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Factors influencing the dry bulk sales and purchase market : capesize vessels

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Factors influencing the dry bulk sales and purchase market: Capesize vessels

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Declaration

I certify that all the material in this dissertation that is not my own work has been identified and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views and are not necessarily endorsed by the University.

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Abstract

Title of Dissertation: **Factors influencing the dry bulk sales & purchase market: Capesize vessels**

Degree: **Master of Science**

The study examines the factors that affect the price of second-hand Capesize vessels. The shipping sector has undergone many developments that introduced changes in doing business in the industry; some of the areas affected by these changes in the sale and purchase market. The selling and buying of vessels have seen tremendous evolution that has impacted trade and specialization. The development includes expanding legal aspects, valuation of ships, negotiation insights, communication, and daily shipping operation activities.

The optimum pricing of second-hand vessels has remained an area of active interest in maritime economics. The study collected secondary empirical data and employed modern techniques to make a valid statistical interpretation, thereby filling in a gap in second-hand Capesize vessel price literature. In this study, a linear relationship by Ordinary Least Squares (OLS) fixed effect framework was applied to estimate empirically the macroeconomic and microeconomic factors influencing the second-hand Capesize vessels. Overall, the present study results provide evidence that second-hand Capesize vessel price differentiation is essential in the dry bulk market. The findings can contribute to a better understanding of the microstructure of the shipping market. Furthermore, the findings show that in the future, investors need to evaluate the vessel based on the technical specifications when making decisions rather than relying only on market information and the last transactions of a vessel with the same characteristics.

KEYWORDS: Capesize vessels, OLS model, fixed-effect method, macroeconomic and microeconomic factors, price volatility, sales and purchase market, vessel value estimation, decision-making tools, investors' behavior, technical specifications.

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List of Abbreviations

ABS: American Bureau of Shipping

BCI: Baltic Exchange Capesize Index

BP: Bunker Price

BV: Bureau Veritas

CIR: China Interest Rates

CLRM: Classical Linear Regression Model:

CP: Coal price

CPCN: Capesize Port Congestion as % of Capesize Fleet

CPCON: Capesize Bulker Contracting

CPDE: Capesize Bulkcarrier Demolition

CPDMA: Capesize Bulkcarrier Demolition - Average Age (Year)

CPFA: Capesize Bulkcarrier Fleet - Average Age (Year)

CPGR: Capesize Fleet Growth (% Yr/Yr)

CPID: Capesize Bulker - Idle vessels

CPNB: Capesize Newbuilding Price

CPORD: Capesize Bulker Orderbook

CPSCV: Capesize Scrap Value

CPSHM: Capesize Secondhand Market Price

CPSLS: Capesize Sales

CR: China Corporation Register of Shipping

DNV-GL: Det Norske Veritas – Germanischer Lloyd

DWT: Deadweight

EQUASIS: Electronic Quality Shipping Information System

IACS: International Association of Classification Societies

IGP&I: International Group of Protection and Indemnity clubs

IOP: Iron Ore Price

KRS: Korean Registry of Shipping

LR: Lloyd's Register Group

MoU: Memorandum of Understanding

NKK: Nippon Kaiji Kyokai

OLS: Ordinary Least Squares

PSC: Port State Control

P&I: Protection and Indemnity club

RINA: Registro Italiano Navale

SIN: Shipping Intelligence Network

S&P: Sales and Purchase

Chapter 1: Introduction

Dry Bulk Shipping

The shipping industry has a vital part in people's prosperity around the globe since nearly 90% of the world trade relies on it for transport. The dry bulk sector is responsible for 43% of the world trade and 55% of sea transportation. The dry bulk carriers are described as the workhorses of shipping as they transport the essentials for trade, such as raw materials, food, and energy. The sector maintains and enhances people's living standards both in the less developed and developed countries worldwide. Apart from the widely known iron ore and coal, the dry bulk carriers also transport cereals, forest products, construction materials such as cement, and bauxite, among other goods that the society needs for maintenance and prosperity. It is estimated that bulk carriers transport almost 700kg of goods every year for every person on the planet (Intercargo, 2020).

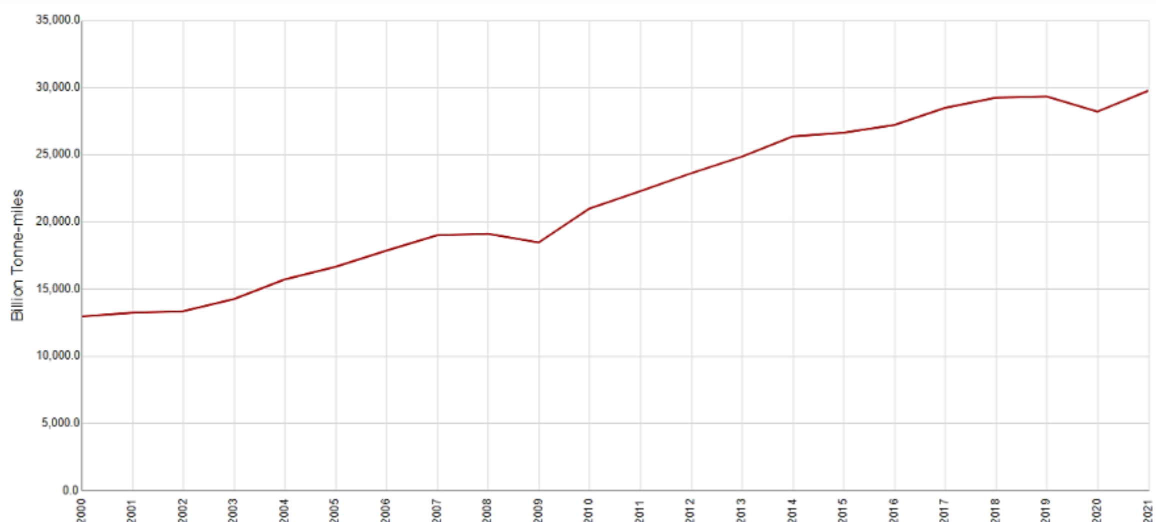


Figure 1: World Seaborne Dry bulk Trade Billion Tonne-miles. Source: Clarkson's Shipping Intelligence Network (SIN).

The dry bulk carriers' transportation and fleet have tripled over the last twenty years to the 12,000 fleets sized over 10,000 deadweights in mid-2020. The world's largest dry bulk carriers are over 210,000 deadweight tons, whereas the largest carriers of ore exceed 400,000 deadweight tones. Over recent times, the economies of scale have also contributed to the increase in bulk carriers' size. The standard Panama carriers have also increased by 30% to reach 80,000 deadweight tons in the last three decades. The average-sized bulker is evolving from Panamax to Kamsarmax to 80,000 deadweight tons in 2020 from 60,0000 DWT of the 1980s. The annual world seaborne dry bulk trade had also doubled in volume from 2,62 billion tons in 2003 to 5,68 billion tons in 2019 (Intercargo,2020). Capesize vessels mainly transport iron ore and coal. Iron ore is crucial to steel products production, and coal is used in electrical energy generation. The two industries influence the economic conditions of many countries.

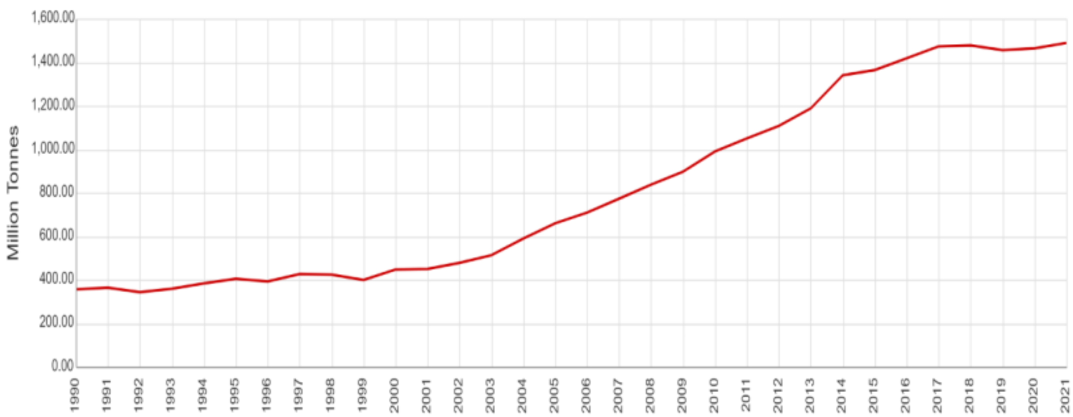


Figure 2: World Seaborne Iron Ore Trade Million Tonnes. Source: Clarkson's Shipping Intelligence Network (SIN)

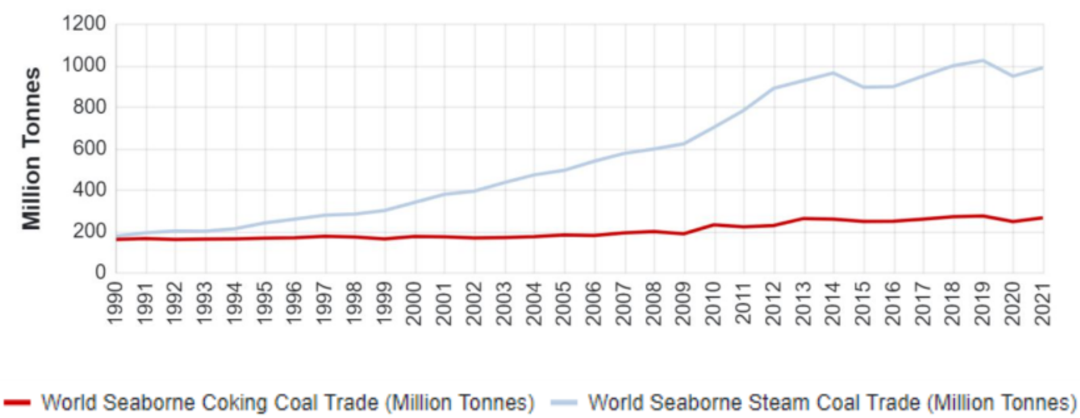


Figure 3: World Seaborne Coking Coal Trade – Million tonnes, World Seaborne Steam Coal Trade – Million tonnes. Source: Clarkson's Shipping Intelligence Network (SIN)

Dry bulk shipping contributes to the achievement of UN Sustainable Development Goals of well-being, climate action, decent work, clean, affordable energy, industry, and infrastructure. Maritime transport is responsible for 90% of world trade, but only responsible for only 2% of the anthropogenic emission of CO_2. The shipping industry has cut its emissions in the last decade by 10% and directly enabling the global trade increase by 30%. The emission of greenhouse gases by the shipping industry has decreased by 25% since 2008. The sector is considered the most efficient cargo carriage mode, whereas the dry bulk sea trade offers cheap, safe, and reliable transportation (Intercargo,2020).

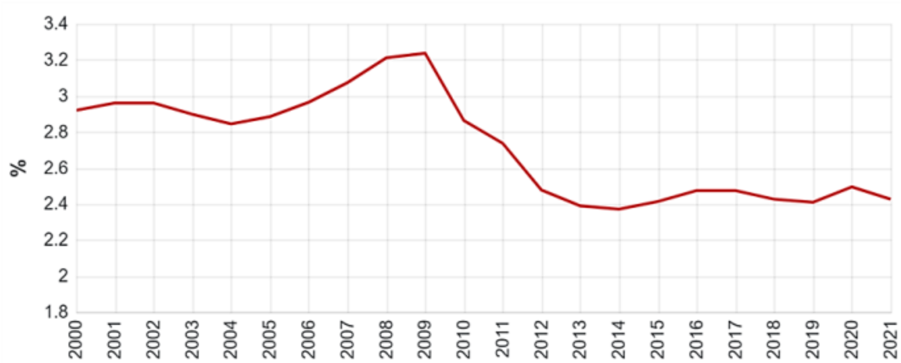


Figure 4: World Shipping Fleet CO2 Output as % of Global CO2 Output %. Source: Clarkson's Shipping Intelligence Network (SIN)

Dry bulk shipping has achieved operational and environmental excellence as it contributes to improving energy efficiency and complies with the Efficiency Design Index of the IMO. It burns less polluting fuels and uses ballast water cleaning systems that prevent contamination of waterways. Environmental excellence demands the collaboration of charterers, fuel suppliers, shipyards, fuel distributors, ship owning community, and engine suppliers for the most appropriate industry solutions. International regulations on shipping standards should encompass all the stakeholders to achieve IMO-set equitable environmental and greenhouse reduction objectives. Economies are likely to falter without the efficient and prosperous dry bulk cargo sector, and world populations will experience supply shortages (Intercargo,2020).

Figure 5: Capesize bulk carrier vessel. Source: Retrieved from www.maritimeinfo.org

Background Context

The second-hand market, also known as the sale and purchase market, is a market for second-hand vessels aged between 1 and 20 or more years-around 1000 transactions (1000 vessels) carried out yearly, with 30% of this being dry-bulk carriers and 30% tanker ships. Therefore, at least one tanker and dry-bulk carriers are sold or purchased each day.

The second-hand market is one of the most competitive as it is an open market where buyers and sellers have no obligations to follow any restrictions on price. The sale and purchase market prices are determined by demand and supply conditions that depend on the current and expected economic activities, current and expected market conditions, bunker prices, and ships' prices. Thus, the sale and purchase market prices depend on market profitability (Alizadeh and Nomikos, 2009).

The shipping industry is a globe-scale business affected by many economic and political shocks worldwide. Shipping plays an essential role in world trade and economy.

It was reported that 90 % of the world trade goods in volume are shipped by sea (Ma, 2012). The shipping industry is characterized by capital-intensiveness, cyclicality, and volatility (Adland and Jia, 2017). The sector is volatile owing to the volatility of the market of dry bulk freight, which is influenced by high competitiveness in which the rate of cargo relies on supply and demand forces (Thalassinos and Politis, 2014).

With the evolution of trade, shipping and trading were differentiated as the shipowners only transported goods for the traders and handed it over to buyers. The shipping industry has welcomed much development in the last decades with its evolution (Englen, Dullart, and Vernimmen, 2007). One of the areas affected by these developments is the ship sale and purchase market (Herbener, 2018). The main area covered by this dissertation touches on the factors that affect the price of second-hand Capesize vessels and investigates differently related macroeconomic and microeconomic factors.

The volatility of vessel prices possesses a sound investment and operational decision, making the challenge for managers and investors concerned with predicting trend reversals. Conversely, this vessel price volatility can also be advantageous and valuable to investors and managers as identifying the factors influencing the variability of vessel prices. Moreover, estimation of the impact of the elements and price variability helps these operational and investment decision-makers gain, withdraw, or take precautions against it (Merika, Merikas, Tsionas, and Andrikopoulus, 2019).

For instance, knowledge of Capesize vessel prices at different times helps stakeholders know if the current price is high or low compared to past estimates. Besides, comparing the costs of ships provides a measure of relativity when different ship type prices are compared amongst alternative shipping investments, forming the basis for the asset portfolio decision for a vessel type (Alizadeh and Nomikos, 2009).

This study aims to explore, from a different viewpoint, the context of second-hand Capesize vessel in the dry bulk market extensively by drawing knowledge and evidence from a sufficient number of studies on the formation of vessel prices and volatility.

The business is classified as a tramp that deals with dry bulk (Zhang, Podobnik, Kenett, and Stanley, 2014).

Unlike the other sectors, the shipping market is oligopolistic, as many barriers exist to the entry into the business for a new shipping company owing to conferences and alliances in the industry;

the dry bulk market is a free competition market (Dai, Hu, Chen and Zheng, 2014). The dry bulk market is characteristically an open market with no entry barrier and exit as anybody can enter the market. This characteristic makes the market a competition intensive one, which means that forecasting the dry bulk market is complicated, with many players and numerous variables involved (Glen and Rodgers, 1997). Dry bulk service inception, several researchers, shipowners, brokers, and shippers, have looked into forecasting the tramp price and the market at large without accurate results. Inaccuracy result from many external variables influencing the sale and purchase market, including country growth and world trade (Strandenes, 2002).

Problem Statement

The present dissertation pays attention to the second-hand Capesize market since volatility exceeds that of Panama and Handymax markets (Karlis, Polemis, and Georgakis, 2016). Kite-Powell and Talley (2001) argue that the Capesize vessels' volatility makes it difficult to forecast. Many shipowners and shipbrokers underpriced the vessel, ignoring critical technical indicators, resulting in a deviation of the asset's real value; fluctuation in the market creates opportunities for speculators to buy low and sell high. Conversely, this vessel price volatility can also be advantageous and valuable to investors and managers as identifying the factors influencing the variability of Capesize second-hand vessel prices.

The availability of consistent and reliable information is crucial for statistical analysis, modeling, and forecasting for sound investment decision-making and risk management.

There is room for improvement, and various parameters need to be considered when shipping companies undertake S&P activities. The evaluation of extra information for determining an asset's price will decrease the risk of the level of risk and transaction costs involved and increase the profit-making opportunities.

The study centers on the factors affecting the price of the second-hand Capesize vessels as there is no clear cut guideline or framework for predicting the prices. The pricing mechanism relies on market information. The research gap that the present study aims to fill in the influence of microeconomic factors such as age, size (DWT), ship classification, flag, builder, country of building, P&I club, vessel detention level based on PSC inspection reports, ballast water treatment system, exhaust scrubber system for SOx emission reduction, main engine type, on the final formation of second-hand Capesize vessels price. Except for the general process of collecting information on market knowledge, time, world market accessibility, contact information, buyers or sellers, the sale or purchase of a ship needs information on the vessel's condition and its technical and operational characteristics. Nowadays, there are many advanced new techniques and approaches, but the information gathered asymmetries among the transaction process parties. Therefore, a better understanding from the side of investors in combination with a reputable broker is vital in the negotiation process; interference and gathering updated and objective information on the ship technical features and profile is essential for a successful reduction of asymmetries which may lead to a proper estimation value of the asset (Stopford, 2008).

Research Objectives

The cyclical nature of the Capesize dry bulk market implies that the market circulates to boom from depression, depending on the many variables involved. The Capesize market is influenced by a range of economic and political variables. The specific variables cannot explain the phenomenon due to volatility. The slim proceeds margin in the shipping business means that the smallest oscillation in prices affects profits (Gong and Lu, 2016). The market size and price prediction ability can help shipowners and stakeholders to plan better to widen their profit margins and reduce market risks and losses (Ayyub et al., 2002). This dissertations' primary aim is the identification of factors influencing second-hand Capesize vessel prices. Additionally, the focal point is to widen the perspective of the shipowners and shipbrokers in the industry by creating a multicriteria optimization system on top of the existing tools. In the quest, this dissertation aims to investigate the variables involved.

Research Scope

The study first focuses on finding variables that affect the dry bulk second-hand Capesize market since the market has many data. The paper will sum up the market variables in demand and supply and external and internal variables.

The dissertation will also look into how a combination of factors affect the Capesize vessel market's price, even though the market and prices rely on the demand and supply forces. A lot of experts worldwide have paid attention to their work on the supply effect on the price and size of the market since a dramatic increase in supply may lead to a fall in price and recession depending on the demand and supply law (Tsolakis, Cridland, and Haralambides, 2003). This dissertation focus on how macroeconomic and microeconomic factors can influence the formation of the second-hand Capesize vessel in the sales and purchase market. Sellers and buyers need to assess each case individually, over multiple options, and rank the various opportunities by evaluating the vessel's technical specifications carefully. The research scope shows that more criteria need to be considered for a successful investment and optimal financial performance—a range of data used to secure the research objectivity.

