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CERTIFICATION OF THESIS PREPARATION

"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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ABSTRACT

Something that is common among the tanker freight rates and oil prices is their volatility. This project seeks to investigate the nature of the relationship among these variables. In order to measure tanker freight rates, time-series of the 1-year time charter rates of VLCC, Suezmax and Aframax were used, while the oil price is measured with the use of the Western Texas Intermediary (WTI) prices per barrel. In addition to those, variables were used to measure global oil production and demand for oil sea transport services in ton-miles. The period that is examined is between 2000Q1 to 2019Q1 and is in quarterly time intervals. The analysis took place using the Vector Autoregression (VAR) analysis. The results indicate that the way the oil price shocks affect volatilities of tanker freight rates depend on the vessel category. WTI shocks affect directly only the values of Aframax freight rates, while there appears to be no direct effect on the freight rates of Suezmaxes and VLCCs. Along with that, the freight rates for all vessel categories are affected by shocks in of oil supply and demand for oil sea transport. Any effect that WTI prices have on the two latter categories is indirect, since oil price shocks affect the values of oil supply and demand for sea transport oil services, with the shocks then being passed on to VLCC and Suezmax freight rates. The reason that Aframaxes are more reactive to oil price shocks, could be attributed to their size that enables them to visit a variety of ports and also alternate between crude oil and clean oil products as their carried commodity. This makes it easier for them to reposition to other routes in order to mitigate these effects, whereas VLLC and Suezmax can call to ports with specific requirements. These findings should be considered both by academics and market practitioners.

Chapter 1: Introduction

1.1 Project's Goal

The importance of the oil commodity for the current industrialised society cannot be stressed enough. It's not necessary only as fuel for industrial production but also in the daily life of consumers for a variety of uses such as heating and transport. One additional characteristic of oil, elaborated further in section 1.2 is the long distance between the oil producing and oil consuming countries. Although there are various methods to transport oil, such as pipelines, the most widely used method is that of sea transport. According to the U.S. Energy Information Administration (EIA), during 2015 a percentage of 61% of produced oil was transported via specialised sea-going vessels called "tankers" (EIA,2017).

Since the requirement of transport of oil by sea is a derived demand (Stopford, 2009), it can be understood there is a close interconnection between the market variables of oil, such as supply, demand and equilibrium price and those of the tanker market. The main goal of this project is to investigate the impact of oil prices shocks using the values of the Western Texas intermediary (WTI) oil on the freights of different tanker vessel categories, namely Very Large Crude Oil Carriers (VLCC), Suezmaxes and Aframaxes.

Having presented the project's main goal, the next sections discuss the main characteristics of the tanker and oil markets.

1.2 Characteristics of the tanker market

Tanker vessels specialise in the sea transport of crude oil and oil products, both "dirty" like heavy fuel oil and diesel oil and "clean" like gasoline, diesel fuel and jet fuel. The categories of tanker vessels based on their size / carrying capacity in deadweight tons (DWT), together with other details such as their beam, draught, daily consumption and speed are presented in Table 1 below:

Table 1: Types and characteristics of tanker vessels

Type	DWT	Beam (m)	Draught (m)	Speed (knots)	Fuel consumption (tons/day)
U/VLCC	200,000 – 500,000	58.4	21.2	15.3	85.7
Suezmax	199,999	46.7	16.6	14.9	62.9
Aframax	80,000 – 120,000	41.7	14.3	15	46
Panamax	60,000 – 80,000	32.8	13.4	14.8	39.1
Products tankers (Handy)	10,000 – 60,000	21.7 – 31.8	8.6 – 12.1	14 – 15.1	22.5 - 37

Source: Stopford (2009)

U/VLCCs are used for long haul routes, in order to take benefit of the economies of scale that they offer. They specialize exclusively in the carriage of crude oil, to the extent that VLCCs are used for the seaborne transport of about 60% of this commodity. They are employed in the routes from Middle East to US East Coast, western Europe and the Far East and from West Africa to the US and the Far East (Stopford, 2009; Alizadeh and Nomikos, 2009).

Suezmaxes are active in medium-haul crude oil trade routes. They carry about 30% of the total seaborne crude oil trade and about 5% of the other dirty products. They are employed in following routes: 1) Middle East to the US East, Coast, western Europe and the western Europe and the Far East, 2) Mediterranean via the Suez Canal, 3) Middle East to the Far East, 4) North Sea to US East Coast, 5) West Africa to the US and Europe Middle East to the US East Coast for crude oil, while for dirty products they are used in the route Middle East to the US East Coast, western Europe and the Far East (Stopford, 2009; Alizadeh and Nomikos, 2009).

