ΔΙΑΤΜΗΜΑΤΙΚΟ ΠΡΟΓΡΑΜΜΑ ΜΕΤΑΠΤΥΧΙΑΚΩΝ ΣΠΟΥΔΩΝ ΣΕ **ΔΙΕΘΝΗ ΝΑΥΤΙΛΙΑ, ΧΡΗΜΑΤΟΟΙΚΟΝΟΜΙΚΗ & ΔΙΟΙΚΗΣΗ** MASTER OF SCIENCE (MSc) IN **INTERNATIONAL SHIPPING, FINANCE & MANAGEMENT**

# *"The impact of freight rates, oil prices and ships' values on stocks prices of listed tanker shipping companies"*

**by**


**Grigoriou Andreas**

**Paliogiannis Fanourios - Thomas**


**A Thesis submitted**

**to the Secretariat of the MSc in International Shipping, Finance and Management of the Athens University of Economics and Business**

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ΔΙΑΤΜΗΜΑΤΙΚΟ ΠΡΟΓΡΑΜΜΑ ΜΕΤΑΠΤΥΧΙΑΚΩΝ ΣΠΟΥΔΩΝ ΣΕ **ΔΙΕΘΝΗ ΝΑΥΤΙΛΙΑ, ΧΡΗΜΑΤΟΟΙΚΟΝΟΜΙΚΗ & ΔΙΟΙΚΗΣΗ** MASTER OF SCIENCE (MSc) IN **INTERNATIONAL SHIPPING, FINANCE & MANAGEMENT**

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"I hereby declare that this particular thesis has been written by me, in order to obtain the Postgraduate Degree in International Shipping, Finance and Management, and has not been submitted to or approved by any other postgraduate or undergraduate program in Greece or abroad. This thesis presents my personal views on the subject. All the sources I have used for the preparation of this particular thesis are mentioned explicitly with references being made either to their authors, or to the URL's (if found on the internet)."

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## Contents

# Abstract

*The purpose of this paper is to investigate and present the impact of shipping market determinants on the stock prices of shipping companies. After collecting data for an 8-year period between August 2014 and September 2021, we are going to examine whether there is any kind of relation between stock prices returns with shipping freight rates, oil prices, vessels' values as well as other economic and financial indicators, to provide further information to the existing bibliography of shipping stock prices forecasting as there is no other paper in the literature examining this impact simultaneously. Our findings indicated that Baltic Dirty Tanker Index (BDTI) and Baltic Clean Tanker Index (BCTI) have a positive correlation with the average share price of the 15 tanker companies that comprise our sample of companies however is rather mediocre both in levels and returns of the variables. In addition, BDTI's and BCTI's p-values showed statistical insignificance in regard to the Ordinary Least Squares (OLS) output where the returns of the data were regressed as well as the freight indices do not Granger cause the share prices neither in terms of the returns nor in terms of their volatilities. As for the tankers' secondhand market and its effect on tankers' companies share price, the correlation matrix reported a relatively positive correlation (0.55) in terms of levels however their correlation was very low in terms of their returns. Regarding OLS, secondhand market proved to be statistically insignificant in explaining shares' prices. Furthermore, there is not pairwise causality between the two variables neither in terms of their returns nor in terms of their volatilities. Last but not least, oil price and shares' price had a very low correlation both in their levels and returns. Although, as OLS output reports, Brent's price is statistically significant at 90% significance level in explaining tanker companies' share price and Brent's price volatilities cause tanker companies' share price volatilities. Concluding, the OLS regression model was statistically significant with high explanatory power (0.70) as well as all the selected independent variables jointly seem to cause shares' prices at 90% significance level.*

# 1. Introduction

The Shipping industry is characterized as a highly capital-intensive business. One major attribute of shipping companies is that about 90% of their assets are tangible. The cost of a new-building or second-hand vessel may exceed USD 100 million. Financing the industry is a sensitive problem requiring a significant amount of capital. The optimal capital structure (how much debt and how much equity) became a difficult problem in a competitive global market, producing significant savings of capital expenditures and an increasing competitiveness for the shipping companies to properly decide how to finance their fleet. Vessels can be liquidated in a relatively flexible manner for the appropriate amount of capital, depending on the prevailing conditions. For this reason, one can understand the importance of constant financing and the different ways to obtain it. If you want to perform better than your competitors, you should strive to reach an optimal mix of funding sources. Even though the nature of this industry contains high risks, it provides those that decide to invest in it with very high returns. To be more specific, high risks include the volatility of freight rates, the cyclicality nature of the sector and the fact that it is an international industry which is affected by global political and economic factors e.g., the closure of the Suez Canal in the 1950s and 1960s, Global Financial Crisis of 2008 etc.

Similar to the construction or heavy industry sectors, the last financial turmoil significantly changed the importance of relevant factors that could influence the financing decision and the capital structure. One way to raise capital in order for a shipping company to realize a particular project or an investment is by deciding to go public through an IPO (Initial Public Offering) and offering part of their ownership by selling stocks to potential investors on one or more of the stock exchanges around the world. New York, Oslo, Hong Kong, Singapore, and Stockholm are all used for public offerings of shipping stocks. The advantage of the capital markets is that once the company is known and accepted by the financial institutions, it offers wholesale finance and a quick and relatively inexpensive way of raising very large sums of money. However, most shipping companies are too small to require funding on this scale and can end up spending a great amount of time and money, raising sums that could be obtained more easily from a commercial bank. In short, the capital markets are not a source of finance to be dabbled in. They are a lifestyle that must be entwined and that is not in every case simple, given the volatile characteristics of the shipping business. As of today, there are 170 shipping companies that have gone public while at the same time, most of the shipping companies decide to remain private. In 2007 there were 181 public shipping companies with a market capitalization (the number of issued shares multiplied by the market value per share) of $315 billion. Shipping and trade are highly interdependent and because of the observed growth in seaborne trade during the last century, it has led to the expansion of the shipping sector and other activities around the industry such as insurance, shipbuilding, shipbroking, shipping finance. It is estimated that the shipping industry contributes the wide majority of the volume of world trade in commodities and manufactured products. (Diamantis-Karavasilis, 2020)

This thesis will focus on the tanker shipping companies and tanker sector in general. From the 170 shipping companies that have gone public, as mentioned previously, there are only 15 that are doing business in the Crude Oil and Oil Products sector with reliable data for further analysis. Significant to mention, that we are trying to make an approach for an industry where no one can give precise answers. Laws of the economic theory do not always apply in the Tanker segment, but this is not an excuse to not conduct further investigation.

## *1.1 Brief Outlook*

Oil prices are determined by global supply and demand. Economic growth is one of the biggest factors affecting petroleum production and therefore crude oil demand. Growing economies increase demand for energy in general and especially for transporting goods and materials from producers to consumers. The world's transportation sector is almost totally dependent on petroleum products such as gasoline and diesel fuel. Many countries also rely heavily on petroleum fuels for heating, cooking, or generating electricity. Petroleum products made from crude oil and other hydrocarbon liquids account for about a third of total world energy consumption.

### 1.1.1 Causes of world oil prices and supply disruptions

Geopolitical events and severe weather that disrupt the supply of crude oil and petroleum products to market can affect crude oil and petroleum product prices. These events may create uncertainty about future supply or demand, which can lead to higher volatility in prices. The volatility of oil prices is tied to the low responsiveness, or inelasticity, of supply and demand to price changes in the short term. Crude oil production capacity and the equipment that uses petroleum products as its main source of energy are relatively fixed in the near term. It takes time to develop new supply sources or to vary production, and when prices rise, switching to other fuels or increasing equipment fuel efficiency in the near term is challenging for consumers to do. These conditions may require a large price change to rebalance physical supply and demand.

Most of the crude oil reserves in the world are located in regions that have been prone to political upheaval or in regions that have had oil production disruptions because of political events. Several major oil price shocks have occurred at the same time that political events caused supply disruptions, most notably the Arab Oil Embargo in 1973–74, the Iranian revolution, the Iran-Iraq war in the 1980s, and the Persian Gulf War in 1990–91. In recent years, conflicts and political events in the Middle East, the Persian Gulf, Libya, and Venezuela have contributed to world oil supply disruptions and increases in oil prices.

Given the history of oil supply disruptions caused by political events, market participants constantly assess the possibility of future disruptions. In addition to the size and duration of a potential disruption, market participants also consider the availability of crude oil stocks and the ability of other producers to offset a potential supply loss. When spare capacity and inventories are low, a potential supply disruption may have a greater impact on prices than might be expected if only current demand and supply were considered.

Weather also plays a significant role in the supply of crude oil. Hurricanes in the Gulf of Mexico can affect oil production and refinery operations in the Gulf region. As a result, U.S. petroleum product prices may increase sharply as supplies from the Gulf to other regions drop. Severe cold weather can also strain product markets as producers attempt to supply enough product, such as heating oil, to consumers in a short amount of time. This seasonal demand can also result in higher prices.

Other events such as refinery outages or pipeline problems can also restrict the flow of crude oil and petroleum products to market. These events can lead to a temporary supply disruption that could increase prices.

The influence of any of these factors on crude oil prices tends to be relatively short lived. Once the supply disruption subsides, oil and product supply chains adjust, and prices usually return to their previous levels.

### 1.1.2 Global Oil Production – The Power of OPEC

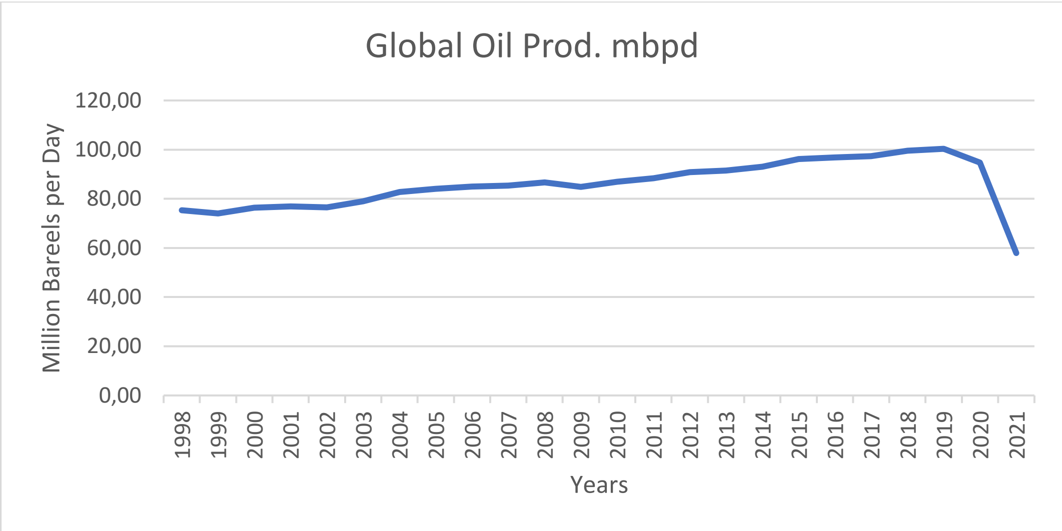


*Figure 1: Global Oil Production, Source: Clarksons SIN.*

The Organization of the Petroleum Exporting Countries (OPEC) can have a significant influence on oil prices by setting production targets for its members. OPEC includes countries with some of the world's largest oil reserves. As of the end of 2018, OPEC members controlled about 72% of total world proved oil reserves, and in 2018, they accounted for 41% of total world crude oil production.

OPEC attempts to manage oil production of its member countries by setting crude oil production targets, or quotas, for its members. Compliance of OPEC members with OPEC quotas is mixed because production decisions are ultimately in the hands of the individual members.

In general, the main factors determining OPEC's effectiveness in influencing oil prices include

- The extent to which OPEC members actually comply with production quotas

- The ability or willingness of consumers to reduce petroleum consumption
- The competitiveness of non-OPEC producers when oil prices change
- The efficiency of OPEC producers to supply oil compared with non-OPEC producers

The difference between oil market demand and supply from non-OPEC sources is often referred to as the call on OPEC because OPEC members maintain the world's entire spare crude oil production capacity. Saudi Arabia, the largest OPEC oil producer and one of the world's largest oil exporters, historically has had the largest share of the world's spare oil production capacity. Developing and maintaining idle spare production capacity is generally not cost-effective for international oil companies (IOC) because the IOC business model maximizes revenue by producing oil as long as the price of selling the oil is higher than the cost of supplying an additional barrel of oil to market. OPEC spare capacity provides an indicator of the world oil market's ability to respond to real and potential disruptions in world oil supplies.

### 1.1.3 Buyers and sellers at a global auction

Crude oil and petroleum product prices are the result of thousands of transactions taking place simultaneously around the world at all levels of the supply chain, from the crude oil producer to the individual consumer. Oil markets are essentially a global auction—the highest bidder will win the available supply.

Like any auction, the bidder doesn't want to pay too much. When markets are tight (when demand is high and/or available supply is low), the bidder must be willing to pay a higher premium. When markets are loose (demand is low and/or available supply is high), a bidder may choose not to outbid competitors, waiting instead for lower-priced supplies. (U.S.E.I.A, 2021)

## ***1.2 Key Market Drivers***

### 1.2.1 Demand for Oil

The demand for oil is an obvious driver of crude tanker demand; the more oil that is needed around the world, the bigger the demand for moving this oil from production to refinery

### 1.2.2 Supply of Oil

Clearly for any oil transportation business the supply of oil is critical to the status of its markets. Oil supply dynamics have undergone a transformation in the past decade.

### 1.2.3 Vessel Supply

Perhaps the key driver of tanker markets is vessel supply. This is the ultimate driver of market fluctuation; when the market is in short supply of ships, the cost of chartering a ship – the freight – goes up but of course down if there are too many ships available. This over- or undersupply of vessels can be viewed on a macro level with the total global supply of ships, which will drive more long-term trends in freight levels, but it can also be viewed on a more regional level where the number of ships available in a specific load area can drive short-term freight fluctuations, which may vary in different load areas. On a global scale the supply of ships is a function of how many newbuild ships are delivered versus how many ships are removed from the fleet. (Euronav, 2017)

## *1.3 Demand for Oil*

### 1.3.1 Crude Oil Imports

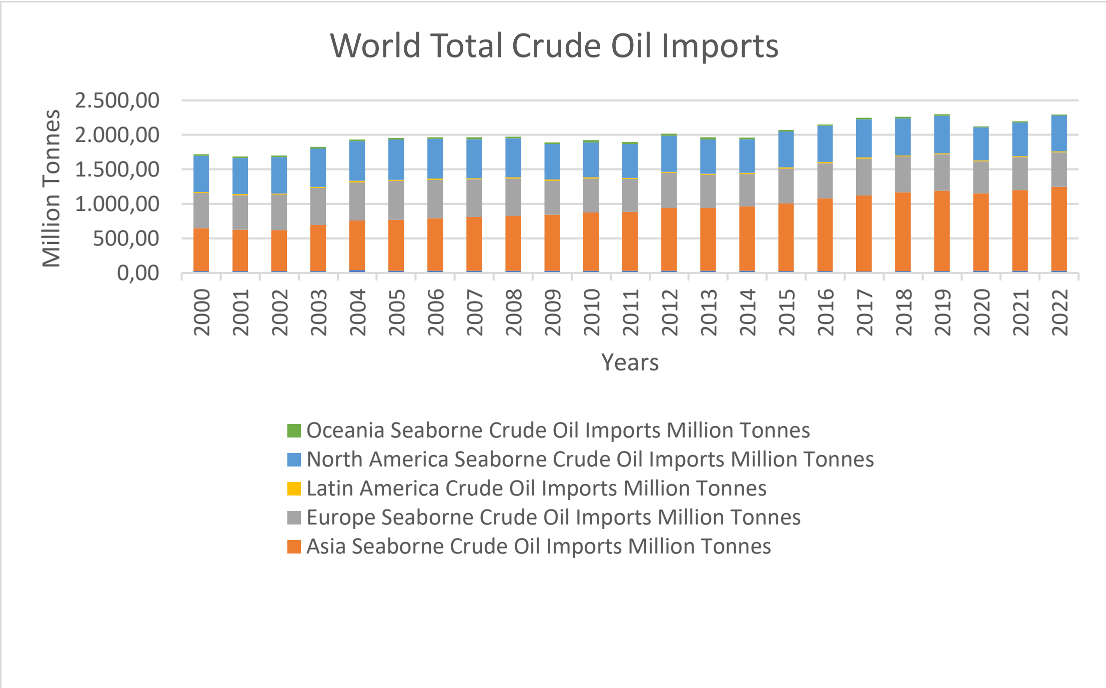


*Figure 2: World Total Crude Oil Imports, Source Clarksons SIN.*

Asia's imports in crude oil are heavily affected from Chinese demand which has grown considerably during the past 15 years. It is significant to mention that on a metric ton's basis, crude imports in 2020 rose 7.3% year on year to 542.39 million mt. (Zhou, 2021) A slow but gradual growth is also observed in crude oil demand of India. However, crude oil imports fell in July 2020 to their lowest since March 2010 as fuel demand slowed amid renewed coronavirus-induced lockdowns and closures of refinery units for maintenance, which marked a fourth straight monthly decline. (Narayanan-Verma, 2020) Near future predictions remain positive for the area though.

The stability of the EU's energy supply may be threatened if a high proportion of imports are concentrated among relatively few external partners. In 2018, almost two thirds of the extra-EU's crude oil imports came from Russia (30 %), Iraq (9 %) and Saudi Arabia, Norway, Kazakhstan, and Nigeria (7 % each) (Eurostat, 2020). Countries of Benelux are leading the crude imports race in EU with Germany, Spain and France following. Crude oil imports took a dive in 2020 as the pandemic raged but projections for the next couple of years, show an upgrowth in the demand for this commodity (HellenicShippingNews, ~~EU Crude Oil Imports Took a Dive in 2020, as the Pandemic Raged~~, 2021).

North America and mainly USA have managed to keep stable their annual demand for imports due to the strategy of "energy independence" promoted by the American congress, which rests on lowering oil imports, seen as a bugaboo for the crisis of the 1970s. Oil imports have not plummeted like one would assume in the ongoing shale-era. Due to slowly changing factors such as regional oil trade patterns, existing infrastructure, regional balances of supply & demand, and other constraints. The good news though is that imports from friend and neighbor Canada have been displaced from obviously more politically risky OPEC (Clemente, 2020).