Research Questions

The following is the main research question of the dissertation:
What factors influence the price of second hand capsizes vessels?

The sub-research question (SRQ) that explored is as follows:
Do the specific microeconomic variables significantly influence the price of second-hand Capesize vessels?

The dissertation investigates the variables relative to the second-hand Capesize vessels' price from the commercial and technical point of view. The study will take into a quantitative analytic approach at secondary empirical data from the sales report of Clarkson's shipping intelligence network (SIN), IMF, and Equasis database.

Research Outcomes

Other significant questions have also been used to motivate the study apart from the main research question. The dissertation mainly deals with influencers of the price of second hand capsize vessels. In pursuit of these answers, this dissertation deals with the ships' sale and purchase market to enable involved parties to understand the second-hand Capesize vessel price formation better. It would be beneficial for the existed and potential investors as they will be able to increase their bargaining power by adding extra parameters on the negotiation stage. The reliability of consistent information plays a crucial role before the acquisition of the vessel. The target is to propose an optimal blend of various microeconomic factors to enrich investors' and managers' decision processes. All the factors influencing the price of vessels are extensively analyzed, and each element is screened to show how it affects the price.

Research Methodology

The study will take into quantitative analytic approach at secondary empirical data extracted from the web-based shipping intelligence database and consulting company, Clarksons. The dataset includes 100 second-hand cape size vessel sales registered between 2017 (July) and 2020 (August).

The Clarksons reports include the transaction dates, names, ages, ship sizes, sellers, buyers, yards, and selling prices in millions. Besides, all the other data collected from Clarksons (SIN), except the iron ore and coal prices (International Monetary Fund) and the PSC inspection records (Equasis database).

The variables collected can be classified as macroeconomic and microeconomic. All the variables are divided into two categories, as shown in table 1 & 2 "data description." Keywords, including OLS model,fixed-effect method, Capesize vessels, macroeconomic and microeconomic factors, price volatility, sales and purchase market, vessel value estimation, decision-making tools, investors' behavior technical specifications, were used to search the related articles. The data analysis is carried out with the fixed-effect method.

The method of the search was based on publications relevant to the subject matter. The original works and reviews were incorporated into the study since they were the most recent established inclusion criteria. After elimination, the most relevant and useful data came from the Clarkson Shipping Intelligence Network.

Regression analysis is used to establish the correlation between the variables, MATLAB software (R2019a version) is used for OLS (ordinary least square) regression analysis with the fixed-effect method. Initial the creation of a base model based on the macroeconomic variable, it was necessary for applying the fixed-effect method and examine the impact of microeconomic factors on the Capesize price.

Research Contribution

The present study aims to increase the growing body of literature on the shipping industry and related business as the study's findings will be relevant to other segments. The study aims to enlighten prospective investors, brokers, stakeholders, and shipowners in the shipping industry for acquiring quality ships based on the factors influencing the price of second-hand Capsize vessels and their importance in predicting improved decisions profit-making tools in the business.

Research Structure

This study is categorized into six (6) main chapters

- **Introduction:** This chapter focused on the study background on dry bulk Capesize ships. It introduces the study objectives as well as highlights the methodology.
- **Literature review:** The section details the Capesize market research, reviews the previous literature on Capesize vessels shipping and market, and identifies the literature gap.
- **Data and methodology:** The third chapter mainly deals with collecting and analyzing the variables, detailing the quantitative analytic approach at secondary empirical data from the sale and purchase records from the Clarkson shipping intelligence network, International Monetary Fund, and Equasis database.
- **Empirical Results:** The fourth chapter presents the empirical results and findings. The process of the analysis of the collected data and the results obtained are discussed in this section.
- **Discussion:** The fifth chapter is the Discussion chapter that discusses the influence on Capesize prices based on the results and the application in the S&P market.
- **Conclusion:**. The sixth and final chapter condenses the dissertation conclusion and suggests future estimation approach prices in the market. The section also shows the research limitation and future research direction related to the market cost and future.

Chapter 2: Literature Review

This chapter develops the dry bulk Capesize market research and gives a literature review on dry bulk Capesize vessel shipping and market.

Dry bulk sector volatility

The shipping business has a vital position in the world's trade and financial system (Karlis, Polemis, and Georgakis, 2016). Even though world trade is dependent on air, truck, and rail transport, the better part of it is carried by ships (Pruyn, Van de Voorde and Meersman, 2011). Dai, Hu, and Zhang (2015) estimate that 90% of world trade goods are transported by ships and posits that most bulk cargo, including coal, oil, and iron ore, is transported by sea. Using the ship includes many advantages realized when transporting large cargo quantities using the cheapest freight. The author also argues that the market situation is represented by cargo since it is subject to supply and demand factors, with the demand being market needs for cargo.

In contrast, the supply is the world fleet volume. The author also notes that many political and economic variables influence freight. As a result, the market experiences cyclical booms and recession due to the significant short term movement. The author's claims have been supported by many experts who assert that the shipping industry is characteristically cyclical, volatile, and subject to fluctuation.

Figure 6: Dry bulk market challenged with oversupply and exogenous disruptions (BDI). Source: Star Bulk Carriers Corporation.

The author also states that the second-hand ships are mostly sold for speculation and fleet strengthening policy. It aims to reduce the average age of the fleer and increase its efficiency. Conversely, the author argues that the buying of second-hand Capesize vessels is relatively easy and less procedural. Due to the market's cyclicality, sharp timing is the most decisive factor of the investors' success (Syriopoulos and Roumpis, 2006).

Hsieh, Troesch, and Shaw (2014) studied the cycle characteristics of industries and noted that shipping, like many industries, tend to have a cyclical life. The authors argue that recognizing the secular variations is essential as they are not dependent on the periodic fluctuations (Chen and Wang, 2004). They also note that the cycle has three components: the first one being the long term cycle, which is triggered by technical, regional, and economic changes. State that bigger ships with efficient technology, handling cargo capacity, reducing prices by mass transportation when dealing with bulk and container ships. According to the authors, the second cycle component is the short term that corresponds with the notions of the people on the shipping cycle and is more volatile and lasts between three to twelve years from one peak to the next. The third component is the seasonal cycle that comes with the demand for sea transport in a particular season (Duru and Yoshida, 2009).

Second-hand vessel value estimation

Thalassinos and Politis (2014) investigated investments in ships' building and observed that shipowners invest much money as shipping is a capital intensive industry. The author argues that it is for this reason that the need to forecast the market size and prices arise to lessen or avoid risks. The author posits that ship owners, charterers, brokers, and traders collect much information on shipping, including the quality of ships available for sale, market conditions, past prices, and the size of demand for and supply of vessels that influence the price of Capesize vessels, and try to forecast the future market. Kavussanos (2017) supports this argument by stating that due to the ongoing spot rate uncertainty and volatility in the international shipping industry, the quantitative analyses on pricing have received a lot of research attention.
Kou, Liu, and Luo (2014) gave their research attention to examining freight rates statistical properties and explored the relationship between ships' prices using the reduced autoregressive model forms. The authors contend that the sea transport supply and demand depend on the geographical imbalance among the fleet size, ton-miles, and commodity consumption. Therefore the prices of second-hand Capesize vessels are also dependent on these factors. Thus, second-hand ship prices and sea transport demand and supply can be quantified about ton-miles explained as the product of average haul and cargo tonnage. The authors also assert that there are many ship price forecast models developed since the earliest econometric applications recognize that the modern models' primary contents are similar except for the complication and the time relevance as they are more updated. The researchers contributed to the growing literature on forecast ship price models in the dry bulk market.

Both Syriopoulos and Roumpis (2006) and Alizadeh and Nomikos (2003) examine various aspects of the correlation between the volume of the second-hand vessels traded and the vessels' price. Sequential Information Flow (Copeland,1976) and a mixture of distribution Hypothesis (MDH) (Clark,1973) are the two theories that illustrate the research results, which shows a positive relation of price and volume. The first takes into account distributed information on supply and demand, symmetrically, by engaging at the same time all the traders, concluding in immediate equilibrium restoration. The second one presumes sequential and random asymmetrical information. The results show a negative relation between the price and the volume in the Capesize sector.

However, microeconomic factors are important determinants of the vessel's price as critical drivers for a proper representation of non and semi-parametric models.

Kohn (2008) investigates the impact of 'micro '-economics factors for determining vessel price by focusing on Generalized Additive Models (GAM) to numerous maritime economics directions. This approach creates various benefits due to the consideration of parametric components combination, such as dummy variables. Another advantage of these semi-parametric frameworks is the fact that the results are implemented using moderately sized samples. Thin plate regression spline is chosen for Kohn's representation for establishing the selection of the factors on Generalized Cross-Validation (Pruyn, Van de Voorde and Meersman, 2011). The dataset structured by considering potential inclusion with smoothness terms contained microeconomic variables like price, newbuilding price, earnings, age, size, number of tanks, number of pumps, pump capacity, speed, and horsepower. Additional data was collected to create the dummy variables like classification society, main engine type, coating, hull information, and IMO standards (regulations). However, he identified that variables show a low correlation level, but it becomes highly significant when applied nonlinear. According to Kohn (2008), nonlinearity is an important point to consider in price determination.

Kavussanos (2017) analyzed the tramp market cycle and forecast. They argued that the capsize market and its cycle, therefore, coincides with the dry bulk market and that the periods of the market diffuse the shipping industry. The author notes that the shipping business is a characteristically cyclical one as there it has experienced many cycles in the last century. Therefore, the authors believe it is crucial to understand the periods' patterns to forecast effectively and predict prices and respectively respond to recessions.

Adland (2000) evaluated the rules of trading based on statistical tests of the bulk shipping market. It concluded that the returns derived from trading strategies are less volatile than those obtained from selling signals and inferior to the return volatility of the buy and hold strategies. The researcher also concludes that the trade rules that brought about superior performance have higher positive investment returns on bullish markets.

On the other hand, Adland and Kerkebakker (2004) contend that considering the illiquid bearish market information and the transaction cost effect, superior performance evidence diminishes except for the case of the Panamax bulk carriers market.

In a study that utilized VAR models, Kavussanos and Alizadeh (2002) analyzed the dynamics of vessel prices that result from the difference between the actual market prices and theoretical prices in the dry bulk sector. Consequently, when the vessel prices are underpriced, the strategy of purchasing responds to the real price rise expectations above the theoretical value, representing future profits. This relationship between the prices of vessels and earnings stimulates the strategies of sales and purchase.

Alizadeh and Nomikos (2007) used simple moving average rules to devise ship sale and purchase timing, based on asset prices derived from vessel price-earnings relationship. They concluded that the returns from buy-and-hold alternatives are inferior to cumulative returns based on simple MA-based strategies. Thus underlining the benefits that result from trading rules apply when making divestment and investment decisions in the dry bulk shipping market.

Maritime economics literature widely covers the influential factors that influence bulk carriers and tankers' freight rates and prices. In this quest, Alizadeh and Talley (2011) studied the microeconomic level dynamics between Suezmax and Aframax, freight rates, large crude carriers, ship age, voyage routes, and 20 Laycan periods. In the second-hand market, Tsolakis, Cridland, and Haralambides (2003) studied and proposed an economic model to forecast second-hand vessels' prices and identify their cycles. The researchers portend that the percentage of new ships as per the order book negatively impacts the costs of large tankers such as Panamax, VLCC, and Suezmax. Alizadeh and Nomikos (2006) examined the second-hand tanker market timing. They argued that tanker price and freight rate co-integration generate crucial information to anticipate the dynamics of vessels' future costs for decision-making on divestment and investment strategies. The study concluded that trade rules and essential market examinations achieve better performance for large tankers, including Aframax and VLCC.

A partial equilibrium model has been developed by Moutzouris and Nomikos (2016), which has incorporated the structural and compartmental characteristics of vessel rates for resale. A strong correlation between net profits, markets, and vessel transactions have been demonstrated.

The research has explored the joint actions in the dry bulk shipping sector of ship costs, net profits, and second-hand trade. A behavioral asset pricing model has been built and approximated with microeconomic foundations capable of considering various business attributes. Also, the real fluctuations of ship rates, average market trading practices, and a positive connection between net earnings and second-hand trades are expressed by the partial equilibrium model.

In comparison to most capital markets' behavioral models, though, underlying considerations and not past results are extrapolated in our climate. Two groups of investors that have heterogeneous views on the mechanism of cash flow have been used. It is proposed that the favorable association between net profits, rates, and secondary vessel sales may be clarified through heterogeneous perceptions, under which two agent categories extrapolate dynamics while concurrently evaluating their competitor's potential market responses.

Kalouptsidi (2014) has defined the number of years of activity, the fleet's age distribution, the time taken to complete and take over the ship, and the cumulated demand for shipping services as critical factors (non-parametric ship value feature). The reselling prices of this model were used to measure a complex ship input and output model. It is seen that shifting the time to construct lowers costs grow both the investment duration and the investment uncertainty substantially. Conclusively, Adland et al. (2018) have highlighted that vessels' resale prices fluctuate depending on specific ship features, especially fuel efficiency. Using hedonic regression in the Handysize subsector of dry bulk ships and data of about 1,600 sales dealings (21 years period), they found a negative and strong link between S&P vessel price and the drop of fuel consumption as shown by a Fuel Efficiency Index.

Sales and purchase market

Dai, Hu, and Zhang (2015) researched the aspects of international maritime transactions and divides ship sales into categories such as sale, purchase, ship management, port agency, chartering, and liner agency. Ship sale and purchase procedure involves shipbroking, which increases market efficiency, speeds up search and matching, and obtains favorable prices.

The researchers note that shipbroking uses research, access to information, market knowledge, foreseen trends, forecast seaborne trade, expected rates, and seller-buyer matching. According to the authors, ship sale and purchase involve information access, commercial advice, negotiation, drafting, and document reform (Haralambides, Tsolakis, and Cridland, 2005). They also argue that the above steps are subject to change due to the increasing complexity of the market and application of market intelligence and legal framework changes, broking, consultancy, finance, and research (Dai, Hu and Zheng, 2015).

Chou and Chen (2019) posit that the information exchange and distribution are significant in ship sale and purchase of ships and involve friendly contacts, relations, and excellent communication skills, implying that ship sale requires essential information, opinions, and distribution relevant parties. The authors believe that research is internet-based information and communication offer the necessary information. New players can enter the market based on the information available on the demand and supply of shipping services, international trade, and freight rates forecast. Also, forecast prices for newbuilding ships and price levels of second-hand vessels in the future, the destruction of the market, and the general trends in the market and market prospects that are not accessible easily (Grammenos, 2013).

The characteristics of the sales and purchase market vary according to the type of ships. In general, the workhorse of this industry is dry bulk ships. The S&P market in 2017 performed at very high levels (93.1 million DWT tonnage). Approximately half of this amount represents bulk carriers transactions, with strong market demand and business activity (Park et al., 2018).

The massive ship market ranges from the small-sized to the large size (Capesize ships).

As there are virtually no current barriers in the industry, a wide variety of industry players exist; consequently, there is a big selection of small and big owners. It is quite liberal to join and leave this sector, and trading is directed at profit margins.

Moreover, in comparison with the oil tankers sector, there are relatively lower policy uncertainties. Following the market activities, the shipowners attempt to establish a fair vessel portfolio to properly manage the financial and organizational uncertainties arising from their ships' ownership and activities. The various parameters taken into consideration when shipping companies undertake sales and purchase activities for ship purchases are noticed.

Existing studies have explored the sales and purchase markets, the vessel's economic life cycles, the shipping market's econometric background, and the shipbreaking market (demolition (Scarsi, 2007).

Adland and Koekebakker (2004) state that in finding the right ship for buying, research is critical to go through the hurdles such as lack of market knowledge, time, world market accessibility, contact information, and buyers-sellers. The sale or purchase needs information on the vessel's condition and its characteristics such as age, spare parts, unique survey, deadweight, main engine type, records, classification, and other features. The authors assert that the information gathered asymmetries among the parties involved in the transaction process and argue that the use of brokers is vital in the negotiation process interference and gathering updated and objective information on the ship on sale and its features for adequate information and reduction of asymmetries (Stopford, 2008).

Conceptual and Theoretical Framework

The research is founded on a conceptual framework that examines the factors that affect second-hand Capsize vessels' price. The factors positively and negatively influence investment and operational decision making in the industry. The dependent variable in the study will be vessel prices of the second-hand Capesize vessel market. In contrast, the independent variables are the contributing factors that influence the second-hand Capesize vessels value.

The asymmetry of information is seen in many sectors of the economy, as observed in the maritime industry. Acik and Ince (2019), in their research on quality uncertainty and market mechanism, refer to information asymmetries between two economic agents as an adverse selection problem. These problems occur when one party has access to more information than the other party and tries to use it to its advantage. The inability of involved parties to recognize other product features due to asymmetric information results in the problem of adverse selection that may cause market failure (Peters, 2019). Akerlof's theory of adverse selection in 1970 is crucial in understanding such dynamic markets as the marine industry (Tsolakis, Cridland, and Haralambides, 2003).

The theory of adverse selection links the bridge between ship purchase, broking, and pricing in the second-hand market (Forrester, 2019) (Beenstock, 1985). It determines the role played by brokers in the determination of the quality and value of Capesize vessels. The microeconomic theory was illustrated by Akerlof using a simplified automobile example. In the present study, the approach is used in a pure ship sale theoretical market, as the market assumption is that the sale of second-hand ships includes good and bad quality ships (Kobylinski, 2003). The name assigned to bad quality ships is 'lemons' so that all sellers and buyers share an exact information amount about the vessel's quality (Kou and Luo, 2015). In the theoretical market, the price of good ships is P_G, while the cost of bad quality ones is P_B. Normally, $P_G > P_B$. The sellers and purchasers value good quality VG ships than those of bad quality V_B and the $P_G>V_G$ and $P_B>V_B$ (Alizadeh and Nomikos, 2007). A market study using this theory helps researchers with insights about markets and used phenomena that influence in many domains (Alizadeh and Nomikos, 2003). The described problem is the asymmetrical information problem that occurs when a group or party has additional info than others on ships' quality (Adland, Roar, and Cullinane, 2005). The assumption is that the sellers of lemons use the information they have on their ship than the buyers to sell it at the price of the good quality ones (PG=PB) as they have been using it for years are will benefit from it (Kavussanos and Alizadeh, 2001). In this case, both good quality and bad quality ships have the same price, and the buyers are out of position (Jiang, 2010). The negative impact on the market amounts to the average quality of ships sold as it will drop, and lemons will gradually take over progressively (Merikas, Merika, and Koutroubousis, 2008). Consequently, the good ships will be left stranded and untraded (Chen, Meersman, and Van de Voorde, 2010). The sellers and purchasers of suitable vessels will eventually leave the market. Explaining the problem of adverse selection destroys the market by driving good out of the market (Beenstock and Vergotis, 1989).

The mechanism counteracting the asymmetrical information for symmetrical use is essential. The significant institutions to curb these include brand-names, licensing, and guarantees (Chang and Chang, 2013). The measures, as mentioned above, work to shift risks from the consumers to the sellers who, in most cases, benefit from asymmetrical information. If consumers buy a product with unsatisfying quality, they will most likely change it (Jin, Kite-Powell, and Talley, 2001). Guarantees also mean that the product's quality is high (Alizadeh and Nomiskos, 2007).

