier now renamed M/V N Fos was sold at $21,4M by KDB Capital to Client of Global Maritime Ltd. It appears that Global Maritime Ltd has purchased vessels at the predicted price and sold vessels at a price close to the LTAV.

5.5 A Case Study: Fair Value Calculation of M/V True Frontier

Various mathematical methods are used for determining ship valuation. Therefore, the results should be compared with the fair value of vessels. Regression analysis can be used as an important tool in determining fair value. The M/V True Frontier has been compared with sister ships and also other dry bulk carriers to achieve investment or disinvestment decision. In order to calculate the optimum and fair value of M/V Frontier, other selected bulk carriers have been analysed in this section.

5.5.1 Age and Attribute Adjustment of M/V True Frontier

Investment or disinvestment decisions need the same procedure to determine the optimum value of the ship. However, the decision to be made regarding the calculated price value will vary depending on which party evaluates it. According to Andreas Mietzner's study "Developing a Dynamic Vessel Valuation Method Based on Real Market Transactions", age and attribute adjustments are necessary to reduce the anomalies of sale and purchase prices (Mietzner, 2015). This study is considered in the thesis in order to integrate age and attribute adjustments into a "Combined Qualitative Ship Valuation Estimation Model". In Table-5.12, the adjusted price of DWT **(DWT_AP)** and the adjusted price of age **(Age_AP)** were calculated using following formulae:

If Age of Comparison Vessel (ACV) ≥ Age of M/V True Frontier (Age_TF) and, Age_Adjusted Price (Age_AP) > Scrap Value (SV) → then

$$\text{Age\_AP} = \text{P} * 1.05^{(\text{ACV} - \text{Age\_TF})} \qquad (5.10)$$

Else If ACV < Age_TF and Age_AP > SV→ then

$$\text{Age}_{\text{AP}} = \text{Actual Price(AP)} * 0.95^{(\text{Age\_TF} - \text{ACV})} \qquad (5.11)$$

Age_AP = SV_i = LDT (Light Displacement Tonnage) * SP (Scrap Price per LTD)

In order to calculate the attribute adjustment on the price, the following formulae were used;

$$DWT\_AP = \frac{\frac{DWT\_TF*30}{DWT\_CV}}{31} * Age\_AP \quad (5.12), \qquad P\_TF = \frac{\sum_{i=1}^{N} DWT\_AP}{N} \qquad (5.13)$$

DWT_AP: Attribute Adjusted Price, **Age_AP:** Age Adjustment Price, **DWT_TF:** M/V True Frontier's DWT, **ACV:** Age of Comparison Vessel, **SV:** Scrap Value, **AP:** Actual Price of Vessels, **+/- 5%:** Depreciation or Devaluation Rate of Vessel, **P_TF:** Adjusted Price of M/V True Frontier.

In Table 5.12, the bulk carriers which are similar to M/V True Frontier were selected. Generally, these are around 179,000 DWT, built over the years 2009-2012 and age at sale varies between 3-7 years. First of all, age adjusted prices were calculated and these values were used to calculate the attribute adjustment of vessel prices. Finally mean values of adjusted prices were calculated. As a result of the calculations, M/V True Frontier's age adjusted price were found to be \$30,92M, and attribute adjusted price of her was \$29,90M. According to Advanced Shipping and Trading S.A. weekly report (WEEK 35, 25thAug to 1st Sept 2017), the Sale Price of M/V True Frontier was declared to be \$29,5M. This value is in harmony with age and attribute adjusted price of M/V True Frontier.

Table-5.12 Age and Attribute Adjustment of M/V True Frontier

Name	DWT	Built	Sold	Age	Price	DWT_AP	TF_DWT	Age_AP	TF_Built
Houheng 2	179.929	2011	2015	4	31,00	28,40	179294	29,45	2010
Besiktas*	179.843	2011	2016	5	23,00	20,34	179294	21,08	2010
Mineral Manila	179.842	2011	2014	3	43,00	39,41	179294	40,85	2010
Besiktas Turkmenistan*	179.797	2011	2016	5	23,00	21,09	179294	21,85	2010
E.R. Beilun*	179.436	2010	2014	4	49,25	47,62	179294	49,25	2010
Cassiopeia Bulker	179.398	2011	2014	3	42,00	37,32	179294	38,59	2010
Ore Pantanal*	179.385	2010	2016	6	35,00	33,85	179294	35,00	2010
Churchill Bulker	179.362	2011	2015	4	28,50	26,19	179294	27,07	2010
Corona Bulker	179.362	2011	2015	4	33,60	30,88	179294	31,92	2010
Camilla Bulker	179.362	2009	2014	5	40,00	40,63	179294	42,00	2010
Gran Trader	179.322	2012	2016	4	23,00	20,09	179294	20,76	2010
Blue McKinley	179.276	2011	2014	3	44,50	40,92	179294	42,28	2010
Cape Althea	179.250	2011	2016	5	24,00	22,07	179294	22,80	2010
Dong-A Leto*	179.221	2010	2017	7	44,60	43,18	179294	44,60	2010
Dong-A Artemis	179.213	2012	2017	5	32,00	27,96	179294	28,88	2010
C. Discovery	179.185	2010	2017	7	30,00	29,05	179294	30,00	2010
C. Blossom	179.185	2009	2016	7	18,90	19,22	179294	19,85	2010
C. Atlas	179.185	2009	2016	7	18,70	19,02	179294	19,64	2010
Hanjin Matsuyama	179.166	2011	2016	5	22,75	20,93	179294	21,61	2010
True Frontier	**179.294**	**2010**	**2017**	**7**	**30,00**	**29,90**		**30,92**	

5.5.2 Regression Analysis to determine adjusted prices of M/V True Frontier

In the light of the case study of M/V True Frontier, it is understood that the price range differs greatly from lower to higher last done transactions for similar bulk carriers in the market. Naturally, willing buyers want to purchase a ship at the lowest price and willing sellers want to sell a ship at the highest price. Hence, a reference point should be determined when bargaining whether investment or disinvestment are appropriate as in Figure 5.2. Regression or Multi-Regression Analysis helps to detect diversions from the reference price line.

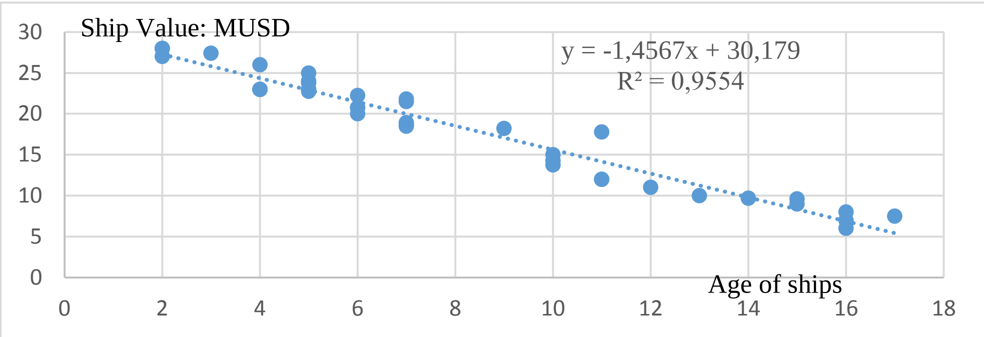

Figure 5-2 Regression analysis of Capesizes to determine adjusted prices of M/V True Frontier

Table-5.13 Multi-regression analysis of Capesizes to determine adjusted prices of M/V True Frontier

SUMMARY OUTPUT						
Regression Statistics						
Multiple R	0,978099929					
R Square	0,956679471					
Adjusted R Squa	0,954272775					
Standard Error	1,423660835					
Observations	39					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	2	1611,344065	805,6720323	397,5073953	2,88727E-25	
Residual	36	72,9651662	2,026810172			
Total	38	1684,309231				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	42,30933179	11,96918065	3,534856147	0,001142048	18,03470832	66,58395526
X Variable 1	-6,5796E-05	6,48719E-05	-1,014244685	0,317234489	-0,000197362	6,57703E-05
X Variable 2	-1,509944363	0,073665618	-20,49727416	1,93803E-21	-1,65934516	-1,360543565

According to Table-5.13, the following formula was determined to be the y variable for multiregression analysis:

$$y = 42,30933179-6,5796E-05*DWT-1,509944363*AGE$$

Table-5.14 Price Adjustment of Capesize

Name	DWT	Age	MP	AP	Difference	Name	DWT	Age	MP	AP	Difference
Cape Liberty	185897	12	19	12,6986	6,3014	C. Blossom	179185	7	18,9	19,9821	-1,0821
NSS Endeavor	184877	15	13,8	8,3285	5,4715	C. Atlas	179185	7	18,7	19,9821	-1,2821
Spring Zephyr	181725	6	22,25	21,4388	0,8112	Hanjin Matsuyama	179166	5	22,75	22,8955	-0,1455
Obelix	181433	5	23,75	22,8955	0,8545	E.R. Bayern*	178978	6	20,75	21,4388	-0,6888
Aquarius Dream	181387	2	28	27,2656	0,7344	E.R. Boston*	178978	6	20	21,4388	-1,4388
Galaxy Dream	181371	3	27,4	25,8089	1,5911	K. Explorer*	178929	4	23	24,3522	-1,3522
Shining Dragon	181365	4	26	24,3522	1,6478	K. Foundation*	178929	4	23	24,3522	-1,3522
Coral Dream	181343	2	28	27,2656	0,7344	Hyundai Talent	178896	5	30,5	22,8955	7,6045
Golden Opus	180716	7	28,85	19,9821	8,8679	E.R. Bavaria	178838	6	20,75	21,4388	-0,6888
Sampaguita Dream	180694	2	27	27,2656	-0,2656	Faustina	177775	6	19	21,4388	-2,4388
Zosco Qingdao*	180389	5	17	22,8955	-5,8955	Sea Pull	177533	10	13,75	15,612	-1,862
Pacific Capella	180346	5	27	22,8955	4,1045	Shin Sho	177489	10	12,2	15,612	-3,412
Pacific Canopus	180330	5	25	22,8955	2,1045	IVS Cabernet	177173	10	20,5	15,612	4,888
Nord-Energy	180310	12	11	12,6986	-1,6986	Bulk Singapore	177173	11	12	14,1553	-2,1553
Bao Zhu Hai	180310	11	17,8	14,1553	3,6447	Global Partnership	176967	10	12	15,612	-3,612
Aurora Venus	180274	6	25	21,4388	3,5612	Spring Hydrangea	176955	10	12	15,612	-3,612
Bulk Hong Kong	180230	10	14,25	15,612	-1,362	Jiang Jun Shan	176924	9	18,2	17,0687	1,1313
Shin-Zui	180201	10	15	15,612	-0,612	Portage	176391	15	9	8,3285	0,6715
First Eagle	180199	4	41	24,3522	16,6478	Nord Power	176346	10	12,25	15,612	-3,362
Yuritamou	180184	10	23	15,612	7,388	Wah Shan	175980	11	20,4	14,1553	6,2447

