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Ship investment strategy: a case study of VLCC tankers

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SHIP INVESTMENT STRATEGY: A Case Study of VLCC Tankers

By

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DECLARATION

I certify that all the material in this dissertation that is not my own work has been certified, 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.

(Signature): ……………………………...

(Date): ……………………………...

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ABSTRACT

Title of Dissertation: **Ship Investment Strategy: Case study of VLCC Tankers**

Degree: **Master of Science**

For decades, the decision to invest in the ship has been and continues to be difficult due to cyclicality, volatility and capital-intensive nature of the shipping industry. Given that, this research explores the ship investment strategy for VLCC tankers which aims: (i) to find out investment decision tools that enhance the decision to either invest in a VLCC newbuilding or secondhand vessel through econometric modelling the long run cointegration relationship between VLCC NB/SH ratio with global shipping economic influential factors, (ii) to explore the investment or divestment timing tool which signal out /indicates the optimal time to invest or divest in VLCC tankers by observing the movement of VLCC NB/SH ratios (increase or decrease), and lastly (iii) to identify the most influential factors/significant variables which affects the VLCC NB/SH ratio.

Taking the VLCC tankers as a study case, the statistical result for this study has revealed that Suezmax secondhand price, VLCC scrap value, Aframax fleet development (dwt), world steel production, and crude Aframax fleet growth rate are the only significant factors which affects the VLCC NB/SH ratio, whereby Aframax fleet development(dwt) is a only factor which influences decision to invest in VLCC newbuilding vessel while the remaining significant factors influences decision to invest or divest in VLCC secondhand vessel. The strength of the proposed decision tools will help shipowners, academia, shipping companies and other industrial practitioners in the shipping industry to make accurate and reliable decisions which enables robust commercial gains instead of being in danger of creating losses and running into bankruptcy.

Keywords: Ship investment strategy, VLCC tankers, VLCC NB/SH ratio, cointegration, decision tool, timing tool, scrap value, Suezmax tankers, and Aframax tankers.

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ARCH	-	Autoregressive Conditional Heteroskedasticity
IMF	-	International Monetary Fund
LIBOR	-	London Interbank Offered Rate
VLCC	-	Very Large Crude Carrier
WB	-	World Bank
dwt	-	Deadweight tonnage
SPM	-	Shipping and Port Management
LNG	-	Liquified Natural Gas
NB/SH	-	Newbuilding /Secondhand Vessel
CLRM	-	Classical Linear Regression Model
OLS	-	Ordinary Least Squares Regression
UNCTAD	-	United Nations Conference on Trade and Development

CHAPTER 1- INTRODUCTION

1.0 Introduction

This chapter describes the overview of the study. It first introduces the background of the study, and then it describes the market condition of a liquid bulk sector. Furthermore, the chapter describes research interest, research questions and finally, it provides the structure of the entire dissertation.

1.1 Background of the study

Remaining in its verifiable and very much demonstrated position in global trade, seaborne trade continues to dominate the highest percent of international commodity trade in terms of volume (Talley & Ng, 2013). The global seaborne trade adds up to 80 per cent of the volume of goods traded globally. This connotes the considerable commitment of international shipping transportation in global trade despite an extended 4.1 per cent fall in the volume of international seaborne trade set off by the COVID-19 pandemic (UNCTAD, 2020).

The liquid bulk sector is one of the main sectors of international seaborne trade, particularly for the VLCC tanker[1] sub-sector that carries off the most fundamental wellspring of energy on the planet: crude oil (UNCTAD, 2020). The tanker shipping segment services the oil market with special utility but adds value to oil by enhancing mobility to deficit areas (Mayr & Tamvakis, 1999).

Alizadeh, Amir H. & Nomikos, 2004; Cheng & Duran, (2004) explained that international tanker shipping is necessary for balancing undistributed demand and supply of oil in different regions of the world. Despite, enormous widespread of uncertainty in maritime supply brought by restrictions imposed by COVID-19 such as labour shortage, but liquid bulk sector in-particular the crude oil tankers have shown enough resilience and remained to be the heart of the global supply chain for the oil industry, carrying thousands of tonnes of crude oil, oil products and chemicals each year from where oil is produced to places with high utility. For instance, from Middle East and West Africa to North America and Far East Asia (UNCTAD, 2020).

[1] VLCC tanker refers to a tanker ship with a dwt of 200,000 dwt or more that is designed for transportation of liquid bulk cargoes. VLCC tankers are mostly utilized to transport crude oil in a long distance particularly from the Middle East and West Africa to the Far East and North America.

1.2 Market conditions in the liquid bulk sector

The Liquid bulk sector deals with the carriage of crude oil, oil products and chemicals. Like other shipping sectors, the liquid bulk sector is not left behind with the development of science and technology and changing economic demand in the global shipping market. Moreover, with changing technology, the liquid bulk vessels also grow in sizes, carrying capacity, and efficiency in operation and technical capability.

Based on the size of the vessel, tanker ships are broadly categorized into Handysize, Panamax, Aframax, Suezmax and UL/VLCC tankers. Moreover, the liquid bulk carriers include other small size tanker vessels such as Small Tankers, Shuttle Tanker which basically carry crude oil from offshore oil wells to terminals, refineries or to bigger tankers and lastly, Asphalt & Bitumen Carrier. Tanker ships are principally deployed to transport crude oil or oil products in a short or long-term haul from the Middle East and West Africa to North America to any other part of the world. The table below shows the types of tanker, carrying capacity of the vessel and the nature of oil carried.

Table 1. Tanker Categories in Liquid Bulk Sector

Ship Type	**Capacity**	**Product Carried**
UL/VLCC Tanker	200,000dwt or above	Crude Oil
Suezmax Tanker	125,000 - 199,000 dwt	Crude Oil
Aframax Tanker	85,000 - 124,999 dwt	Crude Oil & Oil Products
Panamax Tanker	55,000 - 84,999 dwt	Crude Oil & Oil Products
Handysize Tanker	10,000 - 54,999 dwt	Oil Products & Chemicals
Small Tankers	5 - 10K dwt & <5K dwt	Oil Products & Chemicals
Shuttle Tanker		Crude Oil
Asphalt & Bitumen Carrier[2]		Asphalt & Bitumen

Source: Clarkson's Shipping Intelligence Network

1.2.1 Tanker Fleet Development

Figure 1& 2 below show the annual oil tankers, product and chemical tankers (in dwt million) fleet development. In the last 20 years, the world tanker fleet has been gradually increasing from time to time particularly from 2011 due to increased demand for crude oil, oil products and chemicals in the world.

[2] Asphalt and Bitumen Carriers refers to tankers fitted with heating systems which keeps asphalt and bitumen cargoes temperature above 150 degrees Celsius.

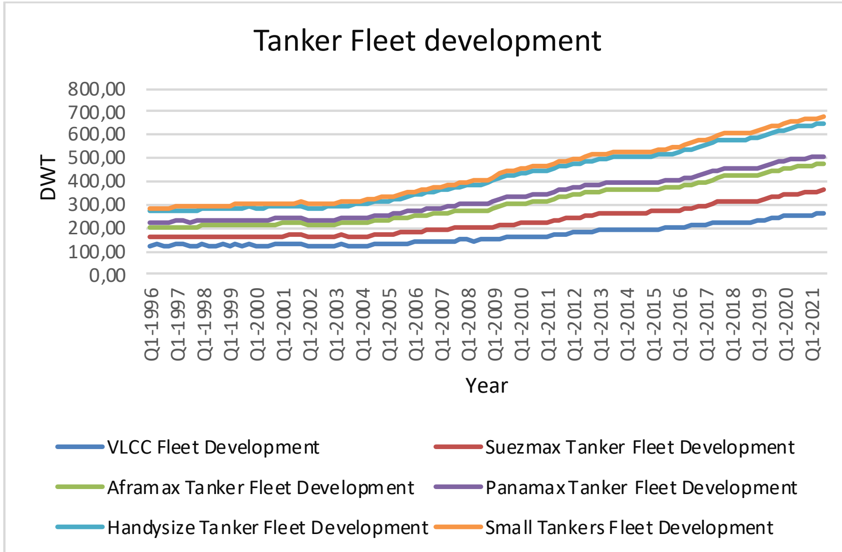

Figure 1. World Tanker Fleet Development (Q1/1996 – Q3/2021)

Source: Clarkson's Shipping Intelligence Network

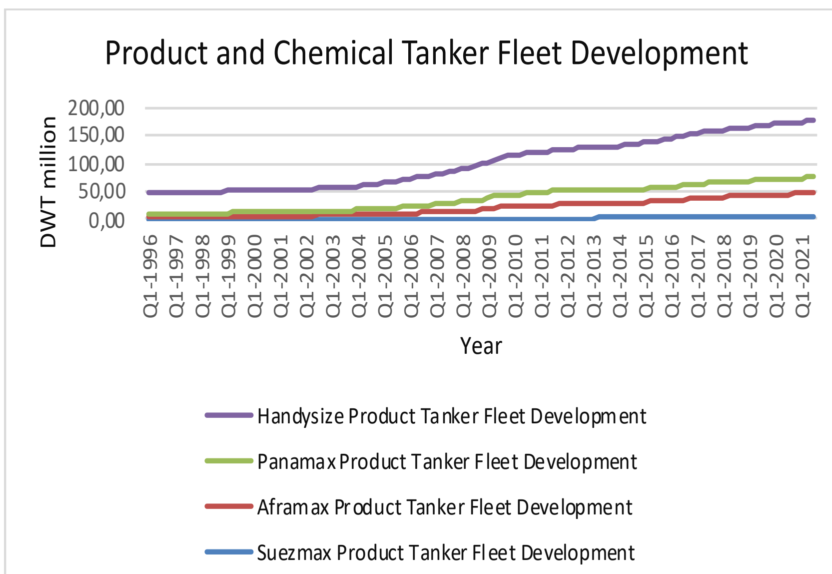

Figure 2. World Products and Chemical Tanker Fleet Development (Q1/1996 - Q3/2021)

Source: Clarkson's Shipping Intelligence Network

1.2.2 Tankers Price in the Market

Unlike other variables, the newbuilding and secondhand tanker prices follow similar patterns in the market such that when the price for one type of newbuilding or secondhand tankers increases the prices of other newbuilding tankers increases and vice versa. Ship prices are highly volatile in the market but the occurrence of different socio-economic crises in the global market, for instance, 2008 global economics crisis and Covid-19 pandemic, largely affects the shipping industry, particularly the tanker sector (See Figure 3&4).

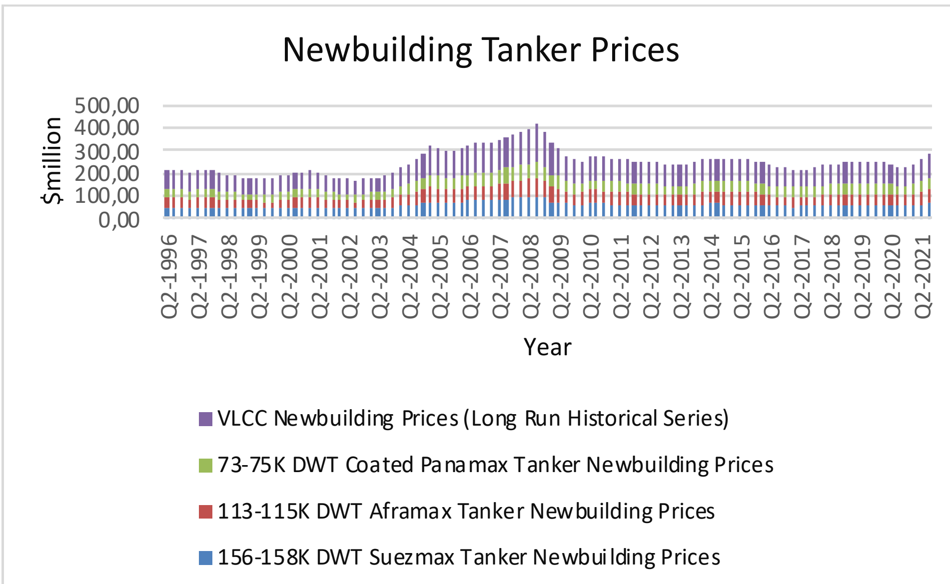

Figure 3. New-building tanker Prices (April,1996 - Sept, 2021)

Source: Clarkson's Shipping Intelligence Network

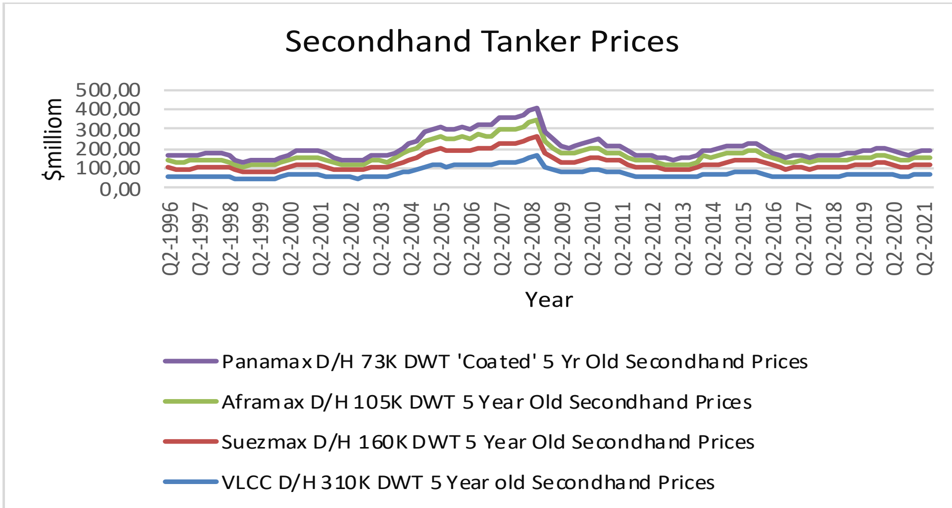

Figure 4. Five Years' Old Secondhand Tankers Prices (April,1996 – Sept, 2021)

Source: Clarkson's Shipping Intelligence Network

1.2.3 Tankers Scrap Value

Despite a decrease in the global volume of the recycled tonnage, ship recycling has remained a critical component in balancing demand and supply in the shipping market. Moreover, the scrap market is a major influencer of market equilibrium and freight rate. Tanker scrap value follows similar trends among different categories of tankers, just as conventional ship pricing (Karlis & Polemis, 2016; Merikas et al., 2015; UNCTAD, 2020).

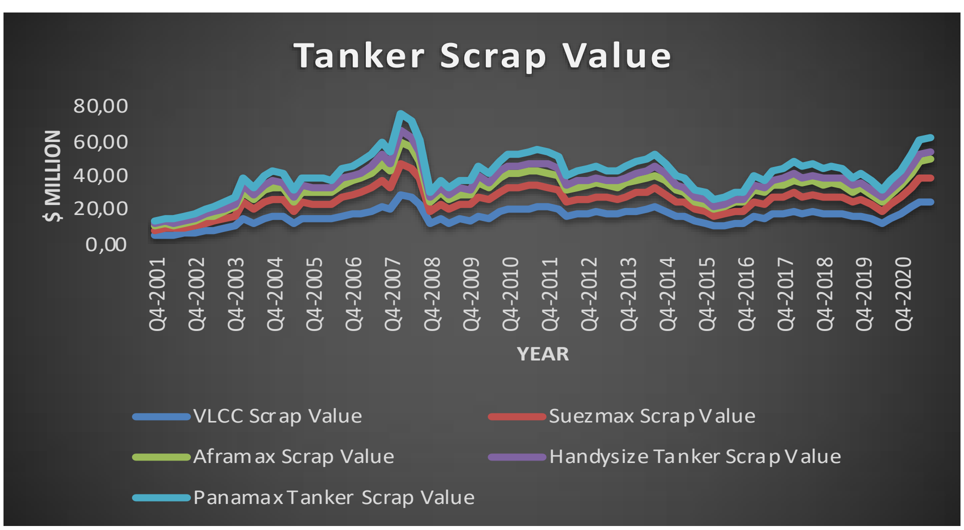

Figure 5. Tankers Scrap Value (October, 2001 - Sept, 2021)

Source: Clarkson's Shipping Intelligence Network

1.2.4 Tanker Sales Volume

Figure 6 represents the quarterly tanker sale in the tanker market for the five main types of tanker ships. The graph shows the number of ships sold varies proportionately with the size of the vessel. Such that the lower the ship size the higher the number of ships sold and vice versa, whereby the Handysize tankers are the most frequently sold carriers.