Therefore, the role of brokers is to minimize uncertainty and information asymmetries on behalf of the buyer. The reputation and the brand quality of the company the broker represents are put at stake during the purchase process (Adland and Koerekebakker, 2004). It is recommendable that stakeholders utilize this framework to pursue high quality when purchasing second-hand ships as any loss in quality amounts to a decline in a big part of the business's capital investment (Kavussanos and Alizadeh, 2002).

Second-hand ship buyers should also use the necessary links to acquire information and seek engineers' help to inspect the vessels to reduce asymmetry information instances.

To overcome the asymmetry information, second-hand ship buyers should be suspicious about the vessel's quality and deal with sellers who invest in significant property and advertising. Therefore, ship buyers should trade with big dealers instead of private sellers since this signals their intention to stay in the sector for an extended period, have more significant incentives, and give warrantees to sell reliable vessels and avoid costs to their reputation.

Chapter 3: Data and Methodology

Data Validation

After an extensive literature review, the data collection and data analysis for the present study were driven by the motivation that different macroeconomic and microeconomic factors affect the vessels' second-hand price differently. The data validation has been checked through visual inspection of each variable independently, followed by a correlation test between the independent variables.

Variables considered for the study

Fifty (50) macroeconomic and microeconomic variables were initially identified. A correlation test analysis (Table 3) was performed to remove all the variables with 80% and higher correlation to minimize multicollinearity risk. Such sorting out of the correlation coefficients led to selecting 18 macroeconomic and 12 independent microeconomic variables. The dependent variable selected for the study is the second-hand price of Capesize vessels (at the transaction date). The independent variables that were considered are as shown in Table 2 & 3 (data description). The mixture of variables was selected based on the findings that microeconomic variables fit into the more extensive models involving the traditional macroeconomic variables for determining the price of second-hand vessels.

Data Description

Our dataset includes 100 sales of Capesize vessels of different sizes (100,000-400,000 DWT), recorded between July 2017 and August 2020. Clarksons Capesize sales reports include the vessel's name, size, age, the yard where the ship was built, seller and buyer, the transaction date, and the price in US dollars (millions).

For this study, all the data (Table 1 and 2) extracted from Clarkson's Shipping Intelligence Network – SIN (secondary source), a web-based shipping database and consulting company; except the PSC inspection records of the vessels (all the data collected from EQUASIS web-based database), and Iron ore and Coal prices (International Monetary Fund). The collected variables are divided into two (2) categories: Macroeconomic, those related to market conditions, and Microeconomic those related to vessel specifications. The price of the second-hand Capesize vessel is the dependent variable, and all the others independent. All the microeconomic variables converted into categorical, age, and size (DWT) were excluded. For variables such as ballast water treatment system, the author assumes that the value of 1 is for vessels with installed BWTS and 0 without, same to exhaust scrubber system for SOx reduction (0=Not Fitted, 1=Fitted). For the detention level (PSC inspection records), the author assumes that the value of 1 represents vessels with at least one detention and 0 for vessels with clean records without any detentions based on the recorded reports.

All the regimes such as Paris MoU, Tokyo MoU, USCG, Indian Ocean MoU, Vina del Mar MoU, Mediterranean MoU, and Caribbean MoU, provides their inspection results to Equasis. "As to PSC information, it should be noted that not all inspections within the Indian Ocean MoU are reported in Equasis. Only inspections from Australia, Bangladesh, France (La Réunion Island), Kenya, India, Iran, Mauritius, Oman, South Africa, Sri Lanka, Sudan, Maldives, and Mauritius considered in these statistics. In 2018, these thirteen countries carried out approximately 99.5% of all inspections within the Indian Ocean MoU. Since September 2019, Equasis also now receives information from Comoros, Madagascar, Myanmar, Seychelles, and Yemen" (Equasis Statistics, 2019).

Data Description			
Independent Variables	**Factors**	**Definition**	**Source**
AGE	Microeconomic	Age	Clarksons SIN (Capesize vessels Sales report)
DWT	Microeconomic	Size / Dwt (tonnes)	
BWTS	Microeconomic	BWTS 0=Not fitted 1=Fitted	
ESS	Microeconomic	Exhaust Scrubber System for Sox 0= Not fitted 1= Fitted	
DL	Microeconomic	Detention rate 0= No detention 1= 1 detention at least	Equasis database (ship's profile, PSC records)
BUILDER	Microeconomic	Builder	Clarksons SIN (Capesize vessels Sales report)
COUNTRY	Microeconomic	Country (Buliders)	
OWNERS	Microeconomic	Owners	
CLASS	Microeconomic	Class (Initial)	
FLAG	Microeconomic	Flag (Initial)	
PI	Microeconomic	P&I club	
ME	Microeconomic	Main Engine type	

Table 1: Data Description – Microeconomic factors. Source: Elaborated by the author.

Table 2: Data Description – Macroeconomic factors. Source: Elaborated by the author

Data Description				
Dependent variable			Definition	Source
PRICE			Price of the vessel at the transaction date (SOLD)	Clarksons SIN
Independent Variables	Factors	Frequency	Definition	Source
IOP	Macroeconomic	Monthly	Iron Ore Price $/ton CFR N 62% China, at the month of transaction	International Monetary Fund
CP	Macroeconomic	Monthly	Coal Price $/ton, Thermal Coal FOB Australia, at the month of transaction	International Monetary Fund
CIR	Macroeconomic	Weekly	China Interest Rates: PBOC 1 year rate %, at the date or week of transaction	Clarksons SIN
BCI	Macroeconomic	Daily	BCI, at the date of transaction	Clarksons SIN
BP	Macroeconomic	Weekly	Bunker Price HSFO 380 cst ($/Tonne) Singapore,at the date or week of transaction	Clarksons SIN
CPNB	Macroeconomic	Weekly	Capesize Bulkcarrier Newbuilding Prices $m, at the date or week of transaction	Clarksons SIN
CPSHM	Macroeconomic	Monthly	Capesize Market Secondhand Prices $m, at the month of transaction	Clarksons SIN
CPSCV	Macroeconomic	Monthly	Capesize Scrap Value $m, at the month of transaction	Clarksons SIN
1YTC	Macroeconomic	Weekly	1 Year Timecharter Rate Capesize Bulkcarrier (Long Run Historical Series) $/day ,at the date or week of transaction	Clarksons SIN
CPID	Macroeconomic	Daily	Capesize Bulker - % Idle DWT (million), at the day of transaction	Clarksons SIN
CPCN	Macroeconomic	Monthly	Capesize Port Congestion as % of Capesize Fleet, at the month of transaction	Clarksons SIN
CPFA	Macroeconomic	Monthly	Capesize Bulkcarrier Fleet - Average Age (Year), at the month of transaction	Clarksons SIN
CPDMA	Macroeconomic	Monthly	Capesize Bulkcarrier Demolition - Average Age (Year), at the month of transaction	Clarksons SIN
CPDE	Macroeconomic	Monthly	Capesize Bulkcarrier Demolition (DWT), at the month of transaction	Clarksons SIN
CPSLS	Macroeconomic	Monthly	Capesize Sales (DWT), at the month of transaction	Clarksons SIN
CPCON	Macroeconomic	Monthly	Capesize Bulker Contracting (DWT), at the month of transaction	Clarksons SIN
CPORD	Macroeconomic	Monthly	Capesize Bulker Orderbook (DWT), at the month of transaction	Clarksons SIN
CPGR	Macroeconomic	Monthly	Capesize Fleet Growth (% Yr/Yr), at the month of transaction	Clarksons SIN

	IOP	CP	CIR	BCI	BP	CPNB	CPSHM	CPSCV	1YTC	CPID	CPCN	CPFA	CPDMA	CPDE	CPSLS	CPCON	CPORD	CPGR	AGE	DWT	BWTS	ESS	DL
IOP	1																						
CP	-0.72554	1																					
CIR	-0.60032	0.724698	1																				
BCI	0.218638	-0.14543	0.041649	1																			
BP	-0.25402	0.563601	0.695459	0.243856	1																		
CPNB	-0.00712	0.036073	0.057965	-0.04549	-0.0242	1																	
CPSHM	-0.22331	0.18739	0.213204	0.1115	0.140007	0.603606	1																
CPSCV	-0.45034	0.5668	0.525897	-0.16679	0.220399	0.707867	0.490096	1															
1YTC	0.059501	0.18604	0.306971	0.737407	0.660914	-0.0625	0.087751	-0.02458	1														
CPID	0.593564	-0.5758	-0.54999	-0.27951	-0.3733	-0.0808	-0.2724	-0.3929	-0.30136	1													
CPCN	0.739352	-0.62887	-0.61606	0.170098	-0.11544	-0.17941	-0.2882	-0.56354	0.155145	0.692367	1												
CPFA	0.736773	-0.76301	-0.636	0.091451	-0.08802	-0.06096	-0.19792	-0.58136	0.086613	0.573661	0.714966	1											
CPDMA	0.353624	-0.33327	-0.22475	0.528404	0.158027	-0.23395	-0.16826	-0.42213	0.393244	0.029417	0.482	0.337564	1										
CPDE	0.201064	-0.42006	-0.56527	-0.21016	-0.55125	-0.17572	-0.23132	-0.3805	-0.4956	0.266212	0.172894	0.278227	0.076317	1									
CPSLS	-0.14446	0.150387	0.114952	0.258924	-0.04492	0.318546	0.290114	0.374881	0.140119	-0.27202	-0.12333	-0.39315	-0.02744	-0.35963	1								
CPCON	-0.40497	0.489635	0.475556	0.0765	0.207272	-0.28517	-0.11674	0.124376	0.086409	-0.26975	-0.3186	-0.555	0.110233	-0.06078	-0.05071	1							
CPORD	-0.07925	0.281918	0.442136	0.045692	0.775141	-0.08566	-0.01384	-0.03743	0.518105	0.037892	0.163408	0.295008	0.125226	-0.39904	-0.31872	-0.0197	1						
CPGR	0.417692	-0.64793	-0.76491	-0.16958	-0.81491	0.114845	-0.09778	-0.21432	-0.59985	0.244001	0.128865	0.263446	-0.06903	0.636242	0.015806	-0.37969	-0.78078	1					
AGE	0.251598	-0.20519	-0.23102	-0.17129	-0.1897	-0.15504	-0.83329	-0.17624	-0.1429	0.356213	0.263939	0.199592	0.063406	0.16738	-0.19391	-0.00091	-0.0276	0.161418	1				
DWT	-0.11729	0.105275	0.058423	-0.04489	-0.13969	0.736376	0.649457	0.758693	-0.13898	-0.14642	-0.28087	-0.26183	-0.29565	-0.15659	0.408408	-0.15782	-0.28852	0.177903	-0.23118	1			
BWTS	-0.07709	0.146874	0.160231	0.063973	0.194637	-0.18445	0.324839	-0.01336	0.090777	-0.19134	-0.03149	-0.10934	-0.02155	-0.14671	0.080474	0.005628	0.076956	-0.15127	-0.52515	-0.13005	1		
ESS	-0.00965	0.086665	0.10678	-0.04126	0.13137	0.253558	0.401612	0.188116	0.040058	-0.01612	-0.09107	-0.08473	-0.09783	-0.15819	0.069712	-0.05145	0.02891	-0.09528	-0.28885	0.269747	0.246164	1	
DL	0.016695	-0.05101	-0.07845	-0.23326	-0.09634	-0.12114	-0.24893	-0.09581	-0.13104	0.127853	0.154313	0.027318	-0.11227	0.040596	-0.06715	0.045324	-0.0067	-0.01028	0.235657	-0.12678	-0.11875	-0.0412	1

Table 3: Correlation test. Source: Elaborated by the author.

Methodology

In the shipping market, numerous authors have taken the effect of economic factors concerning decision making and modeling into consideration. For instance, a study was done by Lyridis et al. (2014) developed forecasting models and included macroeconomic variables for the dry cargo market. Batrinca and Cojanu (2014) developed a multiple OLS regression model, and they endeavored to study the main drivers of the dry cargo freight market and detect the impact of each explanatory variable on the freight rates (Vangelis Tsioumas, 2016). The present study has adopted OLS (Ordinary Least Square) regression analysis to establish the relationship between the study variables in line with the previous studies.

Regression analysis is a statistical technique and a method that is used in examining the relationship between explanatory variables or between the dependent and independents variables (Montgomery et al., 2012). Ordinary Least Squares (OLS) is a widespread method used to fit a line to the data, and a model needs to be created to use Ordinary Least Squares (OLS).
The created model should be linear in the parameters; the parameters are not divided, squared, multiplied together, or cubed. This model aims to analyze the role of the independent variable. This model also examines the effect of the dependent variable when the independent variables are changed.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots\dots\dots\dots + \beta_n X_n + \varepsilon_i \dots\dots\dots (1)$$

From the above equation, the hypothesis can be tested for the study. Generally, the hypothesis is tested at a 5% significance level. Therefore, the null hypothesis is fulfilled for the coefficients for which the p-value is greater than 5%. The alternative hypothesis is fulfilled for the coefficients for which the p-value is less than 5%. In this case, when the null hypothesis is valid, there exists no relationship between the variable Y and that variable. When the alternative hypothesis is valid, then it is noted that there exists a relationship between the variable Y and that variable. Further, the next parameter that is used for estimating a model is the R-squared of coefficients determinants. This figure articulates the percentage of the dependent variable variance, which is enlightened by the independent variable's variance. Unlike the potential predictors' coefficients, R-squared does not have a critical value and, therefore, cannot be tested.

As a general rule, though, "*the better the model fits the data, the higher the R-squared value.*" The following set of assumptions are generally made about the unobservable error terms for the classical linear regression model (CLRM) results to hold.

- The errors have zero mean
- The variance of the errors is constant and finite over all the values of *xt*
- The errors are statistically independent of one another
- No relationship between the error and the corresponding variant
- The error term is normally distributed

The present study develops the model from the general form of the regression analysis given below:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots + \beta_n X_n + \varepsilon_i \ldots\ldots\ldots\ldots (2)$$

From equation (2), Where Y is the dependent variable;

X is the independent variable;

β0 is the constant or intercept;

In this study, Where Y= Dependent variable=PRICE

X= Independent variables are: X1= IOP; X2= CP; X3= CIR: X4= BCI: X5=BP: X6=CPNB; X7=CPSHM; X8=CPSCV; X9= TC; X10= CPID; X11=CPCN; X12=CPFA; X13=CPDMA; X14=CPDE; X15=CPSLS; X16=CPCON; X17=CPORD; X18=CPGR

From equation (2) the variables which are significant that is $p<0.05$, we have taken as base model.

Regression analysis permits using both nominal and interval independent variables because the nominal variable's usage is vital to illustrate the dependent variable. Furthermore, it is also essential for utilizing indicator variables to include nominal parameters to the equation. The dummy or indicator variable values differ between the two integer numbers 0 and 1. The value 0 signifies a particular condition's existence, and the value 1 signifies the lack of the same condition.

In this study, the estimated regression equation and the Base model is as follows:

PRICE = 1 + BP + CPNB + CPSHM + CPID + CPFA……………(3)

From Model (3), we have taken the fixed effect model by including the microeconomic variables one by one. The equations are as follows:

PRICE = 1 + BP + CPNB + CPSHM + CPID + CPFA+ AGE………(4)

PRICE = 1 + BP + CPNB + CPSHM + CPID + CPFA+ DWT………(5)

PRICE = 1 + BP + CPNB + CPSHM + CPID + CPFA+ BWTS…….(6)

PRICE = 1 + BP + CPNB + CPSHM + CPID + CPFA+ESS……….(7)

PRICE = 1 + BP + CPNB + CPSHM + CPID + CPFA+DL+BUILDER……(8)

-Where Builders has 33 categories

PRICE = 1 + BP + CPNB + CPSHM + CPID + CPFA+COUNTRY……(9)

-Where Country has 6 categories

PRICE = 1 + BP + CPNB + CPSHM + CPID + CPFA+OWNERS……(10)

-Where Owners has 66 categories

PRICE = 1 + BP + CPNB + CPSHM + CPID + CPFA+CLASS………(11)

-Where Class has 8 categories

PRICE = 1 + BP + CPNB + CPSHM + CPID + CPFA+FLAG……….(12)

-Where Class has 14 categories

PRICE = 1 + BP + CPNB + CPSHM + CPID + CPFA+PI……………(13)

-Where PI has 12 categories

PRICE = 1 + BP + CPNB + CPSHM + CPID + CPFA+ME……………(14)

-Where ME has 18 categories

From Model (4) to Model (14), we can see which microeconomic (independent) variables impact price.

In this study, first, the basic model is formulated. Initially, all the Macroeconomic variables are checked, and then the base model is formulated by removing one by one insignificant variable until the stage where all the variables become significant. As a result, a p-value with * denotes the factor is significant within 5%, and ** denotes the factor is significant within 10%, for the present study considered both levels. Next, in the found significant variables, microeconomic variables are added one by one to the model to check the significance level. Further, this process is followed for the remaining models. This process is followed for categorical variables like ballast water treatment system, exhaust scrubber system for SOx emission reduction, detention level (PSC inspection records), builder, country (builders), owners, class, flag, P&I, main engine type to examine levels of a categorical variable is significant.

Chapter 4: Empirical results – Findings

1. Base model for Macroeconomic variables with price as the dependent variable.

	Estimate	SE	tStat	pValue
(Intercept)	37.1230	7.8092	4.7538	7.18E-06
BP	-0.0132	0.0046	-2.8802	0.0049 *
CPNB	0.5859	0.0501	11.7044	4.70E-20 *
CPSHM	1.0088	0.0409	24.6487	8.25E-43 *
CPID	-1.3742	0.4332	-3.1721	0.0020 *
CPFA	-6.5169	0.9887	-6.5916	2.51E-09 *
Ordinary R-squared	0.9582			
Adjusted R-squared	0.956	*p<0.05, **p<0.10		

Table 4: Base model for Macroeconomic variables with price as the dependent variable. Source: Elaborated by the author

Since the p-value is less than 0.05 for Bunker prices – The coefficient (parameter estimate) is -0.013214. So, for every unit (i.e., point, since this is the metric in which the tests are measured) increase in Bunker Prices, a -0.013214 unit decrease in price is predicted, holding all other variables constant, significantly different from 0. The coefficient (parameter estimate) for Capesize Bulk carrier Newbuilding is 0.5859, positively related to price. Capesize second-hand market prices coefficient (parameter estimate) is 1.0088 and positively related to price.

For Capesize Bulker - % Idle DWT, -1.37429 coefficient shows a negative correlation, holding all other variables constant. Lastly, for Capesize Bulk carrier Fleet-Average Age, the coefficient (parameter estimate) is -6.5169 and negatively related to price; adjusted R-squared explains that independent variables can predict about 95.6% of the variance in price.

It reveals that Bunker's price (BP), bulker idle vessels (%) (CPID), and bulk carrier fleet – average age (CPFA) appears to have a negative impact. In contrast, bulk carrier newbuilding prices (CPNB) and second-hand prices (CPSHM) appear to impact the volatility of the second-hand capsize vessel price positively.

Bunker price is an important element influencing the Capesize vessel price. Since the p-value is less than 0.05 (significant) for Bunker prices, the coefficient (parameter estimate) is -0.013214, holding all other variables constant, significantly different from 0. A negative coefficient suggests that as the independent variable (BP) increases, the dependent variable tends to decrease. The bunker prices have a negative and significant impact on the Capesize vessel's price and illustrate that if bunker prices drop/rise, the Capesize vessel's price increases/decreases.