Name	DWT	Age	MP	AP	Difference	Name	DWT	Age	MP	AP	Difference
Pleiades Dream	180140	7	18,5	19,9821	-1,4821	Teh May	175085	13	10	11,2419	-1,2419
Cape Rich	180133	6	18,6	21,4388	-2,8388	An May	174674	11	12	14,1553	-2,1553
Blue Everest	180116	5	27	22,8955	4,1045	Ocean Crescent	174222	9	12	17,0687	-5,0687
Houheng 2	179929	4	31	24,3522	6,6478	Voge Master	174092	10	11,5	15,612	-4,112
Besiktas*	179843	5	23	22,8955	0,1045	Bulk Prosperity	172964	16	8	6,8718	1,1282
Mineral Manila	179842	3	43	25,8089	17,1911	Onoe*	172572	15	18,9	8,3285	10,5715
Besiktas Turkmenistan*	179797	5	23	22,8955	0,1045	Koryu	172549	16	6	6,8718	-0,8718
Cassiopeia Bulker	179398	3	42	25,8089	16,1911	Kohju	172498	14	9,7	9,7852	-0,0852
Ore Pantanal*	179385	6	35	21,4388	13,5612	Raiju	172492	15	9,6	8,3285	1,2715
Churchill Bulker	179362	4	28,5	24,3522	4,1478	Nordtramp	171199	14	17	9,7852	7,2148
Corona Bulker	179362	4	33,6	24,3522	9,2478	Cape Stork	171039	19	7,8	2,5017	5,2983
Camilla Bulker	179362	5	40	22,8955	17,1045	Cecilia	170565	16	7	6,8718	0,1282
Gran Trader	179322	4	23	24,3522	-1,3522	CE-Duke*	170094	16	19	6,8718	12,1282
True Frontier	179294	7	30	19,9821	10,0179	Cape Viewer	169381	22	8,3	-1,8684	10,1684
N Fos	179294	7	21,8	19,9821	1,8179	C. Winner	169237	8	11,3	18,5254	-7,2254
Cape Althea	179250	5	24	22,8955	1,1045	Global Winner	161121	17	11,4	5,4151	5,9849
Dong-A Leto*	179221	7	21,5	19,9821	1,5179	Blue Island	152398	17	7,5	5,4151	2,0849
Dong-A Artemis	179213	5	32	22,8955	9,1045	Cape Merlin	150966	20	10,5	1,045	9,455
C. Discovery	179185	7	30	19,9821	10,0179						

Adjustment Prices (AP) in Table-5.14 were calculated by regression analysis. The Capesizes' ages varied from 3 to 22 years between 2014-2017 and deadweight tonnages of them are between 150.966 dwt and 180.140 dwt. Linear Regression and Multi-regression analyses belonging to the Capesizes are shown in Figure 5-3 and, Table-5.15.

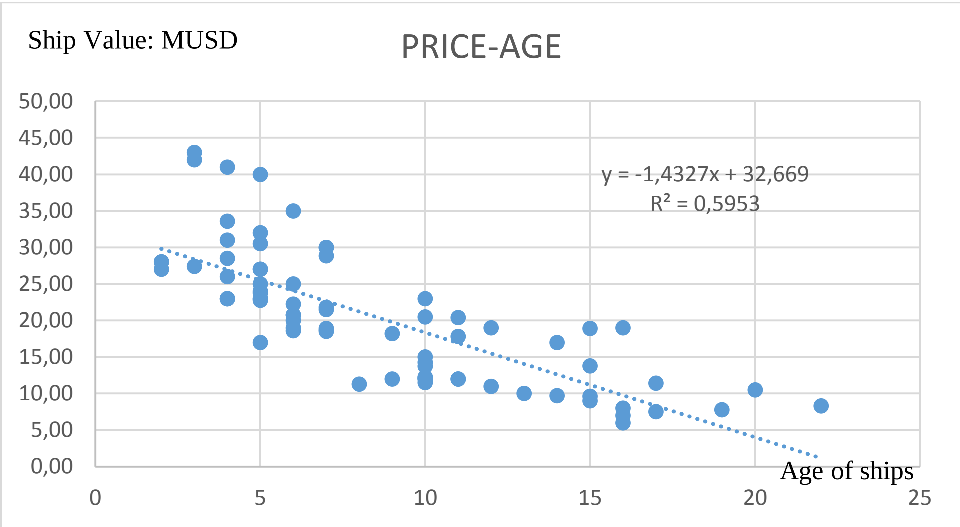

Figure 5-3 Regression analysis of Capesizes' ages varied from 3 to 22 years between 2014-2017 and deadweight tonnages of them are between 150.966 dwt and 180.140 dwt.

Table-5.15 Multi-regression analysis of Capesizes' ages varied from 3 to 22 years between 2014-2017 and deadweight tonnages of them are between 150.966 dwt and 180.140 dwt.

SUMMARY OUTPUT						
Regression Statistics						
Multiple R	0,76063097					
R Square	0,57855947					
Adjusted R S	0,56761296					
Standard Err	6,38641847					
Observations	80					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	2	4311,38863	2155,69432	52,8533394	3,5674E-15	
Residual	77	3140,54824	40,7863408			
Total	79	7451,93688				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	57,6376724	32,2432862	1,78758679	0,07777738	-6,5669129	121,842258
X Variable 1	-0,0001268	0,000175	-0,7248169	0,47076125	-0,0004753	0,00022163
X Variable 2	-1,658175	0,20786626	-7,9771244	1,1257E-11	-2,0720897	-1,2442604

According to Table-5-15, the following formula is the determined y variable.

$$y = 57,6376724-0,00001268*DWT-1,658175*AGE$$

Using this formula, the following predictions have been calculated. Adjustment Prices are shown in Table 5-16. As it is seen in the table, M/V True Frontier's adjusted price is calculated as $23.26M. Since the R squared (R^2) value is less than 0.95, it has been decided to remove abnormal deviations. These calculations cover only sales in 2017.

Table-5.16 Adjustment Price of Capesizes within Multi-regression Analysis for sales in 2017.

Name	DWT	Age	SP	Built	Sold	AP	Difference
Cape Liberty	185.897	12	19,00	2005	2017	14,13	4,87
NSS Endeavor	184.877	15	13,80	2002	2017	9,29	4,51
Golden Opus	180.716	7	28,85	2010	2017	23,08	5,77
Pacific Capella	180.346	5	27,00	2012	2017	26,44	0,56
Pacific Canopus	180.330	5	25,00	2012	2017	26,44	-1,44
Shin-Zui	180.201	10	15,00	2007	2017	18,17	-3,17
Yuritamou	180.184	10	23,00	2007	2017	18,17	4,83
Cape Rich	180.133	6	18,60	2011	2017	24,81	-6,21
True Frontier	179.294	7	30,00	2010	2017	23,26	6,74
N Fos	179.294	7	21,80	2010	2017	23,26	-1,46
Dong-A Leto*	179.221	7	21,50	2010	2017	23,27	-1,77
Dong-A Artemis	179.213	5	32,00	2012	2017	26,59	5,41
C. Discovery	179.185	7	30,00	2010	2017	23,27	6,73
Hyundai Talent	178.896	5	30,50	2012	2017	26,63	3,87
IVS Cabernet	177.173	10	20,50	2007	2017	18,55	1,95
Portage	176.391	15	9,00	2002	2017	10,36	-1,36
Teh May	175.085	13	10,00	2004	2017	13,85	-3,85
Bulk Prosperity	172.964	16	8,00	2001	2017	9,14	-1,14
CE-Duke*	170.094	16	19,00	2001	2017	9,50	9,50
Blue Island	152.398	17	7,50	2000	2017	10,09	-2,59

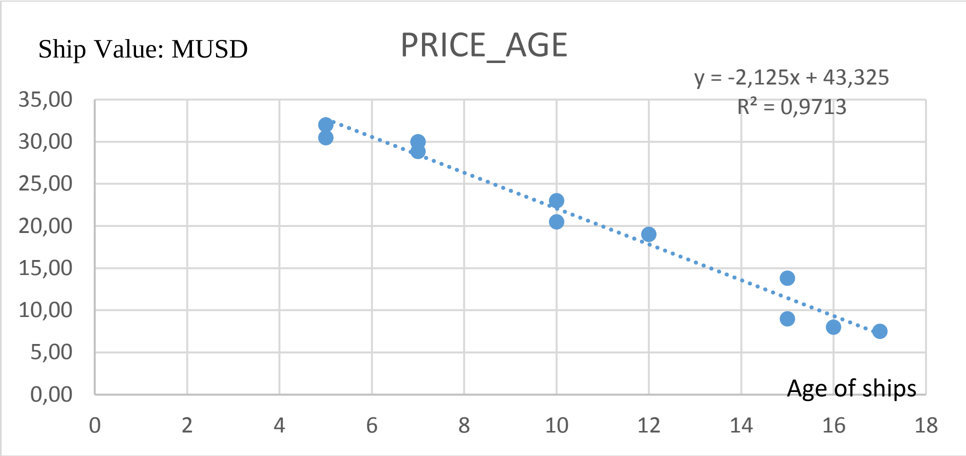

Figure 5-4 Regression analysis of Capesizes for sales in 2007 and deadweight tonnages of them are between 152.398 dwt and 185.897 dwt.

Table-5.17 Multi-regression analysis of Capesizes for sales in 2007 and deadweight tonnages of them are between 152.398 dwt and 185.897 dwt.

Regression Statistics						
Multiple R	0,846269184					
R Square	0,716171531					
Adjusted R Squ	0,682779947					
Standard Error	4,485194167					
Observations	20					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	2	862,9239408	431,4619704	21,44766537	2,24376E-05	
Residual	17	341,9884342	20,11696672			
Total	19	1204,912375				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	28,8666733	32,64750409	0,884192348	0,388926588	-40,01353941	97,74688602
X Variable 1	3,80693E-05	0,000175123	0,217386354	0,830494965	-0,000331407	0,000407546
X Variable 2	-1,551289801	0,283749385	-5,467112478	4,17418E-05	-2,149948673	-0,952630929

The y variable has been determined according to the following formula in Table 5.17.

y = 28,866733+3,8069E-05*DWT-1,5512898*AGE

The following predictions have been calculated using this formula. Adjustment Prices are shown in Table 5.18 and Figure 5-5. As seen in the table, M/V True Frontier's adjusted price has been calculated as \$28.45M.