As for the rest of the World, Africa has only small amounts of Crude Oil Imports. However, the most prominent importers are located in Western and Northern Africa. Africa's excellent diplomatic relations with China might be a good reason to enhance its production in the future and import bigger amounts of oil. Most countries in South America, are self-sufficient in oil. Subsequently the amounts imported by the continent did not exceed 20 million tones, during the past 20 years, on average. The pandemic dropped demand for crude to a historical low level. One of the most interesting cases in the whole report, is the one of Australia (main representant of Oceania). According to the latest warnings from the Australian Institute, the country should dramatically decrease its oil use to ward off a potential crisis by tightening fuel-efficiency standards, introducing electric vehicle targets, and increasing public transport use. Significant to mention that in December 2018, Australia held only 18 days of petrol, 22 days of diesel and 23 days of jet fuel reserves, according to federal government figures. In the event of disruption, emergency powers to ration fuel stocks would take up to three weeks to kick in (Richardson, 2018) (Martin, 2019). Future predictions regarding crude imports indicate stability for all three continents.

### 1.3.2 Oil Products Imports

Strange as it might sound, Singapore is the most prominent importer of refined petrol and other products in Asia region. The highly sophisticated terminals of the country made its port number one destination for the supply of the hinterland. South Korea and China follow at a far second and third place. Future projections show stability in import levels.

Like Singapore, Netherlands manages ports with state-of-the-art equipment and procedures. Thus, the vast majority of oil products imports in Europe take place in Dutch ports. Of course, ports of Germany and the UK also take place in the high import volume of the specific commodity, in Europe. The continent is a large consumer of byproducts thus predictions show an increase.

According to EIA U.S. petroleum net imports in 2019 were the lowest since 1954. Of course, in 2020 we observed a new drop record due to the pandemic. Oil products for North America and mainly USA are lowering gradually from 2005 and on as US governments have decided to weaken their relations with OPEC (previous main supplier) and rely mostly on Canada. Petroleum imports from Canada increased significantly since the 1990s, and Canada is now the largest single source of U.S. total petroleum imports. In 2019, Canada was the source of 49% of U.S. total gross petroleum imports (U.S.E.I.A, 2021).

Imports of refined oil in South America, risen gradually for 2 reasons. First reason relates to the low capacity of oil refiners to accommodate local demand. Second reason is that due to the sanctions imposed to Venezuela by the US, neighbor countries could not have easy access to byproducts. As a result, 2020 imports faced only small decreases amid the pandemic, and future images show that demand will grow larger for oil products.

African imports for oil products are larger than exports. Again, the main players are located in South and Northwestern Africa. Covid-19 pandemic caused a 20% drop in imports for the specific commodity in the area. Projections show that imports will return slightly back to 2019 levels over the next couple of years.

Australia increasingly imports refined petroleum from abroad while its total production decreases. Currently, 51-53% of the imported refined petrol come from Singapore's refineries, with 18% coming from South Korea and 12% from Japan. Asian refineries in particular are extremely competitive in terms of production and transport costs (Richardson, 2018). Many Australian Economists have ringed the emergency bell for the country to become self-sufficient as soon as possible, otherwise the country will face serious deficits in many other commodities. These signs indicate a negative growth for the specific commodity in the medium range future.

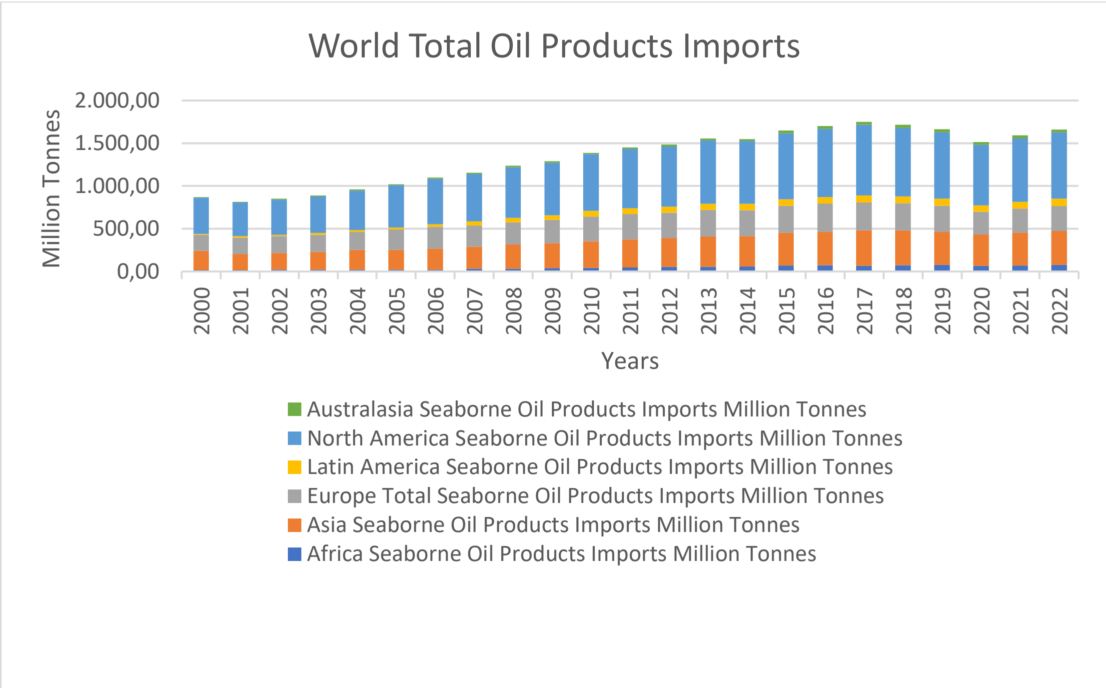


*Figure 3: World Total Oil Products Imports, Source Clarksons SIN.*

## 1.4 Supply of Oil

### 1.4.1 Crude Oil Exports

Despite the sanctions imposed by President Donald Trump to Iran in 2019, Middle East remained on the top of Crude Oil Exports list holding the lion's portion, with countries like Saudi Arabia and Iraq being the top suppliers of crude oil globally.

In the African continent, three countries control the export of crude oil. However, all three of them have lost a significant portion of their market share from 2016 and after. Maritime trade in Africa is shaped by the continent’s trade concentration and limited diversification. Almost 40% of goods exported by sea in 2017 comprised of crude oil. (UNCTAD, 2018).

Talking about losses, Northern Europe has also lost significant ground in the race of exports. The main player in Europe which is Norway had a larger negative impact whereas UK lost smaller amounts. Europe has become mainly a consumer rather than producer, during the past 2 decades. Crude oil exports gained back though, some of the lost ground during the pandemic and future expectations show a slight increase in exports for this commodity in Northern Europe.

Former Soviet countries (mainly Russia), countries of the North-West Africa and Northern Europe, do also represent a stable market share, throughout the years. As tensions between Russia and the European Union mounted and the Asian economies expanded, Russian President Vladimir Putin asked the government to diversify oil export routes. The diversification of export routes also allowed Russia to capture better prices for its crude – for most of the past decade crude in Asia was trading at a premium to Russia’s western oil benchmark blend Urals. Also, from 2019 Russia planned to launch its first major gas pipeline to China, which was poised to help the country to further diversify its energy exports (Yagova, 2019). We can say that Russia, main representant of the FSU countries, is one of the big winners in the field.

Regarding the U.S. crude oil export volumes, those have increased as the number of destinations that receive U.S. exports has also increased. In 2019, the number of U.S. crude oil export destinations surpassed the number of imports according to EIA. This rise coincides with the late 2015 lifting of restrictions on exporting domestic crude oil. U.S. refineries have accommodated this increase in production by displacing imports of light and medium crude oils from countries other than Canada and by increasing refinery utilization rates. More stringent national and international regulations limiting the sulfur content of transportation fuels are also affecting demand for light-sweet crude oil (Hamilton, 2019). Many of the less complex refineries outside of the US cannot follow the competition. Projections for the near future crude exports are high for US due to this technical strategic advantage they possess.

The rise in Latin America reflects Brazil's growing clout among global oil producers as its massive offshore projects come online. Brazil is expected to deliver one of the biggest increases to global supply in the next five years from nations outside OPEC, according to the IEA. Asian refiners were keen for the low-sulfur oil that Brazil sells, as they sought to comply with new maritime regulations to supply ships with cleaner fuel. The oil is from Brazil's prolific offshore deposits known as pre-salt fields. However, rival Latin American producers ceded ground. Venezuela a main exporter of the past decades, was severely affected by its the political instability and in 2019 lost about 35% of its exports (Parraga, 2020).

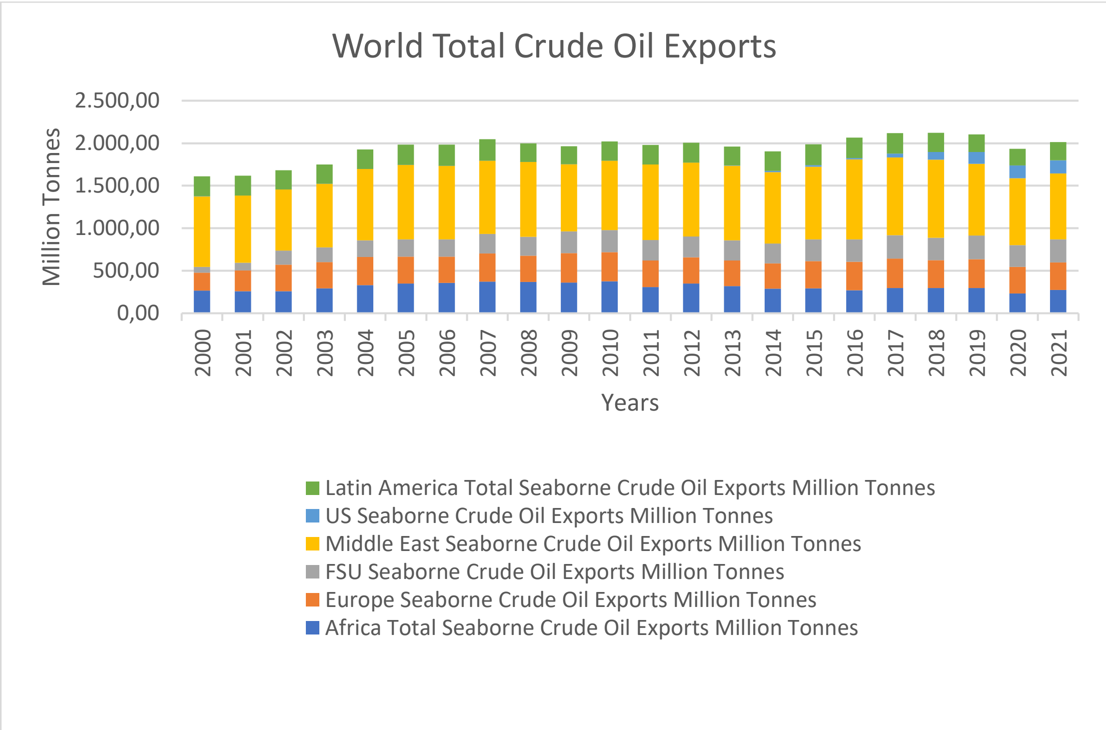


*Figure 4: World Total Crude Oil Exports, Source: Clarksons SIN.*

### 1.4.2 Oil Products Exports

In the European continent 3 main powers starring at the exports of oil products such as refined petrol and gas. Netherland's main export is refined products and they come first in the European list. As we mentioned previously, Norway and UK are more involved in crude oil, but they have also a significant market share in oil products as well.

By 2019 the US had become a net exporter of refined products, selling 3 Mb/d into global markets, just behind Russia (3.2 Mb/d) as the largest refined product net exporter. The US experience stands in sharp contrast to refiners in other industrialized countries like EU and Japan. The secret behind the US success story is technical excellence. US refiners are highly sophisticated and have the benefit of operating in the world's largest oil-consuming nation. Simply put, they are able to produce lots of highly marketable fuels, with few of the less-valuable byproducts. In addition, US refiners are highly adaptive to changing market circumstances as they have exploited the domestic crude oil boom to their benefit. Important to mention that the US has a helping hand from the neighbors to the North as well. US exports of gasoline, diesel and jet fuel all declined in 2020. This led to the closure of many refineries with EIA reporting that operable capacity fell by about 600,000 b/d in 2020. Most analysts expect US and Canadian refined oil production to be broadly flat in coming years due to a cautious oil market outlook and concern among investors that producers have not returned sufficient cash to investors. The likelihood of new policies to limit development of federal lands, and of stricter regulation (for example, of methane emissions), will raise further challenges for domestic producers (HellenicShippingNews, Challenges Ahead for US Refiners, 2021).

Saudi Arabia and UAE are the main players in refined oil exports. Both countries hold considerable energy reserves, offshore and onshore. UAE is the fourth largest producer of petroleum liquids in OPEC and holds the seventh largest natural gas reserves globally. According to the UAE Central Bank's latest statistics, UAE's petroleum exports (hydrocarbons) grew by 13.9 percent to $66.2 billion in 2019 compared with $58.1 billion in 2017 (export.gov, 2019). Most of Saudi Arabia's seven oil refineries in the kingdom have been upgraded to produce premium fuels. Some of them are being expanded. The oil and gas sector accounts for about 50 per cent of gross domestic product, and about 70 per cent of export earnings. However, global pandemic had a serious impact in both countries and the rest Geographical area. Projections for the near future show a positive image, as Middle East keep high quality oil products in its vast resources

Russian domestic refining grew by more than 50 percent as Putin called on the industry to modernize and focus on exports of value-added products rather than crude oil. Exports to the West, which have been the main source of export revenues for Russia and the Soviet Union since the 1960s, have declined by some 15 percent since 2005 (Yagova, 2019). This strategic move of diversification both in terms of production and in terms of exports (Stronger relations with China and the East) led to an upgrowth in oil product exports which was insignificantly affected during the pandemic. Future projections indicate stability.

In South America Venezuela was keeping nearly a quarter of the continents production and exports in oil products. However, the serious instability and financial issues Venezuela faced, led to almost zero exports lowering, as a result, the market share of the continent. The area is rich in oil reserves, but the condition does not seem to change in the future due to political reasons. The African continent keeps a low performance in exports of oil products. Oil reserves are present mainly in South Africa, and North-Western part. There is no high-quality refining service in the area though, which lead to a safe assumption that the region will not be in the spotlight for the specific commodity, in the future.

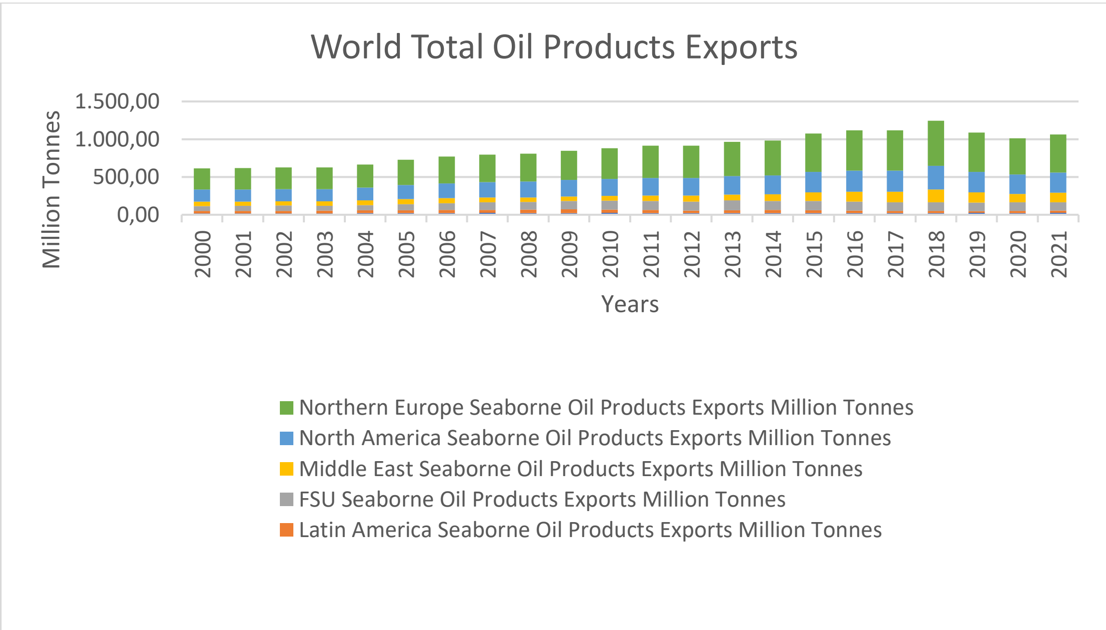


*Figure 5: World Total Oil Products Exports, Source: Clarksons SIN.*

## *1.5 Vessel Supply*

Oil tanker is designed for the bulk transport of oil. Basic types of tankers include crude tanker and product tanker. Crude tanker transports unrefined crude oil from extraction locations to refineries while product tanker ships refined products to points close to consuming markets. Tankers are generally categorized by size, e.g., Handysize, Panamax, Aframax, Suezmax and VLCC/ULCC. Many maritime economists believe that the supply of tanker shipping operates under perfect competition. The first feature is number of shipping service providers. There are several ship owners that own tankers that provide identical shipping services. The second characteristic is the availability of information. In the tanker market, information on freight rate can be searched via such means as the Baltic Index. Hence, shipping service providers are unable to manipulate the price. Obstacles to entry to and exit from the industry exist but these challenges can be managed. Entry barriers, such as government regulations, economic factors, and marketing condition, are not present in the tanker shipping industry. On the one hand, huge capital investment is needed to acquire ships (new ships from the new building market or second-hand ships from the sales and purchase market) to enter the industry. On the other hand, shipping firms may withdraw from the market by selling their assets (i.e., ships) in the second-hand vessel sale and purchase market. The increased cargo volume in the tanker market leads shipping firms to adjust their supply by building new ships in the new building market and acquiring second-hand vessels in the sale and purchase market. In tanker shipping, price level (i.e., freight rate) is influenced by the market (i.e., demand for shipping service and supply of shipping service). In the context of research in tanker shipping, the demand for shipping is seaborne trade in energy products because demand for tanker shipping occurs as a result of demand for seaborne tanker shipping service (i.e., derived demand). On the opposite, the supply of shipping service is fleet size in the tanker shipping market. From the perspective of the industrial organization paradigm, the interaction between the demand for and the supply of tanker shipping service affects the market structure, which in turn plays a significant role in determining the investment and operation decisions in the marketplace (Lun, 2013). The tanker shipping industry comprises four different but closely associated markets. Sea transport services are dealt in the freight market, new ships are ordered and built in the new building market, used ships are traded in the sale and purchase market, and old or obsolete ships are scrapped in the demolition market. Prices of these four shipping markets are determined by the interactions of buyers and sellers of the markets (Dikos-Marcus, 2003).