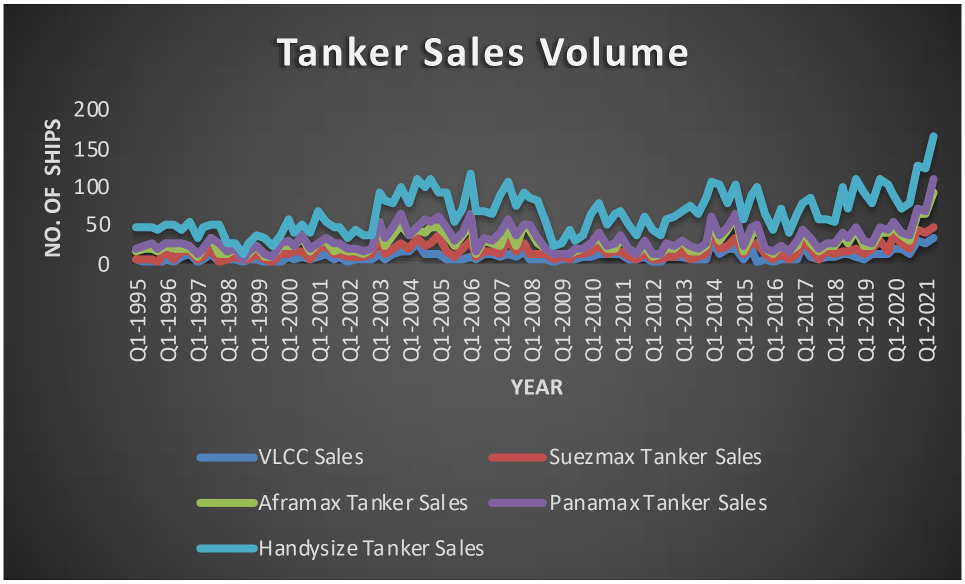

Figure 6. Tanker Sales Volume (January, 1995 - June, 2021)

Source: Clarkson's Shipping Intelligence Network

1.3 Research Interest

This study aims to the extend the current body of research knowledge to model the long-run cointegration relationship between VLCC NB/SH price ratio with global economic influential factors, and use such a relationship as a decision tool of either to invest in a VLCC newbuilding versus secondhand tankers, as well as an indicator for timing investment or divestment decision in tanker sector, particularly to VLCC tankers. More precisely, this study aims to answer the two questions of '*which*' and '*when*' to invest or divest in VLCC tankers. The 'which' question addresses the decision to either invest in a VLCC newbuilding or secondhand vessel, while the 'when' question addresses the timing decision issues of at what time one should invest or divest in a VLCC tankers.

Given the high volatility and capital-intensive nature of the shipping market, it is right idea at a right time that this study intends to assist or enhance shipowner's, operator's, entrepreneurs and academia to answer the two question and help them to overcome high risk of losses or even bankruptcy due to wrong investment decision or misleading of the ideal time to invest in VLCC tankers.

Moreover, the information from this study will provide useful knowledge to asset players that will help them to anticipate and make better decisions for hedging risks, lending, ordering and purchasing of ships; whereby for shipyard the knowledge and information obtained will help in pricing the VLCC newbuilding ships and in making judgement of either to expand their ship construction capacity or not.

1.4 Research Questions

Question 1: The study aims to find out the investment decision tool in VLCC tankers. This research study's the fundamental parameters or variables affecting investment decisions: the decision to either invest in a VLCC newbuilding or secondhand vessel. The study involves different macro and micro economic influential factors such as cost of capital (bank interest rate), global oil production and orderbook just to mention a few, that basically provides significant influences to the shipping sector, particularly the VLCC tankers sub-sector.

To answer the first research question, the study explored and modelled the long run cointegration relationship between VLCC NB/SH ratio with different macro and micro economic influential factors to decide on either to invest in a new VLCC newbuild or secondhand vessel.

Question 2: The study aimed to explore the investment or divestment timing decision in VLCC tankers. This aims to answer the question of when to invest or divest in VLCC tankers, which mainly focuses on determining the optimal time of investing or divesting in VLCC tankers. Therefore, based on VLCC NB/SH ratio increase or decrease this study determines the ideal time to invest or divest in a VLCC tankers. This will definitely reduce the ship prices risk facing investors in VLCC tankers.

Question 3: The study aims to identify the most influential variables of VLCC NB/SH ratio in both monthly and quarterly frequency models. The most dominant variables will be highly considered for investment decisions in VLCC tankers.

1.5 Structure of the thesis

Chapter 1 covers the background of the study, market condition in a liquid bulk sector, research interest, and finally, provides the structure of the thesis. It's a chapter which sets out the base for the entire research.

Chapter 2 reviews all relevant literature to research questions proposed in chapter one. The chapter covers shipping asset investment literature, the literature linking newbuilding and secondhand shipping market and literature in tanker sectors. Moreover, the chapter introduces the research gap identified through review literature and finally, covers the contribution of the study to literature, shipping companies, shipowners, entrepreneurs and academia.

Chapter 3 examines the data collected, provides the economic justification of the chosen variable and describes the conceptual steps used to build the OLS regressions model. Moreover, the chapter provides the study's methodology which clarifies how results were interpreted and finally, gives out the study's limitations.

Chapter 4 presents the outcomes identified in each step or process for developing a classic linear regression model as clearly substantiated in the previous chapter. Moreover, this chapter establishes the statistical relationship between variables and explores how each independent variable and dependent variable is explained.

Chapter 5 provides the discussion and presentation of the empirical results calculated in chapter four of this study. Moreover, this chapter examines the significant factors identified through the classic linear regression model procedures and compares the model with the previous studies to support the claims made in this study.

Chapter 6 concludes on the main results to support the aim and objectives of the study. Furthermore, the chapter provides the recommendations for optimal investment decisions in the VLCC tanker sub-sector, which assists to minimize the state of uncertainties and helps shipping companies, shipowner's, charterer's, shipping banks with ideas that lessen the burden of financial risks in the shipping industry.

CHAPTER 2 - LITERATURE REVIEW

2.0 Introduction

The chapter provides review of all relevant literature to research questions proposed in chapter one. The chapter covers shipping asset investment literature, the literature linking newbuilding and secondhand shipping market and literature in tanker sectors. Moreover, the chapter introduces the research gap identified through review literature and finally, covers the contribution of the study to literature, shipping companies, shipowners, entrepreneurs and academia.

2.1 Shipping Asset Investment Literature

Strandenes, Siri P., (1984) presents a framework for valuation of the ship, suggesting the ship prices are primarily unpredictable. He further explained that the asset (ship) pricing can be explained in absolute or relative terms; whereby absolute valuation relates freight revenues to the price level of the asset while the relative valuation relates the prices of the ship in different market segments.

Gatev et al., (2007) applied the concept of relative valuation in the stock market with a trading strategy called pairs trading and explained that “pick two common stocks that have moved together in the past. If they deviate in value, buy the cheap one and sell the expensive one. If history repeats itself, prices will converge once more, and speculators will gain profit”. This concept applies to shipping whereby high freight rates in a single market portion (dry bulk market) does not naturally deliver high freight rates in the other segment (tanker market).

Arguing that increased contracting of the tankers reduces the potential future supply of new dry bulk carriers as shipbuilding capacity is scarce. However, Beenstock & Vergottis, (1993) contended that freight rate in the two shipping markets cannot follow too far apart due to shipbuilding and scrapping activity as well as existence of combined carriers that can operate in both segments.

Kavussanos, (1996c) explained ship prices and their fluctuations in the market are of utmost significance to investors in the shipping industry taking decisions regarding purchase and sale of vessels. Alizadeh & Nomikos, (2006) explained that the question of the ship price being rational to the fundamental value of the ship are of exceptional significance to ship investment decisions.

Moreover, the existence of ship price volatility provides grounds for occurrence of ship price risk that need to be addressed.

Kavussanos & Visvikis, (2006) clarified that high volatility and cyclicality in rates and prices makes risk management a vital issue and takes a central role in the effective strategic management of business in the shipping industry.

Xu et al., (2011) applied the cointegration method to examine the dynamic relationship between the freight rate and new-building ship prices in a dry bulk sector and found that the freight rate leads the new-building ship in the dry bulk sector. Apart from the cointegration analysis, Lunde, (2002) developed a continuous time model to bridge the freight rate and ship price based on net present value criteria.

Kou & Luo, (2015) modelled the relationship between ship price and freight rate with structural changes and found that the sensitivity of ship prices to freight rate changes are theoretically found invariant to structural changes while the empirically the result showed that the sensitivity of the ship prices is lower for larger ships and for new ships. Moreover, the result showed that secondhand ship investors are more interested in short-term benefits.

A recent work, Alexandridis et al., (2018), provided a portfolio approach that utilizes the modern portfolio theory to improve the freight rate risk management. Alizadeh & Nomikos, (2007b) compared the secondhand ship price and freight rate ratio with its long-run average. This proportion is bigger, it shows that ship prices are excessively high, and accordingly expected to fall. Fan & Luo (2013) applied a binary and nested logit models to examine the ship investment and choice decision. They discovered diverse capacity expansion behaviours between big companies and smaller ones and preference orders for new orders and secondhand ships and ship size categories.

2.2 Literature linking newbuilding and secondhand shipping markets

Kou et al., (2014) intimated that the relationship between new-building and secondhand ship prices contains information that investors and shipowners can use to help make decisions on the choice of ordering new or purchasing old ships which may lead to very different investment performance in a fast-changing market environment. Moreover, Beenstock & Vergottis, (1989); (Beenstock & Vergottis, 1989a; Beenstock & Vergottis, 1993) in their adoption to Markowitz portfolio theory for determining the ship prices explained that new and secondhand ship prices are perfectly correlated and therefore, new and secondhand ships are same asset differing only in age. Strandenes, S. P., (1986) in concurring with other studies in the literature explained that secondhand ship prices are a weighted average of short-term and long-term profits that depend on expectations about the future of the global shipping industry.

Another absorbing fact is one written by Veenstra, (1999) who established that secondhand ship prices of various ship types and sizes can be clarified in terms of the time charter rate, newbuilding ship prices and scrap prices. In addition to that, Kavussanos, (1996b); Kavussanos, (1996a); Kavussanos, (1997) in examining the volatilities in the tanker and dry vessel sector through ARCH modelling found that the prices of the small ships are less volatile compared to larger ships and the volatility nature of this volatility varies across the sizes.

Tsolakis et al., (2003b), in his analysis of the cyclical nature of the secondhand ship prices found that newbuilding prices and time charter rates have a positive effect on secondhand prices for types of ships. However, new-building price variables have a higher impact on second ship prices compared to time charter rate.

Merikas et al., (2008), in modelling the investment decision of the entrepreneur in the tanker market clarified that the cyclicality of the shipping sector along with the expectations framed by the agents (the entrepreneur, the ship owner and the broker) operating in it, determine the movement of the ratio (SH/NP) and hence the decision of the entrepreneur.

Alizadeh & Nomikos, (2003), in their research for secondhand ship prices - volume relationship in the sale and purchase market for dry bulk vessels found that price changes are useful in predicting the trading volume. Moreover, found that increases in trading activity lead to a reduction in the market volatility. However, such findings go in contrast to a number of similar studies in the financial markets which showed the existence of a positive relationship between price change volatility and volume (Chen & Chang, 2006; Lee & Rui, 2002).

Hale & Vanags, (1992) and Glen, (2006) tested the hypothesis whether the market for ships is efficient through a dynamic framework of secondhand tanker and dry vessel prices. They conclude that there is long run market efficiency in the shipping industry.

2.3 Literature in Tankers

For decades, ship investment has been a difficult decision among shipping market practitioners. Shipping market is cyclical and volatile in nature. Price risks[3] manifested by ship price and freight rate fluctuations is a challenge facing investors in the tanker market (Haralambides et al., 2005; Tinbergen, 1931). Meanwhile Batchelor et al., (2007), argued that dynamic behaviour (uncertainty and unpredictability) of a shipping market is a stumbling block to investors in oil tankers. Therefore, identifying the proper time for purchase and sale of a ship is the best solution for investment in a tanker sector (Beenstock & Vergottis, 1989; Tsolakis et al., 2003).

2.4 Research Gap (includes research contribution)

Despite several literature on ship price risk[4], there is little evidence that investment or divestment decisions based on VLCC newbuilding/secondhand ratio (VLCC NB/SH ratio) could be beneficial to investors in VLCC tankers. Pesaran & Timmermann (1995), examined the robustness of price/earnings (P/E) ratio to test the predictability of U.S stock returns. Moreover, they argued for investors to utilize such predictability to earn profit in excess of simple buy and hold strategy in the market index. Although their study is typically based on the stock market, their concept is applicable in shipping markets which trade on ships as physical assets.

Therefore, this study applies VLCC NB/SH ratio as a decision tool for investment or divestment in the tanker market in-particular the VLCC tankers. The courage to utilize VLCC NB/SH ratio as an indicator for investing or divesting aroused through acknowledging the ability different economic parameters has in predicting the stock returns in financial markets. For instance (Lander et al., 1997), applied Price-Earning (P/E) ratio as well as the interest rate spread to forecast the movement of stock market indices. Moreover (Fama & French, 2021; Roll, 1995), applied the Price-Earning (P/E) ratio to predict the stock returns. Therefore, based on research gap provided above the study will contribute to literature as follows:

First, there has been no prior evidence on the performance of trading strategies based on signals provided by VLCC NB/SH price ratio with global market influential factors and how effective it influences investment or divestment decisions in VLCC tankers.

[3] Price risk refers to the uncertainty surrounding cashflows as a result of potential changes in both output (goods and services) and input (labour and raw materials) prices.
[4] Ship Price Risk refers to the risks that arises from fluctuations in the price of a firm's assets, whereby for in shipping industry the value of the ships is the most important asset for a shipping company.

Considering the ship as a real capital asset, its revenue does not only depend on operation but also on the sale of the asset itself. Therefore, it’s in this setting the study examines how effective VLCC NB/SH ratio can be used as an indicator to influence choice decisions to either invest in a VLCC newbuilding or secondhand tankers.

Second, the study compares the price risk for VLCC tankers through looking at VLCC NB/SH ratio increase or decrease. One will be able to understand how VLCC tanker riskier is and be able to identify ideal time to invest or divest in VLCC tankers either in a short- or long-term period.

Finally, the study bridges the gap between theory and practices through theoretical analysis of a ship investment strategy which will practically help shipping companies, investor’s, charter’s, academia and other practitioners to make proper investment decisions in the shipping market particularly to the VLCC tanker sub-sector.

CHAPTER 3 - DATA AND METHODOLOGY

3.0 Introduction

In this chapter, the methodology which examines the ship investment strategy for VLCC tankers is introduced. The chapter first describes the data collected and then provides the economic justification of the chosen variables and describes the conceptual steps used to build the OLS regression model. Furthermore, chapters develop some hypotheses and clarify how to test and interpret them, and finally, it gives out the study's limitations.

3.1 Data Description and Selection

Apart from the data description, the dataset for this study was thoroughly examined and evaluated to discover any inconsistencies or irregularities in the dataset that could lead to the model's biasness. This was accomplished through a visual evaluation, as well as a graphical analysis of each variable used in this study.

3.1.1 Dependent Variables

For the purpose of this study, the two variables were appropriately selected to make a ratio of VLCC newbuilding and secondhand price as a dependent variable for evaluation of choices and timing of investment or divestment decision in VLCC tanker. The Long run Historical Series of VLCC Newbuilding and VLCC Double Hull 310,000 dwt 5 Years Old Secondhand Prices in dollar ($million) terms were successfully collected from Clarkson's Shipping Intelligence Network.

Table 2. List of Dependent Variable for Monthly & Quarterly Models

Dependent Variable		
OLS_Name	**Description**	**Unit**
RATIO_NB_SH	VLCC Newbuilding Prices (Long Run Historical Series)	$m
	VLCC D/H 310K DWT 5-Year-old Secondhand Prices	$m

3.1.2 Independent Variables

Several independent macros, micro and other influential factors were selected for this study. The factors include LIBOR (London Interbank Offered Rate) as a proxy of cost of capital, Global Oil Production, Brent Crude Oil Price, HSFO Bunker Price in Singapore, Global Steel Production, VLCC Scrap Value, VLCC Fleet Development(dwt) and other industrial economic factors were selected and careful examined to see long run cointegration between the dependent and independent variables for this study (see table 3).