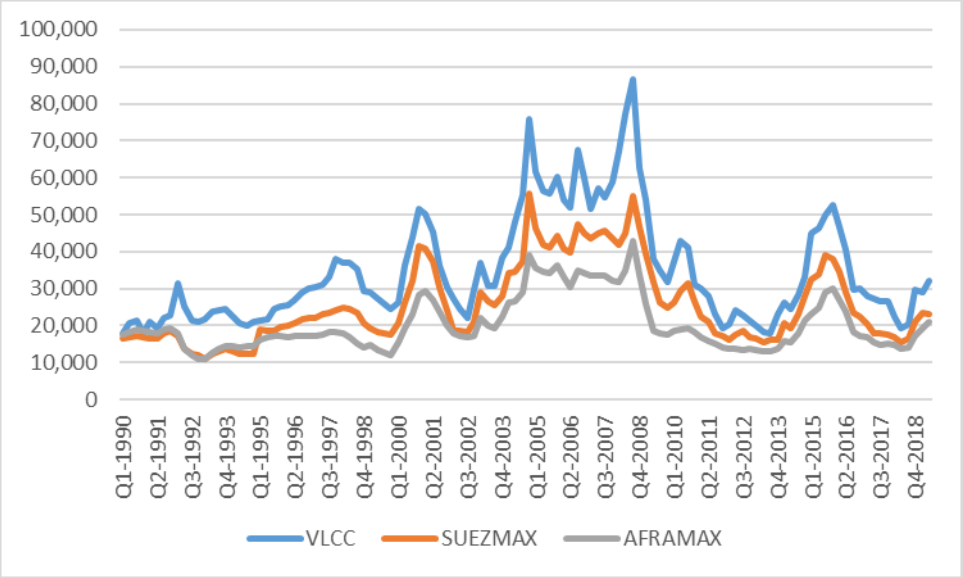
Aframaxes are active in short-haul crude oil trades. They are used for the carriage of 10% of seaborne crude oil, 35% of other dirty products and 20% of clean products. With those vessels (Stopford, 2009; Alizadeh and Nomikos, 2009):

- Seaborne crude oil is traded on the routes: 1) North Sea to the US, 2) West & North Africa to the US and Europe, 3) Singapore and Malaysia to Japan and Venezuela to the US Gulf States.

- Seaborne dirty oil products are traded on the routes: 1) Middle East to US East Coast, Western Europe and the Far East, 2) US Gulf states to other ports of call, 3) Other minor routes worldwide.
- Clean product oils are traded on the routes: 1) Middle East to US East Coast, western Europe and the Far East, 2) US Gulf to different destinations, 3) Other routes worldwide.

Finally, Panamax tankers are used for very short haul crude oil and dirty products trade, while through Handysize product tankers 60% of seaborne trade of dirty oil products and 80% of the seaborne trade of clean oil products take place on routes around the globe. As it can be noted, as the vessels' size decreases there is an increase on the trade that they can be used. This relates to factors such as draught permissions and other port infrastructure and makes smaller vessel more flexible on the routes that they can be employed on (Stopford, 2009; Alizadeh and Nomikos, 2009).

Chart 1: 1-year Time charter rate for Aframax/Suezmax/VLCC, 1990Q1- 2009Q2, ($/pd)



Source: Created by author using data from Clarkson's S.I.N

Chart 1 presents the vessels types' daily rates when they are fixed under a 1-year time charter. As it can be noted, all three vessel types presented peaks on their revenues around 2008, only to be followed by a large decline of rates afterwards. Both of these movements can be connected with the market euphoria and global growth that existed before the collapse of Lehman brothers on 2008 and the global financial crisis that was subsequently created

(Haralambides and Thanopoulou, 2014). The market slump brought vessels earnings to the levels that were comparable to those that existed in the 90's.