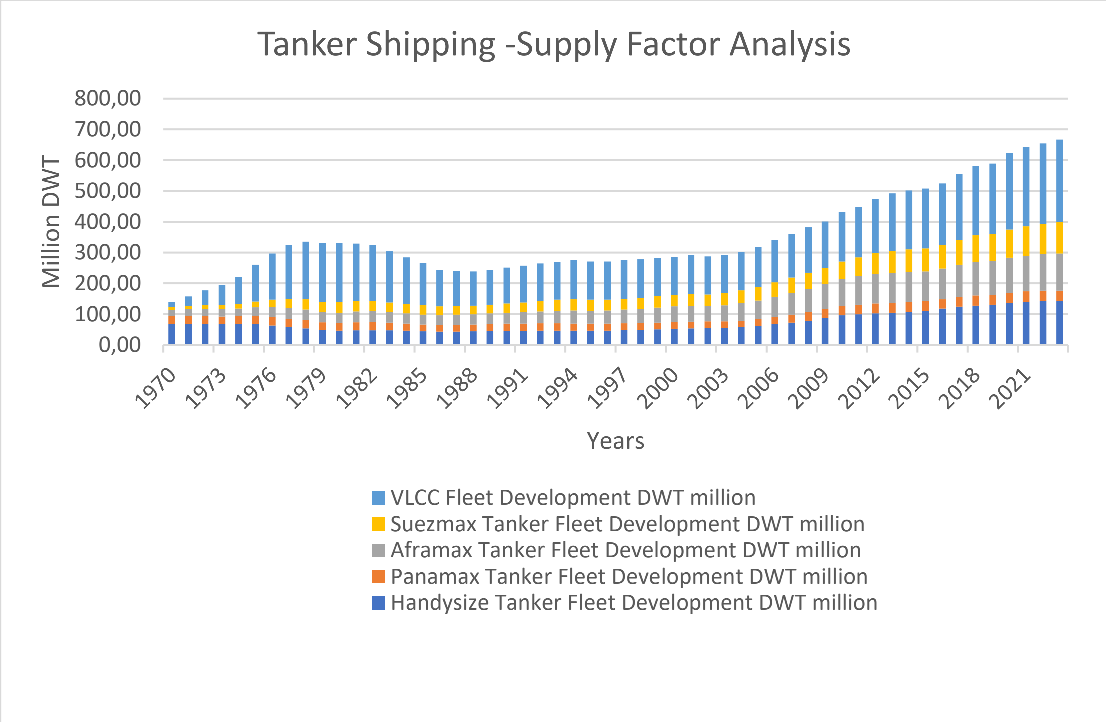


*Figure 6: Tanker Shipping - Supply Factor Analysis, Source: Clarksons SIN.*

In this graph we observe the development of the tanker fleet worldwide for all categories of ships. Although the tanker fleet increased around 12 percent annually around 1970, a shortage on tonnage remained. In 1973 this resulted in an enormous increase in new building orders, especially from oil majors that wanted to gain on the quicker deciding independents, who could ask enormous rates for their vessels. Where the existing tanker fleet comprised some 150 million long tons, in a quarter of a year a tonnage of 75 million was ordered, although new build prices doubled. On 10 October 1973 the Yom Kippur War begun, causing the 1973 oil crisis, tripling oil prices to US$10 per barrel, halting economic growth. It took until the end of the 1980s before any profits were being made in oil transport. The stable upgrowth of Tanker tonnage that occurred in the 1970s was also an outcome of The Suez Canal closure until 1975 with freight rates skyrocketing because of the shortage of tonnage. Ships had to pass the Cape of Good Hope (Devanney, 2006). Even larger tankers were now built

(Evangelista, 2002), as the limitations of the Suez Canal were not governing anymore. In only a couple of years the size of tankers quadrupled to more than 500,000 long tons and there were even plans for tankers of 1,000,000 long tons. Newly build ships sometimes went straight from the yard to lay-up. The situation worsened when the Suez Canal was reopened in 1975. Just when the situation began to improve in 1979, the Iranian Revolution caused the second oil crisis, causing oil prices to rise to US$30. Ships were sometimes sent to the breakers after being in service for only ten years. It took until the end of the 1980s before any profits were being made in oil transport (Devanney, 2006).

The upgrowth of Tanker tonnage was inhibited by the "Tanker War" a conflict between Iran and Iraq that lasted for most of the 1980s and was one of the bloodiest of the late 20th century. It was the naval aspect of the war – in particular the decision by both sides to attack enemy merchant shipping – that significantly affected the tanker shipping segment. It represented the most sustained attack on merchant shipping since the Second World War and resulted in over 400 civilian seamen killed, hundreds of merchant ships damaged and substantial economic losses. Its broader significance lay in the danger such attacks posed to an international economy critically dependent on Gulf oil exports traversing the Straits of Hormuz chokepoint. Equally as significant was the Tanker War's potential for escalation, as outside powers became drawn into the conflict with the intention of ensuring freedom of navigation (Navias, 2019).

In the tanker market the freight peak was accompanied by three years of heavy ordering, from 1988 to 1991, during which there were orders for 55m.dwt of new tankers. This rush of investment was based on three expected developments in the tanker market. Firstly, the fleet of ageing tankers built during the 1970s construction boom was expected to be scrapped at 20 years of age, creating heavy replacement demand in the mid-1990s. Secondly, shipbuilding capacity had shrunk so much in the 1980s that many observers thought there would be a shortage when the replacement of the 1970s-built tanker fleet built up in the 1990s. Thirdly, growing oil demand was expected to be met from long-haul Middle East exports, creating rapidly increasing demand for tankers, especially VLCCs. As it turned out none of these expectations were realized. Most of the 1970s-built tankers continued to trade beyond 20 years; by the mid-1990s shipbuilding output had more than doubled from 15m.dwt to 33m.dwt; and Middle East exports stagnated as technical innovation allowed oil production from short-haul sources to increase faster than expected. Delivery of the tanker orderbook pushed the market into a recession which lasted from early 1992 to the middle of 1995 when a recovery finally started, and freight rates moved onto a steady improving path. As so often happens in shipping cycles, things did not develop as anticipated, and during the next two years the market experienced a classic boom and bust cycle. The Asian economies only remained in recession for a few months, and by the spring of 2000 industrial production was growing faster than ever, at up to 11% per year. Meanwhile the negative sentiment in the tanker market had triggered heavy scrapping of the 1970s tankers which were coming to the end of their life and as a result the tanker fleets grew very slowly.

During the previous years, China had been developing its economy, employing an open-market model which attracted inward investment. In early 2003 it moved into a period of serious infrastructure development, and this required enormous quantities of raw materials. Between 2002 and 2007 China's steel production grew from 144 million tons a year to 468 million tons a year, adding capacity equivalent to that of Europe, Japan and South Korea. Combined with growth of oil imports, in the autumn of 2003 this created an acute shortage of ships. Tanker rates were propelled to new highs and, despite some volatility, stayed at these high levels for the following four years (Stopford, Maritime Economics,3rd Edition, 2009).

Modern Tanker fleet is comprised mostly of Dirty Tanker vessels (VLCCs' and Suezmax mainly). The vast majority of the remaining categories like Aframax, Panamax and Handysize are transporting clean cargo (oil products). At the following stage we will see how supply is working for each of the categories mentioned.

### 1.5.1 VLCC

VLCC Tankers are exclusively comprised of Dirty Cargo ships. As shown in a previous diagram, VLCCs' are the vast majority of ships in the Tanker sector. Orderbook reached at the highest level of 75 million DWT in 2009 and still remained high in the following years. High orderbook will lead to excessive deliveries in the near future, adding excessive tonnage in the market. At the same time, low demolitions do not seem enough to reverse the situation of perpetual overcapacity in the sector.

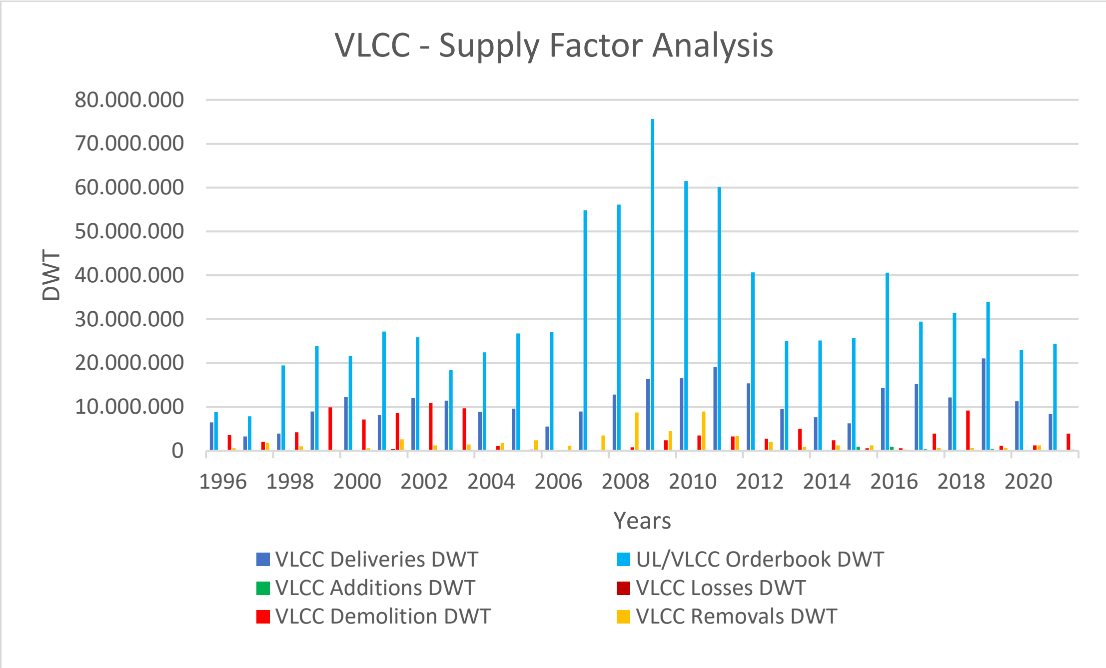


*Figure 7: VLCC Supply Factor Analysis, Soure: Clarksons SIN.*

## 1.5.2 Suezmax

Suezmax Tankers consist mostly of dirty cargo vessels. Post crises years (after 2009) have led to an overcapacity of ships. Future projections might not be quite pleasant for the shipowners of that particular vessel type, as orderbook and deliveries are kept in high levels whereas demolitions and removals of ships are very few to overcome the problem that might be created.

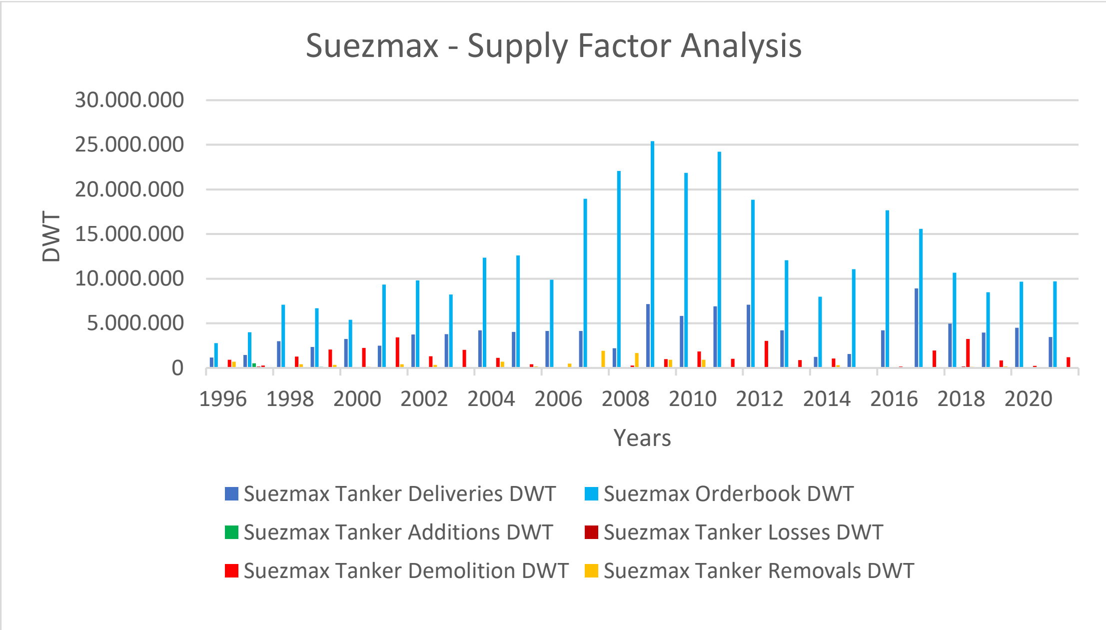


*Figure 8: Suezmax - Supply Factor Analysis, Source: Clarksons SIN.*

## 1.5.3 Aframax

During the golden years of shipping, we observed an unprecedented rise in orders for new Aframax vessels, exceeding the number of 32 million DWT, in 2008. This momentum faded in the following ''post-crisis' years, however still remained in high levels. A significant rise in demolitions during 2017 - 2018, which is accompanied by the reducing number of deliveries and orderbook might be able to let the market relieve. Aframax vessels are the type of category which processes both Clean and Dirty tankers. A positive demand shock in both commodities would probably affect in a positive direction the freight earnings for this vessel category.

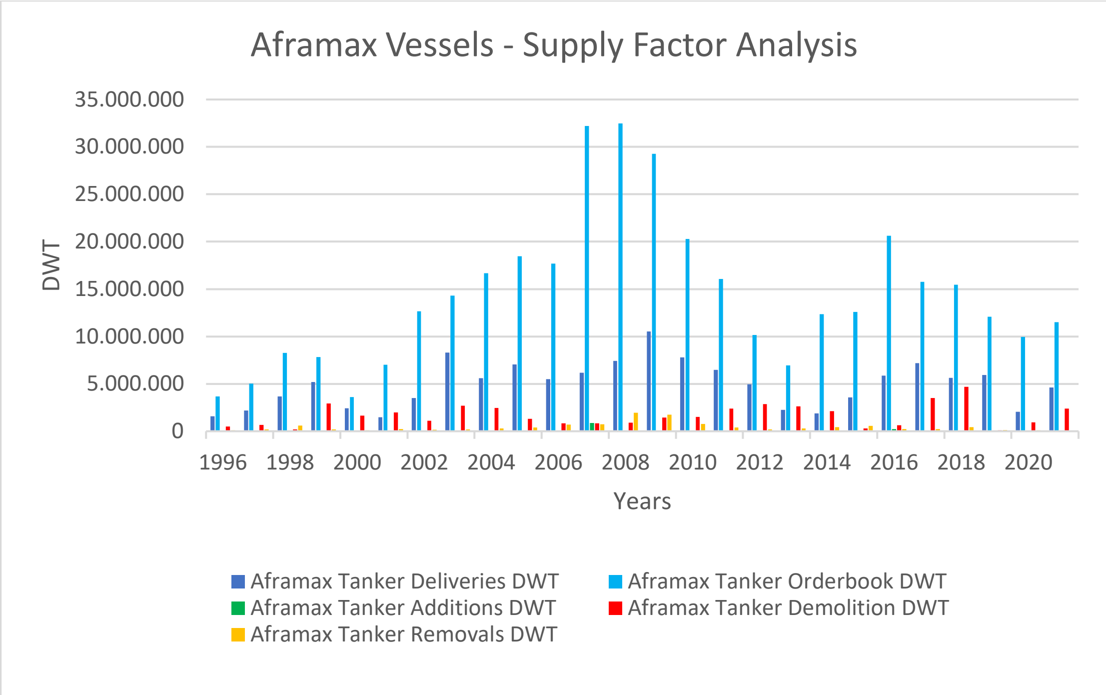


*Figure 9: Aframax - Supply Factor Analysis, Source: Clarksons SIN.*

### 1.5.4 Panamax

In the Panamax Sector the vast majority of vessels transport oil products. We observe a common type of movement as in the Handysize category. Deliveries and Orderbook seem to minimize amid the Corona Virus outbreak. Demolitions, however, are in really low levels to affect freight rates positively. A possible demand shock from one of the main importers of oil-products, would probably lead to an increase in freight earnings for panamax tanker ships.