*Table 3***.** List of Independent variable for Monthly & Quarterly Frequency Models

Independent Variables		
OLS_Name	**Description**	**Unit**
INDUST_CHINA	Industrial Production China	(%)
G_OIL_PROD	Global Oil Prod.	mbpd
UL_VLCC_OBK_dwt	UL/VLCC Orderbook	dwt
C_AFRA_FLGROWTH	Crude Aframax Fleet Growth	(%)
AFRA_OBK_dwt	Aframax Crude Tankers (85-124,999 dwt tonnes) Orderbook	dwt
PANA_NB_	73-75K DWT Coated Panamax Tanker Newbuilding Prices	$m
BRENT_CRUDE	Brent Crude Oil Price	$/BBL
VLCC_FL_DEV	VLCC Fleet Development	No
VLCC_DEMOL	VLCC Demolition	dwt
VLCC_SCR	VLCC Scrap Value	$m
AV_VLCC_EARN	Average VLCC Long Run Historical Earnings	$/day
AV_SUEZ_EARN	Average Suezmax Long Run Historical Earnings	$/day
SUEZ_SH	Suezmax D/H 160K DWT 5-Year-Old Secondhand Prices	$m
SUEZ_NB	156-158K DWT Suezmax Tanker Newbuilding Prices	$m
INDUST_EU	Industrial Production Europe	(%)
SUEZ_SCR	Suezmax Scrap Value	$m
SUEZ_SH	Suezmax D/H 160K DWT 5-Year-Old Secondhand Prices	$m

HSFO_SINGAPORE	HSFO 380cst Bunker Prices (3.5% Sulphur), Singapore	$/Tonne
EX_SDR	Exchange Rates SDR	USD
LIBOR_LONDON	LIBOR Interest Rates	(%)
VLCC_FLD_DWT	VLCC Fleet Development	dwt mil.
SUEZ_FDL_DWT	Suezmax Tanker Fleet Development	dwt mil.
AFRA_FDL_DWT	Aframax Tanker Fleet Development	dwt mil.
PANA_FLD_DWT	Panamax Tanker Fleet Development	dwt mil.
SUEZ_EARN	Average Suezmax Long Run Historical Earnings	$/day
EX_CHINA	Exchange Rates China	Yuan/$
WORLD_STL_PRO	World Steel Production	000't
SUEZ_FLG	Suezmax Tanker Fleet Development	dwt mil.
SUEZ_OBK_dwt	Suezmax Crude Tankers (120-199,999 dwt tonnes) Orderbook	dwt

The data variables were chosen based on economic justification, their relationship to dependent variables and to literature. For instance, Fuller et al., (1993); Jaffe et al., (1989); Lander et al., (1997), all applied the price- interest rate relationship in calculating stock returns in financial markets. The data for these variables were collected both in a monthly and quarterly frequency, that were used to develop two regression models, whereby each model utilized the VLCC newbuilding and secondhand prices ratio relationship with significant variables as an indicator for investment or divestment timing decisions, as well as decision tool of either to invest in VLCC newbuilding or secondhand VLCC tankers.

Like any other financial market, investment in the shipping industry is a bit challenging. The operating profit for ship owners that come through spot rate, time charter rates or through vessel resale value are less unpredictable but cost of capital and all other ship operation costs keep increasing from time to time. All this needs to be solved with an appropriate ship investment decision tool that enhances proper choices of the kind of ship to invest in and knowing the right time to invest or divest in a shipping industry.

In this study, the coverage focuses on the relationship between vessel value - cost of capital, and other global economic influential factors, which basically affects the tanker operations particularly the VLCC tanker sub-sector. The capital-intensive nature of the shipping industry and uncertainty on ship investment caused by high volatility in shipping market, particularly on ship prices, freight rate, and interest rate fluctuations in many ship financing countries such as USA, China, UK, Japan, Norway, Switzerland and some in Greece and Singapore, as well as fluctuation in global oil production and world steel production has made investment in tanker market more dramatic and more unpredictable.

Therefore, this study worked out to solves the above-mentioned difficulties, as well as reducing the cash flow and liquidity or risk of bankruptcy to private individuals and shipping companies investing or intending to invest in shipping industry particularly VLCC tanker sub-sector, through giving out appropriate indicator for investment or divestment timing decisions (Alizadeh, Amir & Nomikos, 2009).

3.1.2.1 Global Macro-economic Factors

Table 3 shows, several exogenous variables like Global steel production, Brent Crude oil prices, Global oil production, LIBOR rate and exchange rate were also included, since they are considered to be the industry’s key drivers as explained below:

Global Oil Production: For many years oil production is a business which is organized in a cartel form of business, where suppliers i.e. OPEC countries have the ability to influence supply and demand of oil in the world through increasing or decreasing production of oil that affects oil price in the world particularly to non-oil producing countries where the majority depends on importation of crude oil and oil products for domestic consumption. Decrease in oil price positively affects the demand (derived demand) for maritime transport and vice versa, more particularly to crude oil carriers such as VLCC tankers which involves for majority transportation of crude oil in the world. For instance, from the Middle East and West Africa to North America (Borenstein et al., 1997; Ringlund et al., 2008).

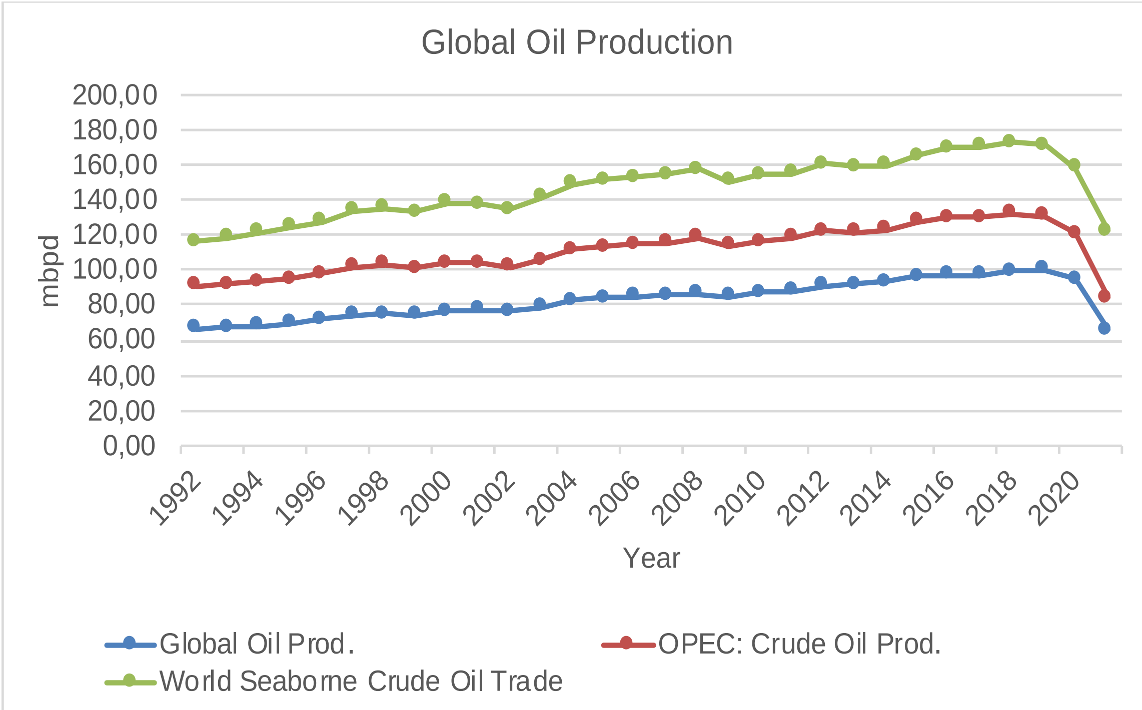

Figure 7. Global Oil Production, OPEC: Crude Oil Production and World Seaborne Crude Oil Trade in mbpd term (1992 – 2021).

Source: Clarkson's Shipping Intelligence Network

Brent Crude Oil Prices: Although, different factors affect global oil production, for many years' fluctuation of Brent crude oil prices has been used as a global benchmark for oil production decisions among oil producing countries in the world. Intuitively, it can be argued that oil producers such as OPEC members, USA and Russia's decision to increase supply or to cut off oil supply largely depends on Brent Crude Oil Prices that directly affects demand for oil in the world. Moreover, this affects the demand for maritime transport, particularly oil tankers which are basically used as a means of transportation from one place to another in the world (Borenstein et al., 1997).

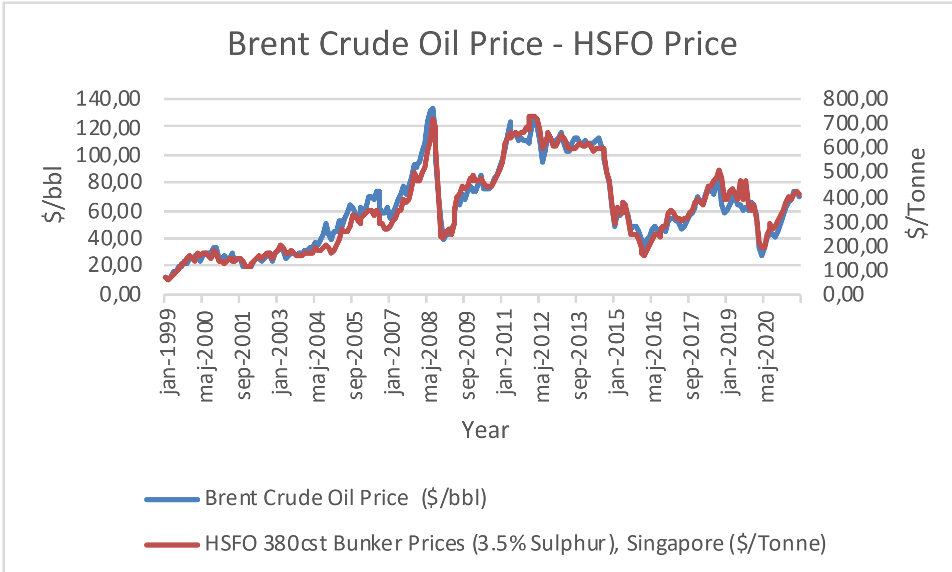

Figure 8. Brent Crude Oil Price & HSFO 380cst Bunker Prices (3.5% Sulphur), Singapore (Jan,1999 – August, 2021).

Source: Clarkson's Shipping Intelligence Network

London Interbank Offered Rate (LIBOR): The capital-intensive nature of the shipping industry influences most shipowners and private individuals to invest in a shipping business through borrowing money from banks to finance ships. In many ship financing countries like USA, China, UK, Japan, Norway, Switzerland, South Korea, Greece and Singapore banks such as JP Morgan, Export-Import Bank of China, Citigroup, Bocomm Financial Leasing, ICBC Financial Leasing, DVB, Danske Bank, Nordea, Korea Development Bank (KDB), Breakwater Capital, and Berenberg Bank involves in providing short or long terms loan to investors in shipping industry. Therefore, it was impossible for this study not to consider the LIBOR rate due to its influences on ship prices risks (Lloyd's List, 2021; Merika et al., 2019).

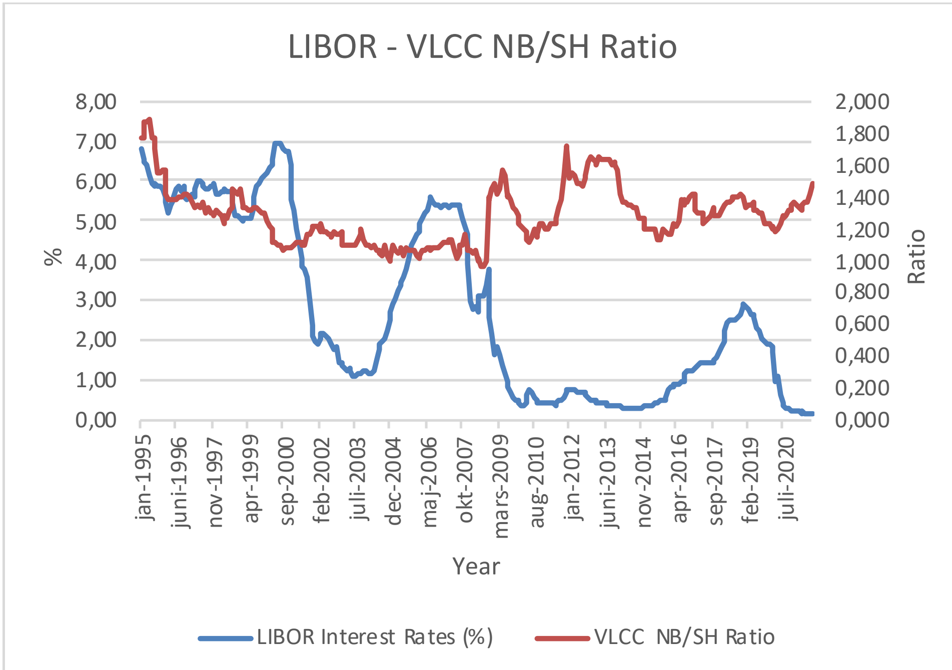

Figure 9. LIBOR Rate and VLCC Newbuilding and Secondhand Prices (January, 1995 – July, 2021).

Source: Clarkson's Shipping Intelligence Network

<u>World Steel Production</u>: The relationship between steel production and ship prices is a relationship that definitely cannot be separated. Ship construction needs steel as key resources for its construction. Moreover, ships are considered a fundamental source of steel after the lifespan of a vessel, where the steel obtained from ships can be used for other economic value. This kind of economic relationship tells the strong influences the world steel production has on ship prices, in the sense that when steel production declines the ship prices increases due to scarcity of steel in the market which are used as a fundamental raw material for ship construction and vice versa (Merikas et al., 2015).

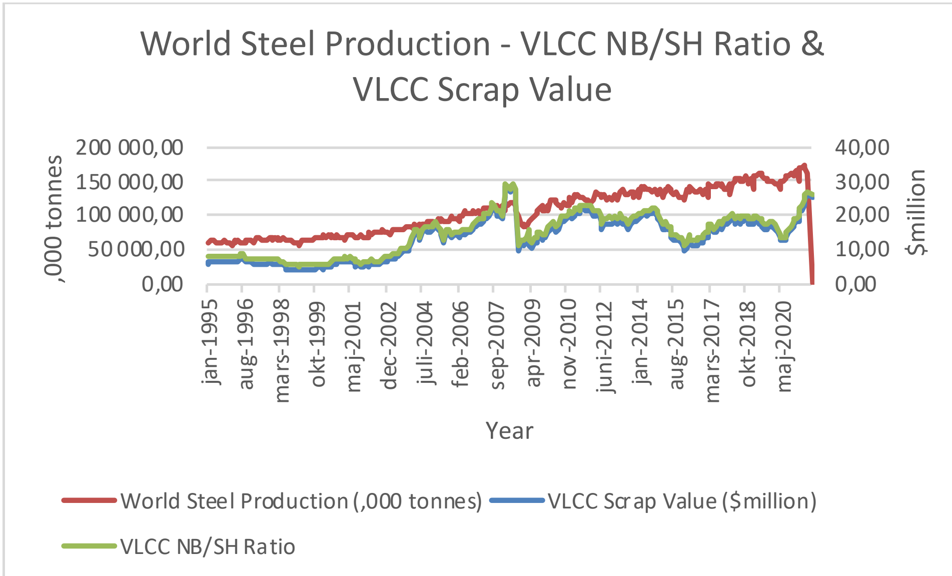

Figure 10. World Steel Production (,000 tonnes) and VLCC NB/SH Ratio & Scrap Value.