Since the value of R squared (R^2) is less than 0.95, it has been decided to remove abnormal deviations. These calculations cover only in 2017 sales.

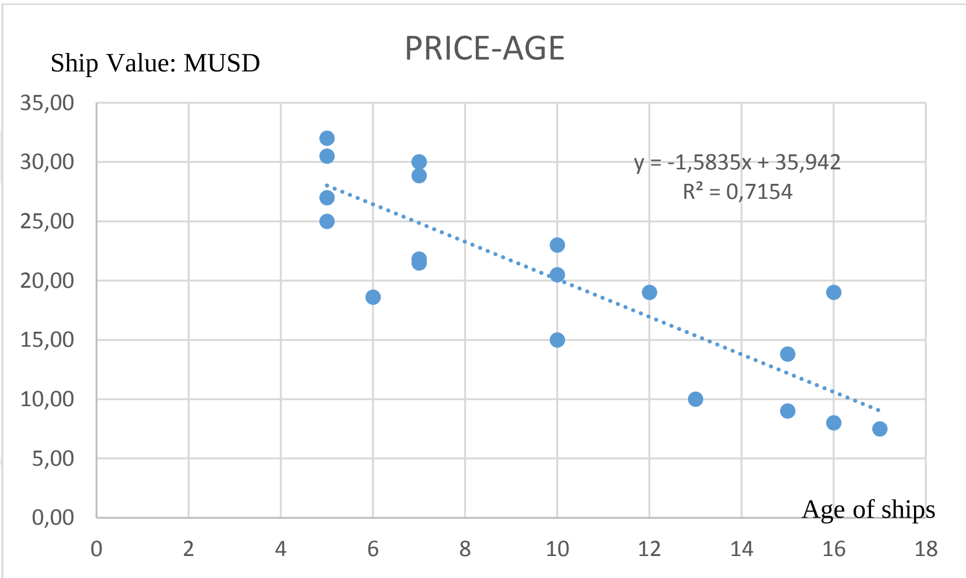

Figure 5.5 Regression analysis of Capesizes in 2017 for determining M/V True Frontier's adjusted price.

The R squared (R^2) value is shown to be lower than 0.95 in Figure 5.5 contrary to the more reliable regression analysis shown in Figure 5.4. As it is seen on Figure 5.4, variable y is:

y = -2,125x + 43,325 when R^2 = 0,9713. Adjusted Price (AP) with Multi-Regression Analysis and AP2 with Regression Analysis are listed in Table-5.18

Table-5.18 Adjustment Price of Capesizes within Regression and Multi-regression Analyses for sales in 2017.

Name	DWT	Age	MP	Built	Sold	AP	AP2
Cape Liberty	185.897	12	19,00	2005	2017	17,83	17,33
NSS Endeavor	184.877	15	13,80	2002	2017	11,45	12,64
Golden Opus	180.716	7	28,85	2010	2017	28,45	24,89
Pacific Capella	180.346	5	27,00	2012	2017	32,70	27,98
Pacific Canopus	180.330	5	25,00	2012	2017	32,70	27,98
Shin-Zui	180.201	10	15,00	2007	2017	22,08	20,21
Yuritamou	180.184	10	23,00	2007	2017	22,08	20,21
Cape Rich	180.133	6	18,60	2011	2017	30,58	26,42
True Frontier	179.294	7	30,00	2010	2017	28,45	24,83
N Fos	179.294	7	21,80	2010	2017	28,45	24,83
Dong-A Leto*	179.221	7	21,50	2010	2017	28,45	24,83
Dong-A Artemis	179.213	5	32,00	2012	2017	32,70	27,93
C. Discovery	179.185	7	30,00	2010	2017	28,45	24,83
Hyundai Talent	178.896	5	30,50	2012	2017	32,70	27,92
IVS Cabernet	177.173	10	20,50	2007	2017	22,08	20,10
Portage	176.391	15	9,00	2002	2017	11,45	12,31
Teh May	175.085	13	10,00	2004	2017	15,70	15,37
Bulk Prosperity	172.964	16	8,00	2001	2017	9,33	10,63
CE-Duke*	170.094	16	19,00	2001	2017	9,33	10,52
Blue Island	152.398	17	7,50	2000	2017	7,20	8,30

5.6 Criticism

The Combined Qualitative Ship Valuation Estimation Model (CQSVEM) compose of six operation steps. These operations are Marketing Value Analysis, LTAV Analysis based on DCF, Age Adjustment on Determined Value, Attribute Adjustment on Determined Value, Regression Analysis and Multi-regression Analysis. Within the case study, various ships values were calculated. Generally, brokers prefer marketing value or, LTAV on DCF approaches. Due to time limitations, brokers have no time to analyse all variations and are required to take quick decisions under market conditions. This case study shows that both marketing value and, LTAV on DCF approaches do not on their own give reliable ship values. These approaches can be used as complementary data in decision-making procedures. In the case study, the following values listed in Table-5.19 are calculated within each step.

Table-5.19 Optimum Price of M/V True Frontier

Process	Method	Value ($M)
STEP-1	**Marketing Value (Mean Price)**	**15,98**
STEP-2	**Marketing Value (Adjusted Mean Price)**	**16,086**
STEP-3	**Marketing Value (Predicted Price)**	**21,40**
STEP-4	**LTAV on DCF (Reduction Rate 15%)**	**34,04**
STEP-5	**LTAV on DCF (Reduction Rate 30%)**	**35,90**
STEP-6	**Age Adjustmnet**	**30,92**
STEP-7	**Attribute Adjustment**	**29,90**
STEP-8	**Regression Analysis (Age Adjustment including 2014-2017 Sales)**	**19,98**
STEP-9	**Regression Analysis (Age Adjustment including 2017 Sales only)**	**28,45**
STEP-10	**Multi-regression Analysis (Age and Attribute Adjustment including 2014-2017 Sales)**	**23,26**
STEP-11	**Multi-regression Analysis (Age and Attribute Adjustment including 2017 Sales only)**	**24,83**
	Optimum Price	**25,52**

According to Clarkson Research Data, M/V True Frontier was purchased during 2/2017 as “N Fos” at $21.80M. However, M/V True Frontier was sold during 8/2017 at $30M. At first glance, it is explained M/V True Frontier’s last done within Step-3 and Step-4. However, the very important question is for whom the price is available. It is very obvious that $30M is moderate for sellers, while $21.80M is conceivable for the purchaser. Regression or multi-regression analysis has utmost importance in determining a reference point. The more data in the time series, the more accurate a reference point is obtained. This reference point will provide the buyer or seller with a reliable guide to which price ranges are reasonable for buying or selling. When actual sale prices are scrutinised, it will be noticed that very few transactions are based on the refrence line. With Combined Qualitative Ship Valuation Model, the upper limit for the buyer and the lower limit for the seller are determined. Hence, the calculated optimal price point will provide significant decision support to buyers and sellers.

6. REGRESSION ANALYSIS FOR A COMBINED QUALITATIVE SHIP VALUATION ESTIMATION MODEL

In chapter-5, A Combined Qualitative Ship Valuation Estimation Model is introduced within the case study for Capesize bulk carriers. There are different types of bulk carriers. Classification societies have classified bulk carriers according to dwt, length, breadth, draft and their other attributes. However, evaluations have shown that the narrower the dwt range, the more accurate the price prediction will be. Therefore, dwt ranges which are narrower than the commonly accepted categories among classification societies are preferred. Deadweight (dwt) tonnages have been divided into 7 sub-groups. In sequence, 10.085 dwt - 29.952 dwt, 30.000 dwt - 49.000 dwt, 50.000 dwt- 63.000 dwt, 67.000 dwt-80.000 dwt. 80.000 dwt - 114.000 dwt, 160.000 dwt -186.000 dwt, and 10.000 dwt -200.000 dwt.

6.1 Regression Analysis-1: 10.085 dwt -29.952 dwt Bulk Carriers

Data for 247 dry cargo ships in the range 10,000 dwt - 29,000 dwt for the period of 2014 to 2017 were collated. The ages of the vessels were calculated from these data. The correlation level between age and price was determined by linear regression analysis. Following this, multi-regression analysis was performed using the appropriate data. Thus, tonnage, age and price relationship were determined. As a result of both analyses, the adjusted prices of the vessels were established. Therefore, the price range has been determined from this analysis. Realised sales and purchases higher than the price range were considered to be overpricing. However, the analysis method of the brokers will vary according to which data basket is available. It is not always possible to create a cluster of ships of particular tonnage. In such a case it may be necessary to make an analysis between ships of different tonnage and different ages but of the same type. If possible, ships of similar tonnage should be clustered in the same sales year. Applied linear regression analysis for 88 selected bulk carriers in the range of 16.730-29.887 dwt and of 4-23 years in age are shown in Figure 6.1

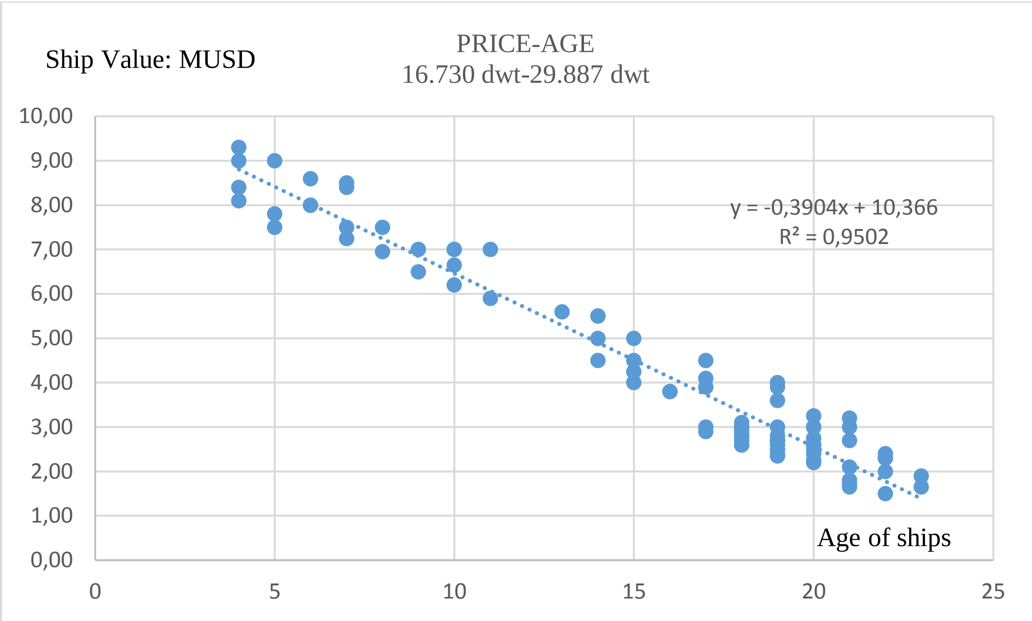

Figure-6.1 Linear Regression Analysis: 16.730 dwt - 29.887 dwt Bulk Carriers

Adjusted Prices were calculated by linear-regression analysis for each of the 88 bulk carriers considering variable y = -0,3904x + 10,366. Prices range from 1,051 $M to -0,914 $M.