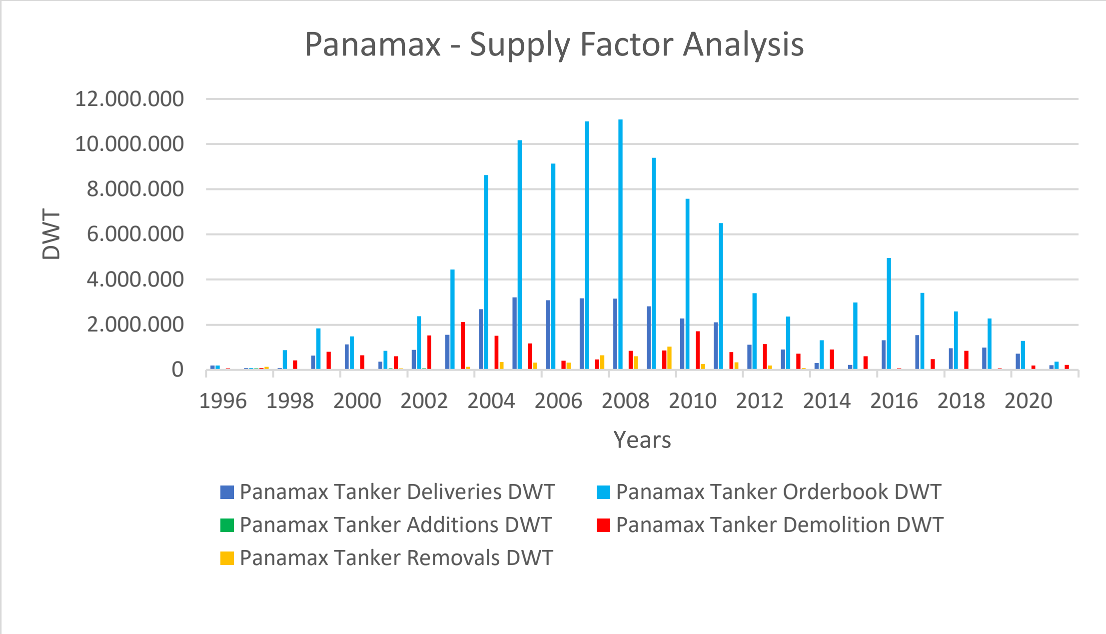


*Figure 10: Panamax Supply Factor Analysis, Source: Clarksons SIN.*

## 1.5.5 Handysize

In the Handysize sector, things tend to move in a positive direction during the past few years. Orderbook and Deliveries are being reducing overtime giving a small capacity for freight earnings to grow. On the meantime, Demolitions seem to keep in stable levels reducing the tonnage for that particular category of ships.

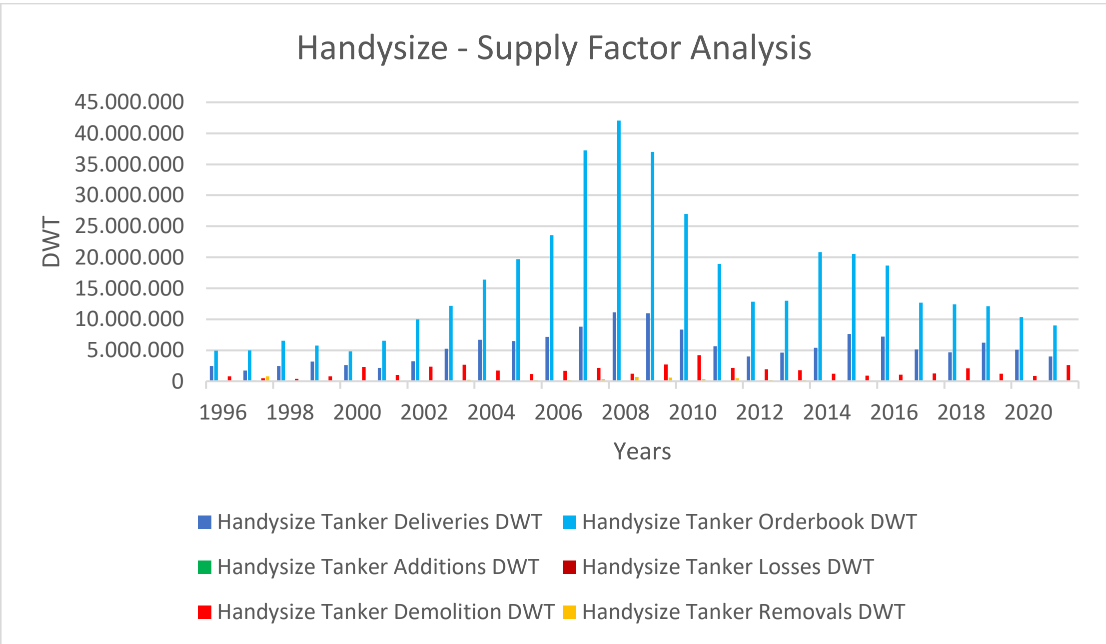


*Figure 11: Handysize - Supply Factor Analysis, Source: Clarksons SIN.*

## *1.6 Market Outlook*

### 1.6.1 Freight Rates

On April 20, 1998, the Baltic Exchange calculated the Baltic International Tanker Routes Index (BITR) for the first time and, three years later, on October 1, 2001, divided it into the Baltic Dirty Tanker Index (BDTI) and the Baltic Clean Tanker Index (BCTI). The BDTI records tankers that transport uncleaned cargo such as crude oil, while the BCTI records tankers that transport cleaned cargo such as oil products (petrol, diesel, heating oil or kerosene). In this graph we observe the movements of indexes referring to both Clean and Dirty Tankers. High volatility is the main characteristic of these 2 measures which also seem correlated from just a visual point of view. Both measures also seem to be susceptible in seasonal effects.

A global economic downturn and the associated drop in demand for shipping as well as overcapacity caused the Baltic Dirty Tanker Index to fall to an all-time low of 619 points on August 20, 2002. In 2004, tanker freight rates increased due to high demand for oil. Supertankers in the 200,000-to-320,000-ton class earned their owners spot rates of up to $ 230,000 a day. On 17 November 2004, the BDTI an all-time high of 3,194 points. In 2008, the international financial crisis, which started in the US housing crisis in 2007, led to a global recession. Because of the lower demand, there was a sharp drop in the price of oil freight rates, especially from the end of the third quarter of 2008. On April 15, 2009, the index fell to an all-time low of 453 points. The loss since July 23, 2008 (2,347 points) is 80.7 percent. On January 15, 2010, the index stood at 1,216 points, 168.4 percent higher than on April 15, 2009. From 2010 until today, condition in the Tanker market remains in a trough level. Both Indexes are being suppressed from the condition of vessel overcapacity that exists in the Tanker market.

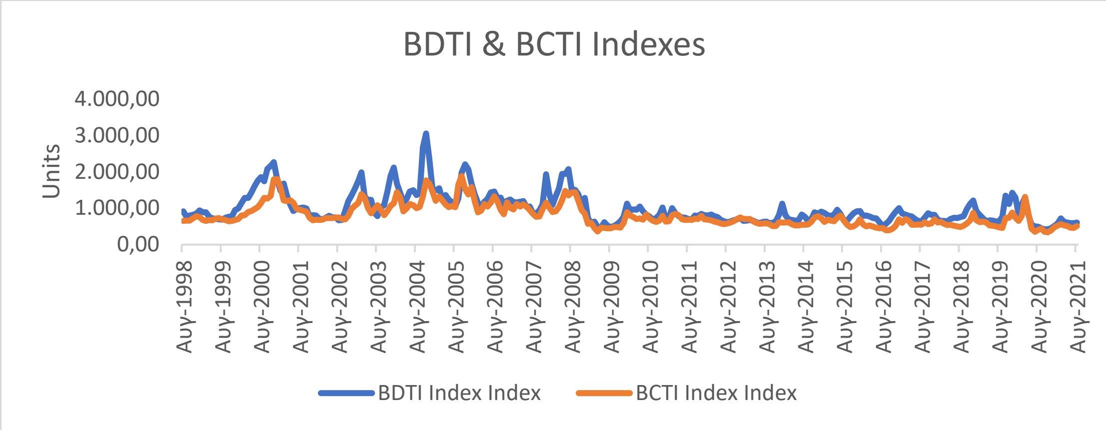


*Figure 12: BDTI & BCTI Indexes, Source: Clarksons SIN.*

## 1.6.2 Oil Prices

In the 1970s, there was a "significant increase" in the price of oil globally partially in response to the 1973 and 1979 oil crises. In 1980, globally averaged prices "spiked" to US$107 (Hannah, 2017). In the early 1980s, concurrent with the OPEC embargo, oil prices experienced a "rapid decline" (Martin-Douglas, 1982). In early 2007, the price of oil was US$50. By July 2008 it reached its all-time peak of US$147. In December 2008, the price of oil plunged to US$34, as the financial crisis of 2007–2008 took hold (Evans-Iris, 2009). The global average price of oil dropped to US$43.73 per barrel in 2016 (Hannah, 2017).By April 2020 the price of WTI dropped by 80%, down to a low of about $5,30 due to the COVID-19 pandemic and the 2020 Russia–Saudi Arabia oil price war (Long, 2020). BBC reported that by April, the price of US oil had "turned negative" as the demand for fuel decreased globally with pandemic-related lockdowns preventing travel. In April, as the demand decreased, concerns about inadequate storage capacity resulted in oil firms "renting tankers to store the surplus supply" (Walker, 2020). An October Bloomberg report on slumping oil prices—citing the EIA among others—said that, with the increasing number of virus cases, the demand for gasoline—particularly in the United States—was "particularly worrisome", while global inventories remained "quite high" (Luz-Guerra, 2020). By mid-October, the pandemic continued to threaten demand for oil keeping the price of oil "stuck" at about US$40 (Javier, 2020). The oil prices were seen rising to hit $71.38 per barrel in March 2021, marking the highest since the beginning of the pandemic in January 2020 (Reuters, 2021). The oil price rise followed a missile drone attack on Saudi Arabia's Aramco oil facility by Yemen's Houthi rebels (WashingtonPost, 2021). The United States said it was committed to defending the country (BNNBloomberg, 2021).

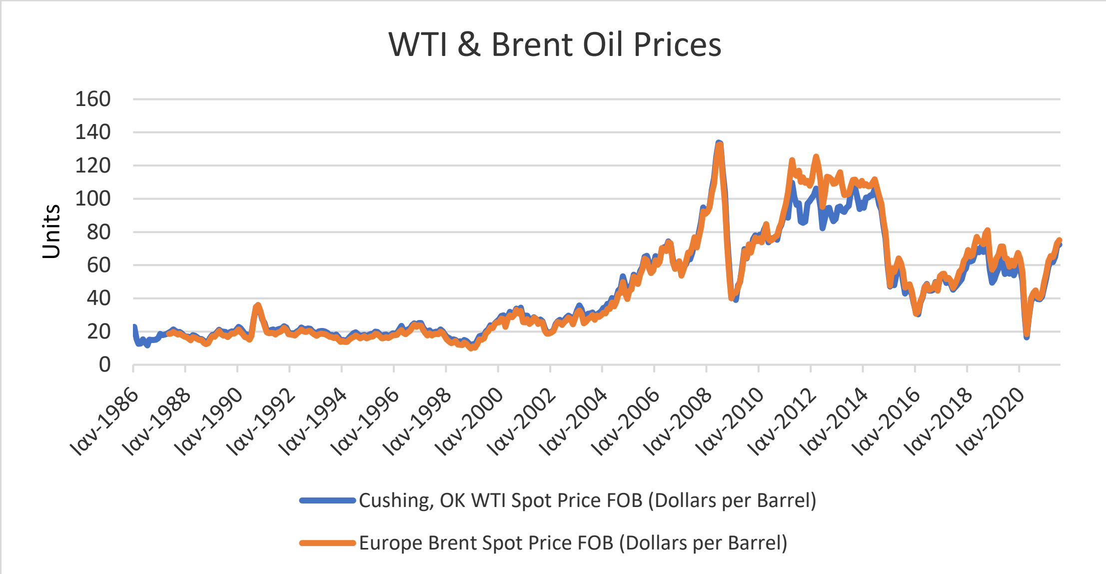


*Figure 13: WTI & Brent Oil Prices, Source: US Energy Information Administration.*

## 1.6.3 Vessels Value

The increased requirement for ships during the 1967-1973 period was greater than in the previous 16 years. Despite rapidly expanding shipbuilding capacity, the shipyards had difficulty keeping pace with demand. The year 1973 was one of the great years in shipping. During the summer the time-charter rate for a VLCC doubled from $2.5 per deadweight per month ($22,000 per day) to $5 per deadweight per month ($44,000 per day). The extremity of conditions sowed the seeds for a spectacular bubble in ship prices. Hill and Vielvoye describe the price spiral in the following terms. The upward movement in ship prices began at the end of 1972, and during 1973 the price of all types of ships rose by between 40 and 60 per cent compared with the previous year, with the most significant increase being paid for tanker tonnage. Owners were prepared to pay vastly inflated prices as a result of premiums on ships with an early delivery … In this situation a very large crude carrier which had been ordered in 1970 or 1971 at a cost of about $26.4 million could realize a price of between $61m and $73.5m (Stopford, Maritime Economics,3rd Edition, 2009).

The Iranian revolution in 1979 pushed the price of oil from $11 a barrel to almost $40 a barrel, triggering a massive response from oil consumers and an appalling tanker cycle. When the oil price increased, there was an immediate reaction and the seaborne trade in oil fell steadily from 1.4 billion tonnes in 1979 to 900 million tonnes in 1983. This laid the foundation for an extreme recession in the tanker market, with a surplus approaching 50% developing as this fall in demand combined with the over-building of the 1970s. The result was a severe depression as the market squeezed cashflow until sufficient tankers had been scrapped to restore market balance. Because there were few old tankers for scrap, especially in the bigger sizes where the surplus was concentrated, this took years to achieve and eventually many younger vessels were scrapped. Laid-up tanker tonnage increased to 40 million dwt in 1982 and 52 million dwt in 1983. By this time tanker prices were back to scrap levels and, even at these prices, ships that were 5 or 6 years old could not always attract a bidder. In the autumn VLCCs were sold for little over $3 million. The statistics do not do justice to the difficulties faced by tanker owners trading on the charter market during this period. In 1985 sentiment hit 'rock bottom. In 1986 the market showed the first signs of starting to pick up. Over the year freight rates increased by 70% and the price of an 8-year-old 250,000 dwt VLCC doubled from $5 million to $10 million. This was the start of a spiral of asset price appreciation, and by 1989 the vessel was worth $38 million, despite being three years older. Inevitably this triggered heavy investment in new tankers and the great tanker depression of 1974–88 ended as it had begun with a phase of speculative building.

The freight peak observed in the tanker market, during the late 80s and early 90s, affected vessel values in a positive way, as well. It was also -inevitably- a period of heavy ordering for new tankers. Shipowners thought it would be a perfect opportunity to renew their fleet which was ordered in 1970s, by operating a more modern fleet capable of covering the needs of Middle East exports. Things did not went as planned and delivery of the tanker orderbook pushed the market into a recession which lasted from early 1992 to the middle of 1995. However, secondhand price index remained almost unaffected with only little losses occurring on vessel values. Late 90s were accompanied by heavy scrapping due to the huge distress in freight earnings.

In early 2001 the collapse of internet stocks triggered a deep recession in the Atlantic and Asian economies, and by the end of 2002 industrial production in both the Atlantic and the Pacific was declining. These two factors negatively affected vessel prices.

Hopefully, the following years were described as the "golden era" of shipping. Chinas' opening to the free market led to an unprecedented rise in freight earnings and subsequently in tanker vessel prices. The existing tonnage was not able to cover the demand for imports in the Chinese mainland and between 2003 - 2008 secondhand price index skyrocketed even reaching at 263 points in September 2008. The delivery of the huge orderbook from 2003-2007 period alongside the real estate bubble which led to the total collapse of all capital markets affected asset prices in shipping, as well.

The years following to the total collapse shipping entered a new round of continuous trough in vessel prices. Mistaken predictions of shipowners led to orders for new ships, thus creating a never-ending loop of overcapacity in the industry. Small rises in secondhand price indexes in the beginning of 2020 were completely leveled by the Covid-19 invasion. Current situation in tanker asset prices remains difficult, with heavy orderbook still on the game and predictions in World Trade for Oil commodities being -only slightly- positive.

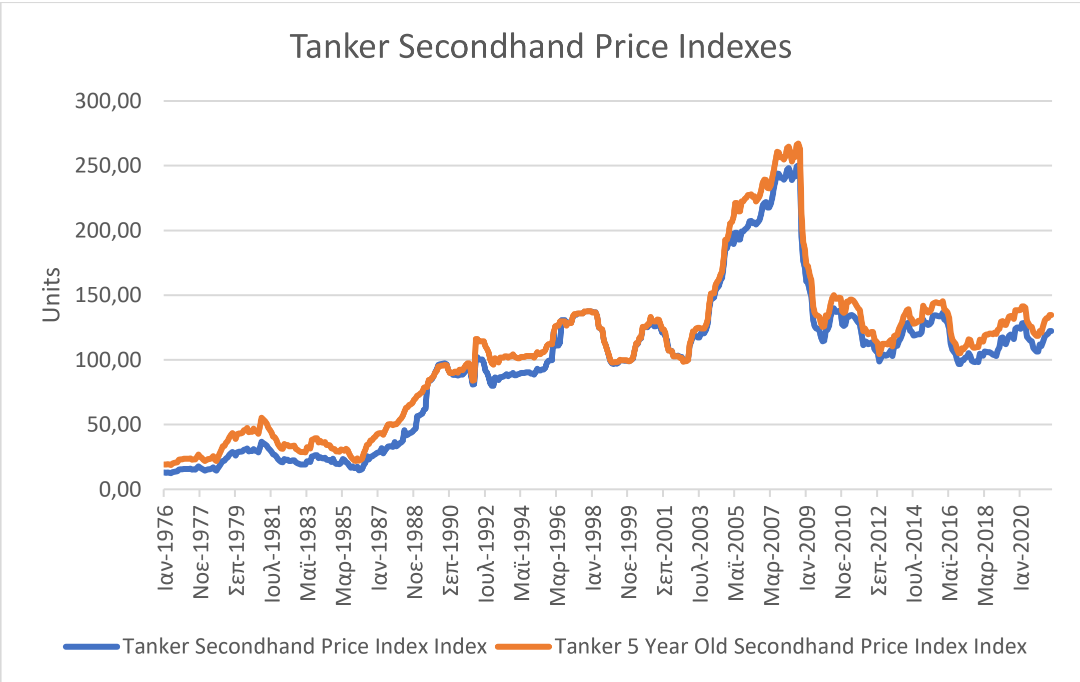


*Figure 14: Tanker Secondhand Price Indexes, Source: Clarksons SIN.*

## 2. Literature Review

It is widely approved that the most important factor from which the highest risk in the shipping industry is derived, is the freight rate risk. The volatility of freight rates is significantly affecting the decisions regarding investments in the shipping market. However, freight movements are not the only ones affecting the performance of a shipping firm. There has been a set of firms related variables, as well as macro-economic ones which leave their stigma into the industry. Therefore, it is necessary to understand this mechanism to provide long run and stable business operations. Before moving further, we should review the relative literature.