Source: Clarkson's Shipping Intelligence Network

3.1.2.2 Industry's Key Influential Factors

Very Large Crude Carrier (VLCC) Orderbook: Orderbook variables were included in the dataset of this study as a key independent variable that affects the VLCC NB/SH ratio. However, It is highly considered that the newbuild order book relates much with VLCC new build vessels and negatively influences secondhand prices (Tsolakis et al., 2003). Oderbook information from different types of tanker ship were included in the data set to see the influences and relevance of other tanker segments with VLCC tanker price. The following orderbook variables were included in a model's dataset:

- UL/VLCC Orderbook
- Suezmax Crude Tankers (120- 199,999 dwt tonnes) Orderbook
- Aframax Crude Tankers (85-124,999 dwt tonnes) Orderbook

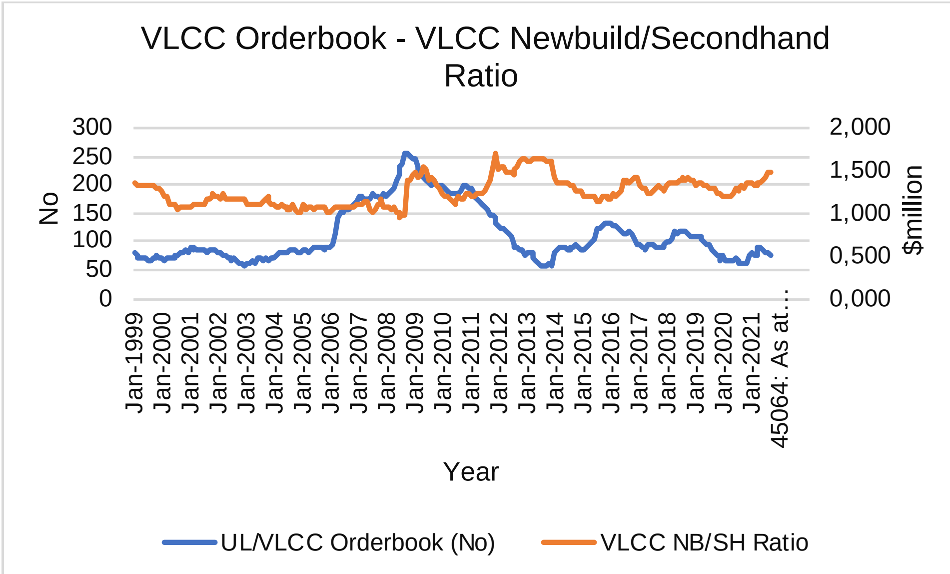

Figure 11. VLCC Orderbook (No) versus VLCC Newbuilding & Secondhand Prices (January, 1999 – July, 2021).

Source: Clarkson's Shipping Intelligence Network

Fleet Growth & Development: Fleet development in different tanker segments provides significant influences on ship prices. Fleet development helps to balance the demand and supply for tankers in the world. Insufficient fleet development in numbers or deadweight tonnage creates scarcity on demand side of maritime transport services particularly to crude oil carriers and vice versa. Fleet development information for different types of crude oil carriers were included in the data variables to see influences of one tanker segment to dependent variable (Brooks, M. R., 1985). The following fleet development variables were included in a model's dataset:

- VLCC Fleet Development(no)
- VLCC Fleet Development (dwt mil.)
- Suezmax Tanker Fleet Development (dwt mil.)
- Aframax Tanker Fleet Development (dwt mil.)
- Panamax Tanker Fleet Development (dwt mil.)
- Crude Aframax Fleet Growth (%)

3.1.3 Pre-Statistics Results of the Variables

3.1.3.1 Descriptive Statistics for a Monthly Frequency Model

The dataset comprises 263 monthly observations from January 1999 to December 2020 for both dependent variables (RATIO_NB_SH) and all independent variables used in monthly frequency regression models. The result includes the minimum and maximum value, the mean, median, standard deviation, and skewness as presented in Table 4 and 5.

Table 4. Preliminary Statistics Results for Dependent Variable (Monthly Frequency model)

			Dependent Variable			
Row	**Maximum**	**Minimum**	**Mean**	**Median**	**Std_Dev**	**Skewness**
RATIO_NB_SH	1,72	0,96	1,25	1,22	0,17	0,70

Table 5. Preliminary Statistics Results for Independent Variables (Monthly Frequency model)

			Independent Variable			
Row	**Maximum**	**Minimum**	**Mean**	**Median**	**Std_Dev**	**Skewness**
PANA_NB_	68,00	29,50	44,06	44,00	8,73	0,62
INDUST_CHINA	23,20	-13,50	10,93	10,25	5,06	-0,55
BRENT_CRUDE	133,21	10,26	61,46	57,66	30,55	0,45
G_OIL_PROD	102,07	72,48	87,61	86,81	7,95	0,00
VLCC_FL_DEV	257,42	120,09	168,54	159,30	40,85	0,53
VLCC_DEMOL	3780769,00	0,00	318189,55	0,00	551952,77	2,69
UL_VLCC_OBK_dw	79725278,00	17337580,00	35054016,64	27807730,50	15434505,64	1,06
VLCC_SCR	28,39	3,82	14,25	15,25	5,54	-0,25
AV_VLCC_EARN	204361,14	3185,06	43661,09	34332,79	34290,40	1,75
AV_SUEZ_EARN	140515,84	4866,55	34407,89	28986,20	23627,90	1,29
SUEZ_SH	105,00	35,00	54,93	49,00	16,52	1,17
C_AFRA_FLGROWT	11,28	-3,26	2,60	2,76	3,17	0,17
AFRA_OBK_dwt	19833996,00	2427696,00	9789280,66	9959531,00	4725709,60	0,42

3.1.3.2 Descriptive Statistics for a Quarterly Frequency Model

The dataset comprises 85 observations from the first quarter of 2000 to second quarter of 2021 for both dependent variables (RATIO_NB_SH) and all independent variables used in a quarterly frequency regression model. The result includes the minimum and maximum value, the mean, median, standard deviation, and skewness as presented in Table 6 and 7.

Table 6. Preliminary Statistics Results for Dependent Variable (Quarterly Frequency model)

Dependent variable						
Row	Maximum	Mimimum	Mean	Median	Std_Dev	Skewness
RATIO_NB_SH	1,71	0,99	1,25	1,21	0,17	0,7

Table 7. Preliminary Statistics Results for Independent Variable (Quarterly Frequency model)

Independent Variables						
Row	Maximum	Mimimum	Mean	Median	Std_Dev	Skewness
SUEZ_NB	100	43	62,84	61,25	12,39	0,95
INDUST_CHINA	28,1	-9,37	11,2	10,35	5,3	-0,13
INDUST_EU	29,56	-20,35	0,75	1,42	5,87	0,05
SUEZ_SCR	18,47	3,06	8,94	9,28	3,16	0,24
SUEZ_SH	105	38	55,77	49,5	16,47	1,25
HSFO_SINGAPORE	732,73	117,62	359,1	323,25	170,15	0,45
EX_SDR	1,63	1,25	1,45	1,45	0,09	-0,22
GLOBAL_OIL	101,55	62,31	88	87,13	7,97	-0,31
LIBOR_LONDON	6,83	0,19	2,08	1,44	1,85	1,07
VLCC_FLD_DWT	258,63	121,44	172,05	161,63	42,15	0,47
SUEZ_FDL_DWT	97,72	37,07	62,59	60,76	18,92	0,21
AFRA_FDL_DWT	116,53	50,12	84	91,12	22,12	-0,23
PANA_FLD_DWT	34,44	20,7	28,26	30,6	4,6	-0,44
SUEZ_EARN	109024,1	5176,62	34591,65	28972,13	21867,07	0,97
EX_CHINA	8,28	6,09	7,17	6,84	0,81	0,35
WORLD_STL_PRO	485624,8	203811	342255,85	351731	83135,49	-0,2
VLCC_OBK	54,59	7,68	21,96	19,01	11,04	1,04
SUEZ_FLG	10,33	-3,56	4,46	4,56	3,31	-0,11
AFRA_CRUDE_FLG	10,4	-3,22	2,46	2,52	3,2	0,3
AFRA_OBK_dwt	19615695	2527896	9998252,71	10169446,5	4706506,4	0,4
SUEZ_OBK_dwt	27462708	5389608	13010727,9	10704470	5752543,8	0,81

3.2 Methodology

This research employs a quantitative research method on the application of econometric technique to build Ordinary Least Square (OLS) Regression, where regression models were built using the data obtained from Clarksons' Research Intelligence Network. The regression was carried out using MATLAB statistical software to investigate the long run relation between the dependent and independent variables, and followed OLS Regression Flowchart (Sahoo, 2021) as presented in *Appendix 1*. After, intensive literature review conducted to examine the previous studies which explored over ship price risk to find out the gap this study researched on. Steps followed in model's construction are as follows:

1) Review of theories to construct a theoretical framework that helps to clarify chosen variables
2) Data assortment
3) Validation of data (through graphical analysis)
4) Estimate of pre-statistical results for the variables
5) Determination of variable's correlation
6) Estimation of regressions and residual diagnosis
7) Validation of the R-Squared and statistical significance of variables
8) Model interpretation and usage

In this study, two linear regression model were developed to examine how different macro and micro-economic variables (independent variables) such as global oil production, world steel production and interest rate affects ship price in shipping market, specifically to VLCC tankers whereby VLCC newbuild and secondhand ratio (VLCC NB/SH ratio) applied as a dependent variable. Moreover, worked to investigate the long run relationship between dependent and independent variables, and applied such a relationship as an indicator for timing decision to invest or divest in VLCC tankers, as well as using such a relationship as a decision tools of either to invest in VLCC new built vessel or VLCC secondhand tankers.

The mechanism for decision or results interpretation is that, the positive regression coefficient of significant variables indicates the explanatory variable relationship with VLCC newbuild vessel while the negative regression coefficient implies the explanatory variable relationship with VLCC secondhand vessel. Meanwhile, ratio decrease indicates that VLCC secondhand price will become relatively more expensive than VLCC newbuild vessel then one should invest in VLCC secondhand vessel instead of buying VLCC newbuild vessel while the ratio increase indicates that one should invest in VLCC newbuild vessel and dis-invest in VLCC secondhand vessel either by reselling or scrapping the vessel to recoup some money.

Monthly and quarterly frequency models were chosen as it allows for reliable results to be achieved and that can be used to make confident economic decisions. Moreover, the error correction term (ECT) was added in both models to capture the short and long run effects of the independent variables on the dependent variable.

The models work to analyze the significance of the independent variables (*X*) and how their fluctuations influence the dependent variable (*Y*). Such that, the variations of dependent variables will be influenced by explanatory variables (Fabozzi et al., 2014). The functional relationship between Y and X variable is expressed by the equation as follows:

$\Upsilon = f(\chi)$ ……………………..…..... (*Equation 1*)

Assuming that the residuals are independent of ·, then the above equation is modeled as follows:

$\gamma = f(\chi) + \varepsilon$ …………………….... (*Equation 2*)

The null hypothesis is that the independent variables have neither impact on choices nor on timing decisions for investment or divestment in a dependent variable. The alternative hypothesis stated that the independent variable has significantly impacted on either choices decision or timing decisions to invest or divest in a dependent variable.

Ho: B1 = 0 **…………………….** (*Equation 3*)

H1: B1≠ 0 **…………………….** (*Equation 4*)

The general form of regression models with more than two variables is as follows:

MODEL I:

$$Y_{1t} = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \dots\dots\dots.. \beta_t X_{kt} + \mu_{1t}$$

- μ_{1t} should be **I (0)** if the variables $Y_{1t},\ \beta_1 X_{1t} + \dots \beta_t X_{kt}$ are cointegrated

MODEL II

$$Y_{2t} = \beta_0 + \beta_1 X_{2t} + \beta_2 X_{2t} + \dots\dots\dots.. \beta_t X_{kt} + \mu_{2t}$$

- μ_{2t} should be **I (0)** if the variables $Y_{2t},\ \beta_2 X_{2t} + \dots \beta_t X_{kt}$ are cointegrated

Where:

- Y_{1t} *and* Y_{2t} are dependent variables;
- x_{1t} , x_{2t} ….. x_{kt} are independent variables;
- β_0 is a constant or intercept
- β_1 , β_2 , …….. β_t are coefficients of the independent variables x_{1t} , x_{2t} …. x_{kt}

The relationship between two variables can be estimated with the help of different techniques in the most basic setting, but not all techniques are equally viable or good for all types of variables. The ideal technique depends on the nature of the variables and the objectives of the relationship.

Variables in the time series analysis usually tend to deviate from their mean courses due to many shocks and cyclic variations, whereby these shocks and cyclic occurrences cannot be captured by simple O.L.S regressions. As thus, the results between two time series variables may be spurious or erroneous (Harris et al., 1995). Therefore, to account for such disparities in estimation, cointegration is used as a viable technique to analyze the real relationship between two time series variables in this study.

Cointegration technique helps to identify how sensitive two variables are to the same average price over a given time period. It does not indicate whether the pairs go in the same or in opposite directions, but can tell whether the distance between the two time series variables remain constant over time (ResearchGate, 2018).

The degree of cointegration needs to be calculated. Moreover, it needs to be interpreted where the greater the degree of cointegration between two variables implies the greater probability of them maintaining a stable or constant distance. Also, the time it takes two cointegrated variables to revert to the mean (ResearchGate, 2018).

Therefore, this study will apply MATLAB statistical software to construct three regression models. To investigate the long run cointegration relationship between ship prices and bank interest rate, in which the relationship between the two variables will be examined to see if it can be used as indicator for timing investment or divestment decisions in VLCC tankers market.

3.2.1 Unit Root Test

Unit root tests are normally required to be performed to find out the stationary or non-stationary variables after the variables for the regression model have been selected. Then, descriptive statistics are done to find the mean and variances of the data that helps to determine whether mean and variances are constant or not. When they are found to be constant, the unit root problem arises that leads to spurious results. To solve such a problem only non-stationary variables, need to be transformed into stationary variables by performing a number of stationarity tests that includes: Augmented Dickey Fuller, Phillips-Perron, and Kwiatkowski-Phillips-Schmidt test (Dickey & Fuller, 1979; Kwiatkowski et al., 1992).

The null hypothesis that the variables include a unit root is tested with the ADF and PP tests, and the null hypothesis is accepted if the probability value in the tests is greater than 0.05. If the probability value is less than 0.05, the alternative hypothesis that the variable is non-stationary and without a unit root is adopted. If the ADF and PP tests bring about different results, the KPSS test will be used to assess the variable's stationarity. The null hypothesis in the KPSS test is that the variable is stationary, and the null hypothesis is accepted if the probability value (P Value) is greater than 0.05. (Shin & Schmidt, 1992).

3.2.2 Multicollinearity Test

Multicollinearity arises when two or more independent variables are significantly correlated, causing the standard error of coefficients to rise and making variables seem statistically insignificant when they are actually truly significant. A correlation test will be performed among the independent variables to address these concerns, where variables having a correlation percentage greater than 80% will be eliminated from the model.

3.2.3 T - Test & F- Test

The T test is used to determine if the independent variable has an effect on the dependent variable, especially whether the variable is significant or insignificant in explaining changes in the dependent variable. When the confidence interval for variables is 0.95 and the probability value is less than 0.05, variables are considered significant and vice versa.

The F test is a multiple hypothesis test that is used to determine whether or not the insignificant variables from the T test are really insignificant. The Wald Test will be used to conduct the F test, which uses a restriction to determine if the variables are equal to zero or not. The null hypothesis is that the variable is equal to zero, and it will be accepted if the P value is more than 0.05 and rejected if it is less than 0.05. Insignificant variables will be eliminated one at a time, with the F test performed after each removal to confirm that no significant variables are lost.

3.2.4 Co-integration Test

The term “cointegration” refers to the long-term movement of underlying variables (Pesaran et al., 2001). A cointegration test is conducted to see if one or more independent variables and the dependent variable have a long-term relationship. This process can only take place if the dependent variable is the I (1) process and the independent variable chosen for the test is likewise the I (1) process.

The Engle Granger Method will be used consisting the following steps:

1. Conduct a root unit analysis to identify the sequence of integration for each series.
2. Conducting cointegration regression and regression testing in order to estimate the long-run relationship between dependent and independent variables.

3.2.5 Autoregressive Process (AR) and Moving Average Process (MA)

The autoregressive process predicts future values based on previous values, whereas the average process examines the influence of past values on the current value by using the error of the past values. The applicability of these processes will be examined in the model, in which the AR and MA of 1 up to 5 will be applied and a significant level of 0.05 be tested. Finally, insignificant AR and MA will be eliminated one by one to allow further tests to be done.

3.2.6 Jarque-Bera Test

To check for normality of the models, the Jarque-Bera test will be used, which evaluates the skewness and kurtosis of the data, as well as its deviation from the normal distribution. The error distribution is not normally distributed if the P value is less than 0.05. In addition, the kurtosis value should be around three while the skewness value should be near to zero. If the test results indicate non-normality, the residuals are plotted to find the outliers with the highest value, and dummy variables will be added to raise the P Value and improve the fit of the model.