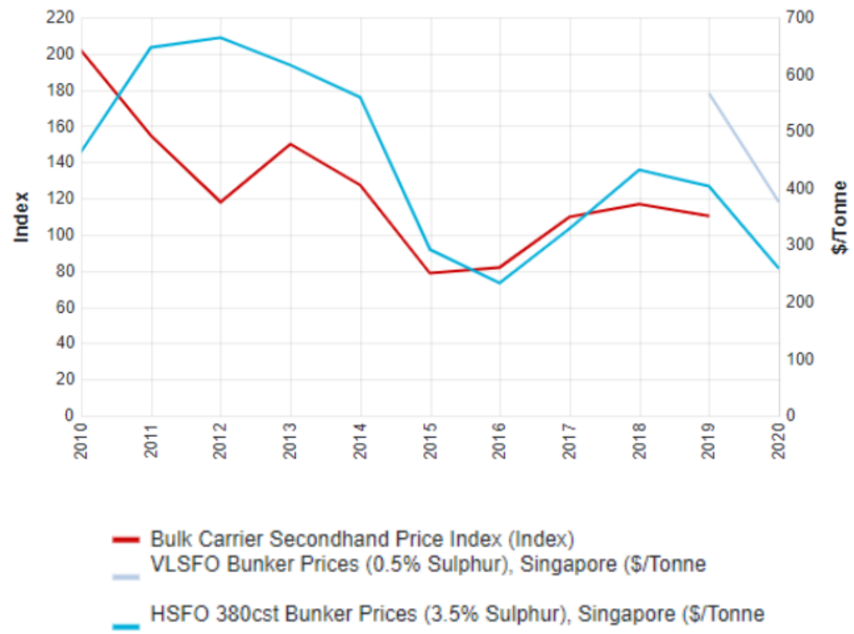


Figure 7: Relation between Bulk Carrier second-hand price Index, HSFO (3.5% Sulphur), and VLSFO (0.5% Sulphur) bunker prices, Singapore ($/Tonne). Source: Clarkson's Shipping Intelligence Network (SIN).

The coefficient (parameter estimate) for Capesize New Building is 0.5859, and for Capesize second-hand market price is 1.0088, both positively related to price. Another important finding is the positive effect of a new building on second-hand vessel price; there is a positive relationship between these two markets. Once the new building prices rise, it is an indicator that reflects the market's financial improvement. The new building price reflects the shipowners' investment behavior and world economic activity (Kavussanos and Alizadeh, 2010). Considering the time lag of 18-24 months between the order's placement and the vessel's delivery, the impact on second-hand vessel price is significant (Tsolakis 2005, Kohn 2008).On the other hand, the second-hand market price is paramount, as the vessel prices are formulated firstly based on the last transaction of a vessel with the same characteristics.

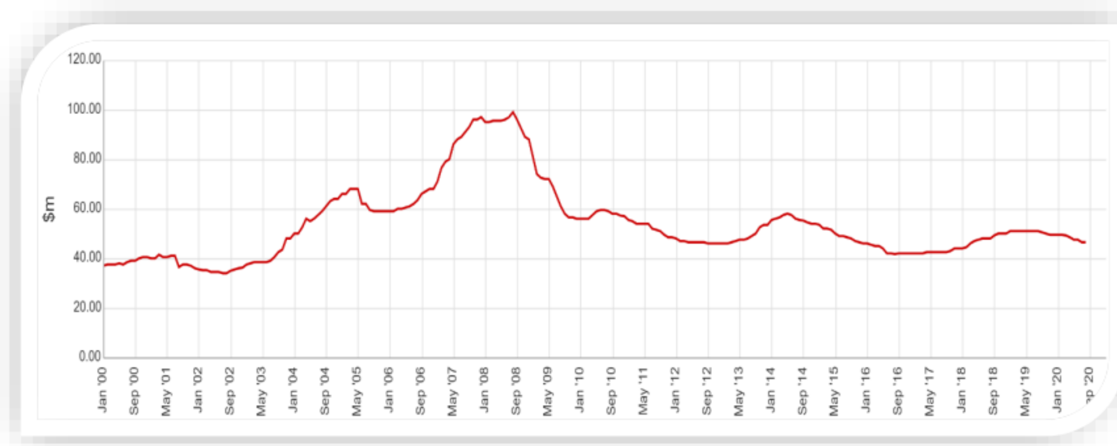


Figure 8:176-180K DWT Capesize Bulkcarrier Newbuilding Prices $m. Source: Clarkson's Shipping Intelligence Network (SIN)

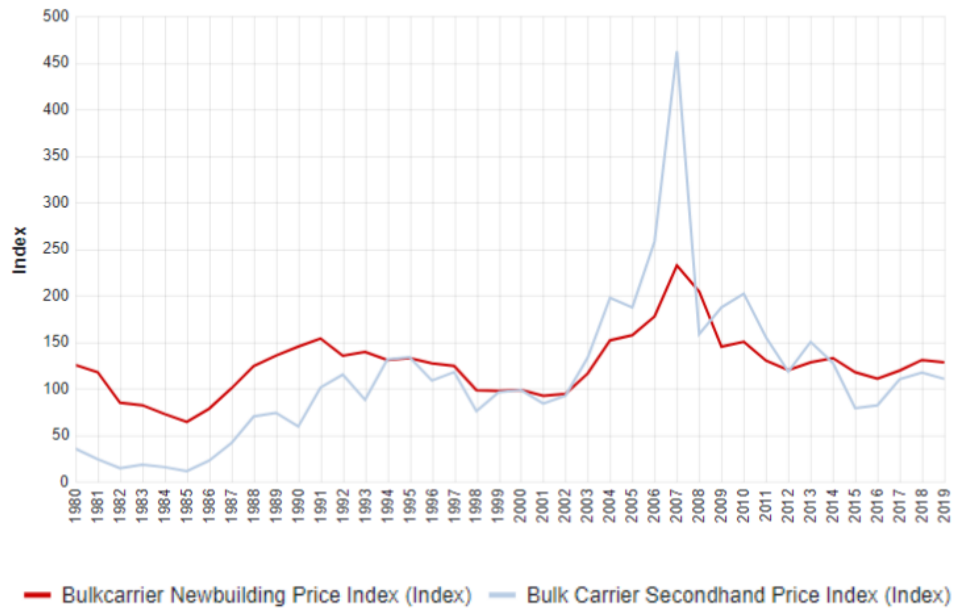


Figure 9: Relation between Bulk Carrier second-hand price Index Bulk Carrier New building price Index. Source: Clarkson's Shipping Intelligence Network (SIN).

Capesize Bulker - % Idle DWT and Capesize Bulk carrier Fleet - Average Age coefficients are negative -1.3742 and -6.5169 (holding all other variables constant respectively), both negatively related with the price. It discloses that both (CPID) Capesize bulker % Idle (DWT) vessels and bulk carrier Fleet – average age (CPFA) appears to have a negative impact. An increase in idle vessels' percentage negatively affects the price, representing the market's underperformance (low freight), seasonal demand, and additional costs derived from the operational part. This underperformance reflects more significant lost opportunity costs. From a technical perspective, if an idle vessel is not properly managed and maintained over the period, it may face difficulties when the ship needs to be ready for sailing.

Regarding the "re-activation" cost, investors always considering this factor and negotiate for a discount based on the sales and purchase market price.

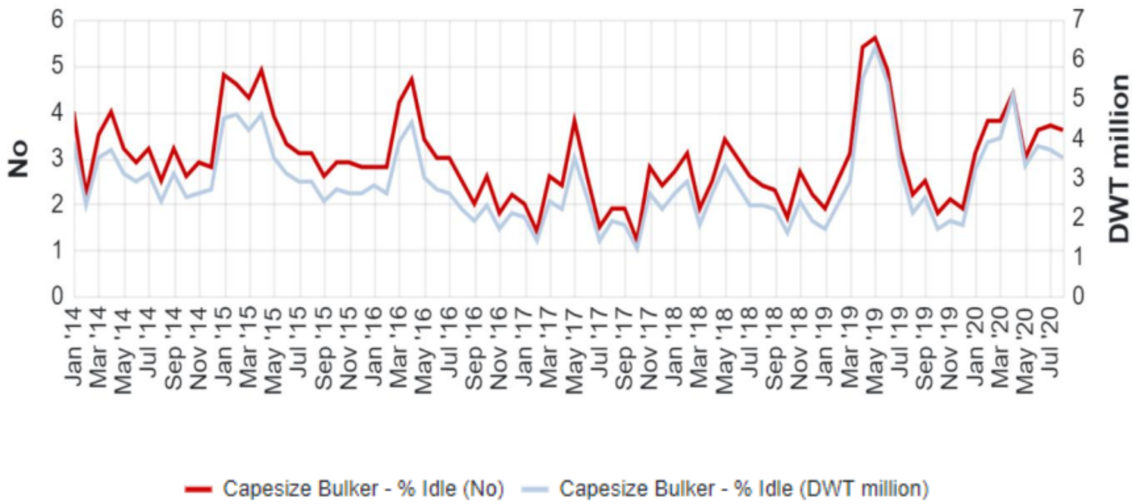


Figure 10: Capesize Bulker - % Idle vessels No and DWT-million.Source: Clarkson's Shipping Intelligence Network (SIN)

Capesize Fleet average age shows that if there is an increase (improvement) on the average age of the entire fleet, the second-hand Capesize vessel's price decreases, which is logical under normal circumstances and applied to other segments and industries as well. The R adjusted square explains that independent variables can predict about 95.6% of the variance in price.

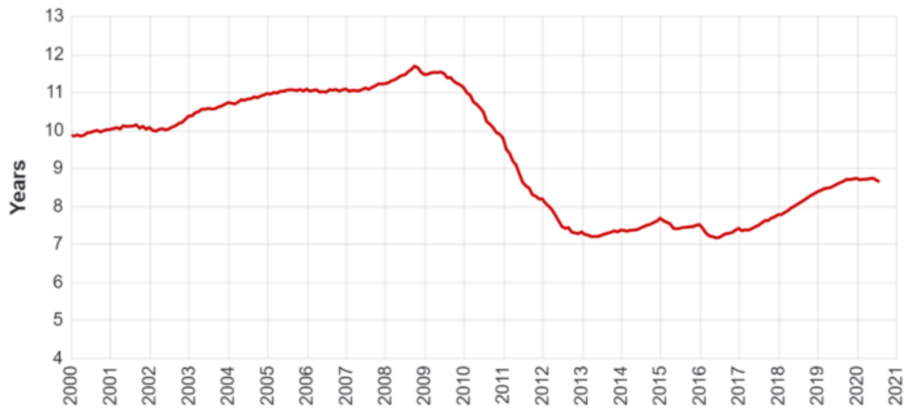


Figure 11: Capesize Bulk carrier Fleet – Average Age Years. Source: Clarkson's Shipping Intelligence Network (SIN)

2. Base model with Microeconomic factor – Age

	Estimate	SE	tStat	pValue
(Intercept)	47.2153	7.2910	6.4758	4.41E-09
BP	-0.0115	0.0041	-2.7984	0.0062 *
CPNB	0.8766	0.0743	11.8061	3.39E-20 *
CPSHM	0.5255	0.1050	5.0055	2.63E-06 *
CPID	-0.7529	0.4082	-1.8447	6.83E-02 *
CPFA	-7.2953	0.8997	-8.1084	2.01E-12 *
AGE	-0.9698	0.1974	-4.9127	3.84E-06 *
Ordinary R-squared	0.9668			
Adjusted R-squared	0.9647	*p<0.05, **p<0.10		

Table 5: Base model with Microeconomic factor – Age. Source: Elaborated by the author

The age of the vessel negatively influences the formation of the price. When the microeconomic variable age added to the macroeconomic variables, there is no change in the macroeconomic variables BP, CPNB, CPSHM, and CPFA are significant at 5% level and CPID at 10% level. Also, the age has a negative coefficient (-0.96976) and an adverse impact on the price at 5% level; besides, adjusted R-squared explains that independent variables can predict 96.5% variance in price. Older vessels are cheaper than the younger and reflect that the new ones are more technologically advanced, energy, and fuel-efficient. For instance, the costs are substantial for the vessels after the second special survey (10 years), due to increased maintenance expenses ordered by classifications such as steel renewal (Merika, Tsionas, and Andronikopoulos, 2019). Nevertheless, older vessels have increased maintenance costs and smaller life business cycles.

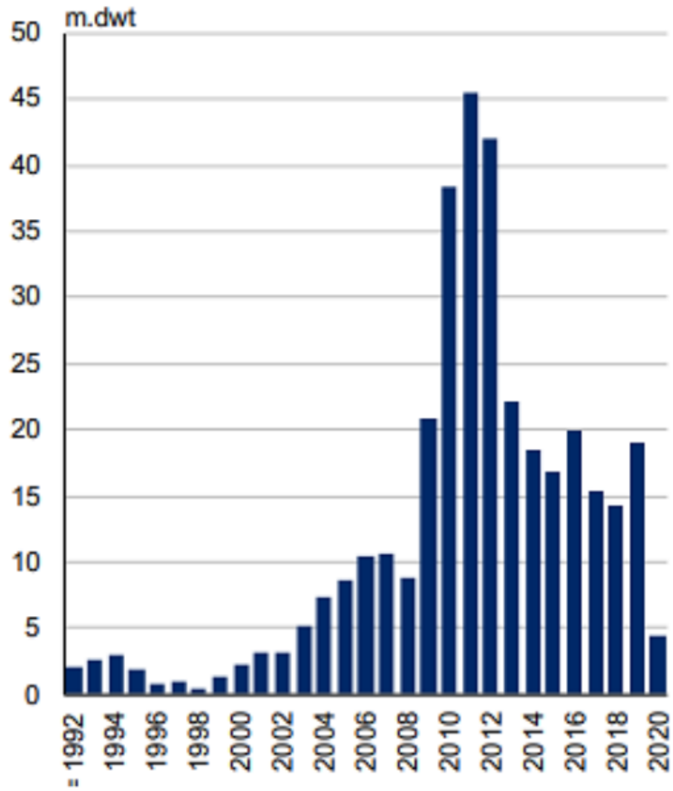


Figure 12: Capesize Age Profile (m.DWT). Source: Clarkson's Shipping Intelligence Network (SIN)

3. Base model with Microeconomic factor – DWT

	Estimate	SE	tStat	pValue
(Intercept)	43.0788	9.4470	4.5600	1.56E-05
BP	-0.0161	0.0053	-3.0576	0.0029 *
CPNB	0.7464	0.1521	4.9070	3.93E-06 *
CPSHM	1.0271	0.0440	23.3314	1.20E-40 *
CPID	-1.3404	0.4337	-3.0906	0.0026 *
CPFA	-7.3256	1.2243	-5.9836	4.04E-08 *
DWT	0.0000	0.0000	-1.1171	0.2668
Ordinary R-squared	0.9588			
Adjusted R-squared	0.9561	*p<0.05, **p<0.10		

Table 6: Base model with Microeconomic factor – DWT. Source: Elaborated by the author

The DWT of the vessels cannot influence the price, as we are exploring specifically the Capesize sector. Moreover, adjusted R-square means that independent variables can predict about 95.6% of the variance in price. No changes to macroeconomic variables. However, selecting the right vessel depends on the shipowner's requirements connected with the vessel's particulars and technical specifications. Practitioners support the concept that larger vessels might be sold at a lower price than smaller since the characteristics are suitable for each particular case based on the route and the cargo (Clarksons, 2020). Many times, shipowners are willing to pay more for a vessel that fits their purpose and business plan regardless of the DWT.

4. Base model with Microeconomic factor – BWTS

	Estimate	SE	tStat	pValue
(Intercept)	35.4083	7.7836	4.5491	1.62E-05
BP	-0.0139	0.0046	-3.0498	0.0030 *
CPNB	0.6352	0.0569	11.1735	6.99E-19 *
CPSHM	0.9648	0.0475	20.3004	6.12E-36 *
CPID	-1.3468	0.4287	-3.1416	0.0023 *
CPFA	-6.5422	0.9778	-6.6905	1.65E-09 *
BWTS_1	1.5081	0.8544	1.7652	0.0808 **
Ordinary R-squared	0.9596			
Adjusted R-squared	0.957	*p<0.05, **p<0.10		

Table 7: Base model with Microeconomic factor – BWTS. Source: Elaborated by the author

Another finding is that BWTS (coefficient 1.5081) has a significant positive impact on second-hand Capesize price at 10% level. When we include the microeconomic variable BWTS to the macroeconomic variables as given above, there are no changes in the macroeconomic variables, BP, CPNB, CPSHM, CPID, and CPFA, are significant at 5%; the adjusted R-square explains that independent variables can predict about 95.7% of the variance in price.

Therefore, a vessel with BWTS has a comparative advantage with non-fitted and can be sold theoretically, with a premium based on the sales and purchase market price.

5. Base model with Microeconomic factor – ESS

	Estimate	SE	tStat	pValue
(Intercept)	37.1466	7.8553	4.7289	8.02E-06
BP	-0.0132	0.0047	-2.8214	0.0058 *
CPNB	0.5860	0.0503	11.6417	7.42E-20 *
CPSHM	1.0100	0.0435	23.2404	1.64E-40 *
CPID	-1.3673	0.4424	-3.0910	0.0026 *
CPFA	-6.5259	0.9992	-6.5315	3.42E-09 *
ESS_1	-0.0756	0.8561	-0.0883	0.9298
Ordinary R-squared	0.9582			
Adjusted R-squared	0.9555		*p<0.05, **p<0.10	

Table 8: Base model with Microeconomic factor – ESS. Source: Elaborated by the author

By adding the microeconomic variable ESS to the macroeconomic variables, there are no changes; BP, CPNB, CPSHM, CPID, and CPFA are significant at 5%; also, the variable ESS has no significant impact on price since the p-value is greater than 0.10. The adjusted R-squared show that independent variables can predict about 95.8% variance in price. The exhaust scrubber system did not affect other macroeconomic variables in the model and the Capesize second-hand price. However, ESS disregarded, as it is a new system that needs more time to be established and accepted by the shipping industry and has been decelerated due to the Covid-19 event.

6. Base model with Microeconomic factor – DL

	Estimate	SE	tStat	pValue
(Intercept)	38.6134	7.7551	4.9791	2.93E-06
BP	-0.0135	0.0045	-2.9695	0.0038 *
CPNB	0.5885	0.0495	11.8990	2.18E-20 *
CPSHM	0.9938	0.0412	24.1032	8.93E-42 *
CPID	-1.3174	0.4290	-3.0710	0.0028 *
CPFA	-6.6336	0.9785	-6.7794	1.09E-09 *
DL_1	-1.4717	0.8016	-1.8360	0.0696 **
Ordinary R-squared	0.9597			
Adjusted R-squared	0.9571		*p<0.05, **p<0.10	

Table 9: Base model with Microeconomic factor – DL. Source: Elaborated by the author

Including the microeconomic variable DL to the macroeconomic variables, there are no changes in the macroeconomic variables. BP, CPNB, CPSHM, CPID, and CPFA are significant at 5%. Besides, the variable DL (coefficient-1.4717) has a negatively significant impact on Capesize price at 10% level and explains that independent variables can predict about 96% (adjusted R-square) variance in price. Nevertheless, an unfavorable ship's profile based on PSC inspection records can negatively influence its value and economic performance in the market.