Table-6.1 Multi-Regression Analysis: 16.730 dwt - 29.887 dwt Bulk Carriers

Regression Statistics						
Multiple R	0,97480156					
R Square	0,95023807					
Adjusted R S	0,9490672					
Standard Err	0,51012155					
Observations	88					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	2	422,378204	211,189102	811,566589	4,1508E-56	
Residual	85	22,1190398	0,260224			
Total	87	444,497244				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	10,3676242	0,44243708	23,4329913	7,497E-39	9,48794078	11,2473077
DWT	-7,921E-08	1,5738E-05	-0,0050333	0,99599583	-3,137E-05	3,1211E-05
AGE	-0,3903575	0,00968933	-40,287369	3,6776E-57	-0,4096224	-0,3710925

Adjusted Prices were calculated by multi-regression analysis in Table 6.1 for each of the 88 bulk carriers considering variable as stated below:

y = 10,3676242 – (7,921E-08) * DWT – 0,3903575 * AGE.

Price ranges were as 1,051041 $M and -0,913602 $M. Adjusted Price Ranges calculated by linear regression and multi-regression analysis are shown in Figure-6.2

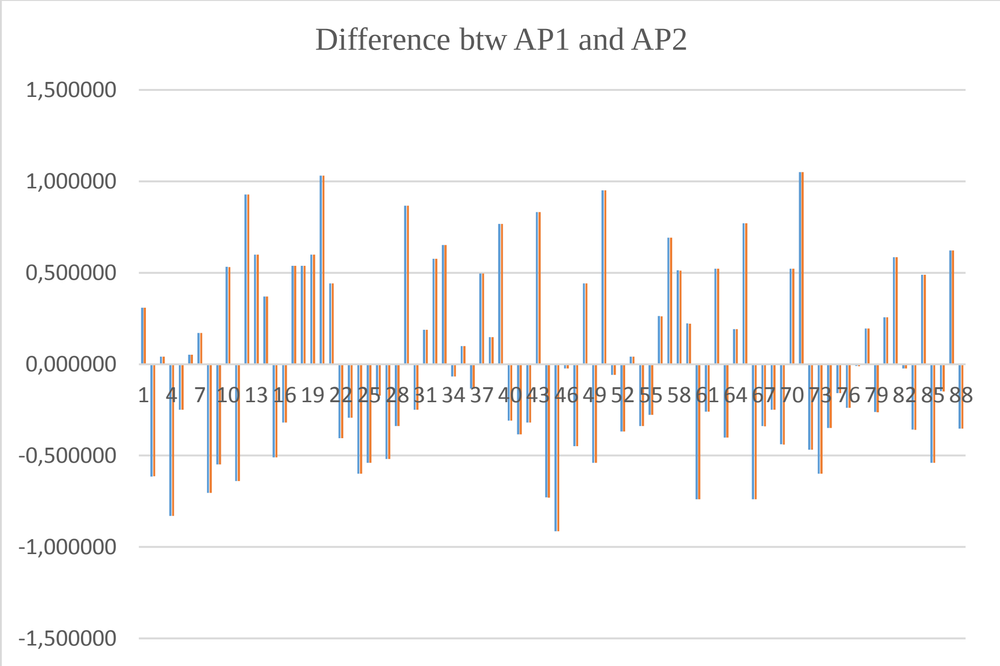

Figure-6.2 Adjusted Price Ranges for 16.730 dwt - 29.887 dwt Bulk Carriers

6.2 Regression Analysis-2: 30.000 dwt - 49.000 dwt Bulk carriers

Data for 262 dry cargo ships in the range of 30.000 dwt - 49.000 dwt for 2014 to 2017 were collated. Applied linear regression analysis for 83 selected bulk carriers in the range of 31.025 dwt - 49.917 dwt and 4-20 years in age are shown in Figure 6.3. Adjusted Prices were calculated by linear-regression analysis for each 83 bulk carriers considering variable,

$y = -0,4549x + 12,408$. Prices range from 1.46 $M to -0.96 $M.

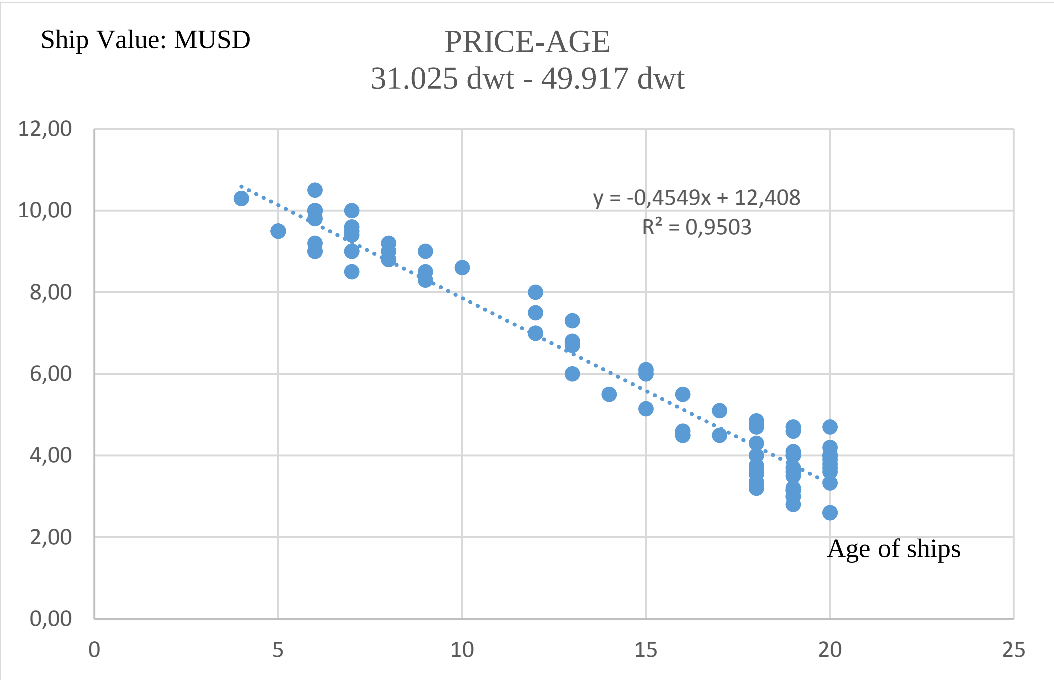

Figure-6.3 Linear Regression Analysis: 31.025 dwt-49.917 dwt Bulk Carriers

Adjusted Prices were calculated by multi-regression analysis for each 83 bulk carriers considering variable y as below in Table 6.2 below.

y = 12,0211181 – (1,3574E-05) * DWT – 0,46731601*AGE.

Table-6.2 Multi-Regression Analysis: 31.025 dwt - 49.917 dwt Bulk Carriers

Regression Statistics						
Multiple R	0,97514527					
R Square	0,95090831					
Adjusted R Square	0,94968101					
Standard Error	0,57700431					
Observations	83					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	2	515,9156843	257,9578	774,8018	4,36838E-53	
Residual	80	26,63471806	0,332934			
Total	82	542,5504024				
	Coefficient	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	12,0211181	0,438809039	27,39487	2,09E-42	11,14786027	12,894376
DWT	1,3574E-05	1,41645E-05	0,958303	0,340797	-1,4614E-05	4,176E-05
AGE	-0,46731601	0,01738836	-26,8752	8,35E-42	-0,50191995	-0,432712

Prices range from 1.40 $M to -1,08 $M. Adjusted Price Ranges have been calculated by linear regression and multi-regression analysis as shown in Figure-6.4

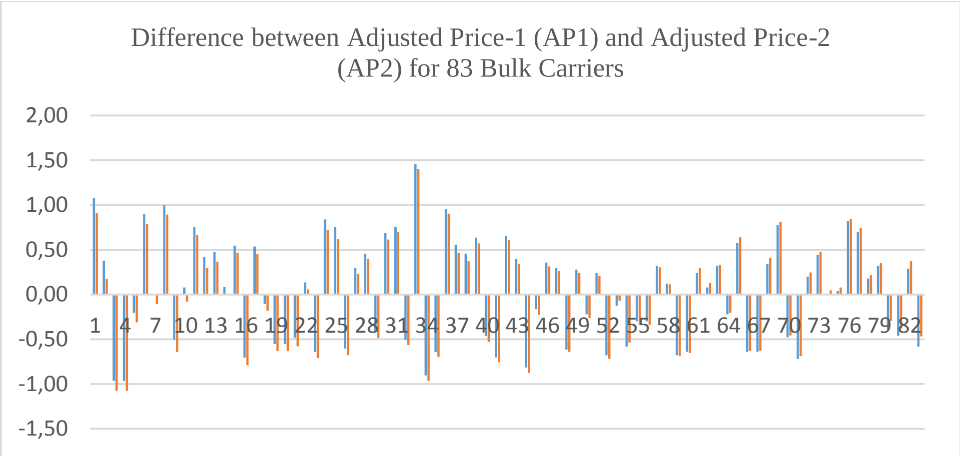

Figure-6.4 Adjusted Price Ranges for 31.025 dwt - 49.917 dwt Bulk Carriers

6.3 Regression Analysis-3: 50.000 dwt - 63.000 dwt Bulk carriers

Data for 257 dry cargo ships in the range of 50.000 dwt-63.000 dwt for 2014 to 2017 were collated. Applied linear regression analysis for 54 selected bulk carriers which they are in the range of 50.077 dwt-58.729 dwt and 3-16 years in are as shown in Figure 6.5

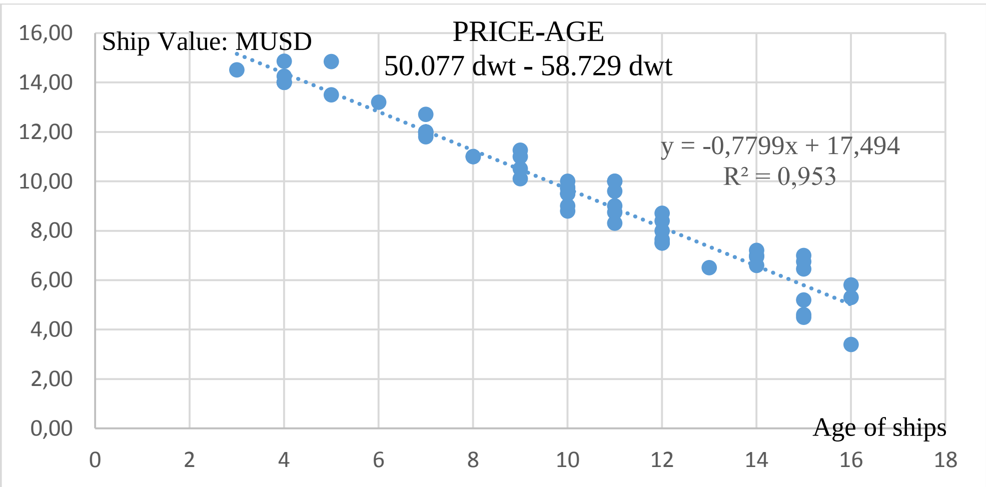

Figure-6.5 Linear Regression Analysis: 50.077 dwt-58.729 dwt Bulk Carriers

Adjusted Prices were calculated by linear-regression analysis for each of the 83 bulk carriers considering variable y = -0,7799x + 17,494. Prices range from 1,25 $M to -1,66 $M as seen in Figure-5.5 Adjusted Prices are calculated by multi-regression analysis for each of the 54 bulk carriers considering variable y as in Table-6.3 below.

y = 10,36762422 – (7,92118E-08) * DWT – 0,77547052*AGE.