3.2.7 Heteroskedasticity and Serial Correlation Test

The model is said to be heteroskedastic when the variance of the error is not constant. Therefore, for the purpose of detecting heteroskedasticity in this study, the white test will be used to determine whether or not there is heteroskedasticity. The null hypothesis of the test is that the residuals are homoscedastic, which is accepted if the probability chi-square is more than 0.05 and rejected if the probability chi-square is less than 0.05. The model has an Autoregressive Conditionally Heteroskedastic (ARCH) effect if the null hypothesis is rejected and the residuals are heteroskedastic.

Serial correlation tests, utilizing the Breusch-Godfrey test with 14 lags, will be employed to ensure that there is no covariance between the error terms; while, up to the stated number of lags, the null hypothesis is that no serial correlation exists.

The following factors influence the correction of heteroskedasticity and serial correlation:

- If it is homoskedastic and no serial correlation - means no correction is required;
- If heteroskedastic and no serial correlation - requires White Correction to be done;
- If heteroskedastic and serial correlation - Newey West Correction has to be done;
- If homoskedastic and serial correlation - Newey West Correction has to be done;

3.2.8 Ramsey Reset Test

The Ramsey Regression Specification Error Test evaluates the model's linearity (Ramsey, 1969). It's a stability diagnostics test, and at a significance level of 0.05, the null hypothesis is that the model is linear. If the model is discovered to be non-linear, there is no way to fix it. This is a final part of OLS regression for this study since it did not cover forecasting part.

3.3 Limitations of the study

Despite different things that were discovered by this study, there were some constraints that were encountered in the process to accomplish this study.

I. Some variables were stationary at I (0) whereas other variables were stationary at I (1). As a result, some of the variables were eliminated before moving to the next steps of the dissertation (Tsolakis et al., 2003).

II. Some data tends to have some inconsistencies, as the results were eliminated in the study.

III. Despite the initial plans to develop three regression models but due to inconsistency in the annual frequency data that were available, the annual frequency model was removed to overcome inaccurate results as number of observations became less of the minimum requirement.

CHAPTER 4 - EMPIRICAL RESULTS

4.0 Introduction

The chapter presents the outcomes identified in each step or process for developing a classic linear regression model as clearly substantiated in the previous chapter. Moreover, this chapter establishes the statistical relationship between variables and explores how each independent variable and dependent variable is explained.

4.1 VLCC Newbuilding/Second-hand Price Ratio

The VLCC newbuilding/secondhand price ratio was calculated from the monthly data collected for the first regression model. The VLCC NB/SH prices ratio for monthly data is positive throughout the period, as shown in *Figure 12*, despite the sharp rise in a period between 2008 to 2009, owing to the 2008 global financial crisis, the NB/SH ratio also shown increase between 2011 to 2012 following a prosperous recovery from the economic crisis that resulted to booming of the market. Following the market's boom, the VLCC NB/SH price ratio later followed the similar pattern, with modest surges and declines leading up to 2020.

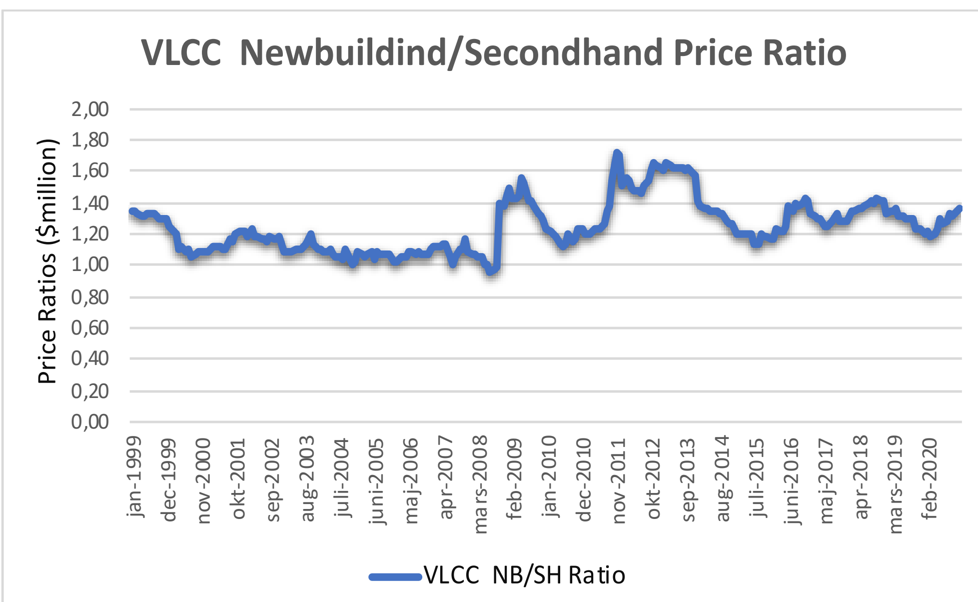

Figure 12. VLCC Newbuilding/Secondhand Price Ratios

4.2 Stationarity Test

Before the regression model was built, the unit root test was performed on each of the selected variables for both models (monthly & quarterly frequency model), to ensure the stationarity level of all variables was computed, as this can affect the model's properties and performance. The unit root test was carried out using stationarity robustness tests of Augmented Dickey and Fuller (ADF), Phillips Perron (PP) and Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) (Banerjee et al., 1992; Vogelsang & Perron, 1998). The results are as highlighted in table 8,9,10 and 11. As can be seen all variables were found stationary in the first difference. Moreover, all the independent variables were found stationarity I (1), with a dependent variable (RATIO_NB_SH) also being classified as the I (1) process.

Table 8. Unit Root Test for Dependent Variable (Monthly Frequency Model)

Dependent variable							
	ADF		**PP**		**KPSS**		
Variable	ADF P-Value	ADF Stat	PP P-Value	PP Stat	KPSS p-Value	KPSS Stat	**Stationary**
RATIO_NB_SH_1	0,001	-15,16	0,001	-15,16	0,1	0,052	I(1)

Table 9. Unit Root Test for Independent Variables (Monthly Frequency Model)

Independent Variables							
	ADF		**PP**		**KPSS**		
	ADF P-Value	ADF Stat	PP P-Value	PP Stat	KPSS p-Value	KPSS Stat	**Stationary**
PANA_NB__1	0,001	-9,503	0,001	-9,503	0,01	0,293	I(1)
INDUST_CHINA_1	0,001	-15,19	0,001	-15,19	0,1	0,009	I(1)
BRENT_CRUDE_1	0,001	-12,293	0,001	-12,293	0,1	0,038	I(1)
G_OIL_PROD_1	0,001	-17,395	0,001	-17,395	0,1	0,038	I(1)
VLCC_FL_DEV_1	0,001	-12,468	0,001	-12,468	0,053	0,145	I(1)
VLCC_DEMOL_1	0,001	-24,734	0,001	-24,734	0,1	0,005	I(1)
UL_VLCC_OBK_dwt_	0,001	-13,314	0,001	-13,314	0,048	0,148	I(1)
VLCC_SCR_1	0,001	-15,643	0,001	-15,643	0,1	0,038	I(1)
AV_VLCC_EARN_1	0,001	-17,006	0,001	-17,006	0,1	0,012	I(1)
AV_SUEZ_EARN_1	0,001	-17,508	0,001	-17,508	0,1	0,011	I(1)
SUEZ_SH_1	0,001	-13,146	0,001	-13,146	0,057	0,142	I(1)
C_AFRA_FLGRWTH_	0,001	-13,65	0,001	-13,65	0,1	0,097	I(1)
AFRA_OBK_dwt_1	0,001	-12,564	0,001	-12,564	0,012	0,211	I(1)

Table 10. Unit Root Test for Dependent Variable (Quarterly Frequency Model)

Dependent Variable							
	ADF		PP		KPSS		
Row	ADF P-Value	ADF Stat	PP P-Value	PP Stat	KPSS P-Value	KPSS Stat	Stationarity
RATIO_NB_SH_1	0,001	-9,06	0,001	-9,06	0,1	0,037	I(1)

Table 11. Unit Root Test for Independent Variable (Quarterly Frequency Model)

Independent Variables							
	ADF		PP		KPSS		
Row	ADF P-Value	ADF Stat	PP P-Value	PP Stat	KPSS P-Value	KPSS Stat	Stationarity
SUEZ_NB_1	0,001	-4,983	0,001	-4,983	0,028	0,172	I(1)
INDUST_CHINA_1	0,001	-14,38	0,001	-14,38	0,1	0,013	I(1)
INDUST_EU_1	0,001	-10,987	0,001	-10,987	0,1	0,022	I(1)
SUEZ_SCR_1	0,001	-9,671	0,001	-9,671	0,1	0,076	I(1)
SUEZ_SH_1	0,001	-6,823	0,001	-6,823	0,1	0,116	I(1)
HSFO_SINGAPORE	0,001	-7,954	0,001	-7,954	0,1	0,052	I(1)
EX_SDR_1	0,001	-7,361	0,001	-7,361	0,1	0,08	I(1)
GLOBAL_OIL_1	0,015	-2,456	0,015	-2,456	0,026	0,175	I(1)
LIBOR_LONDON_1	0,001	-4,386	0,001	-4,386	0,01	0,238	I(1)
VLCC_FLD_DWT_1	0,001	-4,476	0,001	-4,476	0,097	0,12	I(1)
SUEZ_FDL_DWT_1	0,001	-4,701	0,001	-4,701	0,034	0,165	I(1)
AFRA_FDL_DWT_1	0,001	-3,474	0,001	-3,474	0,01	0,393	I(1)
PANA_FLD_DWT_1	0,001	-5,574	0,001	-5,574	0,01	0,375	I(1)
SUEZ_EARN_1	0,001	-9,935	0,001	-9,935	0,1	0,022	I(1)
EX_CHINA_1	0,001	-5,889	0,001	-5,889	0,016	0,2	I(1)
WORLD_STL_PRO_	0,001	-6,027	0,001	-6,027	0,1	0,055	I(1)
VLCC_OBK_1	0,001	-6,325	0,001	-6,325	0,1	0,104	I(1)
SUEZ_FLG_1	0,001	-7,435	0,001	-7,435	0,1	0,039	I(1)
AFRA_CRUDE_FLG	0,001	-5,282	0,001	-5,282	0,1	0,07	I(1)
AFRA_OBK_dwt_1	0,001	-6,146	0,001	-6,146	0,01	0,269	I(1)
SUEZ_OBK_dwt_1	0,001	-7,771	0,001	-7,771	0,1	0,066	I(1)

4.4 Correlation Test

Following identification of the stationarity level of variables, the correlation test was run between pairs of independent variables to identify and eliminate pairs correlating above 80% in order to avoid the multicollinearity issues in the model that can prompt inappropriate outputs and improper conclusion of the model. The results in *Table 12 & 13* respectively show the pair of independent variables that presented the correlation less than 80%. Moreover, removal of highly correlated variables reduces the model sensitivity where omission or inclusion of any variable will not make regression coefficient change considerably.

Table 12. Correlation Table for the VLCC Model (Monthly Frequency Model)

Row	PANA_NB	INDUST_CHINA	BRENT_CRUDE	G_OIL_PROD	VLCC_FL_DEV	VLCC_DEMOL	UL_VLCC_OBK_dwt	VLCC_SCR	AV_VLCC_EARN	AV_SUEZ_EARN	SUEZ_SH	C_AFRA_FLGROWTH	AFRA_OBK
PANA_NB_	1												
INDUST_CHINA	-0,01	1											
BRENT_CRUDE	0,05	-0,05	1										
G_OIL_PROD	0,04	-0,01	-0,08	1									
VLCC_FL_DEV	-0,07	-0,03	0	0,02	1								
VLCC_DEMOL	-0,07	-0,04	0,1	-0,04	0,32	1							
UL_VLCC_OBK_dwt	0,19	-0,14	0,03	-0,01	-0,28	-0,02	1						
VLCC_SCR	0,07	0,01	0,26	0,15	0,01	0,11	0,02	1					
AV_VLCC_EARN	0,08	0,17	-0,16	0,05	-0,04	-0,11	-0,04	-0,01	1				
AV_SUEZ_EARN	0,11	0,1	-0,11	0,11	0,01	-0,02	-0,09	-0,02	0,47	1			
SUEZ_SH	0,34	0,03	0	0,11	-0,06	-0,03	0,21	0,38	0,15	0,11	1		
C_AFRA_FLGROWTH	-0,09	-0,01	0,1	0,02	0,17	-0,05	-0,02	0,02	0,01	0	-0,05	1	
AFRA_OBK_dwt	0,07	0,03	-0,08	-0,04	-0,03	-0,03	0,3	-0,03	0,1	0,01	0,05	-0,16	1

Table 13. Correlation Table for Quarterly Frequency Model

Row	SUEZ_N	INDUST_C	INDUST_E	SUEZ_SCR	SUEZ_SH	HSFO_SINGAP	EX_SDR	GLOBAL_OI	LIBOR_LON	VLCC_FLD_D	SUEZ_FDL_	AFRA_FDI	PANA_FLD_	SUEZ_EARN	EX_CHINA	WORLD_STL	VLCC_OBK	SUEZ_FLG	AFRA_CRU	AFRA_OB	SUEZ_OBK
SUEZ_NB	1																				
INDUST_CHINA	-0,1	1																			
INDUST_EU	0,2	-0,29	1																		
SUEZ_SCR	0,25	0,11	0,27	1																	
SUEZ_SH	0,64	-0,03	0,16	0,33	1																
HSFO_SINGAP	0,21	0,07	0,44	0,45	0,22	1															
EX_SDR	0,17	0,16	0,17	0,39	0,1	0,34	1														
GLOBAL_OIL	-0,06	0,26	-0,21	-0,05	-0,01	-0,01	0,02	1													
LIBOR_LONDO	0,39	-0,19	-0,06	-0,14	0,22	0,03	-0,24	0,18	1												
VLCC_FLD_DW	-0,16	0	-0,09	0,1	-0,14	0,09	0,14	0	-0,09	1											
SUEZ_FDL_DW	0,05	0,09	0,11	0,1	0	0,25	0,21	-0,07	0,1	0,47	1										
AFRA_FDL_DW	-0,12	0	-0,03	-0,02	-0,12	0,09	0,18	0,05	-0,03	0,33	0,46	1									
PANA_FLD_DW	-0,13	0,01	-0,05	-0,13	-0,16	0,13	0,01	-0,03	0,01	0,22	0,28	0,41	1								
SUEZ_EARN	0,2	0,11	-0,13	-0,01	0,35	-0,06	0,02	0,24	0,17	-0,11	-0,09	-0,01	-0,05	1							
EX_CHINA	-0,13	0,01	-0,16	-0,21	-0,02	-0,2	-0,39	0,02	0,16	0	-0,09	-0,02	-0,17	0,12	1						
WORLD_STL_I	0	0,32	0,1	0,19	0,15	0,43	0,24	0,64	-0,03	0,06	0,1	0,08	0,05	0,05	-0,07	1					
VLCC_OBK	0,34	-0,05	0,06	0	0,17	-0,06	-0,03	-0,04	0,16	-0,41	-0,14	-0,09	0,06	-0,06	-0,08	-0,08	1				
SUEZ_FLG	0,02	0,05	0,19	0,15	0,07	0,2	0,23	-0,04	0	0,44	0,67	0,28	0,06	0,05	-0,04	0,07	-0,15	1			
AFRA_CRUDE_	-0,14	-0,02	0,08	0,11	-0,03	0,06	0,17	0,1	-0,08	0,31	0,29	0,56	-0,01	0	0,07	0,15	-0,15	0,49	1		
AFRA_OBK_dv	0,12	-0,03	0,02	0,01	0,07	-0,16	0,05	-0,04	0,02	-0,19	-0,26	-0,26	-0,13	0,02	0,04	-0,16	0,41	0	-0,13	1	
SUEZ_OBK_dv	0,03	-0,08	-0,1	-0,09	0,06	-0,31	0,07	0,17	0,01	-0,08	-0,29	-0,01	-0,06	0,08	-0,1	-0,03	0,16	-0,07	0,02	0,43	1

4.5 T- Test

Using a Classical Linear Regression Model (CLRM), the T-test was performed on both models where significant variables were identified at a 5% significance level while all the insignificant variables were individually eliminated after running the F-test.