Grammenos and Marcoulis undertook an analysis of the expected stock returns for 19 shipping companies listed in the US, Norway, Stockholm, and London. Various factors, including company stock market beta, divided yield, and financial leverage have been identified in the finance literature as determinants of share price performance. They capitalized on these findings and added one more industry specific factor, the average age of the company's fleet, to quantitatively analyze the determinants of the performance of shipping shock returns. They used the Fama-MacBeth methodology to test whether the five factors above have a significant effect on shipping stocks' performance. Their results indicated that the industry specific factor (the average age of the fleet) plus financial leverage, were significant in explaining shipping stocks' returns, whereas the stock market beta and the dividend yield were far less significant. For our work, this failure of stock market beta and dividend yield to explain stock returns, indicated us the selection of the Average P/B ratio from the set of companies chosen, as the main firm related variable. Another financial, yet macro-economic, variable (S&P 500) was selected in our variables list.

Again, Grammenos and Arcoulis (Grammenos-Arcoulis, 2002) attempted to present evidence, for the first time, about the relationships of global macroeconomic sources of risk with shipping stock returns internationally, for the period December 1989– March 1998. For this purpose, a sample of 36 shipping companies (listed in 10 stock exchanges worldwide) was used in the study. A set of macro-economic variables were employed in the analysis such as industrial production, inflation, oil prices, fluctuations in exchange rates against the US dollar and laid up tonnage. Several significant relationships were established between returns of international shipping stocks and global risk factors. Oil prices and laid up tonnage are found to be negatively related to shipping stocks, whereas the exchange rate variable displays a positive relationship. In addition, it is found that, in general, the macroeconomic factors exhibit a consistent pattern in the way in which they are linked to the shipping industry, across countries. This work led us to the selection of Industrial Production to see what type of connection it had with the Tanker firm returns in our list.

Frydenberg et al (Frydenberg, 2007) tried to identify a range of economic and financial risk factors and analyze their empirical impacts on tanker shipping stock returns, using an OLS-regression. Earlier shipping-related studies were concentrated on shipping stock returns in general and the differences between shipping segments with regards to market βs. This paper concentrated on the sources of risk in the tanker segment. All factors were identified with regards to a demand and supply model of tanker shipping. The factors were argued to be the changes in the following: The world return, industrial production, USD exchange rate, the oil price, US crude oil inventories, US crude runs and the size of the tanker fleet. Of these, the world return and the USD exchange rate were found to be positively correlated with the returns of a value-weighted tanker stock portfolio. Crude oil inventories and crude runs were negatively correlated, while changes in world production, oil price and tanker fleet size were insignificant in explaining tanker stock returns. This study, apart from the fact that it was one of the few oriented projects regarding the tanker segment, it also incorporated fleet size as one possible variable. This gave us the idea to choose tanker secondhand vessel price index in our work to find connection with stock returns.

El-Masry et al (El-Masry, 2010) investigated the impact of exchange rates, interest rates and oil prices on stock returns of 143 shipping companies from 16 countries. They also investigated the factors which determine the extent to which firm are sensitive to macroeconomic variables. In order to estimate the impact of exchange rates and interest rates simultaneously on stock returns, a multi-factor ordinary least square (OLS) model was adopted. They found strong evidence that the stock returns of shipping firms are more affected by exchange rate exposure than interest rate exposure or even oil price exposure. Again, in this instance, they envisaged a negative hypothesized relationship between oil prices and the stock returns, but a majority of the coefficients were positive indicating that an increase in the price of oil is beneficial for shipping firms. The dissension of this study with the previously mentioned Grammenos and Marcoulis

(Grammenos-Marcoulis, 1996) & Frydenberg et al (Frydenberg, 2007) about oil prices and their significance on stock returns explanation made us further investigate oil movements by incorporating them in our variables list.

In the case of Alizadeh et al (Alizadeh & Muradoglu, 2014) they investigated the ability of shipping freight rates to predict movements in the US and international stock market due to the fact that they contain information about the global economic activity which is interrelated with international trade. They have considered previous study from Hong and Stein (1999) which stated that the shipping industry can be characterized as one that adapts slowly to changes based on the diffusion hypothesis of information and thus, shipping freight rates are a trustworthy variable for the prediction of stock market direction. Alizadeh et al (Alizadeh & Muradoglu, 2014) tested the significance of BDI changes as an explanatory variable on stock returns of various sectors and company sizes over the period from February 1989 until October 2013 on a monthly basis by conducting several regression analyses. Results derived indicate that freight rates have a positive relation with stock returns across many sectors and are a better explanatory variable for stock returns than oil prices, which were also tested through the same regression process. Such results provide us informative indication for our research since we are going to use the Baltic Dirty and Baltic Clean Tanker Indexes as two of our explanatory variables.

# 3. Methodology

We begin our analysis by finding the average monthly closing stock prices of 15 tanker listed shipping companies. Adding another company-related financial indicator, the P/B ratio, was also gathered for these 15 companies, again, as a form of average. A market related index such as S&P 500 was incorporated to the dataset alongside a macro-economic indicator such the Industrial Production % YR/YR of OECD countries. We also gathered information about Brent oil price in monthly basis, accompanied by the monthly prices of tanker freight rates which are split into 2 categories of cargoes, clean and dirty, and described by BCTI and BDTI accordingly. Finally, we earned the monthly prices for tanker second-hand vessels to identify the changes in vessel values.

Firstly, we examined the pairwise correlation of our selected data levels and we performed the Augmented Dickey-Fuller test on every variable . The ADF's test null hypothesis states that a variable contains at least one unit root and as a result is a non-stationary variable. The model which is used for the conduction of the Augmented Dickey-Fuller test is the following: $\Delta yt = \psi yt\text{-}1 + \Sigma\alpha i \Delta yt\text{-}I + ut$, where y stands for the variable, u indicates the error term and the correction of autocorrelation in error terms is done with the use of a for which the statistical significance is tested with ADF test.

Subsequently, we examined the pairwise correlation and performed ADF tests on our variables' returns. Then, we performed an Ordinary Least Squares (OLS) regression which is a method evaluates the association between one or more independent factors and a dependent variable by minimizing the sum of the squares in the difference between the observed and predicted values of the dependent variable set as a straight line. Subsequently, a Vector Autoregressive (VAR) model was selected according to Akaike (AIC), Schwarz (SC) and Hanna-Quin (HQ) criteria. The vector autoregressive (VAR) model is a simple multivariate time series model that connects current observations of a variable to previous observations of that variable and other variables in the system. The next step of this dissertation's analysis is to test the pairwise Granger causalities of the selected variables and to perform diagnostic tests regarding the autocorrelation and the heteroscedasticity of the model. Finally, a GARCH (1,1) model introduced by Engle (1982), was applied for capturing the variables' volatilities and to create their volatilities time series which are then used for a new VAR model estimation. Finally, pairwise Granger causality is examined on the variables' volatilities.

In continuation to the above and in order to estimate the impact of freight rates, oil prices and ships' values on stocks prices of listed tanker shipping companies we are going to use the following multi-factor model:

$$SPRi = c + \beta1PBRi + \beta2IPi + \beta3BPRi + \beta4BDTIRi + \beta5BCTIRi + \beta6TSIRi + \beta7SP500Ri + Ut,$$

$$(i = 1, 2, 3, \ldots, 80)$$

where SPRi is the Stock Prices Returns, c is the constant, PBRi is Price to Book Ratio Returns, IPi is the Industrial Production % YR/YR, BPRi is the Brent's oil Price Returns, BDTIRi is the Baltic Dirty Tanker Index Return, BCTIRi is the Baltic Clean Tanker Index Return, TSIRi is the Tanker Second-hand Index Return, SP500Ri is the S&P 500 Index Return and Ut are the residuals.

# 4. Data Description

Monthly data were selected for our analysis, starting from October 2014 to June 2021 and gathered from the following sources: Clarksons SIN (Shipping Intelligence Network), DataStream, Bloomberg, Investing.com, OECD Statistics, US Energy Information Administration (EIA). Our data cover approximately a seven-year period (81 observations per variable) and the main reason for this selection has been the availability of appropriate data in terms of quality (reputable sources), quantity as well as being as recent as possible for each one of the variables used for our dissertation's analysis. For the dissertation's econometric analysis, the EViews software package has been used.

## 4.1 Selected Companies Overview

*Table 1 The 13 Tankers' Companies Selected*

| | Stock Exchange | Number of Tanker Vessels (owned) | Number of Gas Vessels (owned) | Number of Vessels Overall (owned) |
|---|---|---|---|---|
| COSCO Shipping Energy Transportation | Stock Exchange of Hong Kong | 168 | 38 | 206 |
| DHT Holdings | New York Stock Exchange | 26 | 0 | 26 |
| D/S Norden A/S | Copenhagen Stock Exchange | 17 | 0 | 36 |
| Euronav NV | Euronext / New York Stock Exchange | 70 | 0 | 70 |
| Frontline Ltd / Bermuda | Oslo Stock Exhange / New York Stock Exchange | 70 | 0 | 70 |
| MISC Bhd | Bursa Malaysia | 69 | 0 | 69 |
| Navigator Holdings Ltd | New York Stock Exchange | 0 | 55 | 55 |
| Nordic American Tankers Ltd | New York Stock Exchange | 22 | 0 | 22 |
| National Shipping Co of Saudi Arabia | Saudi stock exchange (Tadawul) | 75 | 0 | 90 |
| Odfjell SE | Oslo Stock Exhange | 31 | 0 | 31 |
| Scorpio Tankers Inc | New York Stock Exchange | 131 | 0 | 131 |
| Teekay Corp | New York Stock Exchange | 50 | 75 | 127 |
| Tsakos Energy Navigation Ltd | New York Stock Exchange | 64 | 3 | 67 |

COSCO SHIPPING Energy focuses on two core businesses, oil shipping and LNG transportation. The Company's tanker fleet ranks World No.1, covering all mainstream tanker types, and stands out globally with the complete variety of tankers. By the end of August 2021 COSCO operates a self-owned fleet of 168 ships, approximately 2270 million DWT. It also manages 38 LNG carriers with a capacity of 293.6 million CBM. COSCO SHIPPING Energy is listed on the Stock Exchange of Hong Kong (SEHK) since November 1994. (COSCO, 2020)

DHT is an independent crude oil tanker company. Its fleet trades internationally and consists of crude oil tankers in the VLCC segment owning and operating 26 vessels. DHT first entered in NYSE on 15$^{th}$ October 2005. (DHT, 2021)

D/S Norden A/S is one of Denmark’s oldest internationally operating shipping companies. Incorporated in Denmark, Norden was listed on Nasdaq Copenhagen as a part of the OMX Nordic Mid Cap index. The company provides dry cargo and product tankers services globally and offer its shareholders earnings from industry-leading operator activities implemented by a highly skilled organization in addition to cyclical exposure to dry cargo and product tanker markets. It owns a fleet of 36 vessels, of which 17 operate in the Tanker sector. (Norden, 2021)

Euronav is an integrated owner, operator, and manager able to provide complete shipping services in addition to the carriage of crude oil. Its fleet comprises of 70 modern large tankers. Euronav shares are listed on Euronext Brussels (since 2004) as well as on the New York Stock Exchange (since 2015) under the ticker symbol ‘EURN’. (Euronav, 2021)

Frontline Ltd. is a world leader in the seaborne transportation of crude oil and refined products. The Company owns and operates one of the largest and most modern fleets in the industry, consisting of a total number of 70 VLCCs, Suezmax tankers and LR2 / Aframax tankers. Due to Frontline’s brand, financial flexibility, and significant scale, it holds a unique position among its peers. Frontline is listed on both the New York and Oslo Stock Exchanges under the symbol “FRO”. (Frontline, 2018)

MISC Berhad (MYX: 3816) was incorporated in 1968 as Malaysia International Shipping Corporation Berhad and is the leading international shipping line of Malaysia. In September 2005, Malaysia International Shipping Corporation Berhad adopted its present corporate identity and changed its name to MISC Berhad. Its main shareholder is Petroliam Nasional Berhad (Petronas), the national oil conglomerate of Malaysia. The principal business of the Corporation consists of Ship owning, Ship operating, other shipping related activities, Owning and operating of offshore floating facilities as well as Marine repair, Marine conversion and Engineering & Construction works. MISC owns 69 tanker vessels. (MISC, 2021)

Navigator Gas is the owner and operator of the world’s largest fleet of handysize liquefied gas carriers. It consists of 55 self-owned vessels and is listed on NYSE since 2012. (NavigatorGas, 2021)

Nordic American Tankers Limited is an international tanker company. The Company's fleet consists of 22 Suezmax crude oil tankers. It operates its vessels either in the spot market or on shorter-term time charters. Nordic American Tankers Limited ("NAT") was incorporated in Bermuda in 1995. In September 1995 NAT sold securities to the public in the US and in Europe. The shares are today trading at the New York Stock Exchange ("NYSE"). (NAT, 2021)

Bahri is one of the world's largest owner and operator of 43 Very Large Crude Carriers (VLCCs) with a total capacity of more than 13 million DWT. It is also the largest owner and operator of chemical tankers in the Middle East owning 33 vessels. The National Shipping Company of Saudi Arabia was created by a Royal Decree as a public company in 1978, with 22% ownership stake held by the Public Investment Fund (PIF) of the Saudi government, 20% by Saudi Aramco Development Company (SADCO), and the remaining shares listed on the Saudi stock exchange (Tadawul). (BahriSA, 2021)

Odfjell SE is a company specialising in worldwide seaborne transportation and storage of chemicals and other speciality bulk liquids. The Odfjell fleet comprises more than 80 ships in total of which only 31 are self-owned. Odfjell SE is the ultimate parent company of the Odfjell Group, and is a public limited company traded on the Oslo Stock Exchange. (Odfjell, 2021)

Scorpio Tankers Inc. is a tanker shipping company founded by Emanuele A. Lauro on 1 July 2009. It is an international provider in the transportation of refined petroleum products. Scorpio Tankers is headquartered in Monaco, possesses a fleet of 131 tanker vessels and trades on the New York Stock Exchange. (ScorpioTankers, 2021)

Teekay is one of the largest shipowners in the world. They specialise in shipping crude oil, liquefied natural gas and liquefied petroleum gas. Teekay has a number of 64 self-owned tankers and 3 LPG carriers. It operates under four companies that are publicly traded on the New York and Oslo stock exchanges. (Teekay, 2021)

TEN Ltd. currently owns a versatile fleet of 64 modern crude, oil and product tankers, LNGs and shuttle tankers. Growing to become one of the largest ice-class tanker operators in the world, it now lists among its clientele state entities, international oil majors and major oil traders. TEN Ltd. is incorporated in Bermuda, managed out of Athens Greece, listed in the New York Stock Exchange (NYSE) under the symbol TNP and in the Bermuda Stock Exchange (BSX) under the symbol TEN. (TENN, 2021)

## *4.2 Statistical Analysis of Data at their Levels*

Share Price (Average) is a weighted average of the stock prices at the end of each month produced by Bloomberg and based on each company's market capitalization. Share Price (Average) data of our sample were gathered by carefully selecting well known shipping companies, involved in the tankers' sector, listed in stock exchanges around the globe however most of them are listed in stock exchanges of US (NASDAQ, NYSE).

There is a downward trend during the examined period with the lowest point being during the first wave of Covid-19 pandemic and slightly moving upwards since then due to the somehow positive economic sentiment. The variable's mean value over this period is US$ 11.51 while the standard deviation is US$ 4.99. Skewness, which measures the asymmetry of a distribution, is 1.20 and indicates that the data is highly skewed (skewness>1). Regarding the kurtosis of Share Price (Average) data, is 3.08 and the distribution is characterized as slightly leptokurtic (kurtosis>3).

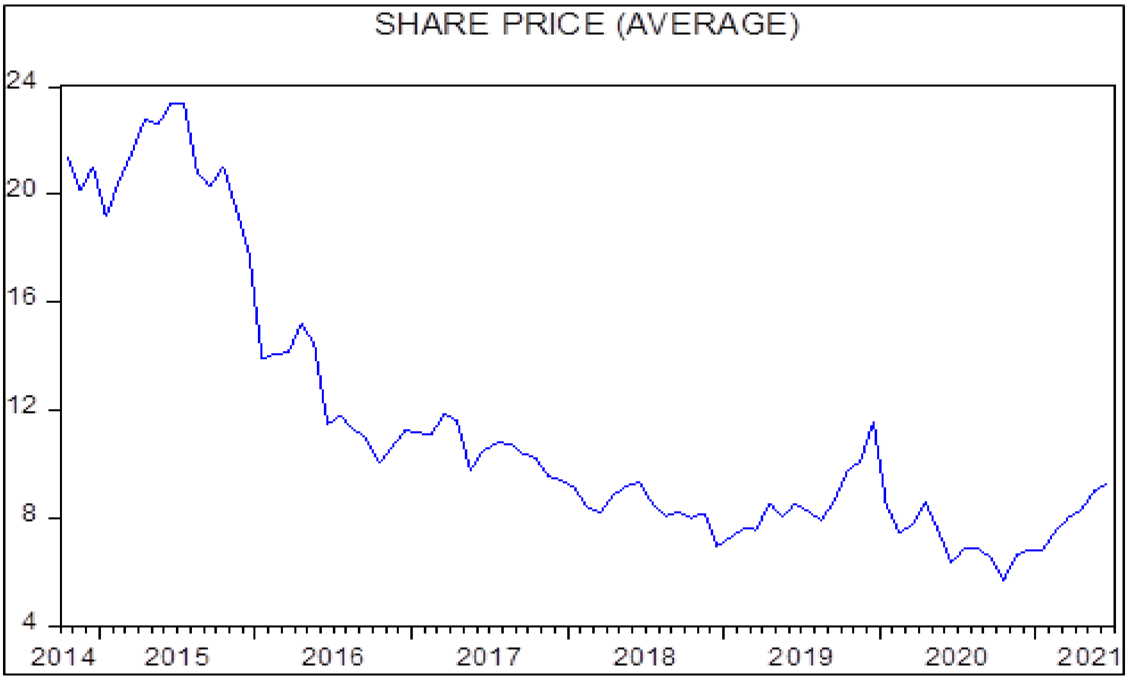


*Figure 15 Share Price (Average)*

The second selected variable of our analysis which is calculated once again as a weighted average (from Bloomberg) of the 13 shipping companies depicted in Table 1, is the Price to Book Ratio (Average). A Price to Book Ratio (P/B Ratio) is used by companies and investors to compare a firm's market capitalization to its book value and typically P/B ratios less than 1 characterize solid investments. Figure 2 shows that over our examined period, the P/B ratio fluctuates greatly, with its highest value being observed during 2015 (1.5) and its lowest in 2017 and 2018 (0.7). Although, for the majority of our sample, the Price to Book Ratio (Average) is less than 1 which shows that the 13 companies of our sample are mostly undervalued by the market and their tangible assets (their ships) have greater value than the firms' market capitalization. The mean value of Price to Book Ratio (Average) is 0.83 and its standard deviation 0.17. In regard to asymmetry statistics, skewness is 1.17 indicating that P/B ratio is highly skewed and kurtosis 3.10 which means that the distribution is leptokurtic.