7. Base model with Microeconomic factor – BUILDER

	Estimate	SE	tStat	pValue
(Intercept)	31.9887	8.7769	3.6447	0.0005
BP	-0.0102	0.0043	-2.3854	0.0201*
CPNB	0.6535	0.0780	8.3747	8.88E-12*
CPSHM	1.0505	0.0638	16.4576	2.64E-24*
CPID	-0.7077	0.4086	-1.7320	0.0882**
CPFA	-6.1094	1.0830	-5.6410	4.46E-07*
RP: BUILDER_2 mai shipyard				
BUILDER_csbc (kaohsiung)	-5.1165	3.4254	-1.4937	0.1403
BUILDER_daehan shipbuilding	-7.2786	3.2799	-2.2191	0.0301 *
BUILDER_daewoo (dsme)	-6.5432	3.6341	-1.8005	0.0766 **
BUILDER_dalian shipbuilding	-8.1228	3.9452	-2.0589	0.0437 *
BUILDER_hhic-phil (subic sy)	-6.8858	3.8393	-1.7935	0.0778 **
BUILDER_hyundai hi (gunsan)	-0.4475	3.2714	-0.1368	0.8916
BUILDER_hyundai hi (ulsan)	-4.5515	3.1112	-1.4629	0.1485
BUILDER_hyundai samho hi	-4.7741	3.2309	-1.4776	0.1446
BUILDER_imabari sb hiroshima	-4.3805	3.1549	-1.3885	0.1700
BUILDER_imabari sb saijo	-4.7595	3.2532	-1.4630	0.1485
BUILDER_jiangnan changxing	0.7815	3.2162	0.2430	0.8088

BUILDER_jinhai heavy ind	-9.5809	3.7085	-2.5835	0.0122 *
BUILDER_jmu ariake shipyard	-0.7326	3.8736	-0.1891	0.8506
BUILDER_jmu tsu shipyard	0.2018	3.2472	0.0621	0.9507
BUILDER_kawasaki hi sakaide	-3.2187	3.0560	-1.0532	0.2963
BUILDER_koyo dock	-6.5342	2.9482	-2.2164	0.0303 *
BUILDER_mitsui sb (chiba)	-5.5345	2.9523	-1.8746	0.0656 **
BUILDER_namura shipbuilding	-6.8778	2.9251	-2.3513	0.0219 *
BUILDER_new century sb	-0.7731	3.2668	-0.2367	0.8137
BUILDER_new times sb	-11.7021	3.0776	-3.8023	0.0003 *
BUILDER_nkk (tsu)	-7.5192	3.4792	-2.1612	0.0345 *
BUILDER_qingdao yangfan	-11.4672	3.4163	-3.3566	0.0014 *
BUILDER_sasebo hi	-4.8888	3.0389	-1.6087	0.1128
BUILDER_shanghai waigaoqiao	-6.8783	3.0335	-2.2675	0.0269 *
BUILDER_sinopacific dayang	-1.9110	3.7925	-0.5039	0.6161
BUILDER_stx sb (jinhae)	-2.5118	3.0579	-0.8214	0.4146
BUILDER_sungdong sb	-11.8750	3.8159	-3.1120	0.0028 *
BUILDER_tsuneishi cebu	-5.8123	3.2852	-1.7692	0.0818 **
BUILDER_tsuneishi zosen	1.6613	3.7370	0.4446	0.6582
BUILDER_universal sb (tsu)	-4.9714	3.0041	-1.6549	0.1030 **
BUILDER_universal sb ariake	-4.7669	3.0993	-1.5381	0.1291
BUILDER_yangzi xinfu sb	-9.9167	3.6363	-2.7271	0.0083 *
Ordinary R-squared	0.9837			
Adjusted R-squared	0.9736	*p<0.05, **p<0.10		

Table 10: Base model with Microeconomic factor – BUILDER. Source: Elaborated by the author

With reference point "2 Mai Shipyard" (Romania) or Damen Shipyards Mangalia as it is known today, different builders from the sample are significant with a negative coefficient. The Damen yard is well-recognized for designing vessels of high-quality standards and more sophisticated like RoPax ferries, cruise ships, and offshore vessels and offshore structures. Compared with the Chinese, Japanese, and South Korean shipyards, the cost of newbuilding vessels is much higher, so shipowners prefer to build their vessels in East Asian shipyards.

By incorporating the microeconomic variable BUILDER, there are no significant changes in macroeconomic variables. BP, CPNB, CPSHM, and CPFA are significant at 5% level. The variable CPID is significant for 10%; the adjusted R-square explains that independent variables can predict about 97% of the price variance.

As shown in Table 11, specific significant builders have a negative coefficient, which explains the significant impact to the Capesize price, in descending order. Both groups represent the major countries (China, Japan, South Korea) in shipbuilding.

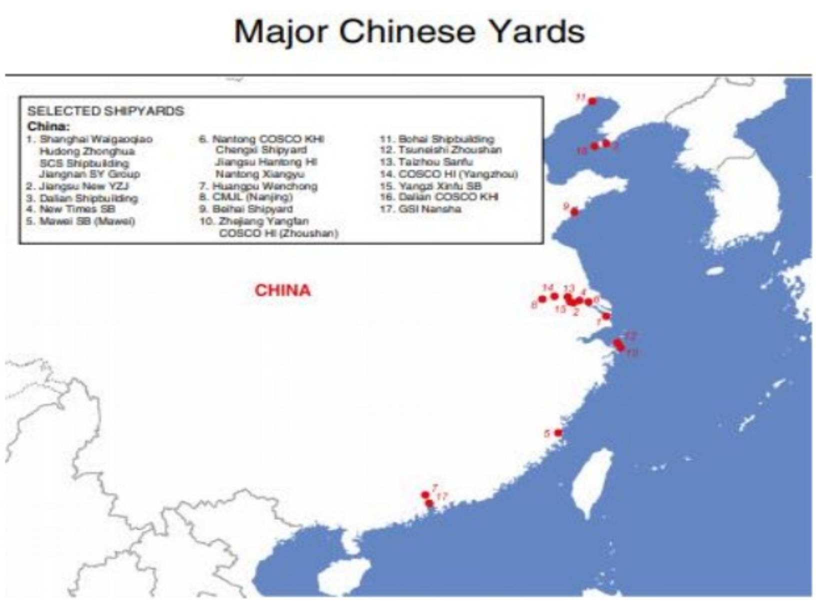
Table 11: Builders – significant level 5% and 10% (descending order).

	Estimate	SE	tStat	pValue
RP: BUILDER_2 mai shipyard				
BUILDER_koyo dock (Japan)	**-6.5342**	2.9482	-2.2164	**0.0303***
BUILDER_namura shipbuilding (Japan)	**-6.8778**	2.9251	-2.3513	**0.0219***
BUILDER_shanghai waigaoqiao (China)	**-6.8783**	3.0335	-2.2675	**0.0269***
BUILDER_daehan shipbuilding (South Korea)	**-7.2786**	3.2799	-2.2191	**0.0301***
BUILDER_nkk (tsu) (Japan)	**-7.5192**	3.4792	-2.1612	**0.0345***
BUILDER_dalian shipbuilding (China)	**-8.1228**	3.9452	-2.0589	**0.0437***
BUILDER_jinhai heavy ind (China)	**-9.5809**	3.7085	-2.5835	**0.0122***
BUILDER_yangzi xinfu sb (China)	**-9.9167**	3.6363	-2.7271	**0.0083***
BUILDER_qingdao yangfan (China)	**-11.4672**	3.4163	-3.3566	**0.0014***
BUILDER_new times sb (China)	**-11.7021**	3.0776	-3.8023	**0.0003***
BUILDER_sungdong sb (South Korea)	**-11.8750**	3.8159	-3.1120	**0.0028***
BUILDER_universal sb (tsu) (Japan)	**-4.9714**	3.0041	-1.6549	**0.1030****
BUILDER_mitsui sb (chiba) (Japan)	**-5.5345**	2.9523	-1.8746	**0.0656****
BUILDER_tsuneishi cebu (Philippines)	**-5.8123**	3.2852	-1.7692	**0.0818****
BUILDER_daewoo (dsme) (South Korea)	**-6.5432**	3.6341	-1.8005	**0.0766****
BUILDER_hhic-phil (subic sy) (Philippines)	**-6.8858**	3.8393	-1.7935	**0.0778****
***p<0.05, **p<0.10**				

Source: Elaborated by the author.

The shipping industry is experienced oriented, and traditionally, it is well-known and recognized in the market that Japanese vessels are more reliable, valuable, simple, and ergonomic than South Korean ships, which are more advanced concerning automation. Moreover, shipowners support South Korean shipyards for more complex projects that require an excellent grasp of technological advancements. According to Xue et . (2020), the production efficiency of shipbuilding relies on three primary drivers: a) Building technique, b) Resource ability, and c) Management level. Last decade, we saw an improvement in shipbuilding efficiency from China; critics, however, argue that they are still far behind technologically from Japan and South Korea. Jiang et al. (2013) mentioned that apart from the demand for new ships as a major indicator of the competitiveness between those three countries, China's shipbuilding advantage derives from the low cost and the price difference.

Figures 13: Major Chinese, South Korean, and Japanese yards. **Source: Clarkson's (SIN).**



8. Base model with Microeconomic factor – COUNTRY (builders)

	Estimate	SE	tStat	pValue
(Intercept)	33.6589	7.9569	4.2302	5.65E-05 *
BP	-0.0115	0.0046	-2.4959	0.0144 *
CPNB	0.5302	0.0551	9.6266	1.89E-15 *
CPSHM	1.0604	0.0448	23.6962	3.28E-40 *
CPID	-1.1357	0.4397	-2.5827	0.01143654 *
CPFA	-6.3094	1.0198	-6.1869	1.83E-08 *
RP: COUNTRY_china				
COUNTRY_japan	2.4590	1.0011	2.4563	0.0160 *
COUNTRY_philippines	1.1904	2.1565	0.5520	0.5823
COUNTRY_romania	5.9738	3.5979	1.6603	0.1004 **
COUNTRY_south korea	2.9085	1.2235	2.3771	0.0196 *
COUNTRY_taiwan	3.0411	2.7146	1.1203	0.2656

Ordinary R-squared 0.962
Adjusted R-squared 0.9577 *p<0.05, **p<0.10

Table 12: Base model with Microeconomic factor – COUNTRY (builders). Source: Elaborated by the author

There is no change in the macroeconomic variables, considering the COUNTRY. BP, CPNB, CPSHM, CPID, and CPFA are significant at 5% level. The adjusted R-square explains that independent variables can predict about 96% of the variance in price.

With China as a reference point, Japan and South Korea are significant (5% level) with a positive coefficient (2.4590 and 2.9085 respectively), and Romania is significant for a 10% level (due to the high-quality standards and cost of building). The country of those builders shows a positive impact on the second-hand Capesize second-hand price.

Shipbuilding is a competitive and oligopolistic market and plays a crucial role in the maritime field as it is supporting and brings together over 50 other industries by building and supply new ships. As dominant players, Japanese shipyards lost the momentum from previous decades as they could not tackle the issues with the shortage of steel resources and the substantial cost of labor. On the other hand, with competitive strategies, South Korean shipyards gain the respect and trust of shipowners over the last four decades (Shih-Liang Chao, Yi-Hung Yeh, 2020). The reasons were that Korean shipyards are competitive is due to massive investment, quality, and efficiency; therefore, prices quoted by those shipyards have become the industry benchmarks (Cullinane, 2005). Shipyards in any other place than the three dominant countries do not attract the investors financially. Therefore, a vessel built in South Korea or Japan should be estimated above the S&P market price compared to vessels built in China.

9. Base model with Microeconomic factor – OWNERS

	Estimate	SE	tStat	pValue
(Intercept)	21.4432	17.3808	1.2337	0.2272
BP	0.0021	0.0087	0.2457	0.8077
CPNB	0.0696	0.3929	0.1773	0.8605
CPSHM	0.8666	0.1330	6.5144	3.93E-07 *
CPID	-0.8577	0.6527	-1.3141	0.1991
CPFA	-2.4843	3.5904	-0.6919	0.4945
RP: OWNERS_2020 bulkers				
OWNERS_agricore hk	-1.7680	5.6815	-0.3112	0.7579
OWNERS_alpha bulkers	1.3429	4.3852	0.3062	0.7616
OWNERS_anglo international	0.3314	3.4188	0.0969	0.9234
OWNERS_berge bulk	1.2601	4.7947	0.2628	0.7946
OWNERS_bocimar nv	0.4753	3.7581	0.1265	0.9002
OWNERS_bocom leasing	34.1220	17.8323	1.9135	0.0656 **
OWNERS_bright navigation	4.2718	5.4647	0.7817	0.4407
OWNERS_bulkseas marine mgmt	-2.7498	5.3890	-0.5103	0.6137
OWNERS_bw dry cargo	0.1192	4.9598	0.0240	0.9810
OWNERS_carras hellas	2.5652	4.4126	0.5813	0.5655
OWNERS_celeste holding	-0.4996	4.1261	-0.1211	0.9045
OWNERS_cetus vessel pte ltd	2.2558	4.8964	0.4607	0.6485
OWNERS_china steel express	1.5628	4.4343	0.3524	0.7271
OWNERS_cosmoship mar.	2.2689	5.9752	0.3797	0.7069
OWNERS_defender holding	7.3225	3.1548	2.3211	0.0275 *
OWNERS_doriko	2.1815	5.3051	0.4112	0.6839
OWNERS_dryships	6.1303	3.5818	1.7115	0.0977 **
OWNERS_eddie steamship	1.0825	4.5589	0.2374	0.8140
OWNERS_empire bulkers	0.0909	3.5294	0.0258	0.9796
OWNERS_global meridian	8.4289	3.0043	2.8056	0.0089 *
OWNERS_goodbulk	2.5492	4.8799	0.5224	0.6054
OWNERS_h-line shipping	5.0739	4.7012	1.0793	0.2894
OWNERS_hsin chien marine	-1.1901	3.5206	-0.3380	0.7378
OWNERS_k-line	1.6418	3.7683	0.4357	0.6663
OWNERS_kassian maritime	4.1505	5.7835	0.7176	0.4787
OWNERS_kondinave	-0.7338	4.2325	-0.1734	0.8636
OWNERS_korea line	0.5491	4.3652	0.1258	0.9008
OWNERS_laskaridis shipping	4.1881	5.3463	0.7834	0.4398
OWNERS_minsheng financial leasing co ltd	-2.0129	3.3907	-0.5937	0.5573
OWNERS_misuga kaiun co ltd	1.9194	3.5442	0.5416	0.5923
OWNERS_miyazaki sangyo	3.2260	4.0084	0.8048	0.4275
OWNERS_navitas cia. mar	0.7121	6.6836	0.1065	0.9159
OWNERS_new shipping	1.6840	4.8434	0.3477	0.7306
OWNERS_ngm energy	0.1571	5.1477	0.0305	0.9759
OWNERS_ningbo marine co ltd	1.5527	4.4727	0.3471	0.7310
OWNERS_nissen kaiun	3.1816	3.2674	0.9737	0.3382

OWNERS_oldendorff carriers	-0.2098	2.8095	-0.0747	0.9410
OWNERS_pavimar sa	5.7162	4.8237	1.1850	0.2456
OWNERS_profy pp	2.5770	4.4158	0.5836	0.5640
OWNERS_reederei c-p offen	1.9469	5.0442	0.3860	0.7023
OWNERS_safe bulkers	-1.9310	4.8470	-0.3984	0.6933
OWNERS_samos steamship	3.2398	4.4391	0.7298	0.4714
OWNERS_seanergy maritime	-2.3481	4.4338	-0.5296	0.6004
OWNERS_sinounion	-1.2699	5.4185	-0.2344	0.8163
OWNERS_sm line	-1.7435	7.0120	-0.2486	0.8054
OWNERS_soon fong shipping	0.1659	3.5796	0.0463	0.9634
OWNERS_star bulk carriers	7.0843	4.5153	1.5690	0.1275
OWNERS_stx marine service	4.8002	5.6242	0.8535	0.4004
OWNERS_sw shipping co ltd	2.0326	4.5026	0.4514	0.6550
OWNERS_tai chong cheang	10.0313	3.5093	2.8585	0.0078 *
OWNERS_times navigation	-4.1232	5.8571	-0.7040	0.4871
OWNERS_unisea shipping	7.3029	4.5910	1.5907	0.1225
OWNERS_winning intl	-0.4621	6.0005	-0.0770	0.9391
OWNERS_xie hai explorer	-1.1061	5.1610	-0.2143	0.8318
OWNERS_xin yuan enterprises	1.5771	5.6719	0.2781	0.7829
OWNERS_xt shipping	4.7433	5.3738	0.8827	0.3847
OWNERS_zodiac maritime	1.6803	4.4600	0.3768	0.7091
OWNERS_ easy luck international	-4.8285	5.5778	-0.8657	0.3938
OWNERS_ laredo marine	-0.9850	5.7809	-0.1704	0.8659
OWNERS_ navios holdings	10.1103	3.3476	3.0201	0.0052 *
Ordinary R-squared 0.9948				
Adjusted R-squared 0.9824		*p<0.05, **p<0.10		

Table 13: Base model with Microeconomic factor – Owners. Source: Elaborated by the author

The influence of the microeconomic variable OWNER to the macroeconomic variables, as given above, affects the macroeconomic variables. BP, CPNB, CPID, and CPFA are found to be insignificant. The variable CPSHM is significant at 5% level with a positive coefficient (0.8666). The adjusted R-square explains that independent variables can predict about 98% of the variance in price

With reference point "2020 Bulkers", among 60 shipowners, several are significant with a positive coefficient. 2020 Bulker ltd is a Bermuda-based owner and operator, and the fleet of the company consists of 8 scrubbers fitted, fuel-efficient Newcastlemax modern vessels with an average age of one (1) year.

Table 12 illustrates shipowners (descending order) who can theoretically value their vessels above the market price (compared with 2020 Bulker) due to their increased bargaining power derived from the company's image and performance in the market.

	Estimate	SE	tStat	pValue
RP: OWNERS_2020 bulkers				
OWNERS_ navios holdings	**10.1103**	3.3476	3.0201	**0.0052**
OWNERS_tai chong cheang	**10.0313**	3.5093	2.8585	**0.0078**
OWNERS_global meridian	**8.4289**	3.0043	2.8056	**0.0089**
OWNERS_defender holding	**7.3225**	3.1548	2.3211	**0.0275**
OWNERS_bocom leasing	**34.1220**	17.8323	1.9135	**0.0656**
OWNERS_dryships	**6.1303**	3.5818	1.7115	**0.0977**
***p<0.05, **p<0.10**				

Table 14: Shipowners – significant level of 5% and 10% (descending order). Source: Elaborated by the author

Based on the results, we can say that statistically significant companies, quite possibly, have set higher standards and build a strong management team in line with a great combination of theoretical assumptions and practical experience. The findings confirm that vessels under these companies' control have proven that they can be sold with a premium based on the market price. Theoretically, the rationale is that the shipowners are prudent and well-known in the market for their reliability by maintaining the vessels in good condition. Reputation, connections, and networks in the shipping industry are vital for those who want to stay in business in the long term, together with a healthy financial background and creditworthiness.