The hypothesis for the test is $Ho: B1 = 0$. Therefore, by rejecting the null hypothesis. It can be determined that significant variables examined in both models significantly affect dependent variables in this study.

Moreover, the findings following the variable's evaluation at the 0.05 significance level are clearly shown in *Table 14 and 15*. These findings and data set are used as a starting point for the development of long run cointegration relationship, which is the model results that will be utilized in this study.

Table 14. T-test Results for Monthly Frequency Model

regression_results_1:					
Linear regression model:					
	RATIO_NB_SH ~ 1 + PANA_NB_ + VLCC_SCR + SUEZ_SH				
Estimated Coefficients:					
		Estimate	**SE**	**tStat**	**pValue**
	(Intercept)	0,0005	0,002	0,282	0,778
	PANA_NB_	0,292	0,099	2,939	0,004
	VLCC_SCR	-0,059	0,020	-2,923	0,004
	SUEZ_SH	-0,649	0,048	-13,57	5E-32
Number of observations: 263, Error degrees of freedom: 259					
Root Mean Squared Error: 0.0258					
R-squared: 0.506, Adjusted R-Squared: 0.5					
F-statistic vs. constant model: 88.4, p-value = 2.02e-39					

Table 15. T-test Results for Quarterly Frequency Model

Regression_results_1							
Linear regression model:							
RATIO_NB_SH ~ 1 + SUEZ_SH + AFRA_FDL_DWT + WORLD_STL_PRO + VLCC_OBK + AFRA_CRUDE_FLG							
Estimated Coefficients:							
		Estimate	**SE**	**tStat**	**pValue**		
	(Intercept)	-0,007	0,007	-1,039	0,302		
	SUEZ_SH	-0,521	0,057	-9,152	5E-14		
	AFRA_FDL_DWT	1,299	0,541	2,402	0,019		
	WORLD_STL_PRO	-0,395	0,081	-4,899	5E-06		
	VLCC_OBK	0,083	0,041	2,031	0,046		
	AFRA_CRUDE_FLG	-0,082	0,038	-2,137	0,036		
Number of observations: 85, Error degrees of freedom: 79							
Root Mean Squared Error: 0,0415							
R-squared: 0,647, Adjusted R-Squared: 0,624							
F-statistic vs. constant model: 28,9, p-value = 1,49e-16							

4.6 Engle - Granger Cointegration Result

The cointegration test was used in this study to see if the independent and dependent variables have a long run relationship (Johansen, 1988). The results in *Table 16 and 17* for monthly and quarterly frequency model respectively, shows that the residual of VLCC_SCR, PANA_NB, SUEZ_SH, AFRA_FDL, WORLD_STL and AFRA_CRUDE_FLG that were deemed stationary at the first difference level after ADF and PP unit root test in this model being significant. This implies the existence of a long run relationship between the six independent variables and the dependent variable, which is VLCC NB/SH ratio.

Moreover, the Error Correction Term (ECT) included in the model followed the similar trend as their parent variables by being stationary in the first difference and having the same parameter of cointegration in which the ECT has a negative coefficient and all being significant at 5% level.

Table 16. Cointegration Result for Monthly Frequency Model

regression_results_3:						
Linear regression model:						
RATIO_NB_SH ~ 1 + VLCC_SCR + SUEZ_SH + ect_VLCC_SCR + ect_PANA_NB_ + ect_SUEZ_SH						
Estimated Coefficients:						
		Estimate	**SE**	**tStat**	**pValue**	
	(Intercept)	0,0008	0,002	0,496	0,620	
	VLCC_SCR	-0,047	0,020	-2,407	0,017	
	SUEZ_SH	-0,656	0,044	-14,788	3E-36	
	ect_VLCC_SCR	-0,351	0,086	-4,101	6E-05	
	ect_PANA_NB_	0,485	0,128	3,795	0,0002	
	ect_SUEZ_SH	-0,260	0,065	-3,978	9E-05	
Number of observations: 263, Error degrees of freedom: 257						
Root Mean Squared Error: 0.0248						
R-squared: 0.549, Adjusted R-Squared: 0.54						
F-statistic vs. constant model: 62.6, p-value = 1.54e-42						

Table 17. Cointegration Result for Quarterly Frequency Model

regression_results_3							
Linear regression model:							
RATIO_NB_SH ~ 1 + SUEZ_SH + AFRA_FDL_DWT + WORLD_STL_PRO + AFRA_CRUDE_FLG + ect_SUEZ_SH							
Estimated Coefficients:							
		Estimate	**SE**	**tStat**	**pValue**		
	(Intercept)	-0,007	0,007	-1,103	0,273		
	SUEZ_SH	-0,537	0,054	-9,924	2E-15		
	AFRA_FDL_DWT	1,222	0,514	2,378	0,020		
	WORLD_STL_PRO	-0,375	0,077	-4,889	5E-06		
	AFRA_CRUDE_FLG	-0,101	0,036	-2,789	0,007		
	ect_SUEZ_SH	-0,148	0,041	-3,639	0,0005		
Number of observations: 85, Error degrees of freedom: 79							
Root Mean Squared Error: 0,0394							
R-squared: 0.682, Adjusted R-Squared: 0,661							
F-statistic vs. constant model: 33,8, p-value = 2,64e-18							

4.7 Autoregressive (AR) and Moving Average (MA) Process

For a decent model to be built, AR and AM are usually set in the model to make it a more parsimonious model. A model that can explain the characteristics of the data with fewer parameters and able to capture all fundamental tendencies or patterns (Brooks, C., 2014).

In this study, 1to 5 AR and MA were initially set in both regression models and finally were removed in both models as they were deemed insignificant with probability values greater than 0.05 (*see Table 18 and 19*).

*Table 18***.** ARMA Result for Monthly Frequency Model

Regression_results_5:						
Linear regression model:						
RATIO_NB_SH ~ 1 + VLCC_SCR + SUEZ_SH + ect_VLCC_SCR + ect_PANA_NB_ + ect_SUEZ_SH						
Estimated Coefficients:						
		Estimate	**SE**	**tStat**	**pValue**	
	(Intercept)	0,001	0,002	0,496	0,620	
	VLCC_SCR	-0,047	0,020	-2,407	0,017	
	SUEZ_SH	-0,656	0,044	-14,788	3E-36	
	ect_VLCC_SCR	-0,351	0,086	-4,101	6E-05	
	ect_PANA_NB_	0,485	0,128	3,795	0,0002	
	ect_SUEZ_SH	-0,260	0,065	-3,978	9E-05	
Number of observations: 263, Error degrees of freedom: 257						
Root Mean Squared Error: 0.0248						
R-squared: 0.549, Adjusted R-Squared: 0.54						
F-statistic vs. constant model: 62.6, p-value = 1.54e-42						

Table 19. ARMA Result for Quarterly Frequency Model

Regression_results_5							
Linear regression model:							
RATIO_NB_SH ~ 1 + SUEZ_SH + AFRA_FDL_DWT + WORLD_STL_PRO + AFRA_CRUDE_FLG + ect_SUEZ_SH							
Estimated Coefficients:							
		Estimate	**SE**	**tStat**	**pValue**		
	(Intercept)	-0,007	0,007	-1,103	0,273		
	SUEZ_SH	-0,537	0,054	-9,924	1,5E-15		
	AFRA_FDL_DWT	1,222	0,514	2,378	0,020		
	WORLD_STL_PRO	-0,375	0,077	-4,889	5,2E-06		
	AFRA_CRUDE_FLG	-0,101	0,036	-2,789	0,007		
	ect_SUEZ_SH	-0,148	0,041	-3,639	0,0005		
Number of observations: 85, Error degrees of freedom: 79							
Root Mean Squared Error: 0,0394							
R-squared: 0,682, Adjusted R-Squared: 0,661							
F-statistic vs. constant model: 33,8, p-value = 2,64e-18							

4.8 Residual Diagnosis

4.8.1 Jarque Bera Test

To notice the behaviour of each residual in the ARMA model, Jarque and Bera (1981) test is performed to observe the residuals behavior. The null hypothesis to test is that the residuals are normally distributed, henceforth the rejection of the null hypothesis at 5% level makes it important to look at the outliers of the residuals when deciding whether to or not to include a dummy variable in the model. The violation of normality assumption has no virtual effects or implications in some instances where the data variable is sufficiently large (Brooks, 2014).

This model was subjected to normality tests, and it was observed that the residuals were not normally distributed. As a result, dummy variables were introduced to the in both monthly and quarterly frequency models to address the problem (*see Table 20*).

Therefore, to attain model normality with a kurtosis near to three, skewness close to zero, and probability less than 5%; the 22 dummy variables were added in monthly and 2 dummy variables were respectively added in a monthly and quarterly frequency model and both models still appeared to be linear, which is the good implication of a good model. For further extensive information see *Appendix 2.*

Table 20. Jarque Bera Result for Monthly Frequency Model

Regression_results_9:					
Linear regression model:					
	RATIO_NB_SH ~ [Linear formula with 24 terms in 23 predictors]				
Estimated Coefficients:					
		Estimate	**SE**	**tStat**	**pValue**
	(Intercept)	-0,001	0,001	-0,792	0,429
	ect_PANA_NB_	-0,011	0,011	-1,046	0,297
	dummy118	0,336	0,021	16,056	0,000
	dummy157	-0,119	0,021	-5,658	0,00000004
	dummy154	0,113	0,021	5,437	0,0000001
	dummy155	0,112	0,021	5,368	0,0000002
	dummy210	0,096	0,021	4,636	0,00001
	dummy181	-0,100	0,021	-4,788	0,000003
	dummy125	0,081	0,021	3,858	0,0001
	dummy16	-0,080	0,021	-3,822	0,0002
	dummy127	-0,080	0,021	-3,804	0,0002
	dummy49	-0,074	0,021	-3,562	0,0004
	dummy108	-0,069	0,021	-3,330	0,001
	dummy102	-0,069	0,021	-3,297	0,001
	dummy70	-0,066	0,021	-3,145	0,002
	dummy32	0,068	0,021	3,260	0,001
	dummy73	0,068	0,021	0,021	0,001
	dummy69	0,066	0,021	3,151	0,002
	dummy152	0,060	0,021	2,886	0,002
	dummy217	-0,060	0,021	-2,894	0,004
	dummy250	-0,059	0,021	-2,812	0,005
	dummy143	0,058	0,021	2,804	0,005
	dummy107	0,058	0,021	2,787	0,006
	dummy113	-0,057	0,021	-2,743	0,007
Number of observations: 263					
Error degrees of freedom: 239					
Root Mean Squared Error: 0.0208					
R-squared: 0.706, Adjusted R-Squared: 0.677					
F-statistic vs. constant model: 24.9, p-value = 8.23e-51					

4.8.2 Heteroskedasticity and Auto-correlation

When building the model, it is vital to discover patterns of heteroskedasticity and serial correlation in the model as part of the underlying assumptions for building a model in which the estimators are required to be Best Linear Unbiased Estimator (BLUE) (Brooks, 2014).

Table 21 represents the result for the monthly frequency model, where after the heteroskedasticity and serial correlation test were carried down results shows that the model does not require any correction since it fits criteria of a BLUE model with no ARCH effect and serial correlation.

However, regression results for quarterly frequency models are shown to have ARCH effect but no serial correlation. Such a regression rejected the null hypothesis of homoscedasticity and accepted the null hypothesis of non- serial correlation; hence White Correction was done (*see Table 22*).

Table 21. Heteroskedasticity and auto-correlation for Monthly Frequency Model

hac_result =
'with no ARCH effect and no serial correlation'

Table 22. Heteroskedasticity and auto-correlation for Quarterly Frequency Model

hac_result =
'with ARCH effect but no serial correlation'

4.9 Linearity Test

To test the linearity of the model one has to use the Regression Specification Error Test (Ramsey, 1969). The Ramsey RESET Test was conducted where both models were deemed linear with a significant level at 0.05. The monthly and quarterly frequency model has the probability value of 48.1% and 88.9% respectively, which indicates that both models are linear and possess the enough explanatory value for the dependent variable (see Table 23 and 24).

Table 23. Ramsey RESET Test Results for Monthly Frequency Model

RESET_test:						
[RESET_test, pValue_RESET, F_stat_RESET] = ramsey_RESET_function (regression_results_7,2)						
Linear regression model:						
	resid ~ 1 + y_fit_p2					
Estimated Coefficients:						
		Estimate	**SE**	**tStat**	**pValue**	
	(Intercept)	-0,001	0,003	-0,450	0,653	
	y_fit_p2	60,718	86,011	0,706	0,481	
Number of observations: 263, Error degrees of freedom: 261						
Root Mean Squared Error: 0,0363						
R-squared: 0,00191, Adjusted R-Squared: -0,00192						
F-statistic vs. constant model: 0.498, p-value = 0.481						
pValue _ RESET = 0,4809						
F_stat_RESET = 0,4983						

Table 24. Ramsey RESET Test Results for Quarterly Frequency Model

RESET_test:							
[RESET_test, pValue_RESET, F_stat_RESET] =ramsey_RESET_function(regression_results_7,2)							
Linear regression model:							
	resid ~ 1 + y_fit_p2						
Estimated Coefficients:							
		Estimate	**SE**	**tStat**	**pValue**		
	(Intercept)	0,0007	0,009	0,078	0,938		
	y_fit_p2	-8,033	57,235	-0,14	0,889		
Number of observations: 85, Error degrees of freedom: 83							
Root Mean Squared Error: 0.0674							
R-squared: 0.000237, Adjusted R-Squared: -0.0118							
F-statistic vs. constant model: 0.0197, p-value = 0.889							

CHAPTER 5 – ANALYSIS AND DISCUSSION

5.0 Introduction

This chapter provides the discussion and presentation of the empirical results calculated in chapter four of this study. Moreover, this chapter examines the significant factors identified through the classic linear regression model procedures and compares the model with the previous studies to support the claims made in this study.

5.1 Monthly Frequency Model

Monthly Frequency Model met all criteria of a BLUE (Best Linear Unbiased Model) model. It’s a model that gives information which was built by consistent, unbiased and efficient information data. The model has 54% of adjusted R square entailing that the model explains fifty-four of the variations in the VLCC NB/SH ratio (Karch & van Ravenzwaaij, 2020). Moreover, the model has the lowest model criterion, which are: *AIC* of **-1.1926e+03**, *AICc* of **-1.922e+03**, *BIC* of **-1.711e+03** and *CAIC* **-1.165e+03**, which explain how robust and strongest explanatory power the model has.

5.1.1 Significant Variables

After running the model, only two variables with their error correction terms among twelve independent variables were found to significantly affect the VLCC NB/SH ratio, which are: VLCC_SCR, the proxy for VLCC scrap price, SUEZ_SH, the proxy for Suezmax Second-hand Price, ect_VLCC_SCR, ect_PANA_NB_, and ect_SUEZ_NB, the proxy for Error Correction Term for VLCC Scrap Price, Panamax Newbuilding Price and Suezmax Second-hand Price.