Tanker freights present another peak around 2015, with VLCCs reaching $52,731 p/d, Suezmaxes reaching $38,154 p/d and Aframaxes reaching $30,000 p/d on 2015 Q4. The reason that after this upward movement they followed a strong downward trend is attributed to the introduction of new tonnage in the market as newbuilding orders were delivered. This increased available supply to a large degree compared to existing demand and caused the freight equilibrium to decline (Brent-Petersen et al., 2018). Furthermore, Brent-Petersen et al. (2018) argue that the crude oil market is burdened by tonnage oversupply and up until 2020 there is no evidence that the freight rates will improve (Chart 2) unless decisions are taken such as slow-steaming or increase of scrapping activity in order to remove available tonnage.

Chart 2: Status of the tanker market shipping cycle until November 2018

Source: Brent-Petersen et al., 2018

That said, although it is not depicted in Chart 1 and taken into account by Brent-Petersen et al. (2018), it is important to note that tanker freight rates reached historical peaks during the third quarter of 2019. This is only due to unforeseen political events, such as the US sanctions on Iran, but also on tanker vessels going to drydock in order to place scrubbers, limiting thus available supply (Laursen et al, 2019). The latter was caused due to the wider trend generated by the IMO 2020 regulations which place a 0.5% limit on vessels' fuels sulphur content (Holnes, 2019). It is possible that these regulations will have significant effect on both the oil and tanker markets, however they are outside the scope of this project.

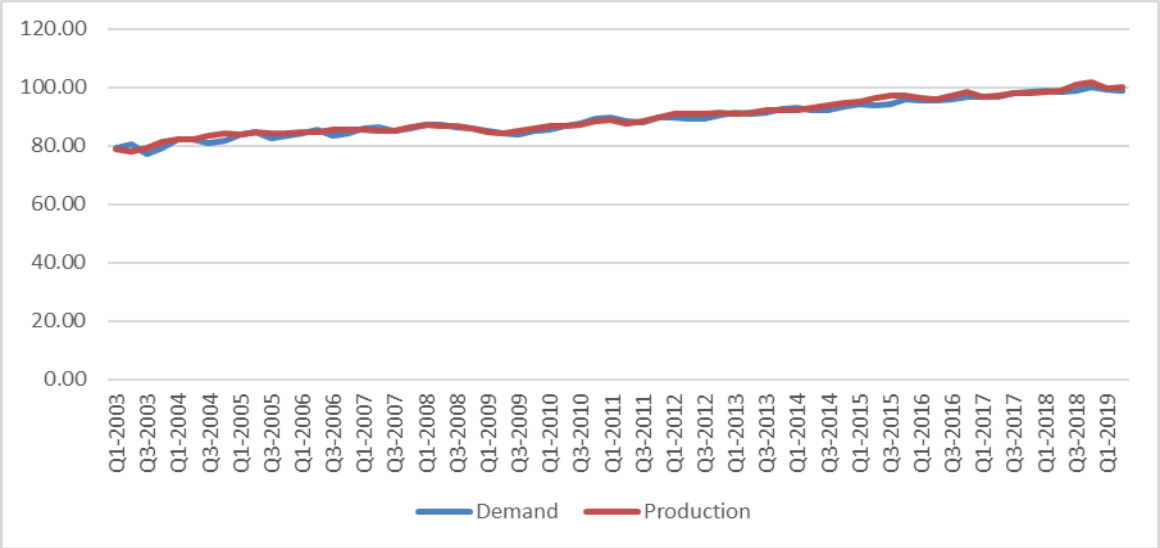
Concerning the vessels ownership for those three vessel types, it can be noted from Tables 11 and 12 / Chart 24 (Appendix, pages 57-58) that Greek companies have a strong presence in the VLCC field, as they have a 28% (14 companies) from the 50 largest companies worldwide. These companies have about 23% of the VLCC vessels both in numbers and carrying capacity, 36% of the Suezmax vessels (Tables 13 and 14/ Chart 25 in the Appendix,

pages 59 – 60) and 31% of the Aframax (Tables 15 and 16 /Chart 16 in Appendix, pages 61-62). While the presence of Greece in the first place is consistent, a differentiation can be noted in the following positions across the three vessels. So in the case of VLCC vessels, Greece is followed by Japan, China P.R. and South Korea, in the case of Suezmax vessels it is followed by Norway, United Kingdom and the United States, while in the case of Aframax vessels it is followed by Singapore and United Kingdom. In addition to that, it can be noted that a large percentage of tankers is owned by companies in "Other countries" which is a sum of the percentages of countries that have 2% and less of participation in the list with the 50 largest companies per vessel category. Concerning the fleet's average age, it can be seen that in the VLCC vessels Greece and Japan have a fleet above the average age, while China P.R. and Korea have fleet with age below the average. For the Suezmax vessels, Greece's fleet is slightly below the average age while the United Kingdom has a very young fleet. At the same time, Norway and USA have fleets above the average age. Finally, the fleets of Greece and Singapore are below the average age, while UK is above this figure.