Table-6.3 Multi-Regression Analysis: 50.077 dwt - 58.729 dwt Bulk Carriers

Regression Statistics						
Multiple R	0,976227719					
R Square	0,95302056					
Adjusted R Squa	0,951178229					
Standard Error	0,650989958					
Observations	54					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	2	438,4430481	219,2215	517,29063	1,36035E-34	
Residual	51	21,6131842	0,423788			
Total	53	460,0562323				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	10,36762422	0,442437079	23,43299	7,497E-39	9,487940777	11,24730767
DWT	-7,92118E-08	1,57376E-05	-0,00503	0,9959958	-3,13698E-05	3,12114E-05
AGE	-0,77547052	0,03732336	-20,7771	1,51E-26	-0,850400292	-0,700540749

Price range from as 2,14 $M to -0,71 $M. Adjusted Price Ranges were calculated by linear regression and multi-regression analysis as shown in Figure-6.6

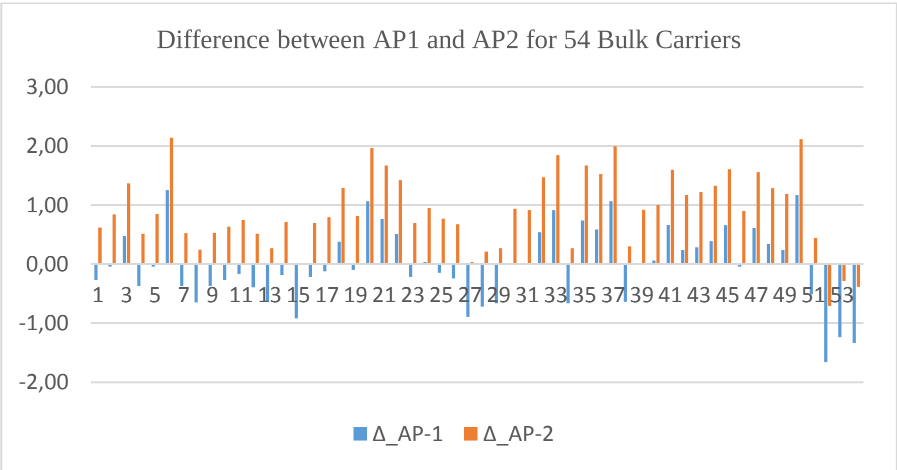

Figure-6.6 Adjusted Price Ranges for 50.077 dwt - 58.729 dwt Bulk Carriers

6.4 Regression Analysis-4: 67.000 dwt - 80.000 dwt Bulk carriers

Data for 257 dry cargo ships ranging from 67.000-80.000 dwt for 2014 to 2017 were collated. Applied linear regression analysis for 41 selected bulk carriers ranging from 69.057 to 78.236 dwt and 3-20 years in age are shown in Figure 6.7

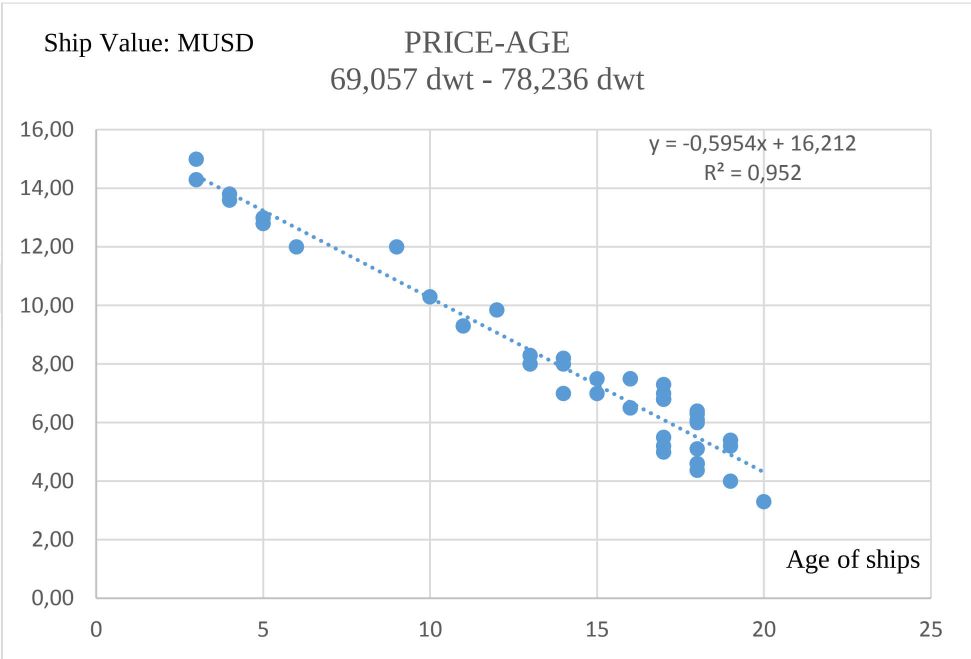

Figure-6.7 Linear Regression Analysis: 69.057 dwt - 78.236 dwt Bulk Carriers

Adjusted Prices were calculated by linear-regression analysis for each 41 bulk carriers considering variable

$$y = -0,5954 *AGE + 16,212.$$

Prices range from were as 1,21 $M to -1,12 $M as seen in Figure-6.7. Adjusted Prices were calculated by multi-regression regression analysis for each of the 41 bulk carriers considering variable y as below in Table-6.4,

$$y = 19,0292671 – (3,664E-05) * DWT – 0,6013685 *AGE.$$

Table-6.4 Multi-Regression Analysis: 69.057 dwt - 78.236 dwt Bulk Carriers

Regression Statistics						
Multiple R	0,97588907					
R Square	0,95235948					
Adjusted R Square	0,94985208					
Standard Error	0,69816742					
Observations	41					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	2	370,277341	185,138671	379,820132	7,613E-26	
Residual	38	18,5226345	0,48743775			
Total	40	388,799976				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	19,0292671	5,06433473	3,7575058	0,00057569	8,77705743	29,2814768
DWT	-3,664E-05	6,5727E-05	-0,5574208	0,58050894	-0,0001697	9,6419E-05
AGE	-0,6013685	0,02409811	-24,955003	3,602E-25	-0,6501526	-0,5525844

Prices range from were as 1.17 \$M to -1.14 \$M. Adjusted Price Ranges calculated by linear regression and multi-regression analysis are shown in Figure-6.8

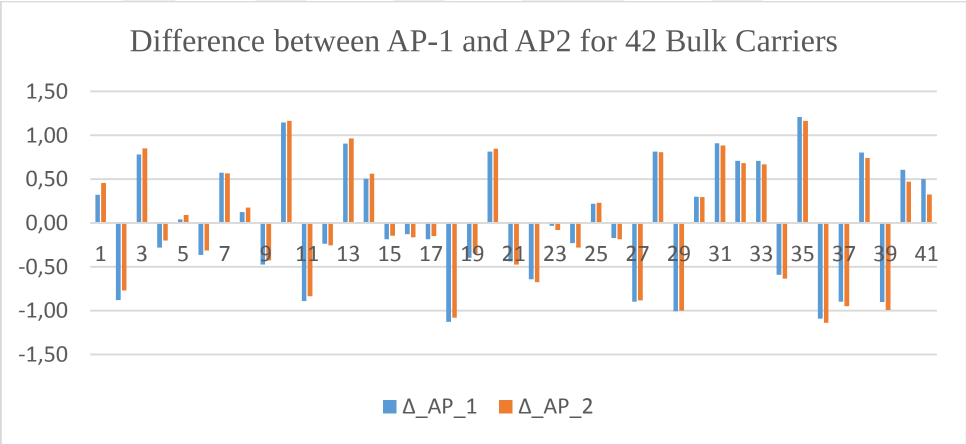

Figure-6.8 Adjusted Price Ranges for 69.057 dwt - 78.236 dwt Bulk Carriers

6.5 Regression Analysis-5: 80.000 dwt-114.000 dwt Bulk carriers

Data for 119 dry cargo ships ranging from 80.000 to 114.000 dwt for 2014 to 2017 were collated. Applied linear regression analysis for 43 selected bulk carriers ranging from 80.448 to 99.047 dwt and 2-13 years in age are shown in Figure 6.9.

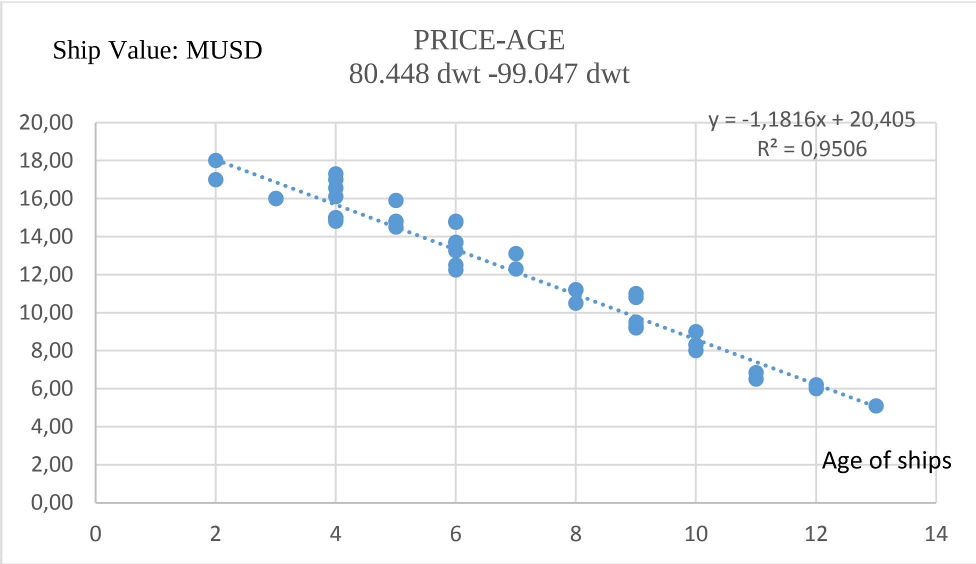

Figure-6.9 Linear Regression Analysis: 80.448 dwt - 99.047 dwt Bulk Carriers

Adjusted Prices were calculated by linear-regression analysis for each of 43 bulk carriers considering variable y = -1.1816*AGE + 20,405. Prices range from 1.16 $M to 1.96 $M as seen in Figure-6.9. Adjusted Prices were calculated by multi-regression regression analysis for each of the 43 bulk carriers considering variable y as in Table-6.5 below.

y = 25.75078486 – (6.68508E-05) * DWT + 1,142437037*AGE.