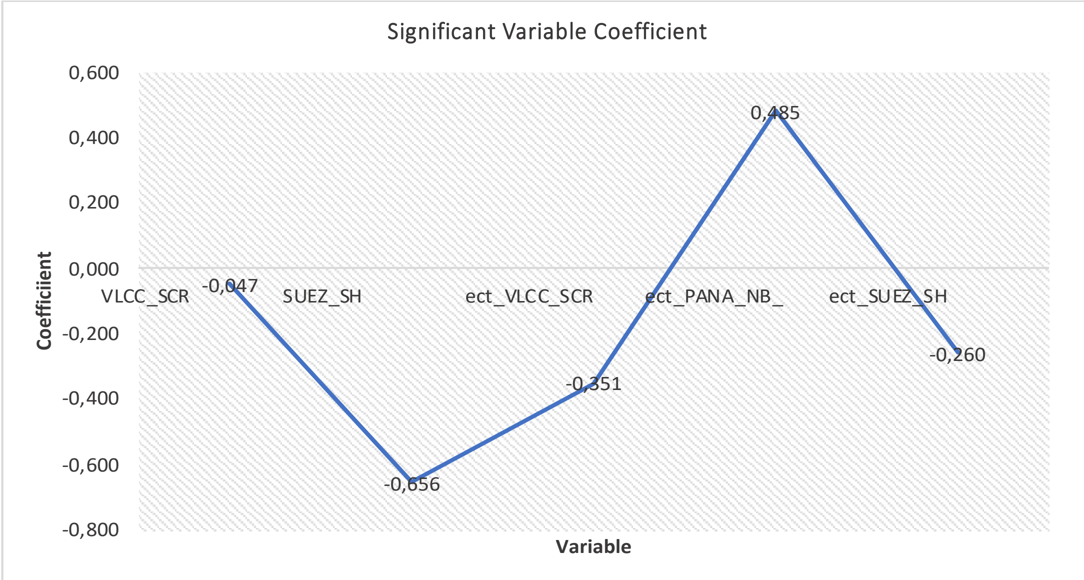

Figure 13. Significant Variables' for Monthly Frequency Model

5.1.1.1 VLCC Scrap Value (VLCC_SCR)

In a monthly frequency model VLCC Scrap Value is the second most influential factor of VLCC NB/SH ratio, with a negative regression coefficient of -0.047and negative error regression coefficient of -0.351. This infers the existence of long run cointegration relationship between VLCC scrap value and VLCC NB/SH ratio, whereby every one-point increase in a VLCC scrap value, there will be 0.047 or 4.7% increase in a VLCC NB/SH ratio. In addition, the negative trend between the two variables may be seen in the scatter plot below (*see Figure 14*).

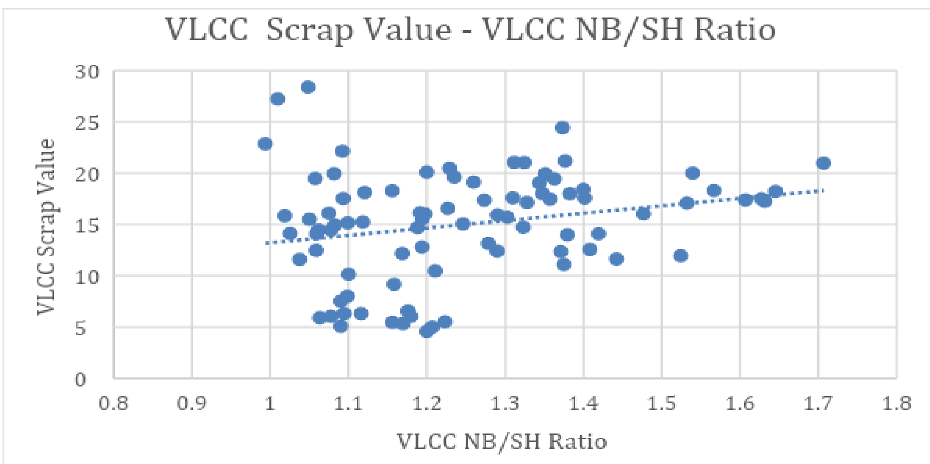

Figure 14. Scatter Plot for VLCC Scrap Value and VLCC NB/SH Ratio

The ratio decrease (negative coefficient) denotes that the VLCC secondhand vessel price will become relatively more expensive than VLCC newbuild vessels. Therefore, one investing or interested to invest in VLCC tankers should choose to invest in a VLCC secondhand vessel instead of a VLCC newbuild vessel. Moreover, one should consider to invest in VLCC secondhand vessel at a time when VLCC scrap value increases and consider divesting when the scrap value starts to decline because most businessmen resale their ships when scrap value is high in the market leading to deficit in a tanker service and hence, the profit increase to ones in operations. Although a number of factors, including the market cycle, influence the decision to sell a ship for scrap, the demolition market is an important market area in the maritime industry that helps to balance demand and supply. According to (Karlis & Polemis, 2016), the demolition market helps to balance supply and demand in the shipping industry, and it is a primary driver of market equilibrium and freight costs.

5.1.1.2 Suezmax Second-hand (SUEZ_SH)

Similar to the first significant variable, Suezmax secondhand vessel is the variable which has the greatest effects on VLCC NB/SH ratio with a negative regression coefficient of -0.656 and the negative error coefficient of -0.26. This denotes the strong information the variable has on the dependent variables, whereby one-point increase in Suezmax secondhand price leads to 26% increase in the VLCC NB/SH ratio and vice versa. In addition, the inverse relationship between the two variables is as illustrated in *Figure 15*.

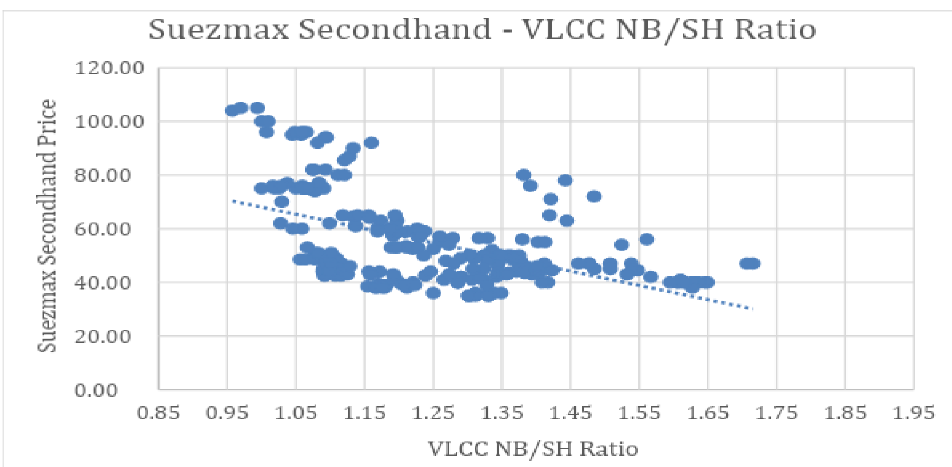

Figure 15. Scatter Plot for Suezmax Secondhand Price and VLCC NB/SH Ratio

The ratio decrease signals the fact that VLCC second hand ship prices will become more relatively expensive than VLCC newbuild vessels. Therefore, investors in a VLCC tanker should choose to invest in a VLCC secondhand ship instead of investing in a VLCC newbuild vessel. Moreover, one should consider a time when Suezmax secondhand price increases as the ideal or right time to invest in VLCC secondhand tankers and vice versa. Given the fact that, the secondhand vessel has the upper hand in the market to take any immediately advantage that emerges since it would be readily available in the market within a short period of time compared to newbuilding vessel requires a lead time one to two years to be delivered and deployed in daily operation (Beenstock & Vergottis, 1989). Moreover, this concur with (Dai et al., 2015a), who revealed that the news generated from the secondhand vessel market induce a volatility shock in the freight rate market as compared to market information emanating from the newbuilding vessel market.

5.2 Quarterly Frequency Model

Quarterly frequency model is a BLUE model with adjusted R-squared of 66%, which entails the greater ability of the model to provide the strong information generated or gathered from consistent, unbiased and reliable data (Phillips, 2014). The model has the lowest *AIC* of **-302.9494** *AICc* of **-301.8725**, *BIC* of **-288.2935** and *CAIC* of **-282.2935** which tells how robust and strong explanatory power the model has.

5.2.1 Significant Variables

Like in other scientific research better discussion comes out of the best results. Based on model information criterion three test (t-test, cointegration test and ARMA test) results were compared to get the best result for the model, where cointegration test appeared to be the best results with the lowest possible model criterion. After running the model only four variables including one error correction term (ECT) were found significant out of twenty-one variables, which are: SUEZ_SH, used as a proxy of Suezmax secondhand, AFRA_FDLDWT used as a proxy of Aframax Fleet Development(dwt), WORLD_STL_PRO which represent World Steel Production(000’t), AFRA_CRUDE_FLG which represent Crude Aframax Fleet Growth(%Yr), and finally, ect_SUEZ_SH.

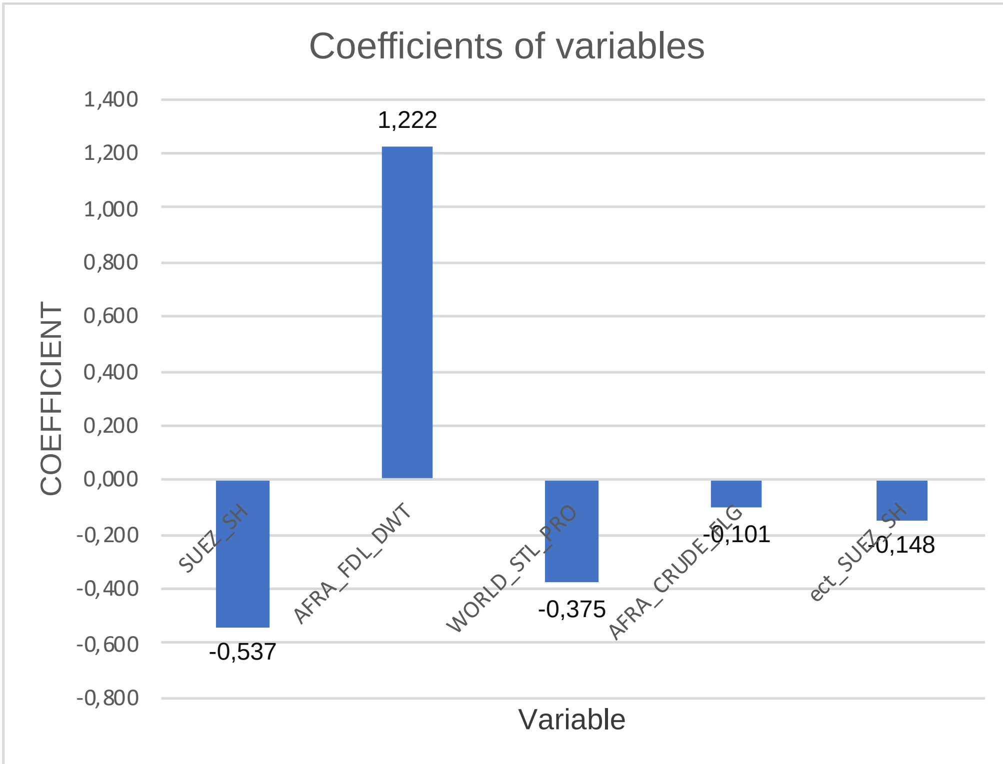

Figure 16. Significant Variables' for Quarterly Frequency Model

5.2.1.1 Suezmax Secondhand Price ($million)

Suezmax secondhand price is the most significant variable in a quarterly frequency model with a negative regression coefficient of -0.537and the negative error coefficient of -0.148, which indicates the existence of long run cointegration relationship between VLCC Secondhand prices and the Suezmax secondhand prices as well as strong information the variable in VLCC NB/SH ratio. Statistically this implies that for every 1% increase in a Suezmax secondhand prices will results to 53.7% increase in VLCC NB/SH ratio. In addition, the negative trend between the two variables is as illustrated in *Figure 17*.

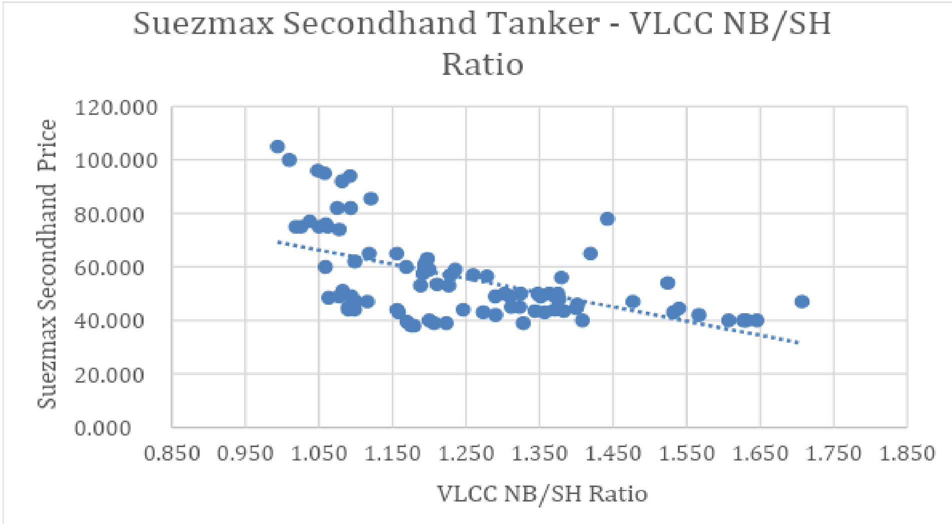

Figure 17. Scatter Plot for Suezmax Secondhand Price and VLCC NB/SH Ratio

The ratio decrease (negative coefficient) denotes that prices for VLCC secondhand tankers will become relatively more expensive than VLCC newbuild vessel. Therefore, investor or private individuals interested to invest in VLCC tankers should invest in VLCC secondhand vessel instead of newbuild VLCC tankers. Moreover, on timing the investing or divesting time in a VLCC tankers one should consider to invest in a VLCC secondhand tankers when the Suezmax secondhand prices is increasing in the market, since such as an increase in price signal out the presence of high demand for crude tanker services in the market, as well as increasing profitability index for VLCC tanker operation and vice versa. In the same vein, this concur with (Beenstock, 1985) who observed that secondhand prices are flexible whereas newbuilding prices are relatively sticky such that newbuilding prices adjust to secondhand prices over time. However, this opens the room for criticism because the shipping industry is supply and cost driven while the secondhand vessels are market driven (Haralambides et al., 2005).

5.2.1.2 Aframax Fleet Development(dwt)

The results for the quarterly frequency model show that the Aframax fleet development(dwt) is only variable among all variables which has the least impact on the VLCC NB/SH ratio with a positive regression coefficient of 1.222. This infers the existence of long run cointegration relationship between the Aframax Fleet Development (dwt) and VLCC newbuild tanker prices, whereby for every one-point increase of Aframax Fleet (dwt) bring about 1.222 point or 122% increase in a VLCC NB/SH price ratio. In addition, the positive relationship between the two variables is as illustrated in *Figure 18*.

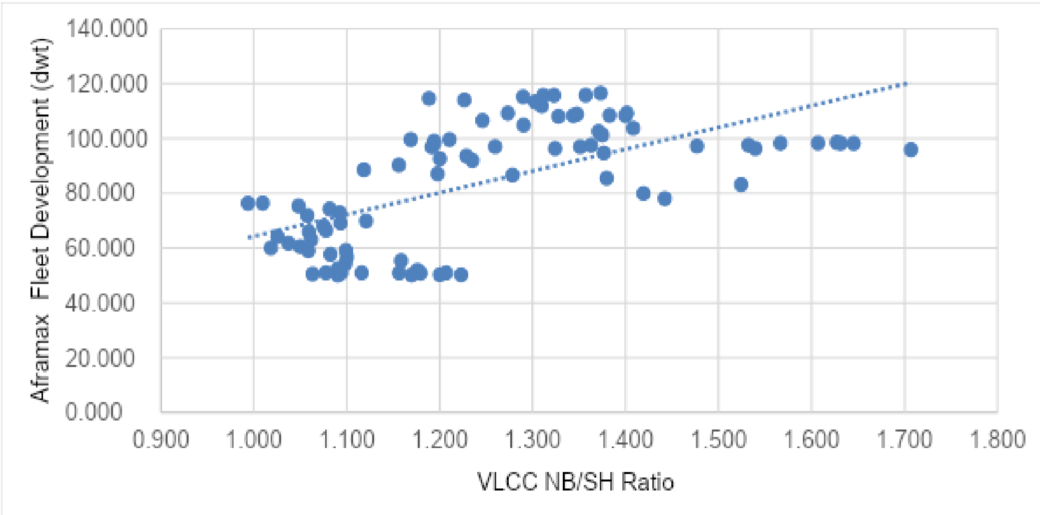

Figure 18. Scatter Plot for Suezmax Secondhand Price and VLCC NB/SH Ratio

The ratio increase (positive coefficient) denotes that the VLCC newbuild tanker price will become relatively more expensive compared to VLCC secondhand tanker prices. Therefore, investors should invest in a VLCC newbuild vessel and divest in a VLCC secondhand vessel to recoup some money(value) before their price declines more and more. Despite the fact that, investing in secondhand vessels enables shipowners to immediately take the prompt advantages which emerge in market but it's very useful to invest in a newbuilding vessel equipped with new science and technology since it helps owners to take enjoy a number of advantages particularly to newly introduced rules and regulation which insist on carbon and Greenhouse Gases (GHG) emissions reduction. For instance, the IMO 2020 regulation which mandates 0.5% of Sulphur in commercial ship fuel whereby ships navigating in Emission Control Areas (ECAs) must maintain 0.1% emission level (DNV et al., 2018). Also, buying a new ship saves energy efficiency and long-life span to operate in the market (TOKUŞLU, 2020).