10. Base model with Microeconomic factor – CLASS

	Estimate	SE	tStat	pValue
(Intercept)	37.8885	8.4819	4.4670	2.37E-05
BP	-0.0132	0.0049	-2.6747	0.0089 *
CPNB	0.5990	0.0570	10.5057	3.78E-17 *
CPSHM	1.0121	0.0455	22.2418	1.17E-37 *
CPID	-1.2603	0.4574	-2.7555	0.0071 *
CPFA	-6.7669	1.0852	-6.2356	1.57E-08 *
RP:CLASS_abs				
CLASS_bv	-0.7025	1.9492	-0.3604	0.7194
CLASS_cr	-2.1761	3.6828	-0.5909	0.5561
CLASS_dnv gl	-0.2230	1.6034	-0.1391	0.8897
CLASS_krs	1.5800	2.2269	0.7095	0.4799
CLASS_lr	0.8132	1.3320	0.6105	0.5431
CLASS_nkk	0.3452	0.9405	0.3670	0.7145
CLASS_rina	4.8437	3.6937	1.3114	0.1932
Ordinary R-squared 0.9597				
Adjusted R-squared 0.9542		*p<0.05, **p<0.10		

Table 15: Base model with Microeconomic factor – CLASS. Source: Elaborated by the author

By combining the microeconomic variable CLASS to the macroeconomic variables, there is no change in the macroeconomic variables. BP, CPNB, CPSHM, CPID, and CPFA are significant at 5% level. The variable CLASS is insignificant without any effect on the price at 5% and 10% level.

In our results, it can be seen that there is no influence on the price of second-hand Capesize vessel from the Classification. The reason might be most probably because all the Classification in our sample, such as ABS, BV, CR, DNV-GL, KRS, LS, NKK, RINA, are members of IACS members society. Each of the members developed a series of notations voluntarily by adding additional criteria beyond the standard requirements and regulations; however, it may not be an essential element for acquiring a vessel in the sales and purchase market.

The element classification society has already been rejected in previous studies (Pruyn, Van de Voorde and Meersman, 2011).

Due to class societies' willingness to cut corners to gain or retain clients, it is commonly recognized that stilted competition in the classification/certification market has led to different approaches (Hoffmann, Sanchez, and Talley, 2005).

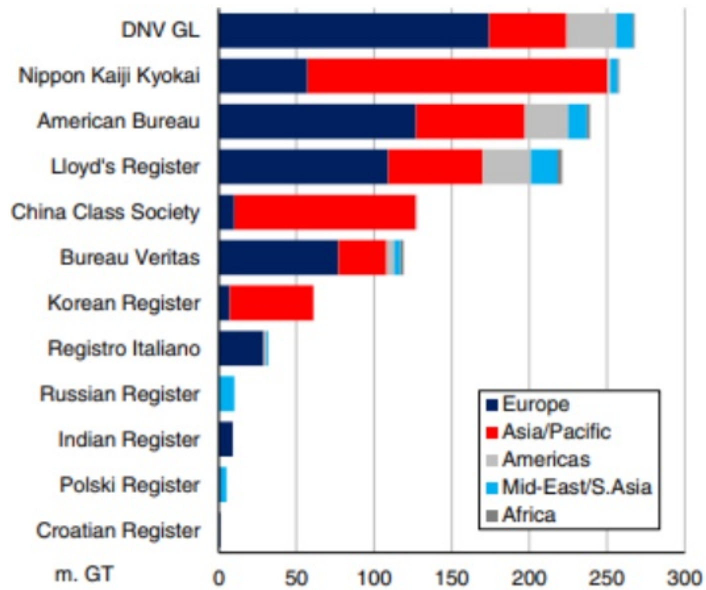


Figure 14: Class Society By Owner Region. **Source: Clarkson's Shipping Intelligence Network (SIN)**

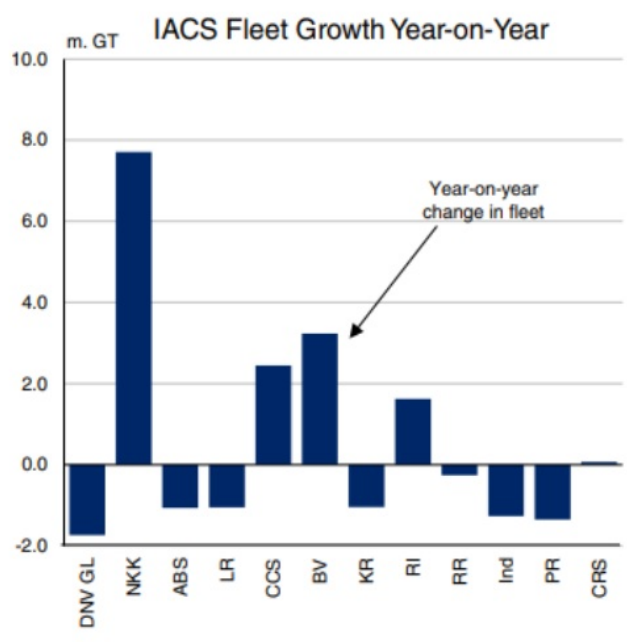


Figure 15: IACS Fleet Growth Year-on-Year. Source: Clarkson's Shipping Intelligence Network (SIN

11. Base model with Microeconomic factor – FLAG

	Estimate	SE	tStat	pValue
(Intercept)	37.8638	8.3618	4.5282	2.02E-05
BP	-0.0095	0.0053	-1.7964	0.0762 **
CPNB	0.5627	0.0845	6.6579	3.06E-09 *
CPSHM	1.0023	0.0428	23.4370	7.72E-38 *
CPID	-1.4929	0.4640	-3.2174	0.0019 *
CPFA	-6.9599	1.0451	-6.6599	3.03E-09 *
RP: FLAG_bahamas				
FLAG_cyprus	-0.9135	3.3992	-0.2687	0.7888
FLAG_hong kong	4.6308	3.8764	1.1946	0.2357
FLAG_isle of man	-0.9770	2.9740	-0.3285	0.7434
FLAG_japan	4.2606	4.2583	1.0005	0.3200
FLAG_liberia	3.2426	2.4692	1.3132	0.1928
FLAG_madeira	1.5469	3.5512	0.4356	0.6643
FLAG_malta	4.7000	3.6341	1.2933	0.1996
FLAG_marshall islands	1.7089	2.5497	0.6702	0.5046
FLAG_panama	4.2194	2.5943	1.6264	0.1077
FLAG_singapore	3.2599	3.0310	1.0755	0.2853
FLAG_south korea	5.9319	3.4270	1.7309	0.0873 **
FLAG_taiwan	5.5264	4.2306	1.3063	0.1952
FLAG_united kingdom	6.2656	3.5250	1.7775	0.0792 **
Ordinary R-squared	0.966			
Adjusted R-squared	0.9584		*p<0.05, **p<0.10	

Table 16: Base model with Microeconomic factor – FLAG. Source: Elaborated by the author

The variables CPNB, CPSHM, CPID, and CPFA, are significant at 5% level, while BP at 10% level. With reference point to the Bahamas flag, South Korea and United Kingdom flags have a significant positive impact on the price at 10% level; the adjusted R-squared explains that independent variables can predict about 96% variance in price.

Based on the results, the United Kingdom and the Republic of Korea flags can positively influence the second-hand Capesize vessel's price (10% level). Stricter safety standards and regulations in comparison with the open registry flags (FOC) is one of the reasons; along with higher administrative fees (legal and policy instruments), higher operating costs (increased manning costs), which do not reflect the condition of the vessel necessarily as it is more relevant with management approach and maintenance plan. All the vessels that initially registered under those two (2) flags during the construction period tend to be more reliable in quality standards. From the private shipping business perspective, selecting a flag is a primary step for a successful shipping operation.

"Operators from traditional maritime countries are found to flag out high-quality vessels, whereas those from open registry countries tend to flag out low-quality ones" (Meifeng Luo, Lixian Fan, K.X Li, 2009). Moreover, according to the ICS Shipping Industry Flag State performance table, we can see that both show positive performance indicators and are not targeted or blacklisted by the port state controls (Paris MOU, Tokyo MOU, USCG).

		United Kingdom	United Kingdom	United Kingdom	United Kingdom
PORT STATE CONTROL	PARIS MOU WHITE LIST				
	NOT ON PARIS MOU BLACK LIST				
	TOKYO MOU WHITE LIST				
	NOT ON TOKYO MOU BLACK LIST				
	USCG QUALSHIP 21				
	NOT ON USCG TARGET LIST				
RATICATION OF CONVENTIONS	SOLAS 74 (AND 88 PROTOCOL)				
	MARPOL ANNEXES I - II				
	MARPOL ANNEXES III - VI				
	LL 66 (AND 88 PROTOCOL)				
	STCW 78				
	ILO MLC				
	CLC/FUND 92				
A739	RECOGNIZED ORGANIZATIONS				
AGE	AGE OF FLEET				
REPORTS	STCW 95 'WHITE LIST				
	COMPLETED ILO REPORTS				
	IMO MEETINGS ATTENDANCE				
IMO	IMO AUDIT SCHEME				

Figure 16: The United Kingdom and South Korea. Interactive Flag State Performance Table (Shipping Industry Flag State Performance Table). Source: International Chamber of Shipping (ICS).

		Republic of Ko...	Republic of Ko...	Republic of Ko...	Republic of Kor...
PORT STATE CONTROL	PARIS MOU WHITE LIST				
	NOT ON PARIS MOU BLACK LIST				
	TOKYO MOU WHITE LIST				
	NOT ON TOKYO MOU BLACK LIST				
	USCG QUALSHIP 21				
	NOT ON USCG TARGET LIST				
RATICATION OF CONVENTIONS	SOLAS 74 (AND 88 PROTOCOL)				
	MARPOL ANNEXES I - II				
	MARPOL ANNEXES III - VI				
	LL 66 (AND 88 PROTOCOL)				
	STCW 78				
	ILO MLC				
	CLC/FUND 92				
A739	RECOGNIZED ORGANIZATIONS				
AGE	AGE OF FLEET				
REPORTS	STCW 95 'WHITE LIST				
	COMPLETED ILO REPORTS				
	IMO MEETINGS ATTENDANCE				
IMO	IMO AUDIT SCHEME				

12. Base model with Microeconomic factor – P&I

	Estimate	SE	tStat	pValue
(Intercept)	33.2256	8.8997	3.7333	0.0003 *
BP	-0.0085	0.0051	-1.6745	0.0978 *
CPNB	0.5884	0.0564	10.4343	9.05E-17 *
CPSHM	0.9988	0.0452	22.0983	1.60E-36 *
CPID	-1.3981	0.4522	-3.0916	0.0027 *
CPFA	-6.0975	1.0597	-5.7538	1.42E-07 *
RP: PI_britannia p&i				
PI_gard p&i	-0.5292	2.3096	-0.2291	0.8193
PI_japan p&i	-1.2547	2.3109	-0.5430	0.5886
PI_korea p&i	2.6731	3.3016	0.8096	0.4205
PI_north of england p&i	-1.7797	2.3011	-0.7734	0.4415
PI_skuld	-3.8473	3.3509	-1.1481	0.2542
PI_standard club p&i	-0.8520	2.7743	-0.3071	0.7595
PI_steamship mutual p&i	-0.3730	2.3991	-0.1555	0.8768
PI_the london p&i club	-3.4618	2.4055	-1.4391	0.1539
PI_the swedish club p&i	-3.6318	4.1250	-0.8804	0.3812
PI_uk p&i club	-1.3768	2.5564	-0.5386	0.5916
PI_west of england p&i	0.1148	2.3627	0.0486	0.9614
Ordinary R-squared 0.9636				
Adjusted R-squared 0.9566		*p<0.05, **p<0.10		

Table 17: Base model with Microeconomic factor – P&I. Source: Elaborated by the author

The microeconomic variable PI does not change the macroeconomic variables statistically. The variables CPNB, CPSHM, CPID, and CPFA, are significant at 5% level, while BP at 10% level. With reference point "Britannia P&I" club, all of them are insignificant with no impact on forming the Capesize second-hand vessel price. From the author's point of view, it was worth examining this factor as the market information plays a crucial role in pursuing a second-hand vessel's competitive price. P&I clubs provide protection and indemnity insurance to shipowners for the ship's hull and machinery (Hull and Machinery underwriters) and against third party liabilities and claims. Usually, P&I clubs preferred to deal with prudent owners, and they know very well about their historical background, but this does not necessarily prevent the two (2) parties to come into agreement. Moreover, shipowners can select from a plethora of different P&I clubs; the preferable one is a personal choice.

Consequently, the P&I does not have any influence on the price of a second-hand Capesize vessel.

American Steamship Owners Mutual Protection and Indemnity Association, Inc
The Britannia Steam Ship Insurance Association Limited
Gard P&I (Bermuda) Ltd.
The Japan Ship Owners' Mutual Protection & Indemnity Association
The London Steam-Ship Owners' Mutual Insurance Association Limited
The North of England Protecting & Indemnity Association Limited
The Shipowners' Mutual Protection & Indemnity Association (Luxembourg)
Assuranceforeningen Skuld
The Standard Club Ltd
The Steamship Mutual Underwriting Association (Bermuda) Limited
Sveriges Ångfartygs Assurans Förening / The Swedish Club
United Kingdom Mutual Steamship Assurance Association (Bermuda) Ltd
The West of England Ship Owners Mutual Insurance Association (Luxembourg)

Table 18: International Group of P&I clubs (Alphabetical order). Source: IGP&I, table elaborated by the author.

13. Base model with Microeconomic factor – ME

	Estimate	SE	tStat	pValue
(Intercept)	25.8872	9.4044	2.7527	0.0074
BP	0.0017	0.0085	0.2005	0.8416
CPNB	0.1245	0.3718	0.3349	0.7386
CPSHM	0.9959	0.0905	11.0021	1.84E-17 *
CPID	-0.5035	0.4133	-1.2184	0.2268
CPFA	-3.9492	2.3324	-1.6932	0.0945 **
RP:ME_man b&w 6g70me-c 9.2				
ME_man b. & w. 6g70me-c9.5	-1.0804	2.6126	-0.4135	0.6804
ME_man b. & w. 6s60mc-c7.2	2.3459	4.8580	0.4829	0.6305
ME_man b. & w. 6s60mc-c8.2	2.6838	5.5326	0.4851	0.6290
ME_man b. & w. 6s70mc-c7.1	3.5317	2.9841	1.1835	0.2403
ME_man b. & w. 6s70mc-c7.2	5.5415	2.2211	2.4950	0.0147 *
ME_man b. & w. 6s70mc-c8.2	2.6152	3.4512	0.7578	0.4509
ME_man b. & w. 6s70mc6	1.1829	3.5337	0.3348	0.7387
ME_man b. & w. 6s70mc6.1	3.4893	2.7688	1.2602	0.2114
ME_man b. & w. 6s70mc6.2	0.8264	2.4402	0.3386	0.7358
ME_man b. & w. 6s70me-c7.2	-2.0138	3.2508	-0.6195	0.5374
ME_man b. & w. 6s70me-c8.2	6.3764	2.2046	2.8924	0.0050 *
ME_man b. & w. 6s80mc-c6.1	2.4743	3.9703	0.6232	0.5350
ME_man b. & w. 7s65me-c7.2	11.3121	3.3159	3.4115	0.0010 *
ME_man b. & w. 7s65me-c8.2	7.3190	2.0588	3.5549	0.0007 *
ME_man b. & w. 7s80me-c8.2	28.5226	16.9302	1.6847	0.0961 **
ME_man b. & w. 8dkrn60/195	3.2543	5.7937	0.5617	0.5760
ME_wartsila 6rt-flex58t-b	5.9352	5.5882	1.0621	0.2915
Ordinary R-squared	0.9783			
Adjusted R-squared	0.972		*p<0.05, **p<0.10	

Table 19: Base model with Microeconomic factor – ME. Source: Elaborated by the author

Lastly, adding the microeconomic variable ME to the macroeconomic variables seems to change the macroeconomic variables. The variable CPSHM is significant at 5% level, while CPFA at 10% level. The variables BP, CPNB, and CPID, are found to be insignificant. The adjusted R-square explains that independent variables can predict about 97% of the variance in price.

With reference point, the main engine type "MAN B&W 6G70ME-C 9.2 ", four (4) types among 18, are significant (5% level) with a positive coefficient (Table 20-descending order). One type is significant for 10% with a positive coefficient (28.5226); for the main engine's specific model, the difference is due to the higher horsepower relatively compared to others. Following the results, vessels with this type of engine can be sold with a premium based on the market price (in comparison with MAN B&W 6G70ME-C 9.2). All the manufacturers are focusing on designing energy-efficient main engines and, at the same moment, to meet the forthcoming regulations and IMO guidelines.

According to MAN B&W, "For MAN B&W MC-C-TII and ME-C-TII designated engines, the design and performance parameters have been upgraded and optimized to comply with the International Maritime Organisation (IMO) Tier II emission regulations. The ever valid requirement of ship operators is to obtain the lowest total operational costs, especially the lowest possible specific fuel oil consumption at any load, and under the prevailing operating conditions" (MAN B&W,2014).

	Estimate	SE	tStat	pValue
RP:ME_man b&w 6g70me-c 9.2				
ME_man b. & w. 7s65me-c7.2	**11.31213**	3.315859	3.411524	**0.001032***
ME_man b. & w. 7s65me-c8.2	**7.318977**	2.05882	3.554938	**0.00065***
ME_man b. & w. 6s70me-c8.2	**6.376413**	2.204573	2.892358	**0.004969***
ME_man b. & w. 6s70mc-c7.2	**5.541544**	2.221097	2.494958	**0.014738***
ME_man b. & w. 7s80me-c8.2	**28.52259**	16.93016	1.684721	**0.096092****
***p<0.05, **p<0.10**				

Table 20: Main engine (ME) – significant level of 5% and 10% (descending order). Source: Elaborated by the author

From an economic perspective, a high degree of reliability, flexibility, environmental aspects, low maintenance cost, low fuel and lubricating oil consumption, service frequency, spare parts, and special tools tend to be the primary criteria for the shipowners and operators in the sales and purchase market.

Chapter 5:Discussion

This research examines the factors influencing the price of second-hand capsizes vessels using an econometric analysis approach. The study collected secondary empirical data extracted from the Clarksons web-based shipping intelligence database and consulting company and employed modern economic techniques to make a valid statistical interpretation, thereby filling in a gap in the literature of second-hand capsizes vessel prices. Microeconomic factors such as age, ballast water treatment system, detention level, builders, flag, country of build, shipowners, and main engine type seem to influence the model differently.

Studies have identified various determinants, including micro and macroeconomic factors, influence the second-hand capsize vessel prices. The majority of the literature had considered factors such as the freight rates, newbuilding price, scrap value, bunker price, LIBOR rate, and the correlation between the markets to predict the price of the second-hand Capsize vessels. However, this research was different from previous studies. It was built on the existing literature by considering additional variables; other factors that have not been discussed much in the literature have been considered. Specifically, this research focuses on the underlying data and a combination of macro and micro-economy theory for determining the price of the second-hand capsize vessels. Besides, we defined a *priori* which elements could influence the outcome, though not assuming a clear linear link between them. In order to understand which factors could influence the outcome, each microeconomic factor was added *priori* (Pruyn, Van de Voorde, and Meersman, 2011).

Age, size (DWT), the flag of the ship, classification society, type of the main engine, builder (shipyard), builders country, shipowners, ballast water treatment system, exhaust scrubber system for Sox emission reduction, P&I club, number of PSC deficiencies based on ship's profile was examined.

In this study, OLS fixed-effect model was used, where all macroeconomic variables were initially added to the model. Bunker price (BP), Capesize idle vessels (CPID), Capesize Fleet - average age (CPFA), Capesize newbuilding prices (CPNB), and Capesize second-hand market prices (CPSHM) significantly influences the price of the second-hand Capsize vessel. Those are significant were further taken into the second level model.

The model indicates that the current bunker prices have a negative and significant impact on the Capesize second-hand price.