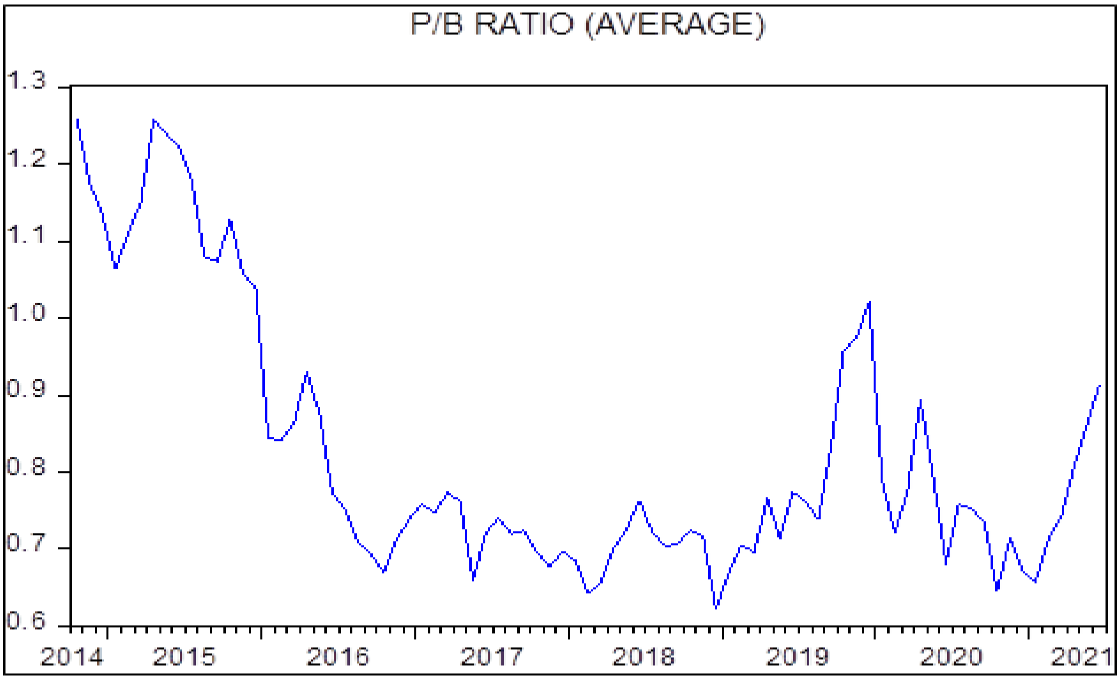


*Figure 16 Price to Book Ratio (Average)*

Baltic Dirty Tanker Index (BDTI) is an assessment index of the freight rates in the dirty tankers' segment i.e., the tanker ships that carry dirty products such as crude oil and fuel oil, published by the Baltic Exchange and is an estimation of the market conditions made by major associated brokers of the Baltic Exchange that are called panelists done daily, from Monday to Friday. Figure 3 shows that BDTI constantly fluctuated during the examined period, staying most of the times below the 1,000 units barrier. The index peaked during 2019 due to the Gulf Crisis and the rally continued during the first semester of 2020 when oil prices were pretty low and traders wished to enter in a steep contango buying cheap oil, storing it, and selling it later pocketing the margins. Although, the second part of 2020 has been disastrous for the dirty market and the trend still continues in 2021. As for the descriptive statistics, the mean value of BDTI is

774.81 units while its standard deviation is 205.67 units. The skewness of the index is moderate (0.97) however its kurtosis is rather high (4.30) indicating a leptokurtic curve of the distribution.

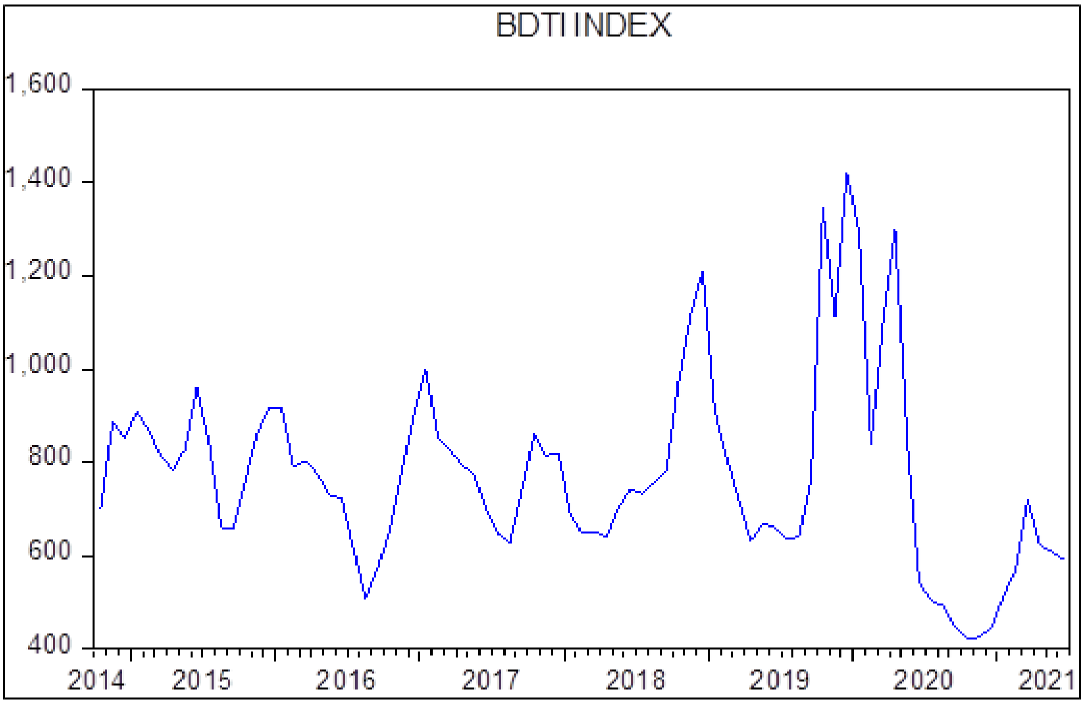


*Figure 17 BDTI*

Baltic Clean Tanker Index (BCTI) is respectively published by the Baltic Exchange as an assessment of the freight rates in the clean tankers' market or the tanker ships which transport clean petroleum products (CPP) such as heating gasoil and gasoline. In Figure 4 we see that there is a moderate fluctuation over these 7 years span apart from a significant rise in the second part of 2019, followed by a steep drop in 2020 and onwards. The index's mean value is 585.65 units, and the standard deviation is 147.42 units. BCTI is highly skewed (1.59) and leptokurtic (8.54).

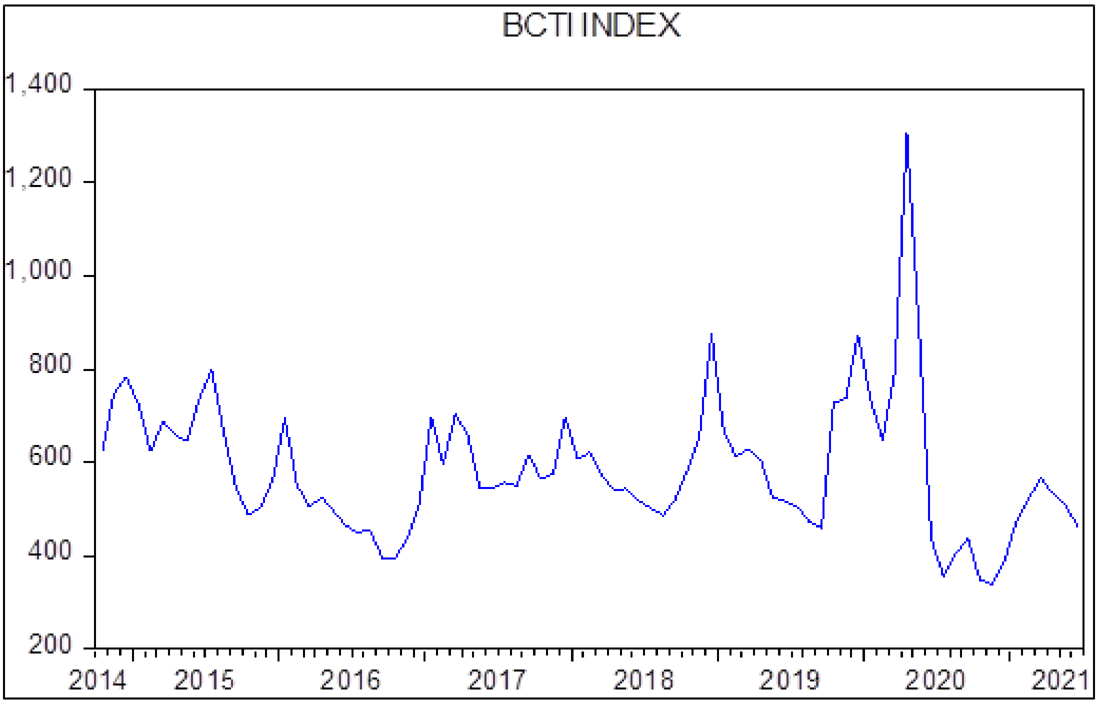


*Figure 18 BCTI*

Brent crude oil is the price of oil which is element of operational cost in shipping industry and was selected instead of West Texas Intermediate (WTI), as it is the global benchmark. Figure 5 shows us the fluctuations in Brent's price during the time period examined. Due to an increase in overall production, changes in OPEC policy, geopolitical concerns, and the strengthening of the US currency, there is a significant drop from June 2014 to early 2016 (World Bank, 2015). During this time, the price of a barrel of oil fell from 113€ to 30€. The price then appears to recover until September 2018, when it reaches a price plateau of 83€. Thereafter, a second decline occurred, and the price dropped further reflecting the political standoff between Iran and the United States reaching the lowest point in April 2020 when the barrel's price was US$ 18.38. The mean is US$ 56.12, the standard deviation 13.26 while the skewness indicates symmetrical data (0.19) and the distribution is platykurtic (2.89).

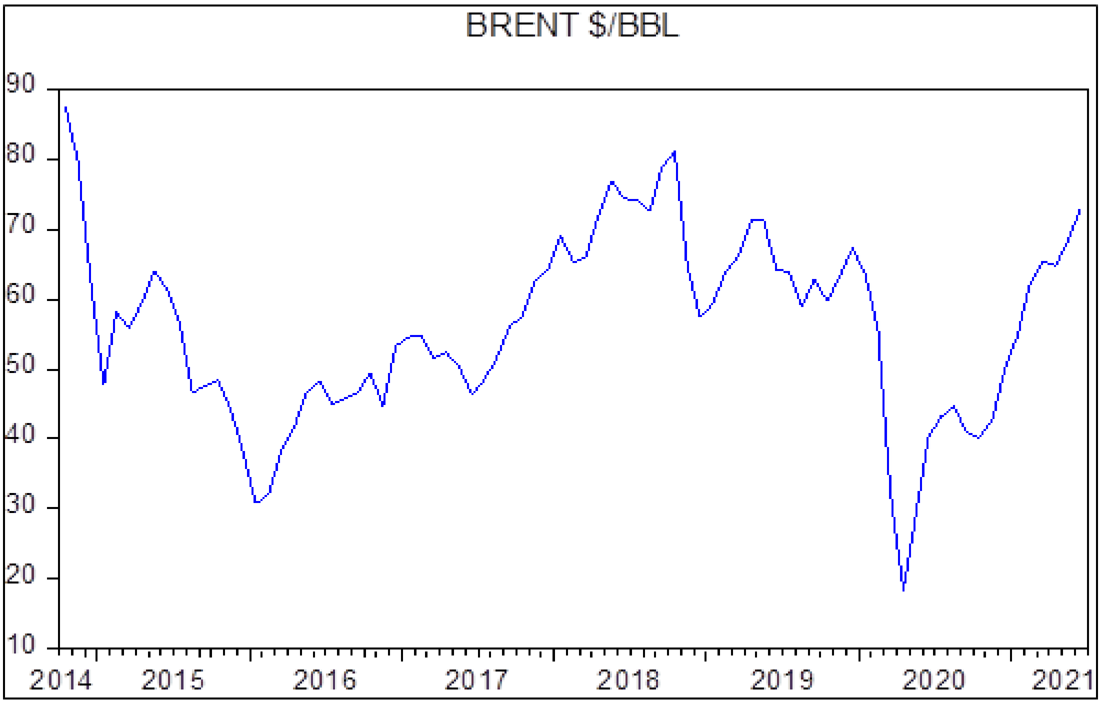


*Figure 19 Brent Price $/bbl*

Considering Industrial Production as a very important indicator for the economic activity, we wanted to include it in our analysis and the available monthly data we found are on a Year Over Year (YoY) form derived from OECD Statistics. Figure 6 shows that Industrial Production YoY has remained relatively stable for the biggest part of our sample apart from 2020 when the global production was reduced greatly, in comparison with 2019, as a side effect of the Covid-19 outbreak. On the contrary, there is big YoY change in 2021 as the global economy has been recovering and production rose back to the levels of the era prior to Covid-19. The index's mean value is 0.34 and the standard deviation is 6.03, an extreme value caused by the shock to the global economy due to the pandemic. Moreover, data are fairly symmetrical in regard to skewness (0.31) however kurtosis' value is high (11.27) and the distribution is leptokurtic.

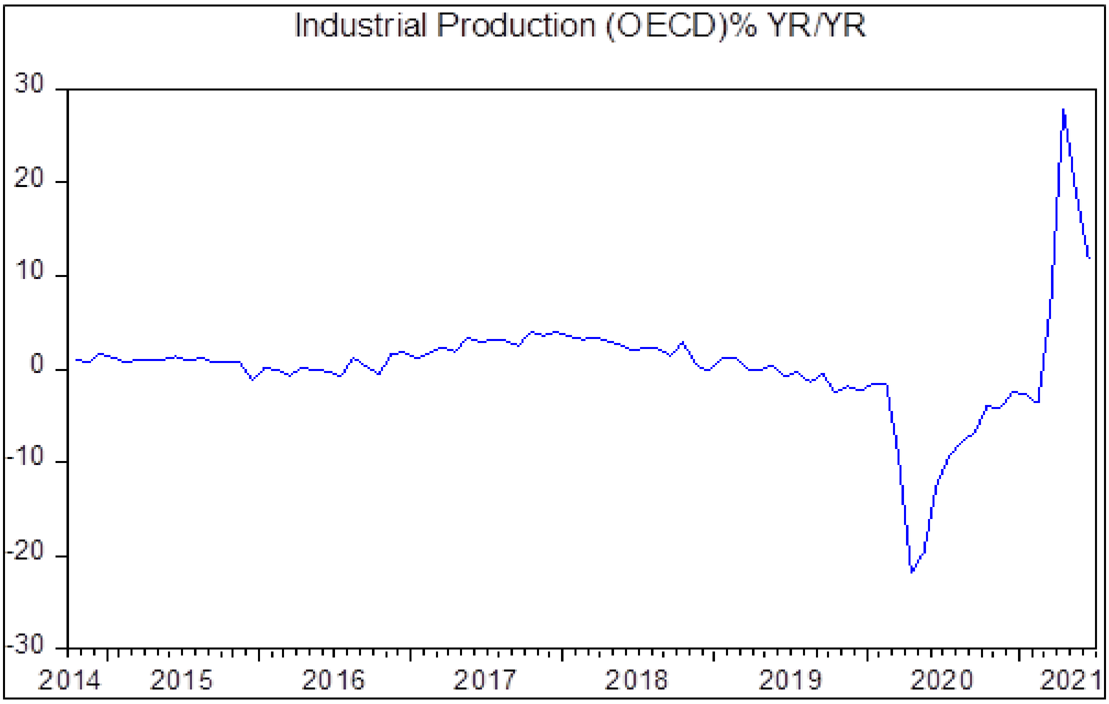


*Figure 20 Industrial Production*

The Standard and Poor's 500 Index (S&P 500) is a stock market index that tracks the performance of 500 big businesses listed on US stock exchanges. It is one of the most widely followed stock market indices. More than $5.4 trillion was invested in assets connected to the index's performance as of December 31, 2020. The S&P 500 index is a capitalization/free-float weighted index. Apple Inc., Microsoft, Alphabet Inc. (containing both class A and C shares), Amazon.com, Facebook, and Tesla, Inc., Nvidia, Berkshire Hathaway and JPMorgan Chase & Co were the 9 largest firms on the list of S&P 500 corporations as of September 30, 2021, accounting for 28.1 percent of the index's market capitalization. As it is shown in Figure 7, S&P 500 has been steadily increasing since 2014 with some minor drops to its price apart from the steep decline of its value in 2020 caused by the pandemic. The mean is 2,653.22 units while the standard deviation is 577.94 units. Regarding the asymmetry statistics, the data contained in our sample are moderately skewed (0.92) and the distribution is leptokurtic (3.42).