1.3 Characteristics of the oil market

While the tanker market is a part of this project, it is not the sole focus of it. The other main point of consideration is that of crude oil and its prices. "Crude" is oil in its initial state. Through its refinement, different oil products are produced that are necessary both for industrial product and for the daily life. One category of these refined products is that of the lighter distillates, referred commonly as "clean products" and include among them kerosene, gasoline and naptha. These products are usually carried by vessels that have cleans tanks with coatings in order to prevent cargo contamination and reduce their corrosion. The other category is that of the lower distillates, referred commonly as "dirty products". These include products such as fuel oil and residual oil and due to their low viscosity they often require cargo-tanks with steam-heating coils (Stopford, 2009).

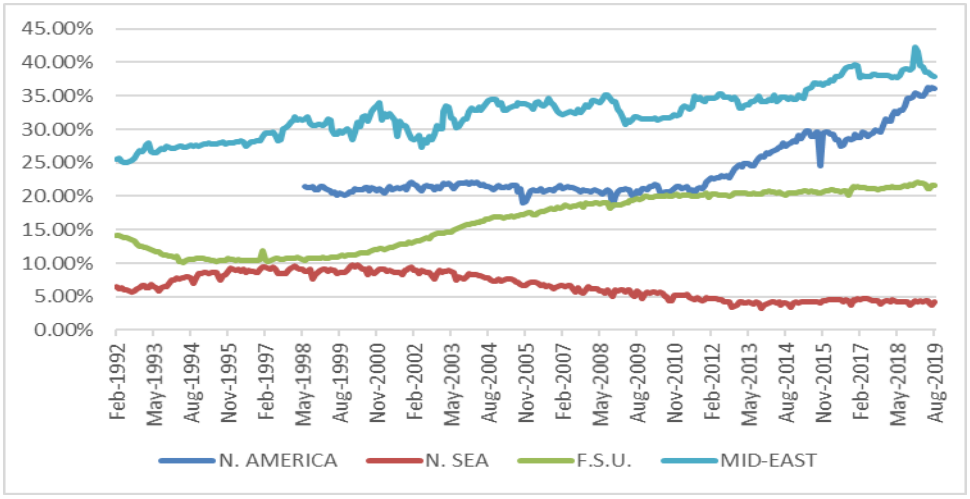
Chart 3: Global oil production and demand in mbpd (2003Q1 – 2019Q2)



Source: Created from author with data from Clarksons S.I.N.

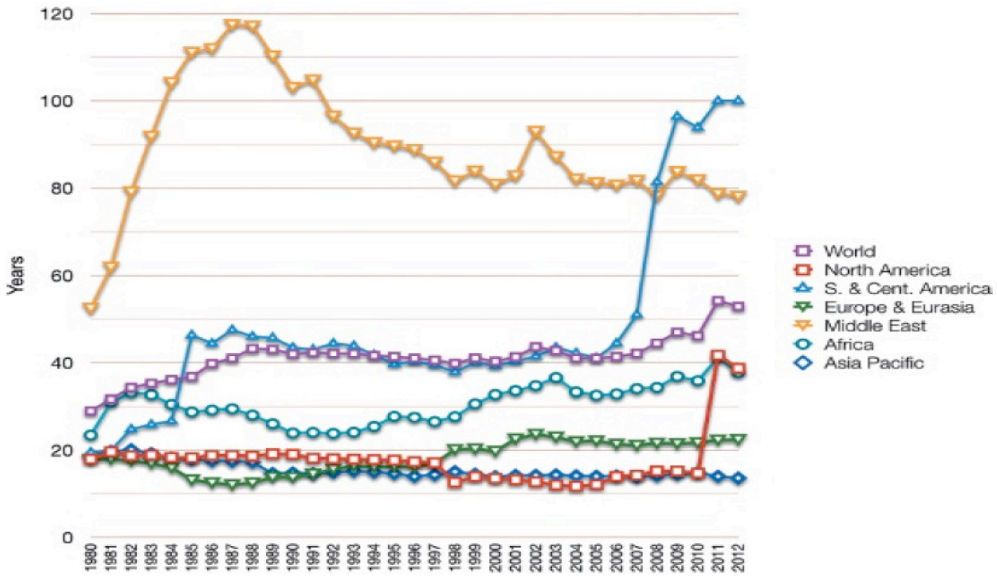
As it can be seen from Chart 3, oil production and consumption on a global level grow consistently and concurrently. Further information about global oil production is provided on Chart 4, which shows that the for the last 30 years it relies mainly on the reserves from the region of Middle East. At the same time, during the last decade, USA has increased its production, while the activity of other regions, such as the North Sea, have declined. Chart 5 depicts in a clearer manner both the large volume produced in the region of Middle East and countries in the Americas (South, Middle and the USA) to use more of their oil reserves for production.