Previous studies showed that freight rates could offset the fluctuations in bunker price to impact second-hand vessels; the relation between second-hand Capesize and the bunker price seems justified because we did not include any freight parameters (base model).

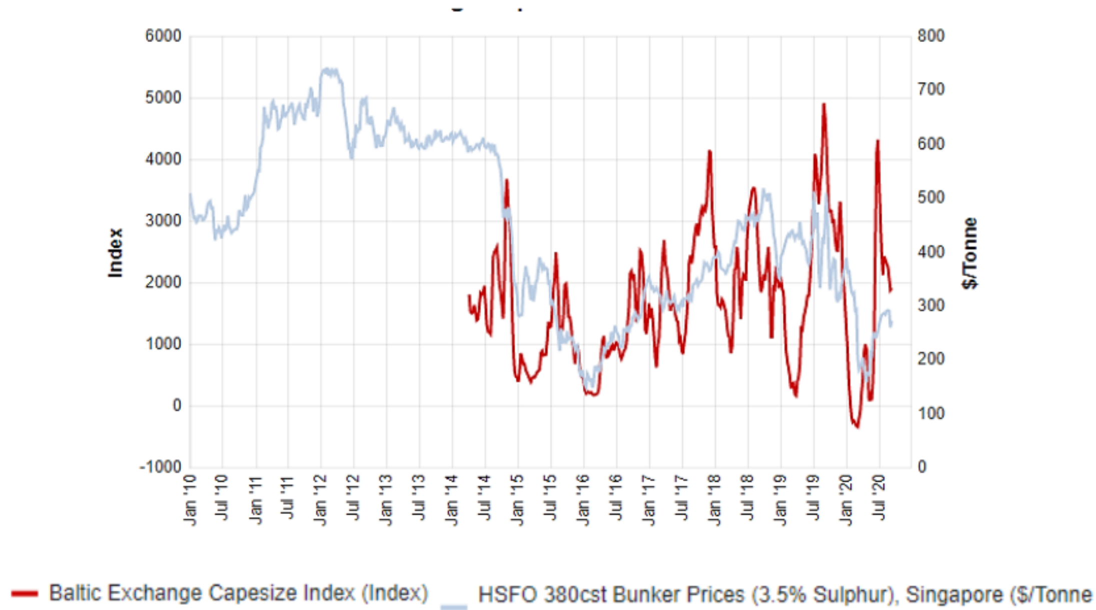


Figure 17: Relationship between BCI and Bunker price. **Source: Clarkson's Shipping Intelligence Network (SIN)**

Another important finding is the positive effect of a new building on a second-hand vessel price. Both markets are positively related and influence the decision of shipowners. According to Kavussanos and Alizadeh (2010), the new building price reflects shipowners' investment behavior and world economic activity. Besides, the law of demand and supply governs the shipping market and formulates the final price. The findings are similar to previous studies, where authors proved a positive relationship between the two shipping markets. As the sales and purchase of vessels is a professional service industry, knowledge related to fundamental characteristics of shipping, shipbuilding, economics, forecasting, and legal fields is necessary to predict the price of vessels (Alizadeh, 2007). Such knowledge is also essential to estimate ship investment finances, vessel management, and ship insurance parameters (Hwang et al., 2011). Autoregressive models have shown that newbuilding and time charter rates are the two major macroeconomic variables that affected second-hand vessel price irrespective of their type and capacity both in the short and long run (Adland et al., 2020).

On the contrary, the capital cost was only significantly related to the bulk carriers' second-hand price. In this regard, the findings of the present study are aligned with the findings of Tsolakis et al. (2003) because this study showed that CPNB (Capesize Bulk carrier Newbuilding Prices $m) and CPSHM (Capesize Market Secondhand Prices $m) were positively and significantly correlated with the price of the second-hand Capesize vessels. Such correlations are supported by the capital asset pricing model (CAPM) by Fama and Fench, who emphasized the market's asset value and the asset value of a stock in determining the share value process. Moreover, both CPNB and CPSHM relate to the capital's cost to influence the vessel's asset value. The concept that the supply-demand framework only governs second-hand vessels' price was discarded by Haralambides et al. (2005) when contended that the freight market and the S&P market were interdependent. Instead, the author showed that the second-hand ship prices are dependent on the expectations because they are real capital assets.

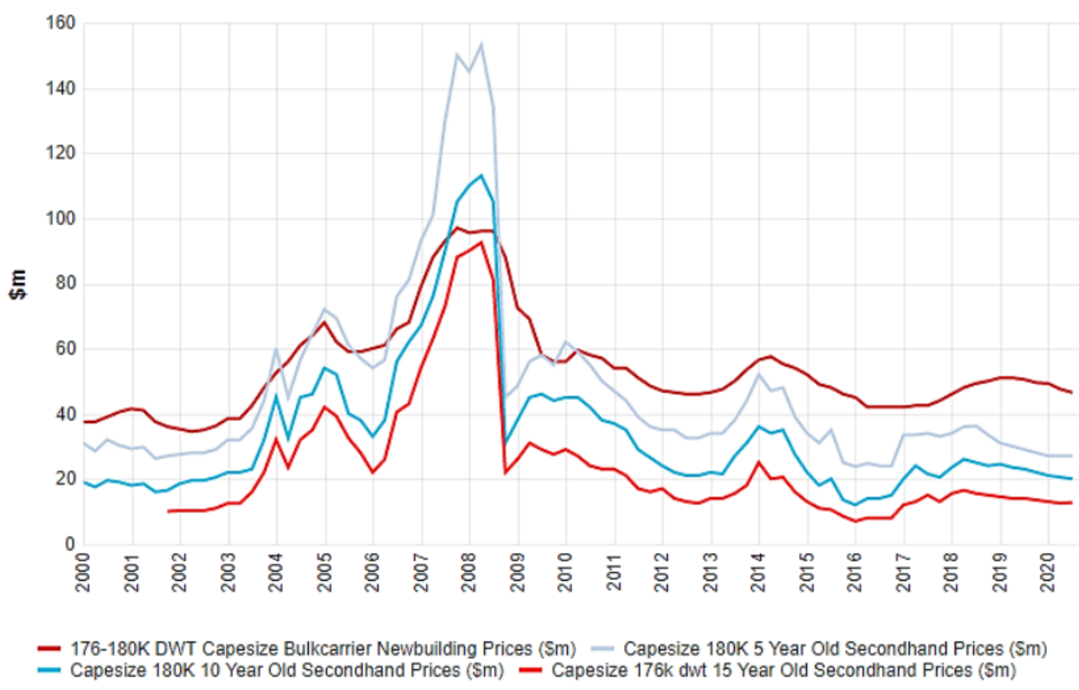


Figure 18: Relationship between Newbulding and Second-hand Capesize vessel (behavior). Source: Clarkson's (SIN).

The Capesize Idle vessels (negatively influence the price of Capesize) reflects the condition of the market. It is well known, especially after the crisis of 2008, that the dry bulk market is challenged with oversupply and exogenous disruptions. Based on the findings, investors should systematically monitor the market and adjust investment decisions by considering the number of Idle vessels. During these challenging times, shipowners who do not secure long-time employments, without a strong market position, suffer from financial losses and liquidity.
To that extent, they are ready to sell their vessels as earlier as possible by decreasing the vessel's price to stay afloat in the business pool.
The fleet average (Capesize) is another important element and displays the market direction (the results showed a negative influence on the price). The same rule also applies to other industries. Alongside advances in technology, they are transforming the whole shipping industry. The second-hand vessels are mostly sold for speculation and fleet strengthening policy. Nevertheless, it aims to reduce the average age of the fleet and increase its efficiency.
Paradoxical, this is a general rule, as there is strong evidence that when the market is booming, the average age increases and the opposite. Following the results, investors must monitor the market carefully for acquiring a vessel at the right timing. The right timing is essential for achieving a successful investment, keeping in mind fluctuation in the shipping market.
In continuation, age accounted for the model while keeping all other variables as constant. Nonetheless, the model did not affect all other macroeconomic variables. That is a common approach in the literature on vessel valuation due to a strong positive correlation between the vessel age at the transaction date and second-hand Capesize price (e.g. (Adland & Koekebakker, 2007; Kohn, 2008)). It was observed that age (adjusted R square, 96.5%) was also statistically significant and negatively influenced the Capesize vessel's price, which indicates that the age depreciation is a significant predictor of the second-hand Capesize price. Our findings are similar to the studies conducted by Kohn (2008) and Adland and Koekebakker (2007), where authors showed nonlinearity as an essential aspect to be taken into account in at least price determination (vessel valuation).
Shipbrokers and charterers prefer to acquire younger vessels by offering a small premium some times. However, due to the market's competitiveness, shipowners are very well aware, and they are trying to keep their fleet in the best possible condition.

Similarly, size/Dwt (tonnes) was examined. However, this did not affect all other variables in the model (adjusted R square 95.6%) and cannot significantly predict the Capesize prices. As mentioned in empirical results-findings, the vessels' size as an element is not considered necessary to acquire the right Capesize second-hand vessel. Factors such as routes and cargo are the main drivers. The shipowners are looking for vessels that meet their requirements regardless of the size (DWT) within a specific sector.

By adding BWTS (environmental equipment) did not change the model (adjusted R square, 95.7%), but it had a significant positive impact on the price of the Capesize vessel. Another finding is that vessels with installed BWTS are sold for a higher price than others (dataset). IMO's BWM Convention entered into force on 8 September, and MEPC 71 reached an agreement on the implementation dates. Afterthought, IMO has adopted by MEPC 72 (April 2018) and enters into force in October 2019, a mandatory code (BWMS Code) for approval of ballast water management systems (IMO,2019). All the vessels shall meet the D-2 standards by having a ballast water treatment (BWTS) approved, installed and commissioned, at the first IOPP renewal on or after 8 September 2019 at the latest (DNV-GL,2019).

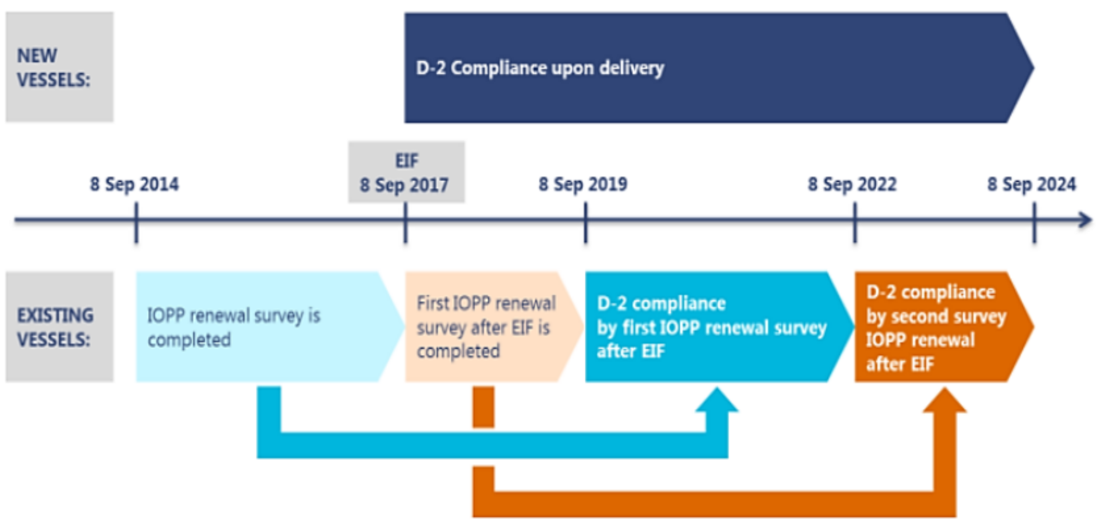


Figure 19: BWTS implementation timeline. Source: Retrieved from

http://www.gard.no/web/updates/content/26329761/do-not-wait-too-long-before-installing-bwm-system.

Shipowners are obliged to comply with the existed regulations by adopting new technologies, which is quite challenging from a financial perspective. BIMCO estimates that the cost of installation varies between $500,000-5,000,000$ depends on the ship's size, technology, and shipping companies management approach; the required time is from two (2) to five (5) weeks based on the shipyard availability, technical support team, and classification approval procedures.

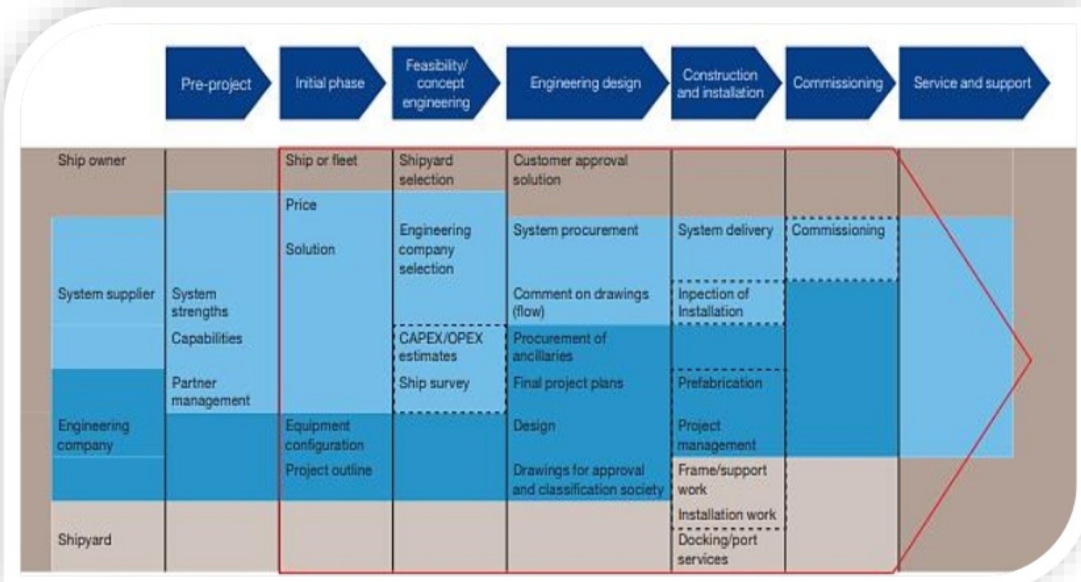


Figure 20: Phases of a retrofit BWTS project. Source: Alfa Laval BWTS guidelines.

There is no one solution for everyone, and requires much research. The proper choice of a system is another challenge, as there are numerous technical difficulties to be overcome in equipping an existed vessel. Mechanical, physical, or chemical are three treatment approaches, and many companies offering different technologies such as UV irradiation (ultraviolet lighting application after filtration), Electrolysis, and Chemical injection (after filtration).

With the deadlines on the horizon, looking into the second-hand market, it would be beneficial for investors to acquire a vessel that has already installed BWTS for saving time and cost.

The exhaust scrubber system does not have any influence on the Capesize price second-hand price. Nowadays, it is a hot topic, and many investors are looking for energy-efficient and renewable sources options. Fuel characteristics and engine design, comparatively, are two components that indicate environmental performance. It is mandatory for the ships, after the enforcement of the IMO regulation (MARPOL Annex VI) on 1 January 2020, either to use low sulphur (0.50% SOx) or high sulphur fuel (3,50% SOx) by fitting a scrubber system, always following the existed legislation.

According to Clarksons, the cost of retrofitting varies between $1,000,000-$4,000,000 depends on the ship's size and the choice of the system, and the required time is 45 to 60 days.

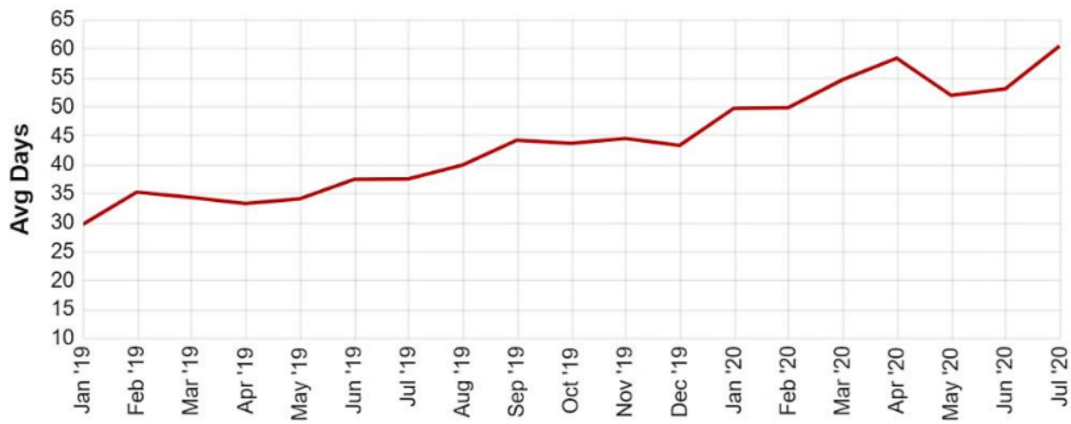


Figure 21: World Fleet, Average days under SOx scrubber retrofit average days. Source: Clarkson's Shipping Intelligence Network (SIN)

Due to Covid-19, many shipowners postponed or cancelled the installation of scrubbers because of the favourable fuel prices. Based on the current circumstances, the differential between high and low sulphur fuel works positively for them.

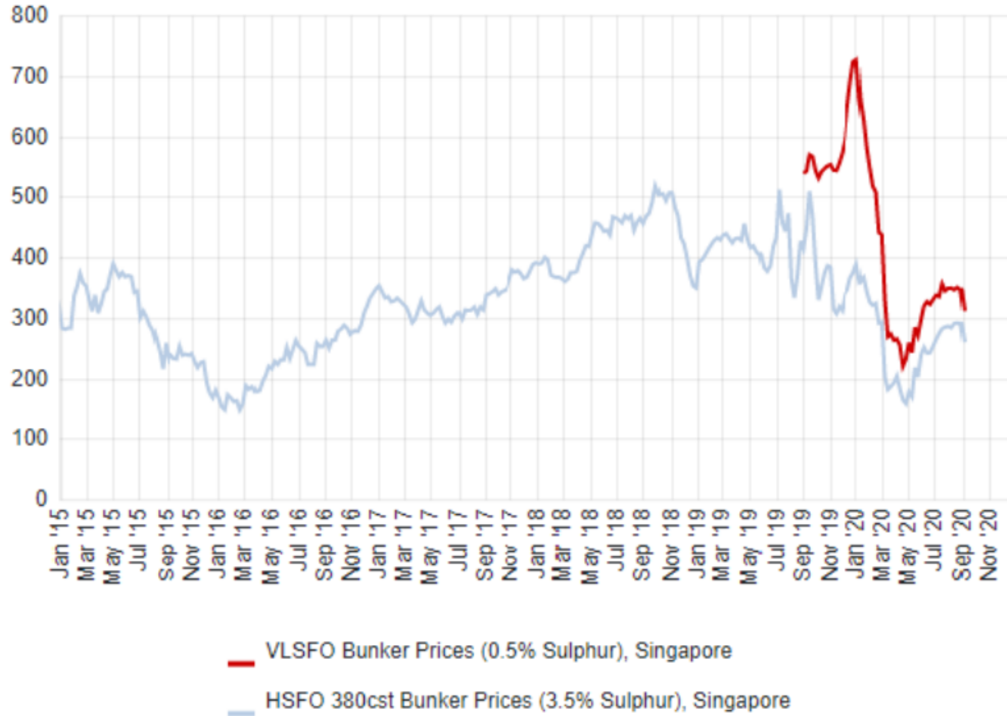


Figure 22: HSFO (3,5% Sulphur) and VLSFO (0,5 Sulphur) Bunkers prices, Singapore $/Tonne. Source: Clarkson's Shipping Intelligence Network (SIN).