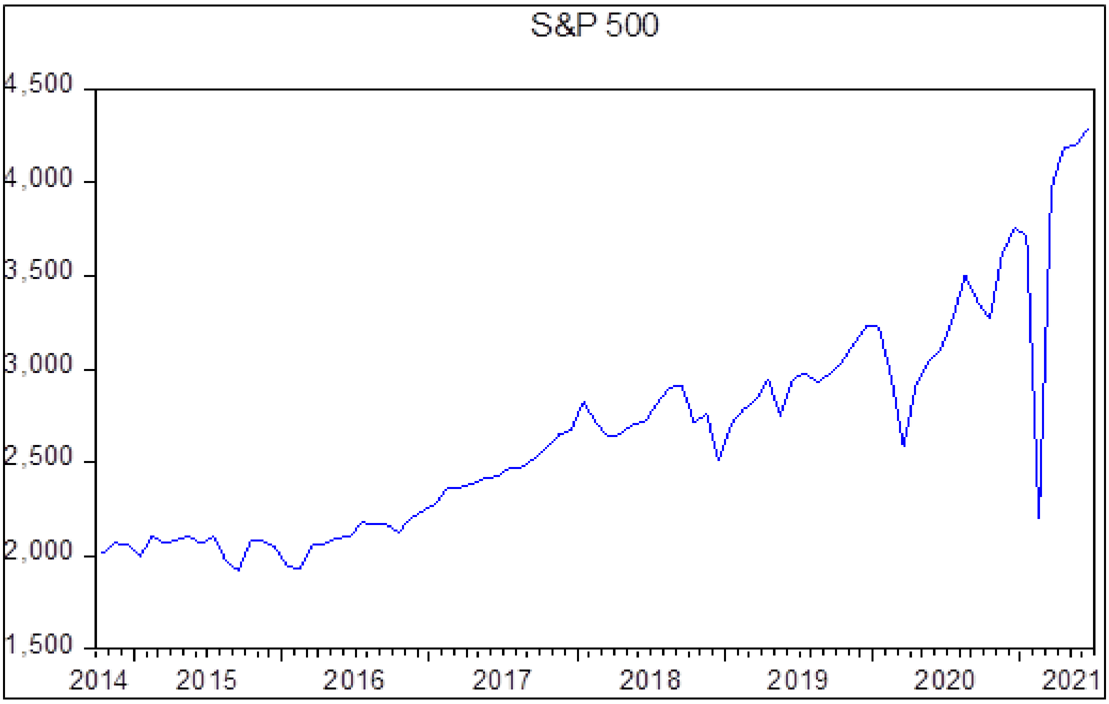


*Figure 21 S&P 500*

As we wanted to include in our analysis a variable that captures the price movements of the tankers' secondhand market, the Tanker Secondhand Price Index, devised by Clarksons SIN, was chosen and it covers all the sub-sectors of the tankers' segment. The index is characterized by continuous, and rather big, fluctuations during the short time span that our sample covers. The price of a secondhand ship is strongly related to the prevailing freight rates, as well as to the sentiment for the market, in a much greater extent than a newbuilding vessel as a used one can be acquired immediately and be commercially exploited while the delivery of a new ship lasts from 18 to 36 months on average. The mean value of the Tanker Secondhand Price Index is US$ 114.86 million, and its standard deviation is US$ 11.50 million. Finally, the index's skewness indicates symmetry (0.20) and the distribution is platykurtic (1.80).

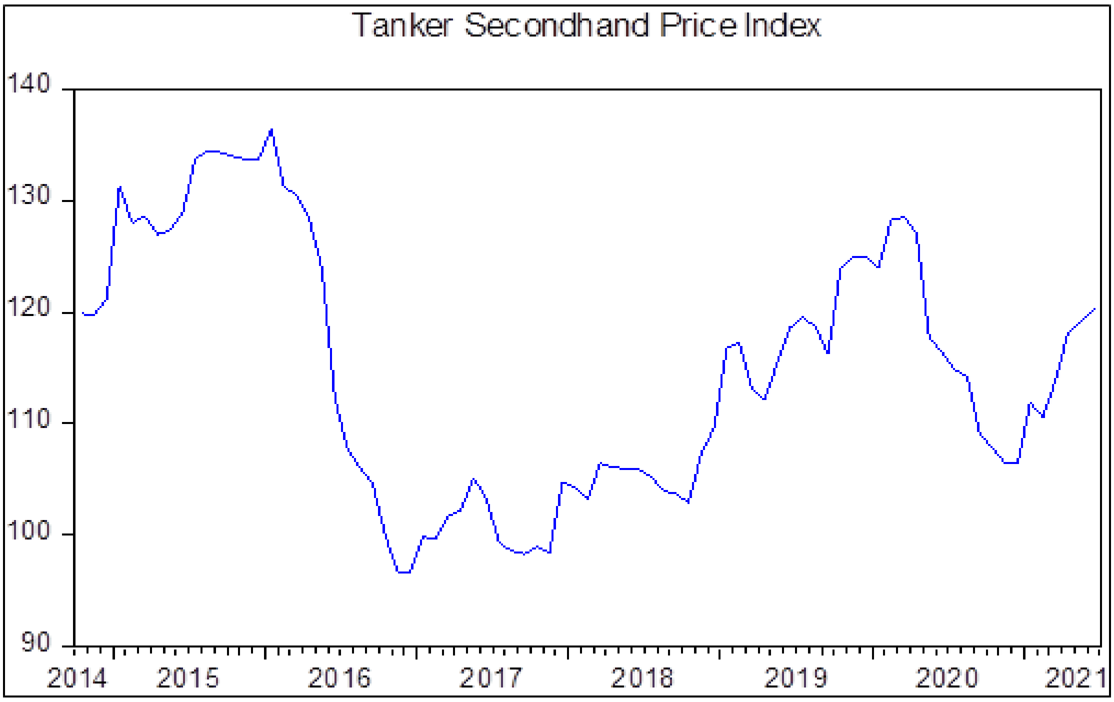


*Figure 22 Tanker Secondhand Price Index*

Table 2 below indicates the descriptive statistics measures (mean and standard deviation) and the measures of asymmetry (skewness and kurtosis) for all 8 variables used for the analysis of our dissertation.

*Table 2 Statistical Measures of Data at their levels*

| | Observations | Mean | St. Deviation | Skewness | Kurtosis |
|---|---|---|---|---|---|
| **Share Price Avg.** | 81 | 11.51 | 4.99 | 1.19 | 3.08 |
| **BDTI** | 81 | 774.81 | 205.06 | 0.97 | 4.30 |
| **BCTI** | 81 | 585.65 | 147.42 | 1.59 | 8.54 |
| **Brent $/bbl** | 81 | 56.12 | 13.26 | -0,19 | 2.89 |
| **Industrial Prod. % YR/YR** | 81 | 0.34 | 6.03 | 0.31 | 11.27 |
| **P/B Ratio Avg.** | 81 | 0.82 | 0.17 | 1.17 | 3.11 |
| **S&P 500** | 81 | 2653.22 | 577.94 | 0.92 | 3.42 |
| **Tanker Secondhand Index** | 81 | 114.86 | 11.50 | 0.20 | 1.80 |

## 4.2.1 Relations Between Variables

Table 3 provides information about the correlation between the variables. The correlation coefficient lies between -1 and 1. The closer to unit, the higher is the correlation.

*Table 3 Variables' Correlation Matrix*

| | SHARE_PRICE__AVEI | BCTI_INDEX | BDTI_INDEX | BRENT_$_BBL | INDUSTRIAL_PRODU | P_B_RATIO__AVEI | TANKER_SECO | S_P_500 |
|---|---|---|---|---|---|---|---|---|
| SHARE_PRICE__AVERAGE_ | 1 | - | - | - | - | - | - | - |
| BCTI_INDEX | 0.24 | 1 | - | - | - | - | - | - |
| BDTI_INDEX | 0.17 | 0.77 | 1 | - | - | - | - | - |
| BRENT_$_BBL | -0,032 | -0,057 | 0.02 | 1 | - | - | - | - |
| INDUSTRIAL_PRODUCTION | 0.12 | -0,027 | -0,16 | 0.52 | 1 | - | - | - |
| P_B_RATIO__AVERAGE_ | 0.91 | 0.35 | 0.28 | 0.04 | 0.03 | 1 | - | - |
| TANKER_SECONDHAND_PRICI | 0.57 | 0.32 | 0.29 | -0,025 | -0,15 | 0.72 | 1 | - |
| S_P_500 | -0,66 | -0,17 | -0,2 | 0.21 | 0.14 | -0,40 | -0,18 | 1 |

According to Table 3, Baltic Clean Tanker Index (BCTI)is strongly positively correlated with Baltic Dirty Tanker Index (BDTI) (0.77) proving that dirty products market moves quite in parallel with the clean products trade however this is not always the case. In addition, BCTI is moderately correlated with Price to Book Ratio (Average) and Tanker Secondhand Price Index with correlation value of 0.35 and 0.32 respectively.

Regarding BDTI, there is only the aforementioned strong correlation with BCTI (0.77) and a moderate correlation with P/B Ratio (0.28). Correlation with Tanker Secondhand Price Index is slightly lower (0.29).

As for Brent, there is a moderately strong correlation with Industrial Production (0.51). Regarding the rest of examined variables, shares' price is highly correlated with P/B ratio (0.91), moderately correlated with Tanker Secondhand Market (0.57) and strongly negatively correlated with S&P 500 (-0.66). Price to Book Ratio is highly correlated with Tanker Secondhand Price Index (0.72), moderately with BCTI and BDTI (0.35 & 0.28) and moderately but negatively correlated with S&P 500 index (-0.40).

## 4.3 Unit Root Tests

Stationarity of variables has to be tested. In order to test the stationarity of the variables at their levels, the Augmented Dickey-Fuller (ADF) unit root test was used. Table 4 reports the ADF results. Values in Table 4 represent the p-values where the null hypothesis of non-stationarity cannot be rejected if the p-value is higher than 5%.

According to ADF test, the variables BDTI, BCTI, Brent's price per barrel and Industrial Production % YR/YR seem to be stationary at their levels, except for

Industrial Production and P/B ratio, which are ratios, as their p-values are below 0.05. Although, Share Price Avg, Price to Book Ratio Avg, S&P 500 Index and Tanker Secondhand Index seem to contain at least 1 unit root as their p-values at 95% significance level are 0.2964, 0.0889, 0.9975 and 0.4688 respectively. On the other hand, the results are quite different when the ADF test is applied to variables' returns instead of variables' levels. As the p-values of all variables are lower than 0.05 except for P/B Ratio (0.0889), the null hypothesis of non-stationarity can be rejected at 90% significance level for our variables. In conclusion, all variables have to be used in their 1st differences (returns), apart from P/B Ratio and Industrial Production, as the series must be stationary for Vector Autoregressive models (VAR) to be applied.

*Table 4 Augmented Dickey-Fuller Test Results*

| Augmented Dickey-Fuller (ADF) | Variables | Levels | Returns |
|---|---|---|---|
| | Share Price Avg. | 0.2964 | 0.0000 |
| | BDTI | 0.0182 | 0.0000 |
| | BCTI | 0.0002 | 0.0000 |
| | Brent $/bbl | 0.0150 | 0.0000 |
| | Industrial Prod. %YR/YR* | 0.0095 | - |
| | P/B Ratio Avg. | 0.0889 | - |
| | S&P 500 | 0.9975 | 0.0001 |
| | Tanker Secondhand Index | 0.4688 | 0.0000 |

## 4.4 Statistical Analysis of Returns

In Table 5 are depicted the descriptive statistics measures (mean and standard deviation) and the measures of asymmetry (skewness and kurtosis) of the returns of our analysis variables. Share Price Average has a mean value of -0.01 while BDTI, BCTI, Brent's price, and S&P 500 all have a mean value of 0.01. As for the three remaining variables, Industrial Production's mean is 0.34 while the mean of Price to Book Ratio Average is 0.83 and 0 for Tanker Secondhand Index. Regarding standard deviation, it fluctuates 0.03 to 0.17 for all variables apart from the one of Industrial Production with a price of 6.03. Skewness is rather high in BDTI and S&P 500 cases with respective values of 1.03 and 4.07, Share Price Avg and BCTI are moderately skewed (-0.65 &

0.83) while the values of the rest of the variables indicate symmetry [-0.5, 0.5]. Regarding kurtosis, all variables have price above 3, so their distributions are leptokurtic.

Table 6 depicts a correlation matrix of the variables' returns. Generally, apart from 2 cases, the pairwise correlations are relatively weak, either positively or negatively. There is a strong correlation of BDTI and BCTI (0.67), and a moderately strong and negative correlation between Baltic Clean Tanker Index (BCTI) and Brent $/ barrel (-0.47).

*Table 5 Statistical Measures of Data's Returns*

| | Observations | Mean | St. Deviation | Skewness | Kurtosis |
|---|---|---|---|---|---|
| **R_Share Price Avg.** | 80 | -0,01 | 0,08 | -0,67 | 3,56 |
| **R_BDTI** | 80 | 0,01 | 0,16 | 1,03 | 7,56 |
| **R_BCTI** | 80 | 0,01 | 0,17 | 0,83 | 5,98 |
| **R_Brent $/bbl** | 80 | 0,01 | 0,14 | 0,31 | 7,97 |
| **Industrial Prod. % YR/YR** | 80 | 0,34 | 6,03 | 0,32 | 11,26 |
| **P/B Ratio Avg.** | 80 | 0,83 | 0,08 | -0,26 | 3,55 |
| **R_S&P 500** | 80 | 0,01 | 0,17 | 1,17 | 3,11 |
| **R_Tanker Secondhand Index** | 80 | 0,00 | 0,03 | 0,08 | 4,60 |

*Table 6 Correlation Matrix of Variables' Returns*

| | R_SHARE_PRICE_A | R_BCTI_INDEX | R_BDTI_INDEX | R_BRENT_$_BBL | INDUSTRIAL_PROD | P_B_RATIO_AVE | R_TANKER_SE | R_S_P_500 |
|---|---|---|---|---|---|---|---|---|
| R_SHARE_PRICE_AVERAGE_ | 1 | - | - | - | - | - | - | - |
| R_BCTI_INDEX | 0.29 | 1 | - | - | - | - | - | - |
| R_BDTI_INDEX | 0.30 | 0.67 | 1 | - | - | - | - | - |
| R_BRENT_$_BBL | 0.03 | -0,47 | -0,29 | 1 | - | - | - | - |
| INDUSTRIAL_PRODUCTION_ | 0.08 | -0,10 | 0.01 | -0,03 | 1 | - | - | - |
| P_B_RATIO_AVERAGE_ | 0.15 | 0.10 | 0.14 | -0,16 | 0.02 | 1 | - | - |
| R_TANKER_SECONDHAND_PR | 0.11 | 0.26 | 0.23 | -0,33 | 0.29 | 0.08 | 1 | - |
| R_S_P_500 | 0.18 | -7,30E+10 | 0.09 | 0.10 | 0.10 | 0 | 0.07 | 1 |

# *5. Empirical Analysis*

## *5.1 OLS Output*

In table 6, which depicts the correlations between our variables returns, we saw that Baltic Dirty Tanker Index (BDTI) & Baltic Clean Tanker Index (BCTI) are highly correlated (0.67). In order to avoid the existence of multicollinearity that weakens the statistical significance of the regression model, we need to exclude at least 1 of those two variables from the next steps of our analysis. BCTI is statistically significant in explaining Share Price with p-value of 0.0019 and Brent's price is also statistically significant however at 90% significance level with a p-value of 0.0587. Although the rest of the variables are not independently statistically significant in explaining tanker companies' share price, the model's F-overall indicates its statistical significance at 95% significance level with a p-value of 0.017. On the other hand, R-squared (18.59%) and adjusted R-squared (11.90%) show weak explanatory power of the model. Finally, the model is overall of statistical significance with Pro(F-statistic) equal to 0.017248.

Table 8 reports the OLS regression output excluding BCTI. BDTI is the only statistically significant variable of the model with p-value of 0.0098. In addition, R-squared and Adjusted R-squared are lower in comparison with the model that includes BCTI as independent variable (18.59% > 15.20% & 11.90 % > 8.23 %) and Prob(F-statistic) shows significance of the model in the 90% significance level in comparison to 95% significance level of the model that includes BCTI as independent variable.

As a result, we will proceed to our empirical research excluding BDTI from our analysis. In addition, we will exclude Industrial Production, P/B Ratio Avg. and S&P500 as they are of low importance to our model excepting Tanker Secondhand Price Index as we want to further analyze its impact on Share Price Avg. Our empirical research will be continued with the following model:

$$SPRi = c + \beta 1BPRi + \beta 2BCTIRi + \beta 3TSIRi + Ut,$$

(i= 1, 2, 3, …,80)

where SPRi is the Share Price Returns, c is the constant, BPRi is the Brent's oil Price Returns, BCTIRi is the Baltic Clean Tanker Index Return, TSIRi is the Tanker Second-hand Index Return and Ut are the residuals.

*Table 7 Ordinary Least Squares (OLS) Regression Output Including BCTI*

| Dependent Variable: Share Price Avg. | | |
|---|---|---|
| Variable | Coefficient | Prob. |
| C | -0.072596 | 0.1071 |
| R_BCTI | 0.189459 | 0.0019 |
| INDUSTRIAL PROD. | 0.001463 | 0.3470 |
| P/B RATIO AVG | 0.073969 | 0.1681 |
| R_BRENT $/BBL | 0.144484 | 0.0587 |
| R_S&P500 | 0.110590 | 0.1800 |
| R_TANKER SECOND. PRICE INDEX | 0.087143 | 0.8012 |
| R-squared | 0.185929 | |
| Adjusted R-squared | 0.119019 | |
| F-statistic | 2.778.790 | |
| Prob(F-statistic) | 0.017248 | |

*Table 8 Ordinary Least Squares (OLS) Regression Output Including BDTI*

| Dependent Variable: Share Price Avg. | | |
|---|---|---|
| Variable | Coefficient | Prob. |
| C | -0.063720 | 0.1660 |
| R_BDTI | 0.154593 | 0.0098 |
| INDUSTRIAL PROD. | 0.000761 | 0.6256 |
| P/B RATIO AVG | 0.064546 | 0.2396 |
| R_BRENT $/BBL | 0.089021 | 0.2202 |
| R_S&P500 | 0.100273 | 0.2351 |
| R_TANKER SECOND. PRICE INDEX | 0.143921 | 0.6824 |
| R-squared | 0.152053 | |
| Adjusted R-squared | 0.082358 | |
| F-statistic | 2.181.711 | |
| Prob(F-statistic) | 0.054348 | |

## *5.2 VAR Model Selection*

The information criteria are used in order to select the appropriate model. Table 9 reports the Akaike (AIC), Schwarz (SC) and Hanna-Quin (HQ) information criteria. As a rule of thumb, we choose the criterion with the minimized figure and in our case is the Akaike (AIC).