Table-6.5 Multi-Regression Analysis: 80.448 dwt - 99.047 dwt Bulk Carriers

Regression Statistics						
Multiple R	0,977752422					
R Square	0,9559998					
Adjusted R Square	0,95379979					
Standard Error	0,761635772					
Observations	43					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	2	504,1477171	252,073859	434,543384	7,39764E-28	
Residual	40	23,20356198	0,58008905			
Total	42	527,3512791				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	25,75078486	2,435558486	10,572846	3,781E-13	20,82833754	30,6732322
DWT	-6,68508E-05	3,02335E-05	-2,2111513	0,03280433	-0,00012796	-5,747E-06
AGE	-1,142437037	0,043920032	-26,011753	1,1107E-26	-1,23120273	-1,0536713

Prices range from 1.56 $M to -1.13 $M. Adjusted Price Ranges calculated by linear regression and multi-regression analysis are shown in Figure-6.10.

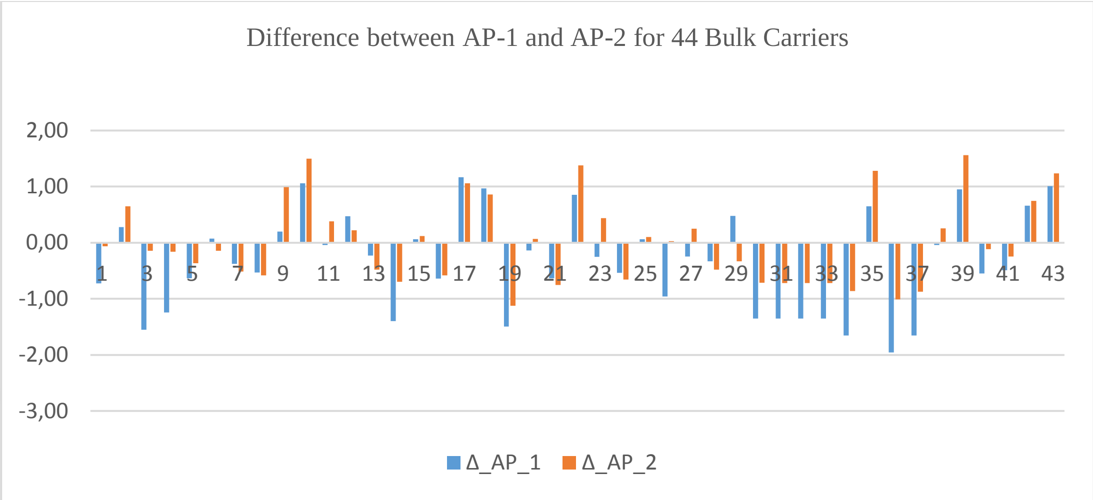

Figure-6.10 Adjusted Price Ranges for 80.448 dwt - 99.047 dwt Bulk Carriers

6.6 Regression Analysis-6: 160.000 dwt - 186.000 dwt Bulk carriers

Data for 92 dry cargo ships ranging from 160.000 to 186.000 dwt for 2014 to 2017 were collated. Applied linear regression analysis for 33 selected bulk carriers ranging from 161.121 to 181.725 dwt and 2-17 years in age are shown in Figure 6.11.

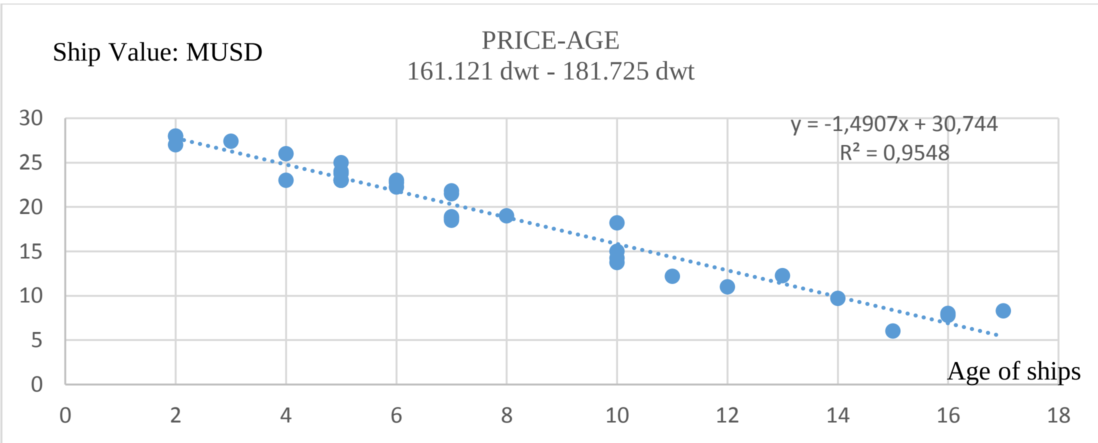

Figure-6.11 Linear Regression Analysis: 161.121 dwt - 181.725 dwt Bulk Carriers

Adjusted Prices were calculated by linear-regression analysis for each of 33 bulk carriers considering variable y = -1.4907*AGE + 30,744. Prices range from 2.88 $M to 2.33 $M as seen in Figure-6.11. Adjusted Prices were calculated by multi-regression regression analysis for each of 33 bulk carriers considering variable y as in Table-6.6 below.

$$y = 67{,}3001761-(0{,}000198439 * DWT) - (1{,}653056555 * AGE)$$

Table-6.6 Multi-Regression Analysis: 161.121 dwt - 181.725 dwt Bulk Carriers

Regression Statistics						
Multiple R	0,980942887					
R Square	0,962248948					
Adjusted R Square	0,959732211					
Standard Error	1,32107305					
Observations	33					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	2	1334,545253	667,27263	382,3399183	4,5075E-22	
Residual	30	52,35702011	1,745234			
Total	32	1386,902273				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	67,3001761	15,00046392	4,4865396	9,8852E-05	36,66514181	97,93521039
DWT	-0,000198439	8,13853E-05	-2,4382624	0,020894033	-0,00036465	-3,22278E-05
AGE	-1,653056555	0,085803154	-19,265685	1,91644E-18	-1,828289972	-1,477823137

Prices range from 2.42 $M to -2.28 $M. Adjusted Price Ranges calculated by linear regression and multi-regression analysis are shown in Figure-6.12.

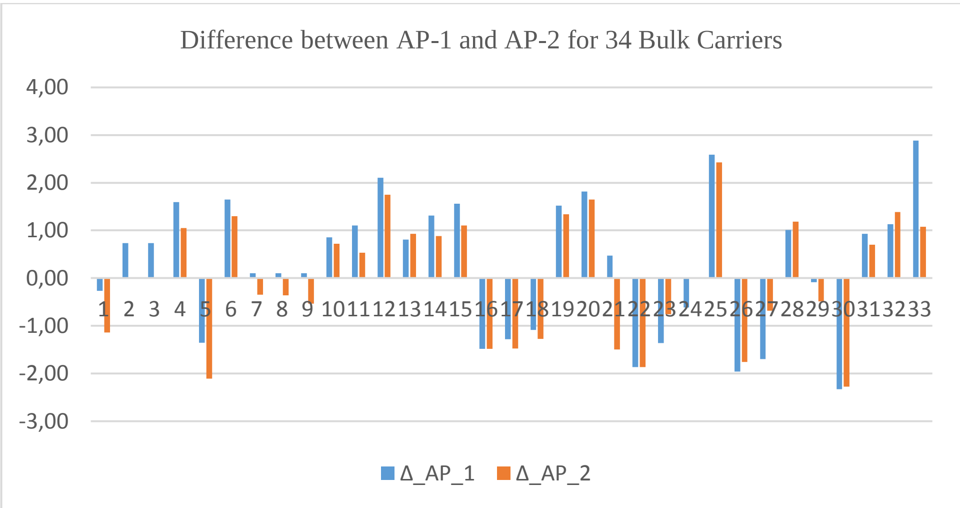

Figure-6.12 Adjusted Price Ranges for 161.121 dwt -181.725 dwt Bulk Carriers

6.7 Regression Analysis-7: 10.000 dwt - 200.000 dwt Bulk carriers

The y variable which was determined by regression analysis for clustered bulk carriers in the range of 10,000 to 200,000 dwt, was calculated again by regression analysis for all vessels without clusters. Data for 341 dry cargo ships ranging from 10.000-200.000 dwt for 2014 to 2017 were collated. Applied linear regression analysis for 228 selected bulk carriers ranging from 18.233 to 172.549 dwt and 2-23 years in age are shown in Figure 6.13.