5.2.1.3 World Steel Production (000't)

The result for this model shows world steel production has a variable with the second greatest impact on the VLCC NB/SH ratio with a negative regression coefficient of -0.375. This infers the existence of long run cointegration relationship between the World steel production and VLCC secondhand tankers prices, whereby each one percentage point increase of world's steel production lead to 0.375 points or 37.5% increase in VLCC NB/SH price ratio. Furthermore, the negative relationship between the two variables is as illustrated in *Figure 19*.

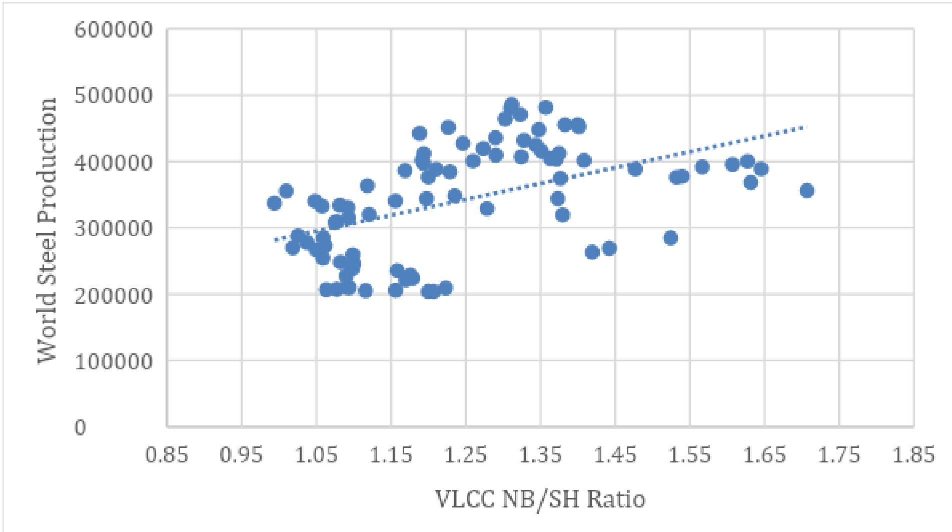

Figure 19. Scatter Plot for World Steel Production and VLCC NB/SH Ratio

The ratio decrease (negative coefficient) denotes that the price for VLCC secondhand vessels will become relatively more expensive than VLCC newbuild vessels. Therefore, one investing or interested to invest in a VLCC tanker should invest in a VLCC secondhand vessel instead of VLCC newbuild vessel. Moreover, on timing when to invest or divest in VLCC tanker sub-sector on should consider to invest in VLCC secondhand vessel because when the World steel production increases VLCC scrap value decreases and one should consider to divest or resale the vessel when world steel production decreases meaning that when steel supply decreases VLCC scrap value increases. Also, despite the fact that this factor cointegrate with secondhand vessels but the steel it has great contribution on newbuilding vessels since steel is a main material used for ship construction. This concurs with (Mulligan, 2008), who argued that given the design dimension of a ship its cargo carrying capacity is determined along with the required amount of steel.

5.2.1.4 Crude Aframax Fleet Growth (%Yr)

Crude Aframax Fleet Growth is the third in the list of significant variables which has higher impact on the VLCC NB/SH ratio with a negative regression coefficient of -0.101. The results infer the existence of long run cointegration relationship between the Crude Aframax Fleet Growth and VLCC secondhand price, whereby for every 1% growth of Crude Aframax Fleet signal out 0.101 point or 10.1% increase in the VLCC NB/SH price ratio. Moreover, the negative relationship between the two variables is as illustrated in *Figure 20*.

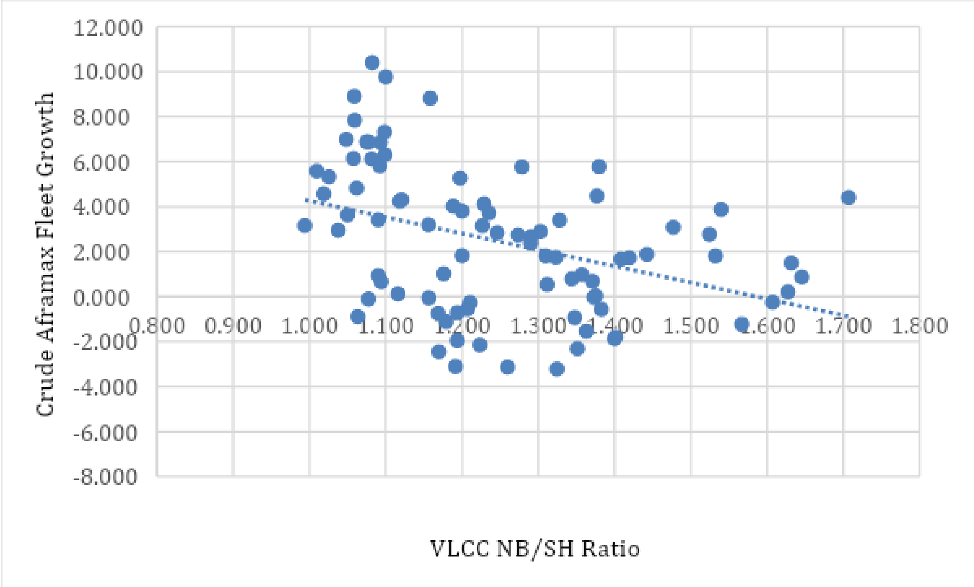

Figure 20. Scatter Plot for World Steel Production and VLCC NB/SH Ratio

The ratio decrease (negative coefficient) denotes that the price for VLCC secondhand tankers will become relatively more expensive than price for VLCC newbuild vessels. Therefore, one investing or interested to invest in VLCC tankers should choose to invest in a VLCC secondhand vessel instead of a VLCC newbuild vessel. Moreover, the one timing on when to invest or divest in a VLCC tanker sector has to invest in a VLCC secondhand vessel at a time when the Crude Aframax Fleet is growing in the market that's when there is high demand for Crude Aframax Tankers and divest or resale at a time when demand for Crude Aframax tankers start declining.

5.3 Dominant Variables

Regarding the monthly and quarterly frequency model, the most dominant significant variable among the all significant variables in both models is a Suezmax secondhand vessel with negative regression coefficient of -0.656 and -0.537 for monthly and quarterly frequency model respectively. Moreover, the variable has error regression coefficients of -0,26 and -0.148 respectively for both models. This reveals the strong influences the variable has to the VLCC NB/SH ratio in particular the VLCC secondhand vessel. Therefore, investors in VLCC tanker vessels, particularly VLCC secondhand tankers, should carefully monitor the trend of these tankers in the market before committing their resources to invest in the VLCC tanker sub-sector.

5.4 Model Comparison (Monthly *vs*. quarterly frequency Model)

After both monthly and quarterly models conclude, it is usually necessary to compare the both models to see the most robust model. Based on the model criteria it can be concluded that the quarterly frequency model is far a better model compared to a monthly frequency model. Since it was built of more consistent, unbiased and efficient data (Brook, 2014). The model has a 66% of adjusted R-squared which means that the model explains sixty six percent of the variation of VLCC NB/SH ratio and greater ability of the model to provide the strong information compared to 54% of a monthly frequency model. In addition, the model has the lowest model criterion of negative -**302.9494** of *AIC*, **-301.8725** of *AICc*, **-288.2935** of *BIC* and **-282.2935 of** *CAIC* which tells how robust and strong explanatory power the model has.

CHAPTER 6 – CONCLUSION AND RECOMMENDATIONS

6.0 Introduction

This chapter concludes on the main results to support the aim and objectives of the study. Moreover, the chapter covers study's contribution to literature, challenges encountered, areas for future study and finally, provides the recommendations for optimal investment decisions in the VLCC tanker sub-sector, which assists to minimize the state of uncertainties and helps shipping companies, shipowner's, charterer's, shipping banks with ideas that lessen the burden of financial risks in shipping industry.

6.1 Conclusion

This study examines the ship investment strategy for VLCC tankers. The potential implication of this study underpins the use of long run cointegration relationship between the VLCC NB/SH ratio with global economic influential factors as an indicator for timing investment or divestment decision in a liquid bulk sector in particular to VLCC tankers. In addition, the study underpins the movement of VLCC NB/SH ratio (increase or decrease) as a decision tool of either to invest in VLCC newbuild or secondhand vessel. By doing so, this study contributes to the existing literatures as follows: first, through the decision to examines how effective the long run cointegration relationship between VLCC NB/SH ratio with global shipping economic influential factor could be used as a decision tool to either invest in a VLCC newbuild or secondhand vessel. Second, the study helps to understand how risky it is to invest in VLCC tankers and helps to understand how the movement of VLCC NB/SH ratio could be used for signaling the ideal/optimal time to invest or divest in VLCC tankers on a short – or long- term basis. Lastly, the study helps to bridge the between theory and practices through analyzing the ship investment strategy which helps both academia and industrial practitioners to make appropriate decisions for investment in a liquid bulk sector particularly to VLCC tankers.

Contrary to the most sought factors to influence ship price such as cost of capital (. i.e. interest rate) and global oil price. The statistical results for this study have shown that VLCC newbuilding/secondhand ratio (VLCC NB/SH ratio) is dominantly influenced by Suezmax secondhand price, VLCC scrap value, Aframax fleet development(dwt), world steel production, and crude Aframax fleet growth, whereby Aframax fleet development(dwt) specifically influences and cointegrates with VLCC newbuilding price while the remaining factors which includes: Suezmax secondhand price, VLCC scrap value, world steel production and crude Aframax fleet growth dually influences and integrates with VLCC secondhand vessel.

In the course of this study, a total of three methodological drawbacks were encountered which changed the initial plans to have three regression models and ended up with two regression models. Since the annual frequency model was eliminated because of inconsistency of some data, smaller number of observations and some variables being stationary at the I (0) process.

For further studies in the future, it would be interesting to see studies on ship investment strategy for other types of crude oil carriers in particular Suezmax, Aframax and Panamax tankers. Additionally, it would be significant to see a ship investment strategy for offshore oil drilling vessels which temporarily store and carry crude oil and LNG gasses from the oil rigs to ashore storage tankers.

6.2 Recommendations

Understanding of the ship price risk before the decision to invest in the shipping market is always important since it helps individuals, shipping companies or anyone who wants to invest in the shipping market to overcome the risk of bankruptcy given that the shipping industry is highly volatile, cyclical and capital intensive in nature. As explained by (Jensen, 2017; Song et al., 2019)) & Song et al., (2019), all stakeholders in the field must have a clear understanding of where they want to be in the future, not so much in terms of precise cargo volumes and fleet size, but rather in terms of what will be required for their fundamental business model to be profitable.

Despite the fact that investment decisions regarding ship price risk is always difficult to make among investors in shipping sector but critical monitoring and analysis of volatility tendencies in VLCC tankers in particular to each variable behaviour which transitionally affect the liquid bulk sector enables practitioners in shipping business to notice all unusual market trends and take immediate response which reduces both financial and business risks (Dai et al., 2015). Therefore, the findings for this study can be utilized for ship investment strategy by observing the trend of identified global economic influential factors for the VLCC tanker sector, which would help shipping companies, ship owners, academia and other shipping industry practitioners to be able to draw better conclusion for future investment decisions in shipping markets.

Moreover, its most for unquantifiable variables(qualitative assessment) to be considered through different policies introduced by government, port authorities, shipping lines and other national and international organization such ministries, maritime authorities and international Maritime Organization (IMO) to complement quantitative analysis that has been made through this study to reduce uncertainty on ship investment in particular to VLCC tankers.

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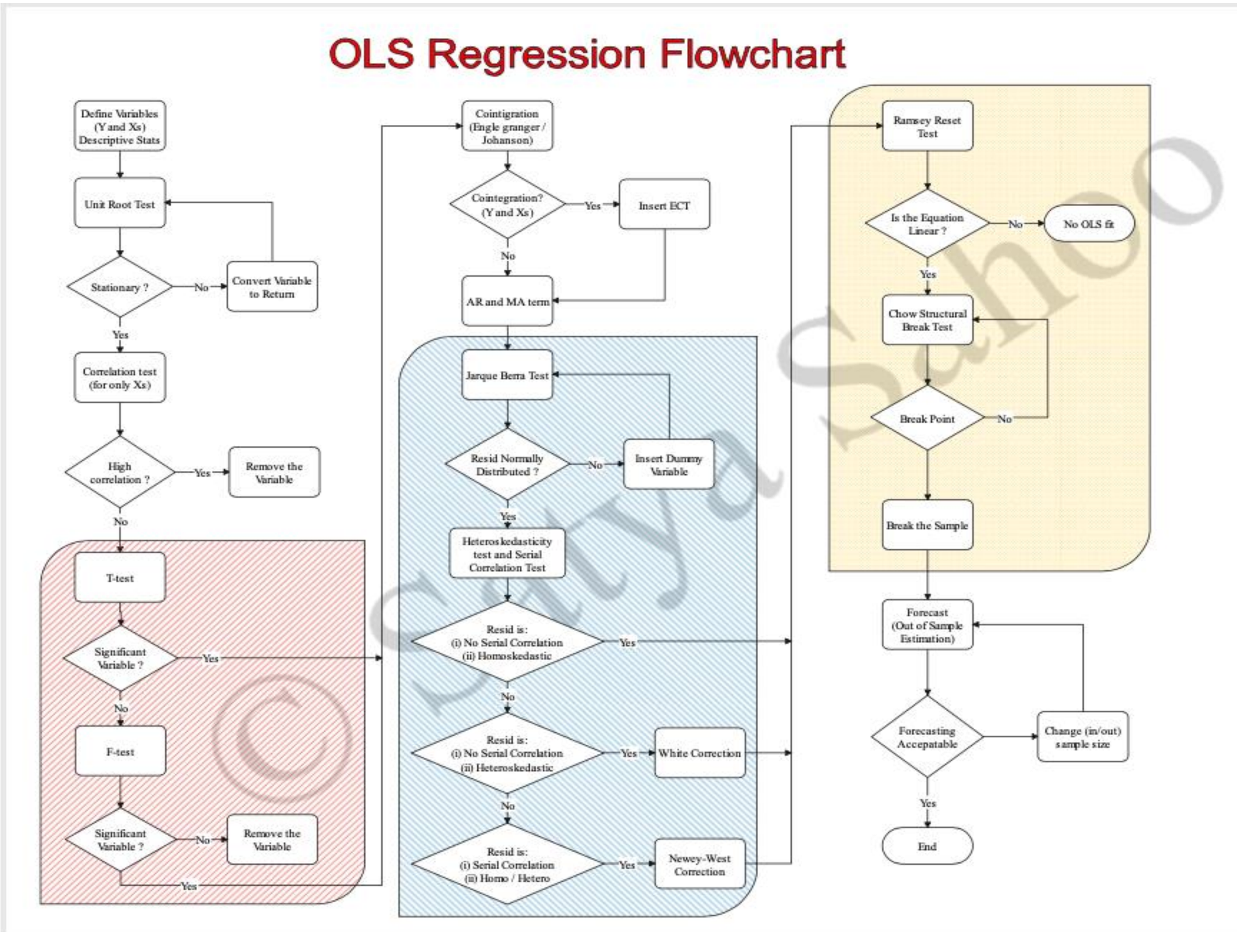
APPENDICES

Appendix 1 OLS Regression Flowchart



Appendix 2 Jarque Bera Test Result (Quarterly Frequency Model)

regression_results_9					
Linear regression model:					
RATIO_NB_SH ~ 1 + AFRA_FDL_DWT + dummy36 + dummy48					
Estimated Coefficients:					
		Estimate	**SE**	**tStat**	**pValue**
	(Intercept)	-0,008	0,007	-1,107	0,272
	AFRA_FDL_DWT	0,290	0,531	0,546	0,587
	dummy36	0,374	0,050	7,486	8E-11
	dummy48	0,220	0,050	4,429	3E-05
Number of observations: 85, Error degrees of freedom: 81					
Root Mean Squared Error: 0.0492					
R-squared: 0,489, Adjusted R-Squared: 0,47					
F-statistic vs. constant model: 25,8, p-value = 8,04e-12					