*Table 9 VAR Lag Order Selection Criteria*

| Lag | AIC | SC | HQ |
|---|---|---|---|
| 0 | -8,610122 | -8,484617* | -8,560106 |
| 1 | -8,874656* | -8,247133 | -8,624577* |
| 2 | -8,724587 | -7,595046 | -8,274445 |
| 3 | -8,458216 | -6,826656 | -7,808011 |
| 4 | -8,569733 | -6,436154 | -7,719465 |
| 5 | -8,421550 | -5,785953 | -7,371219 |
| 6 | -8,456933 | -5,319317 | -7,206539 |
| 7 | -8,487383 | -4,847749 | -7,036926 |

* indicates lag order selected by the criterion
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

### 5.2.1 VAR Model Estimation Results

In the Appendices section of this dissertation, we present the VAR model estimation results as they were produced by EViews statistical package.

In the first table are depicted the coefficients of our variables' returns with 1 lag and how they affect themselves and the other variables' returns with 0 lag. In order to obtain their p-values, we created a system of equations and jointly regressed them with the OLS method, and the output is depicted in the second table.

In total, there are 20 coefficients whereas the p-values of the majority of them are not statistically important at 95% significance level apart from coefficients C (6) and C (13). C (6) represents the coefficient of Share Price Avg returns at lag 1, at the second equation with R_BCTI as dependent variable. The coefficient C (6) indicates that there is a statistically significant relationship between Share Price returns 1 month ago (1 lag) and current BCTI returns. Although, the model suffers from serial correlation as Durbin-Watson statistic is 1.88 and subsequently leading to unreliable hypothesis testing. C (13) represents the coefficient of Brent's Price returns at lag 1, at the 3rd equation where the dependent variable is the Brent's Price returns. This relationship indicates the strong relationship between oil prices a month ago and the prevailing oil prices. We have 4 models with different dependent variables: 1st with Share price Returns as dependent variable, 2nd with BCTI, 3rd with Brent's Price and 4th with Tanker Secondhand Price Index. All models seem to have low explanatory power with the highest being the one of the 3rd models with Brent's Price Returns as as dependent variable and R-squared of 12.41%.

## *5.3 Granger Causality*

Granger causality is a statistical concept of causality that is based on prediction. According to Granger causality, if a signal X1 "Granger-causes" (or "G-causes") a signal X2, then past values of X1 should contain information that helps predict X2 above and beyond the information contained in past values of X2 alone. The Null Hypothesis states that there is no causality between two variables and can be rejected if p-value is lower than 0.05 at 95% significance level or lower than 0.10 at 90% significance level. Table 10 depicts the pairwise causalities in sense of Granger.

At 95% significance level, the model's dependent variable Share Price Avg Returns., which refers to average closing price of the stocks of the 13 listed tanker companies of our sample, is only Granger caused by R_BCTI at 95% significance level with p-value 0.0132. Although, Share Price Avg. does not Granger cause any variable at 95% significance level and the same happens at 90% significance level.

*Table 10 Granger Causality*

| Null hypothesis: No Causality | | Lags:1 Obs: 79 |
|---|---|---|
| **From** | **To** | **P-Value** |
| R_Share Price Avg. | R_BCTI | 0,2161 |
| R_BCTI | R_Share Price Avg. | 0,0132 |
| R_Share Price Avg. | R_BRENT $/bbl | 0,8836 |
| R_BRENT $/bbl | R_Share Price Avg. | 0,2486 |
| R_Share Price Avg. | R_Tanker Second. | 0,1186 |
| R_Tanker Second. | R_Share Price Avg. | 0,6818 |

## 5.4 Diagnostic Tests

The next step of our dissertation's analysis is the diagnostic tests regarding autocorrelation and heteroscedasticity our model.

The autocorrelation test is conducted with the LM test where the null hypothesis states that there is no autocorrelation. As it is reported in Table 11, the p-value at lag 1 is greater than 0.05 at 95% significance level and as a result the null-hypothesis cannot be rejected, so there is no autocorrelation in the examined model.

*Table 11 LM Autocorrelation Test*

| Null hypothesis: No serial correlation at lag h | | | | | | |
|---|---|---|---|---|---|---|
| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
| 1 | 1.175.679 | 16 | 0.7605 | 0.730615 | (16, 205.3) | 0.7609 |
| 2 | 1.886.441 | 16 | 0.2758 | 1.192.338 | (16, 205.3) | 0.2762 |
| **Null hypothesis: No serial correlation at lags 1 to h** | | | | | | |
| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
| 1 | 1.175.679 | 16 | 0.7605 | 0.730615 | (16, 205.3) | 0.7609 |
| 2 | 3.432.002 | 32 | 0.3571 | 1.080.658 | (32, 233.9) | 0.3592 |

Regarding the heteroscedasticity test, the White test is employed. The null hypothesis states that the residuals are homoscedastic, in other words they have constant variance.

Table 12 depicts that the null hypothesis can be rejected as the p-value is lower than 5% at 95% significance level and as a result the residuals are heteroscedastic.

*Table 12 White Test for Heteroscedasticity*

| Joint test: | | |
|---|---|---|
| Chi-sq | df | Prob. |
| 1.444.681 | 80 | 0.0000 |

## 5.5 Volatility Causality

Because the residuals are not homoscedastic, the volatility can be captured using a GARCH model. To begin, fresh time series for the VAR model's error terms with 1 lag are created. One time series for each variable in the model. The GARCH (1,1) model is then applied to each time series, and finally, the econometric software EViews provides a variance series for each variable. Subsequently, we are going to test the new variance series is sense of Granger causality.

Table 13 below reports the results of Granger Causality on volatilities' time series. Volatility of BCTI causes the volatility of Share Price (p-value 0.0367) as well as the volatility of Tanker Secondhand Price Index (p-value 0.0268) at 95% significance level. Additionally, volatility of Brent's Price seems to cause volatility of BCTI (p-value 0.0016) and vice-versa (p-value 0.0050) at 95% significance level as well. Finally, at 90% significance level, volatility of Share Price Granger causes the volatility of Tanker Secondhand Price index with a p-value of 0.0723.

*Table 13 Granger Causality on Volatilities' Time Series*

| Null Hypothesis: No Causality | | Lags: 1 |
|---|---|---|
| | | Obs: 78 |
| From | To | P-Value |
| V_Share Price Avg | V_BCTI | 0,6646 |
| V_BCTI | V_Share Price Avg | **0,0367** |
| V_Share Price Avg | V_Brent $/bbl | 0,4658 |
| V_Brent $/bbl | V_Share Price Avg | 0,4229 |
| V_Share Price Avg | V_Tanker Second. | **0,0723** |
| V_Tanker Second. | V_Share Price Avg | 0,7902 |
| V_Brent $/bbl | V_BCTI | **0,0016** |
| V_BCTI | V_Brent $/bbl | **0,0050** |
| V_Tanker Second. | V_BCTI | 0,2928 |
| V_BCTI | V_Tanker Second. | **0,0268** |
| V_Tanker Second. | V_Brent $/bbl | 0,9221 |
| V_Brent $/bbl | V_Tanker Second. | 0,0725 |

# 6. Conclusion

Shipping is considered the industry with the highest risk due to the extreme volatility of the freight markets. Predicting and measuring the demand and supply for sea transportation has been proven to be a challenging task and even more for the oil trade, where there have been rapid and dramatic changes in the demand-supply equilibrium over time. The oil shipping industry can be described as a near-perfect competitive market in which shipping companies serve as price takers and have no influence over prices as due to its nature, shipping is a derived demand sector. Tanker transportation demand is influenced by a variety of factors, including global economic development, oil prices, weather conditions, and political actions.

The results of our analysis indicate that freight rates, and more specifically, the Baltic Clean Tanker Index (BCTI), have a positive correlation with the average share price of the 13 tanker companies that comprise our sample of companies In addition, BCTI's p-value showed statistical significance in regard to the Ordinary Least Squares (OLS) output where the returns of the data were regressed as well as the freight indices do not Granger cause the share prices in terms of the returns however they do in terms of their volatilities. Moreover, our results showed that BCTI's volatility causes volatilities of tankers secondhand prices and Brent's price as well which is something that is against the theory as shipping is a derived demand and cannot affect the products prices itself.

As for the tankers' secondhand market and its effect on tankers' companies share price, the correlation matrix reported a positive correlation (0.57) in terms of levels however their correlation was very low in terms of their returns (0.11). Regarding OLS, secondhand market proved to be statistically insignificant in explaining shares' prices. Furthermore, there is not pairwise causality between the two variables in terms of their returns however there is one in terms of their volatilities as Share Price causes Tankers' Secondhand Price Index at 90% significance level.

Last but not least, oil price and shares' price had a very low correlation both in their levels and returns. Although, as OLS output reports, Brent's price is statistically significant at 90% significance level in explaining tanker companies' share price and Brent's price volatility cause BCTI's volatility.

The scope of this dissertation was to examine the impact of (tanker) freight rates, oil prices and secondhand tankers' market on the shares' price of listed tanker companies and there is no other paper in the literature examining this impact simultaneously. Our expectation was to prove through our analysis that the prices of the tangible assets of tanker companies, the ships, would be strongly correlated with their shares' price and we showed that there is a positive correlation between them, and that share's price affects the tankers' secondhand price. Additionally, we expected to show that oil prices affect tanker companies' share price and our results failed to come to an agreement with the previous findings of El-Masry & Olugbode (El-Masry, 2010) that an increase in the price of oil has a direct benefit for shipping firms. Although, our results indicate both the non-systematic relationship between oil prices and freight rates and also the relationship of freight rates with the price of the share of a tanker shipping company in terms of volatilities causalities. Finally, the results of this dissertation's analysis seem to come to an agreement with Amir H. Alizadeh and Gulnur Muradoglu (Alizadeh & Muradoglu, 2014) where their results indicate that freight rates have a positive relation with stock returns across many sectors.

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# Appendices

## 5.2.1 VAR Model Estimation Results

Vector Autoregression Estimates
Date: 12/05/21 Time: 14:16
Sample (adjusted): 2014M12 2021M06
Included observations: 79 after adjustments
Standard errors in ( ) & t-statistics in [ ]

| | R_SHARE_... | R_BCTI_IN... | R_BRENT_... | R_TANKER... |
|---|---|---|---|---|
| R_SHARE_PRICE__AV... | 0.037159 | 0.609526 | 0.224031 | 0.017173 |
| | (0.12164) | (0.24597) | (0.19417) | (0.04188) |
| | [ 0.30548] | [ 2.47807] | [ 1.15380] | [ 0.41008] |
| R_BCTI_INDEX(-1) | -0.081653 | -0.090272 | 0.147373 | 0.004808 |
| | (0.06601) | (0.13347) | (0.10536) | (0.02272) |
| | [-1.23707] | [-0.67634] | [ 1.39873] | [ 0.21157] |
| R_BRENT_$_BBL(-1) | 0.011880 | -0.260813 | 0.304546 | 0.028174 |
| | (0.08116) | (0.16412) | (0.12956) | (0.02794) |
| | [ 0.14637] | [-1.58913] | [ 2.35062] | [ 1.00830] |
| R_TANKER_SECOND... | 0.546525 | -0.355587 | -0.408980 | 0.256083 |
| | (0.35017) | (0.70809) | (0.55897) | (0.12055) |
| | [ 1.56073] | [-0.50218] | [-0.73166] | [ 2.12421] |
| C | -0.005097 | 0.015584 | 0.006739 | 0.000259 |
| | (0.00954) | (0.01930) | (0.01524) | (0.00329) |
| | [-0.53398] | [ 0.80740] | [ 0.44230] | [ 0.07887] |
| R-squared | 0.048080 | 0.095541 | 0.124183 | 0.068281 |
| Adj. R-squared | -0.003375 | 0.046651 | 0.076841 | 0.017918 |
| Sum sq. resids | 0.516169 | 2.110599 | 1.315242 | 0.061178 |
| S.E. equation | 0.083518 | 0.168883 | 0.133317 | 0.028753 |
| F-statistic | 0.934412 | 1.954210 | 2.623125 | 1.355776 |
| Log likelihood | 86.61922 | 30.99166 | 49.67323 | 170.8590 |
| Akaike AIC | -2.066309 | -0.658017 | -1.130968 | -4.198963 |
| Schwarz SC | -1.916344 | -0.508052 | -0.981003 | -4.048998 |
| Mean dependent | -0.006062 | 0.008208 | 0.008782 | 0.000472 |
| S.D. dependent | 0.083377 | 0.172966 | 0.138755 | 0.029014 |

| | |
|---|---|
| Determinant resid covariance (dof adj.) | 1.45E-09 |
| Determinant resid covariance | 1.12E-09 |
| Log likelihood | 365.7986 |
| Akaike information criterion | -8.754395 |
| Schwarz criterion | -8.154535 |
| Number of coefficients | 20 |

System: UNTITLED
Estimation Method: Least Squares
Date: 12/05/21 Time: 19:46
Sample: 2014M12 2021M06
Included observations: 79
Total system (balanced) observations 316

| | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C(1) | 0.037159 | 0.121639 | 0.305482 | 0.7602 |
| C(2) | -0.081653 | 0.066005 | -1.237068 | 0.2170 |
| C(3) | 0.011880 | 0.081164 | 0.146373 | 0.8837 |
| C(4) | 0.546525 | 0.350173 | 1.560727 | 0.1197 |
| C(5) | -0.005097 | 0.009545 | -0.533980 | 0.5938 |
| C(6) | 0.609526 | 0.245969 | 2.478066 | 0.0138 |
| C(7) | -0.090272 | 0.133470 | -0.676342 | 0.4994 |
| C(8) | -0.260813 | 0.164123 | -1.589132 | 0.1131 |
| C(9) | -0.355587 | 0.708092 | -0.502177 | 0.6159 |
| C(10) | 0.015584 | 0.019301 | 0.807396 | 0.4201 |
| C(11) | 0.224031 | 0.194169 | 1.153797 | 0.2495 |
| C(12) | 0.147373 | 0.105362 | 1.398728 | 0.1629 |
| C(13) | 0.304546 | 0.129560 | 2.350622 | 0.0194 |
| C(14) | -0.408980 | 0.558972 | -0.731664 | 0.4650 |
| C(15) | 0.006739 | 0.015236 | 0.442304 | 0.6586 |
| C(16) | 0.017173 | 0.041877 | 0.410076 | 0.6820 |
| C(17) | 0.004808 | 0.022724 | 0.211568 | 0.8326 |
| C(18) | 0.028174 | 0.027942 | 1.008304 | 0.3141 |
| C(19) | 0.256083 | 0.120554 | 2.124212 | 0.0345 |
| C(20) | 0.000259 | 0.003286 | 0.078866 | 0.9372 |

Determinant residual covariance 1.12E-09

Equation: R_SHARE_PRICE__AVERAGE_ = C(1)*R_SHARE_PRICE__AVERAGE_(-1) + C(2)*R_BCTI_INDEX(-1) + C(3)*R_BRENT_$_BBL(-1) + C(4)*R_TANKER_SECONDHAND_PRICE_INDEX(-1) + C(5)
Observations: 79

| | | | |
|---|---|---|---|
| R-squared | 0.048080 | Mean dependent var | -0.006062 |
| Adjusted R-squared | -0.003375 | S.D. dependent var | 0.083377 |
| S.E. of regression | 0.083518 | Sum squared resid | 0.516169 |
| Durbin-Watson stat | 2.032388 | | |

Equation: R_BCTI_INDEX = C(6)*R_SHARE_PRICE__AVERAGE_(-1) + C(7)*R_BCTI_INDEX(-1) + C(8)*R_BRENT_$_BBL(-1) + C(9) *R_TANKER_SECONDHAND_PRICE_INDEX(-1) + C(10)
Observations: 79

| | | | |
|---|---|---|---|
| R-squared | 0.095541 | Mean dependent var | 0.008208 |
| Adjusted R-squared | 0.046651 | S.D. dependent var | 0.172966 |
| S.E. of regression | 0.168883 | Sum squared resid | 2.110599 |
| Durbin-Watson stat | 1.882797 | | |

Equation: R_BRENT_$_BBL = C(11)*R_SHARE_PRICE__AVERAGE_(-1) + C(12)*R_BCTI_INDEX(-1) + C(13)*R_BRENT_$_BBL(-1) + C(14) *R_TANKER_SECONDHAND_PRICE_INDEX(-1) + C(15)
Observations: 79

| | | | |
|---|---|---|---|
| R-squared | 0.124183 | Mean dependent var | 0.008782 |
| Adjusted R-squared | 0.076841 | S.D. dependent var | 0.138755 |
| S.E. of regression | 0.133317 | Sum squared resid | 1.315242 |
| Durbin-Watson stat | 1.938471 | | |

Equation: R_TANKER_SECONDHAND_PRICE_INDEX = C(16) *R_SHARE_PRICE__AVERAGE_(-1) + C(17)*R_BCTI_INDEX(-1) + C(18)*R_BRENT_$_BBL(-1) + C(19)*R_TANKER_SECONDHAND_PRICE_INDEX(-1) + C(20)
Observations: 79

| | | | |
|---|---|---|---|
| R-squared | 0.068281 | Mean dependent var | 0.000472 |
| Adjusted R-squared | 0.017918 | S.D. dependent var | 0.029014 |
| S.E. of regression | 0.028753 | Sum squared resid | 0.061178 |
| Durbin-Watson stat | 2.036848 | | |