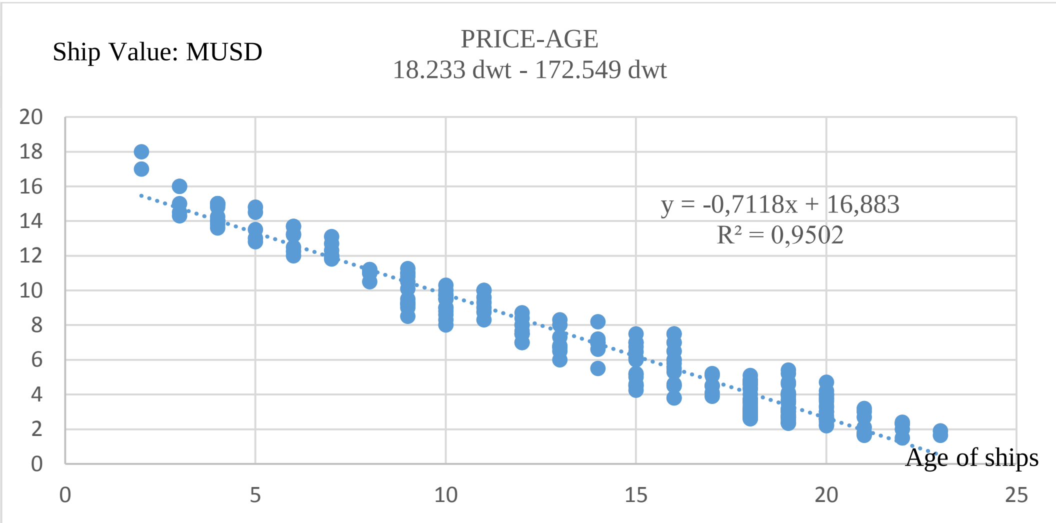

Figure-6.13 Linear Regression Analysis: 18.233 dwt - 172.549 dwt Bulk Carriers

Readjusted prices were calculated by linear-regression analysis for each of 228 bulk carriers considering variable y = -0.7118 * AGE + 16,883. Prices range from 2.54 \$M to -1.98 \$M as seen in Figure-6.13 Adjusted Prices were calculated by multi-regression regression analysis for each of 228 bulk carriers considering variables as shown below in Table-6.7.

$$y = 15{,}3948736 + (1{,}7313E\text{-}05 * DWT) - (0{,}6712277 * AGE)$$

$$y_{min} = 14{,}8777392 + (2{,}2263E\text{-}05 * DWT) - (0{,}6938724 * AGE)$$

$$y_{max} = 15{,}9120079 + (1{,}2362E\text{-}05 * DWT) - (0{,}6485831 * AGE)$$

Table-6.7 Multi-Regression Analysis: 18.233 dwt - 172.549 dwt Bulk Carriers

Regression Statistics						
Multiple R	0,97922131					
R Square	0,95887438					
Adjusted R Sq	0,95850882					
Standard Erro	0,82683551					
Observations	228					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	2	3586,49327	1793,24664	2623,02109	1,224E-156	
Residual	225	153,822817	0,68365696			
Total	227	3740,31609				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	15,3948736	0,26242968	58,6628513	2,418E-138	14,8777392	15,9120079
X Variable 1	1,7313E-05	2,5124E-06	6,89092359	5,5035E-11	1,2362E-05	2,2263E-05
X Variable 2	-0,6712277	0,01149147	-58,410962	6E-138	-0,6938724	-0,6485831

Price ranges were between -2,49 and 2,68 $M as shown below in Table-6.8.

Table-6.8. Price Changes in Regression Analysis: 18.233 dwt -172.549 dwt Bulk Carriers

Variable	**Linear Regression (Clustered) ($M)**		**Linear Regression (Non-clustered) ($M)**		**Multi-Regression (Non-clustered) ($M)**	
	Price (min)	**Price (max)**	**Price (min)**	**Price (max)**	**Price (min)**	**Price (max)**
y	**-1,30**	**1,39**	**-1,98**	**2,54**	**-2,17**	**2,53**
y_{min}	**-**	**-**	**-**	**-**	**-1,85**	**2,68**
y_{max}	**-**	**-**	**-**	**-**	**-2,49**	**2,37**

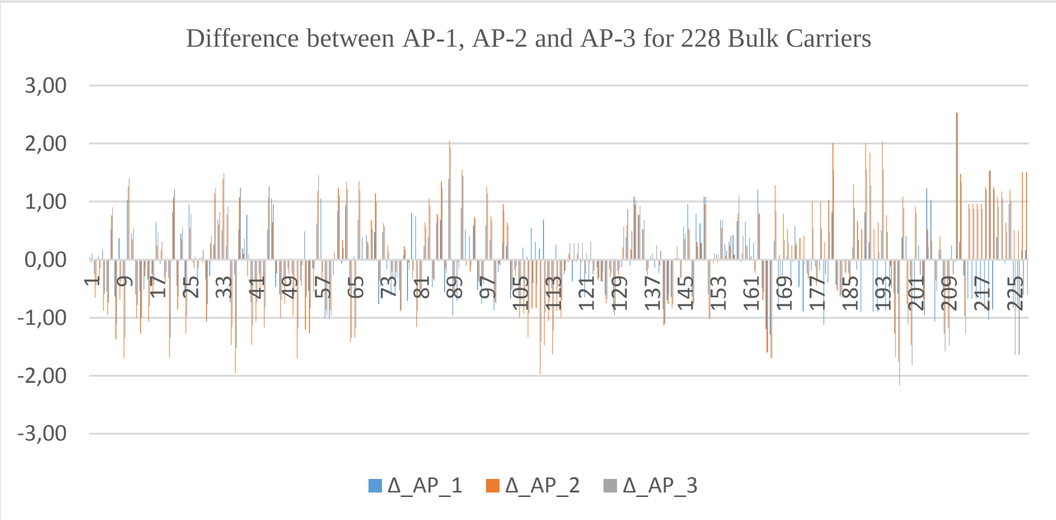

Figure-6.14 Adjusted Price Ranges for 18.233 dwt -172.549 dwt Bulk Carriers

Readjusted Price Ranges calculated by linear regression and multi-regression analysis are shown in Figure-6.14.

6.8 Findings and Discussions

Findings are related with multi-regression analysis for the Combined Qualitative Ship Valuation Estimation Model are as shown in Table 6.9

Table-6.9 Interpretation of Regression Analysis

DWT Range	Number of Observations	Average Variance in the price of Vessel ($M)	t-test > 2 (Yes / No)	F ≥ 1-5 (Yes / No)	R^2 > 0,95	P Value (*)
16,730-29,887	88	0,51012155	DWT / AGE		0,95	DWT / AGE
31,025-49,917	83	0,57700431	DWT / AGE		0,95	DWT / AGE
50,077-58,729	54	0,65098995	DWT / AGE		0,95	DWT / AGE
69,057-78,236	41	0,69816742	DWT / AGE		0,95	DWT / AGE
80,448-99,047	43	0,76163577	DWT / AGE		0,95	DWT / AGE
161,121-181,725	33	1,32107305	DWT / AGE		0,95	DWT / AGE
18,233-172,549	**228**	**0,82683551**	**DWT / AGE**		**0,95**	**DWT / AGE**

(*) P value was evaluated in the following table 6.10

Table-6.10 Interpretation of P Value

P Value	Wording	Summary
$0.01 \leq p < 0.05$	**Significant**	*****
$0.001 \leq p < 0.01$	**Very Significant**	******
$P < 0.001$	**Very (Extremely) Significant**	*******
$0.05 \leq p < 0.10$	**Borderline of Significance**	**ns**
$P > 0.10$	**Not significant**	**ns**

Source: Compiled from multi various statistics documents by author.

According to Table 6.9, an average of $0.51 million variance in the price of vessels ranging from 16,730 to 29,887 DWT cannot be explained by the y equation. However, the t statistic is – 40.28, which is a highly significant value for AGE values in the range of 4-23 years. R^2 is 0.95 that 95% of the variation in y is explained by the equation. Respectively, average variances in:

$0.51 million (16,730-29,887 DWT),

$0.57 million (31,025-49,917 DWT),

$0.65 million (50,077-58,729 DWT), $0.69 million (69,057-78,236 DWT),

$0.76 million (80,448-99,047 DWT), and

$1.32 million (161,121-181,725 DWT) in the prices of vessels cannot be explained by the y equations.

At first glance, although a dependent variable in the range of 16,730-78,236 DWT is not significant, dependents varying within the range of 18,233-172,549 DWT can be explained as having extremely high significance, because, the first six steps for clusters are an appropriate process for finding the harmonic data.

After these steps, all the selected vessels in the wide range of DWT were tested as significant or highly significant according to t and F statistics. In short, it is outstandingly clear that multi-regression analysis for bulk carriers in the range of 18,233 dwt -172,549 dwt is more accurate and available to determine the fair value of the vessels.

According to concrete result of the multi-regression analysis, the equation as follows indicates that,

$$y = 15{,}3948736 + (1{,}7313E\text{-}05 * DWT) - (0{,}6712277 * AGE)$$

on average the second-hand price of bulk carriers increases by $17.313 per 1 DWT while it loses $671.278 in value every year (per 1 AGE).

There are four common methods to estimate real estate value. These are:

- The Sales Comparison Approach-SCA,
- The Capital Asset Pricing Model (CAPM),
- The Income Approach
- The Cost Approach

CAPM is a calculation based on risk assessment similar to LTAV. The the CAPM formula (Investopedia, 2020) is as follows;

$Ra=Rrf+\beta a*(Rm-Rrf)$ **where:**

Ra=Expected return on a security, Rrf=Risk-free rate, Rm=Expected return of the market, βa=The beta of the security, $(Rm-Rrf)$ = Equity market premium

Although Beta is the only relevant factor for measuring stock risk, - volatility here is comparatively lower than that of the shipping market.

In addition, real estate life cycles are considerably longer than ships' economic ages. One of the most changeable factors in LTAV calculation is freight rates. However, best return rates as variables are the most important factors for the CAPM calculation. When both ratios are compared, the risk factor is higher in the maritime market and the forecasts are not as accurate as the real estate market. Therefore, the most probable value for buying or selling by calculating the fair price and optimizing the fuzzy values with regression analysis was the basis of this study.

As shown in Table 6-11, assumed criteria for future estimation of ship values are quite different from those considered to determine property values.

Table-6.11 Assumed Criterias for LTAV Calculation

Assumed Criterias	Value	Explanation
Operating Days	358 days	Maximum number of available running days-charter days in a typical year
Operating days in years with dry docking	343 days	Maximum number of available running days in years with dry docking-class renewal
The Gross Charter Rate per day for the Current Year and the following four-year estimations obtained from “Baltic Capesize Indexes” and “Advanced Shipping and Trading S.A. Weekly Reports”.	As in table 5.1.	Estimations of DGCR have been obtained from “Baltic Capesize Indexes” and “Advanced Shipping and Trading S.A. Weekly Reports”. Daily Gross Charter Rates (Current Charter Rates) were realized as $18,500 for 2017, $22,000 for 2018 and, $16,000 for 2019. The next two years' estimations are $17,500 for 2020 and $16,500 for 2021.
Years following four-year estimations till a ship age of 25 years	As in table 5.1.	The other estimations of Daily Gross Charter Rates from 2021 to 2035 are consecutively calculated by the following years' daily charter rates at 2.0% interest rates for ships aged between 6-25.
Actual Booked Days	326 days	It is 95% of the total available running days
Reduction Rate-1	30%	The daily gross charter rate for ships more than 20 years old is assumed to be 30% for sample-1
Reduction Rate-2	15%	The daily gross charter rate for ships more than 20 years old is assumed to be 15% for sample-1
Daily Net Charter Revenues	6.5%	Ship management fee and freight commissions as a percent of the gross daily charter rate
WACC-1	7.3%	Weighted Average Cost of Capital-1
WACC-2	4.72%	Weighted Average Cost of Capital-2
Risk-Free Rate (r_f)	2.2%	Data obtained from US Treasury bond yields over a 10 year period for r_f , Drobetz’s study for β_E (Drobetz, Menzel, & Schröder, 2014). (http://www.federalreserve.gov/releases/h15/data.htm)
Equity beta (β_E)	1.2	Drobetz’s study for β_E (Drobetz, Menzel, & Schröder, 2014)
Market Risk Premium (MRP)	4.1	Dimson’s study for MRP (Dimson, Marsh, & Staunton, 2002)
Scrap Prices per long ton	As in Table 5.1	According to Advanced Shipping and Trading S.A. weekly report (WEEK 35, 25thAug to 1st Sept 2017), scrap prices were $295 (Turkey), $260 (China), $380 (Pakistan), $385 (Bangladesh), and $375 (India).