The appearance of this unexpected event -Covid-19, created uncertainty in the market and parallel, has changed the investors' behavior, by looking from a financial perspective the pay-back period. Hence, investors are confused about whether it is a good option or not; it is a controversial matter which is frequently debated. To that extent, all the involved parties started to investigate various possible alternatives options. In the near future, the whole shipping industry will face more challenges. Adopting alternative fuels and technologies for greener shipping would be the first step into a new business environment.

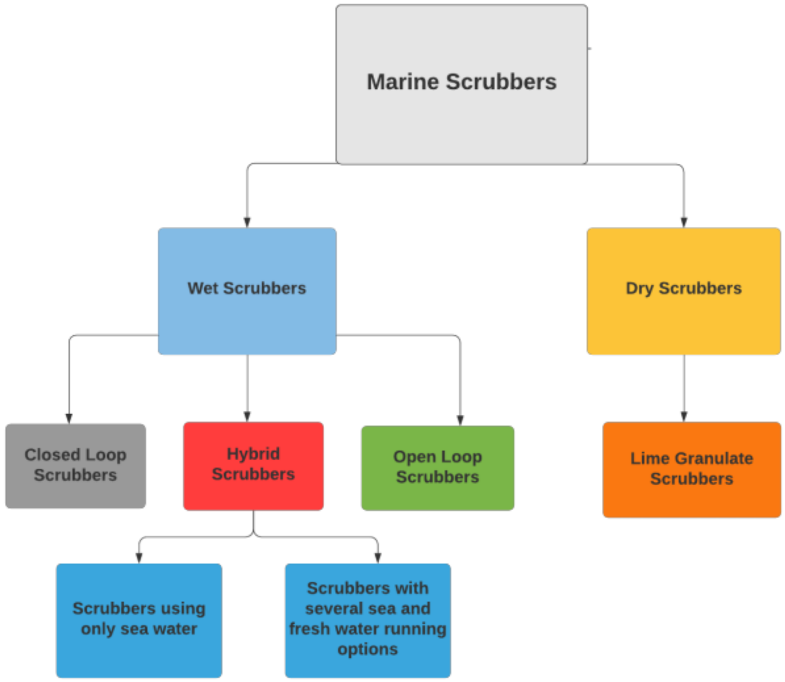


Figure 23: Exhaust scrubber system categories. Source: Elaborated by the author.

Detention level also affects the Capesize prize, as it is a significant (10% level) and negatively impacts the Capesize price. Port State control (PSC) has the authority to detain a vessel with major deficiencies, considered it unseaworthiness, having as a result for a ship to do not be able to depart from the inspection port. Vessels under detention need to rectify all the deficiencies within the given time framework by port state control officers and then need to be verified through re-inspection. Any delay in the schedule means considerable losses for a shipowner and harms the shipping company's image.

Also, shipbrokers and charterers are always looking for vessels that meet the essential criteria for the next possible employment based on the characteristics and specifications, without considering the ship's profile based on PSC inspection reports. However, still, at the same time, they do not want to lose time and money. By disregarding this factor, after acquiring the asset, the shipowners may most likely suffer from financial losses due to underperformance as port state controls target their vessels.

Many shipowners were trying to reshape the vessel's image by changing the name, flag, and class, which is costly and inefficient, as all the records remaining on the relevant databases until the end of the vessel's life. In order to change a vessel's profile in the market requires much effort and systematic work from the management side.

Shipowners ignored this factor based on our data, as most of the vessels with higher detention levels sold for a higher price (dataset). The investors should negotiate the possibility of a discount on the vessel's price by taking into account the candidate's ship's detention level (PSC inspection records) as an additional criterion for an improved decision-making tool, which may lead to a successful investment.

Figure 24: PSC officers from different regimes. Source: Retrieved from https://safetyatsea.net/news/2020/asia-pacific-port-state-control-regime-detains-most-vessels-according-to-data/.

The results show that the builder did not affect the macroeconomic variables, but in the dry bulk capsize S&P market, the slope coefficient shows that specific builders significantly negatively predicted the price. According to the Top 20 builder list (orderbook) of Capesize vessels from Clarksons, based on the current orderbook (measured in DWT), the market is dominated by China. The shipowners place their orders in Chinese shipyards due to high competitiveness in building bulk carriers and financially more attractive than others.

However, studies have shown that in terms of technological leadership and energy efficiency, the first place is shared and interchanged between Japan and South Korea chronologically over the last decades. The results may reflect the market's real situation, without considering, of course, the negotiation part and the agreement between two or more parties.

The findings are useful, as the potential investors can create a ranking system and increase their bargaining power before the pre-purchase inspection.

Rank	Builder	Location	Number	Total	Avg Size	Unit	Country/Region
1	Shanghai Waigaoqiao	Shanghai	22	4,428,000	201,272	DWT	China P.R.
2	Beihai Shipyard	Qingdao	20	4,885,000	244,250	DWT	China P.R.
3	COSCO HI (Yangzhou)	Yangzhou	11	2,310,000	210,000	DWT	China P.R.
4	New Times SB	Taizhou	11	2,641,000	240,090	DWT	China P.R.
5	Yangzi Xinfu SB	Taizhou	11	2,756,000	250,545	DWT	China P.R.
6	Hyundai Samho HI	Yeongam	9	2,345,000	260,555	DWT	South Korea
7	Jiangsu Hantong HI	Nantong	8	1,672,000	209,000	DWT	China P.R.
8	Tianjin Xingang HI	Tianjin	7	1,930,000	275,714	DWT	China P.R.
9	JMU Tsu Shipyard	Tsu	6	1,254,000	209,000	DWT	Japan
10	Namura Shipbuilding	Imari	5	667,300	133,460	DWT	Japan
11	Huangpu Wenchong	Guangzhou	5	600,000	120,000	DWT	China P.R.
12	Hyundai HI (Ulsan)	Ulsan	4	1,300,000	325,000	DWT	South Korea
13	JMU Ariake Shipyard	Kumamoto	4	1,222,000	305,500	DWT	Japan
14	Bohai Shipbuilding	Huludao	3	624,000	208,000	DWT	China P.R.
15	Imabari SB Marugame	Marugame	3	580,000	193,333	DWT	Japan
16	Dalian COSCO KHI	Dalian	2	420,000	210,000	DWT	China P.R.
17	Oshima Shipbuilding	Saikai	2	200,000	100,000	DWT	Japan
18	JMU Kure Shipyard	Kure	1	182,000	182,000	DWT	Japan
19	Jiangsu New YZJ	Taizhou	1	180,000	180,000	DWT	China P.R.
20	Imabari SB Hiroshima	Mihara	1	240,000	240,000	DWT	Japan

Table 21: Capesize vessels - Top 20 Builders (Orderbook). Source: Source: Clarkson's Shipping Intelligence Network (SIN)

Country of builders such as Japan and South Korea show a significant and positive impact on the second-hand Capesize price. The three Asian countries China, Japan, and South Korea, control

90% of the global shipbuilding market (Clarksons,2020); many of the shipyards in each country merged to overcome the present shrinkage in orderbook as the overcapacity has plagued the shipping industry worldwide. Based on the results, firstly, South Korean, and second Japanese vessels are more valuable than Chinese. The shipping industry is experienced oriented, and traditionally, it is well-known and recognized in the market that Japanese vessels are more reliable, valuable, simple, and ergonomic than South Korean ships, which are more advanced concerning automation. Moreover, shipowners support South Korean shipyards for more complex projects that require an excellent grasp of technological advancements. By maintaining a superior technological edge across the competitors, South Korean shipyards, driven by innovation, and the main target is always to develop high-value-added and fuel-efficient vessels (OECD, 015). The findings challenge Tsolakis's (2003) observation, who reported that the country of build does not influence second-hand vessels' price. However, their conclusions were based on Panamax vessels and not on the Capesize.
The study results can be used by speculators and other market players for the evaluation and negotiation stage.

Adding the “Flag” had a similar impact where it did not affect the macroeconomic elements. However, specific countries like South Korea and the United Kingdom alone did show an indirect and positive impact on the Capesize price. The flag selection from a business perspective is an essential step for a successful shipping operation; it may also lead to a lower PSC inspection frequency, resulting in a lower financial risk for the shipowners and operators. Therefore, a flag with positive past safety records (low casualty rate) and reputation increases any shipping company's profile and raises the probability of positive profitability by avoiding financial losses.

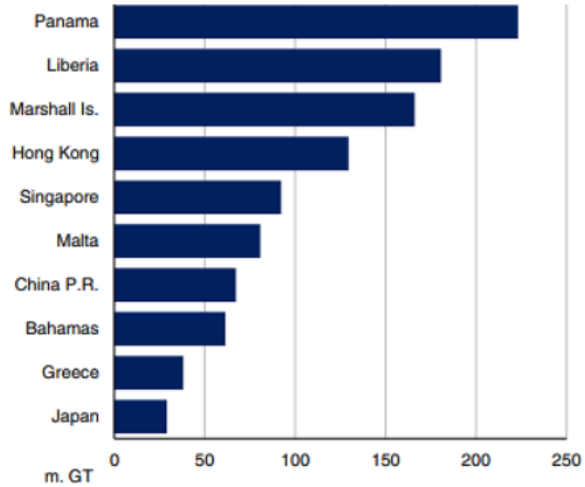


Figure 25: Top 10 Flag State Fleets (m. Gross Tonnage). Source: Clarkson's Shipping Intelligence Network (SIN)

The addition of classification did not affect the model, and the slope coefficient supports a negative class-second Capesize vessel price relationship. However, it is found to be a statistically insignificant effect on the Capesize price.

Initially, the shipowners, to gain higher coverage conditions from their insurer and increase the vessel's value at the same time, started to use Classification societies to assess the ship's seaworthiness, technically by performing periodical surveys.

Nowadays, it is a common practice and has become compulsory; for a vessel involved in international trade, it is an obligation to be classified, certified, and regularly inspected by any of the classification societies members of IACS (most likely). Besides, Classification societies act as a recognized organization (RO) and are responsible for issuing certificates on behalf of the Flag State.

All the IACS self-regulated body members claimed that their surveys and inspections tend to be of high quality, enforcing high standards when issuing vessel certificates.

Hence, vessels bearing their classification certificate are generally considered high-quality vessels and are more likely to comply with international safety and environmental standards. (Hoffmann et al., 2005; Li et al., 2009). However, it is only for authentication purposes that the vessel complies with standards and does not reflect the market's performance.

"The purpose of a Classification Society is to provide Classification and statutory services and assistance to the maritime industry and regulatory bodies as regards maritime safety and pollution prevention, based on the accumulation of maritime knowledge and technology" (IACS,2020).

A vessel's seaworthiness is the most critical and primary obligation for shipowners; all the operators should emphasize building a comprehensive and robust maintenance plan to meet the mandatory standards and simultaneously generate positive financial results.

Therefore, to sum up, there is no impact on the second-hand Capesize price, as long as the vessel is classified by one of the IACS members.

Including shipowners as a covariant had a significant impact on the model where significance disappeared for BP, CPNB, CPID, and CPFA. Only CPSHM had a significant and positive impact on the second-hand Capesize price. Nowadays, shipping companies face pressure to address many challenges; the key to survival is a successful management team capable of creating a positive impact, generating superior financial results, and adopting the rapid changes in the dynamic business environment.

However, from a broader perspective, three (3) components are essential for a proper comparison, operational performance, image, and profitability (Jugovic,2011).

From an economic perspective, the present findings were following the nature of the shipping industry. Nevertheless, timing is another critical factor for achieving a successful investment keeping in mind the characteristics and the nature of the global shipping market.

The large number of established shipping companies that operate in the industry are those of conservative investors who have been in the market for more than a century.

As leading global brands in seaborne shipping, companies that are significant and positive in our results will be able to sell their vessels with a premium based on the second-hand market price (with reference point “2020 Bulker”). Consequently, these shipowners have substantial expertise and experience regarding the industry, translating into more accurate future market decisions.

By fitting the ME to the model as a covariant, only CPSHM and CPFA remained significant, where the last show negative impact while the former had a positive impact. Depending on the size of the vessel, influential factors such as overall performance (speed-power combination), weight, emissions (rules and regulations), environmental effects, fuel consumption, lubricating oil consumption, noise and vibration, operating and maintenance cost, spare parts cost, need to be evaluated when selecting a machinery system. Under the current circumstances, the emission level of greenhouses gases is crucial, and others for the final decision. Specific main engine (ME) types did show a significant and positive impact on the Capesize prices. Vessels with MAN B&W 7S65ME-C7.2, 7S65ME-C8.2, 6S70ME-C8.2, 6S70MC-C7.2, main engine type can be sold with a premium in comparison to MAN B&W 6G70ME-C 9.2. Therefore, shipowners can increase their profitability by setting a higher price on their assets, considering the market benchmark. However, amongst all, the predictability of MAN B&W 7S80MC-C8.2 is substantially stronger, as indicated in the slope coefficient due to higher horsepower relatively compared to others.

On the other hand, it would be beneficial for shipowners to acquire a vessel with one of those main engines from an operational perspective. It reflects reliability, low fuel and lubricating oil consumption, fewer spare parts. Besides, it creates flexibility in assigning engineers to operate the engine plant and service, among the important functional issues contributing to the cost-benefit (MAN B&W,2014).

Overall, capsize second-hand market price was a significant predictor of second-hand Capesize vessel's price after accounting for all the variables. Our findings corroborate with the previous study findings where second-hand vessel market price is shown to have the most considerable impact on the formation of either new or second-hand Capesize vessel price (Syriopoulos & Roumpis, 2006; Lun & Quaddus, 2009; Jiang & Lauridsen, 2012; Alizadeh & Nomikos, 2003; Adland & Koekebakker, 2007). The study broadly reflected that the parameters, whether macroeconomic or microeconomic, are related to assets, profitability, and goodwill positively influence the second-hand Capsize vessels' price. On the contrary, the parameters related to liabilities, losses, idle time, and depreciation negatively influence second-hand Capesize vessels (Knapp et al., 2008).

The findings of the research could be useful for a robust asset play strategy. Investors can increase their negotiation power by applying the necessary elements into the agreement.

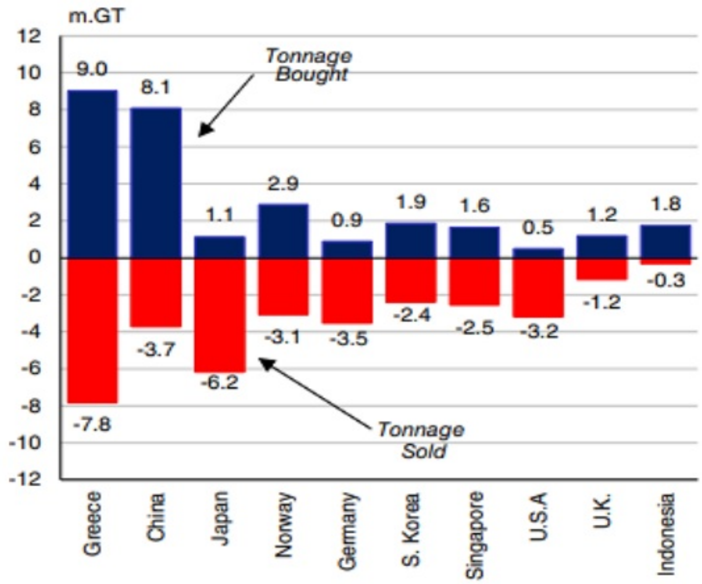


Figure 26: Buyers & Sellers, Last 12 Months. Source: Clarkson's (SIN).

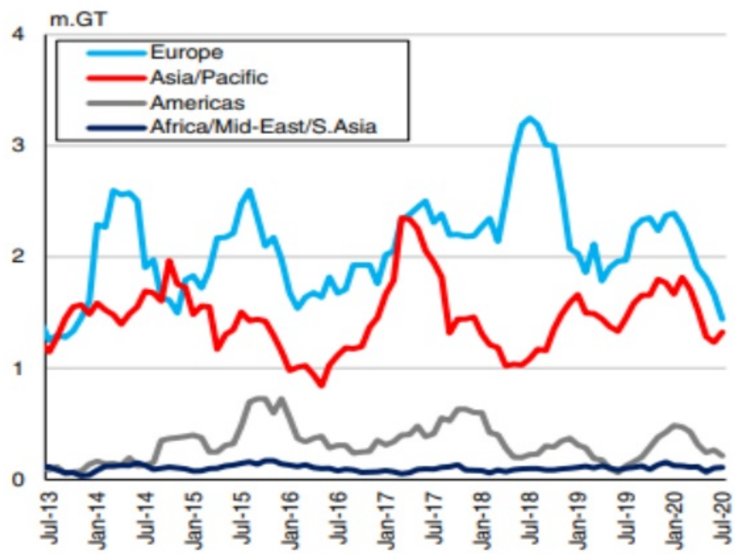


Figure 27: Buyers & Sellers. Source: Clarkson's (SIN).

Chapter 6: Conclusion - Limitations

The present research examines the volatility of second-hand Capesize vessels' price on the world dry bulk shipping market using the data of the last 100 transactions between July 2017 and August 2020. Specifically, a linear relationship by Ordinary Least Squares (OLS) fixed effect framework using MATLAB software (R2019a version) was applied to estimate empirically the macroeconomic and microeconomic factors influencing the second-hand Capesize vessels. Overall, the present study results provide evidence that second-hand Capesize vessel price differentiation is essential in the dry bulk market. Further, our findings accounted for many explanatory variables that appear to influence the Capesize vessel's price. The findings show that among many other factors, microeconomic variables such as age, shipowners, main engine type, builder, and country of builders, remain the most influential covariates. Noticeable factors such as ballast water treatment system, PSC records (DL), the flag had indirect and lesser influence in the relationship between selected macroeconomic variables and the second-hand Capesize vessels' price.

Besides, second-hand market prices did not lose its significance despite adding the most influential microeconomic factors.

However, the study had a limitation. In this study, an empirical model was built and tested for the macro and microeconomic level relationships. Although an attempt was made to account for other explanatory variables (microeconomic), due to COVID-19, the researcher could not collect data from shipowners. Another limitation was the size of the data and the observations. The sales report from Clarksons providing transactions from July 2017 up to date, and technical information were too limited. Therefore, the author could not collect the necessary data to examine the price volatility's behavior more profoundly for an extended period. Lastly, the study did not account for other markets such as containers and tankers or other ship types on the dry cargo market. Therefore, future studies have to be conducted in the line of thought. Despite the above limitation, the study incorporated both the supply and demand aspects, making the present study hypothesis more reliable. The dissertation also included several variables that have not been tested empirically, and specific attention has been given to each of the microeconomic factors that affect the price. Besides, the results have been tested and are representative of the entire dry bulk industry.

The findings can contribute to a better understanding of the microeconomic structure of the shipping market. Furthermore, the findings show that in the future, investors need to evaluate the vessel based on the technical specifications when making decisions rather than relying only on market information and the last transactions of a vessel with the same characteristics. There is an immediate need to adapt and copy other market patterns, like cars, airlines. The findings would also be useful for investors who construct their portfolios of real assets to attain superior capital gains. Therefore, sales and purchase market competitiveness should exceed the traditional model and superficial consideration of the asymmetrical information and move into a modern approach by adopting philosophies from other industries.

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