7. CONCLUSION

Vessel valuation is a complex process where many parameters affect each other, and which is directly affected by economies of scale. There are many ship-related variables such as type, age, cargo, carrying capacity, construction date, date commissioned, shipyard, seaworthiness, classification societies, country of ship registration, flag state, cargo, equipment and technical specifications, operating costs, interest rates, discount rate, commission and brokerage fees, inflation, freight rates, etc. which directly affect the valuation of the ship. A maritime market of $ 80 billion per year is naturally affected by world GDP, and there is a correlation between new shipbuilding and used, scrap and freight markets. Since the data of the markets mentioned are not transparent, the data related to ship valuation cannot be accessed one-to-one and simultaneously. For this reason, brokers try to determine fair value by collecting the prices of ships of the same age, type and carrying capacity from open sources and using the average of the prices thus obtained. This method is quite primitive and misleading. The common ship valuation method should be according to fair value rather than market value, especially in times of crisis that cause excessive or low pricing. In this research, if a sufficient amount of valid data can be found, it is clear that various mathematical models could be used to determine the predicted value of the ships. In particular, The Long Term Asset Value (LTAV) Model on Discounted Cash Flow (DCF), that is the Hamburg Ship Valuation method, determines reasonable prices for sellers, however, it is not suitable for buyers, financiers, bankers, insurers or related courts. However, while regression analysis for vessel valuation determines the fair price for buyers and what is reasonable for financiers, insurers and bankers, it is not suitable for the courts. Therefore, it has been concluded that buyers, sellers and third parties should agree by calculating a price range that determines the maximum purchase limit for buyers and the minimum sales limit for sellers which would provide significant decision support in ship valuation. During the theoretical background and literature review, a gap was identified related to the fair value calculation and it was realized that a reasonable price range calculation can be reliable and suitable for all parties.

For this purpose, the "Combined Qualitative Ship Valuation Estimation Model" was created. This model is composed of eleven stages. Eleven different prices are determined for the same ship at each level. These are the values obtained between the minimum and maximum prices of a ship. However, fair value is used to determine which value is suitable for whom. The average value of these eleven steps is calculated as fair value. Linear regression and multi-regression analysis are an essential part of the model. Using regression analysis, it was found that the market value calculation was more accurate for ships between 0 and 5 years old, but regression analysis was needed for ships between the ages of 6 and 21 years. Price determination should be made by using multi-regression analysis before performing LTAV calculation. These prices should be readjusted according to age and attribute and the value obtained should be benchmarked with LTAV. In the calculations involving age 21-25, it was found that a comparison with the demolition price of the ship would be more accurate. Since ship valuation is a very broad subject, some limitations have been made in the study. Due to the importance of major cargoes in the maritime trade, second-hand dry cargo ships were considered in the study. Since the value of newbuildings are determined according to the cost approach, an improved model has been tried for second-hand dry cargo ships whose prices fluctuate the most. In terms of both regression analysis and calculation of LTAV, **"non-significant"** findings were obtained for 0-5 year-old ships.

Market value or cost approach to determine newbuildings will be more reliable in determining a value. In the analysis, it was seen that the prices of the same age, same tonnage and the same type of ships were close to the market value in the regression analysis. However, since it is not always possible to find a minimum sufficient number of transactions (around 20) at a desired time, it may be necessary to analyze the buying or selling values of different tonnages, different ages and different years or en-bloc purchases and sales while considering the time series. In this case, firstly, clustering of data is important to extract the appropriate data by linear regression analysis. It will be possible to find the best price range by gathering the collected data without clustering and subjecting it to multiple regression. Thus, the data of 1443 dry cargo ships were reduced to 342 reliable data sources and the appropriate price range of each cluster was determined.

As a result of the analysis, it was found that a price difference in the range of $ 2.68M to (-) $ 2.49M was reasonable, while transactions outside this range were subject to excessive or low pricing. It was calculated that the LTAV on DCF calculation, which is the Hamburg Ship Valuation Method, would not be correct for ship valuation alone. But it would minimize the loss of value in crisis periods when compared to market valuation. Hence, LTAV which was higher than the optimum value, could be reduced to a more reasonable price by using the combined model, No seller wants to sell at the lowest price, and no buyer will want to buy at the highest. This is why a price difference of Capesize and larger dry bulk carriers up to +/- $ 10M in times of crisis is unacceptable. The LTAV on DCF formula includes revenues, OPEX costs, discount rate, interest rate, demolition prices, commission expenses, number of days that ships are active, and age-related reduction rate etc. LTAV on DCF has to be calculated after predicting the future values of each of these parameters. A prediction error here may also cause the result to be calculated incorrectly. Therefore, during the case study, future estimations of prior articulated parameters were calculated within a specific range according to the state of the economy. Thus, the most probable values of LTAV on DCF were found.

One of the variables most affected by the fluctuations in the economy was freight rates. Since freight rates affect Time Charter (TC) Rates, it determines the daily chartering values of ships and this value can change the revenue and expense balance of ships in a positive or negative way. Freight rates can be calculated on a USD basis when indices such as BDI, which allow the monitoring of freight values daily, are multiplied by a certain coefficient. If the Index Multiplier (IM) coefficient, commonly used by brokers, is accepted as 0.110345333, the Time Charter Equivalent (TCE) value may not always reflect the current situation. Therefore, in times of crisis, an Index Multiplier (IM) should be determined and then the freight rate should be calculated. It is considered that 10-year U.S. Treasury rates and LIBOR interest rates should be taken into consideration in the calculation of interest rates and discount rates. It is highly probable that the fluctuations in exchange rates will make future estimations more difficult as will the changes in tax rates affecting accounting. One of the best LTAV Method practicers is VesselsValue. The data pool of VesselsValue is suitable for big data management. Calculation modules created by Vessel Value determine Market Value, Demolition Value, LTAV on DCF, Book Value and Replacement Value. However, these values are not combined by VesselValue. Current mathematical analyses make predictions for short-term economic fluctuations. However, no serious studies have been conducted on the impact of long waves initiated by Kondratieff and maintained by highly respected scientists. In order to reveal the importance of the subject, it has been examined within a chapter of this thesis. New opportunities and capabilities such as artificial intelligence, big data management and blockchain system will eliminate the intermediaries. Ship sales on blockchain systems will shelve many old approaches and techniques used today. Systems that enable ships to be treated as securities and evaluated in secondary markets will make maritime economy more transparent. Thus, making future estimations will be easier. It is considered that if the Combined Qualitative Ship Valuation Estimation Model is used with integrated service-oriented information systems, ship values can be estimated more accurately. Thus, it is thought that estimation according to short waves of 20 years or less without examining long waves of 50 years, 100 years and 250 years will result in multiple value estimations for the same ship and which would be the most accurate value, is open to speculation. It has been established that it is not possible to analyze multiple data with human intelligence alone, considering the risk that long waves involving technological leaps may overlap with short cycles. It is important that artificial intelligence applications, psychological tendencies of customers and anomalies created by maritime trade mobility in any part of the world be detected. The decisions regarding ship supply and demand can be taken in a reliable way by following dynamically the economies of scale. It was realized during the writing of this thesis that, in addition to the valuation of only a single vessel, firm valuations and fleet valuations were also important. However, the inability to access big data due to confidentiality issues regarding financial records of firms is a major obstacle for such valuations and thus poses limitations to this study. In the future, should the opportunity arise to access big data, a logistic regression analysis utilizing the bayesian approach can be done and the effects of fleet and firm valuations on a single vessel can also be determined. Companies such as Clarkson Research, VesselValue, Baltic Exchange, Shanghai Shipping Index were able to provide the necessary services for ship valuation thanks to their large data resources. The ability of each country to conduct big data management in its official or private institutions and to have a mechanism to analyse them will be a very important tool for strategic decision processes. In the analyses, it was found that age and dwt factors were more effective than other variables, but age criterion was the most influential factor. In previous studies, age and tonnage variables were taken into consideration as these factors were found to be effective. In the regression analysis, it was observed that the age factor had an effect of around 60-70%. Within the scope of the ANOVA test, when the t-test, p-value and F significance level were taken into consideration, the results were extremely significant. Also, the fit is extremely good, with a regression coefficient of 0.95. It has been concluded that it can be possible to obtain fair value by benchmarking the values obtained from the regression analysis with LTAV on DCF and then adjusting for the age and property of the prices of these vessels. Regression analysis was found to be a reliable control method in terms of reference point. It was concluded that the LTAV on DCF, which the courts described as complementary, must be matched by regression analysis. In general, brokers acknowledge that ships suffer a 5% depreciation per year. However, it was calculated that there was an annual devaluation of 5.2% to 7.2% between 2014 and 2017. As a result, in the future, this model can be composed with integrated information management systems, where the optimal ship value, which the buyer and seller is willing to agree to, will be considered reasonable by the courts in case of disagreement. Also, this model can ensure that insurance companies and financial systems will provide significant support to strategic decision makers.

Consequently, research questions (p.44) were met in the thesis. In this context, an attempt has been made to fill the gaps in current valuation methods (especially the Hamburg Ship Valuation Method) in light of the “Combined Qualitative Ship Valuation Estimation Model” (CQSVEM). It is understood that Hamburg Ship Evaluation Method is the most useful approach for sellers. However, Long Term Asset Value on DCF analysis must be supported with the CSQVEM model to determine the ships value more accurately. Hence, the determination of a fair value will serve as a reference point for all parties.

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PUBLICATIONS/PRESENTATIONS ON THE THESIS

1. Koray, M. and Çetin, O. (2019). Ekonomik Döngülerde Kuru Yük Gemilerinin Değerlemesi için Adil Fiyatın Belirlenmesi (Determining The Fair Value for Dry Bulk Carriers' Valuation in Economic Cycles), Journal of Social and Humanties Sciences Research, ISSN 2450-1149, Volume 6, Issue 39, pg.1724-1733

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