Chart 4: Oil production trends



Source: Created from author with data from Clarksons S.I.N.

Chart 5: Reserves-to-production ratios in selected regions



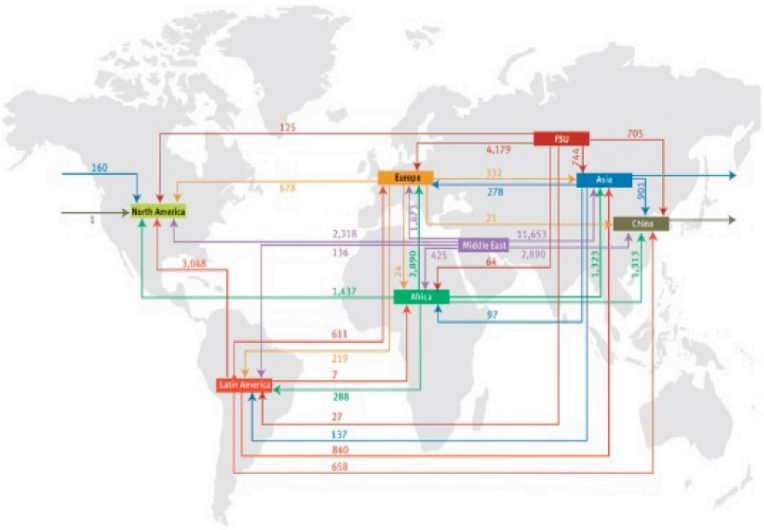
Source: Tamvakis, 2015

When discussing the topic of oil consumption, it is important also to take into account the Organization of the Petroleum Exporting Countries (OPEC). This organization was created in the 1960s by the governments of countries with oil reserves who wanted to exploit their own resources and increase their oil revenues rather than let them at the disposal of foreign oil companies. While the organization was initially ignored, this changed drastically in the 70s. This is owed mainly to the fact of the growing demand for oil which encouraged oil imports by countries such as the USA that had become dependent on it, while at the same time USA's domestic production was declining. This, combined with the Arab Oil embargo imposed due to the Yom Kippur war caused the first oil price shock, due to the rapid increase of crude oil prices (Tamvakis, 2014) for the period of October 1973 to January 1974.

OPEC's presence was noticed both in the second and third oil price shocks. The second oil price shock was due to the Iranian Revolution in 1979 and the nationalization of the oil companies located there. This caused an increase in oil prices that lead oil companies to seek better ways to conserve oil and search for new reserves in locations that were politically safe, such as Alaska and the North Sea. The third oil crisis was caused by an internal conflict of OPEC. As a result of the second oil crisis, many consumers sought to reduce their oil consumption causing a decline in demand. At the time, OPEC members saw this drop and would adjust production on their own in order to increase their revenues, rather than follow the organization's policies and production quotas. This drove oil prices to low values both for OPEC members and Non-OPEC producers (Tamvakis, 2014). Other oil shock price crises were the following (Stopford, 2009; Tamvakis, 2014):

- A shock was created due to the invasion of Iraq on Kuwait and the subsequent decrease on Kuwaiti oil production. This was offset by Saudi Arabia that increased its oil output and secured the stability of global production.
- The Asian crisis. OPEC, noting the continuous growth of in the Asian region during 1997 decided to increase their production quota. When the Asian financial crisis occurred on the second half of 1997, another collapse was caused in the price of oil per barrel up until 1999.
- The global financial crisis of 2008. The collapse of Lehman brothers created uncertainty and insecurity about the condition of the global financial system and caused a decline in global economic activity. Oil price is used as a proxy for the condition of the global economy and indicated these feelings of uncertainty by declining to low values, after having reached peak prices during summer 2008.

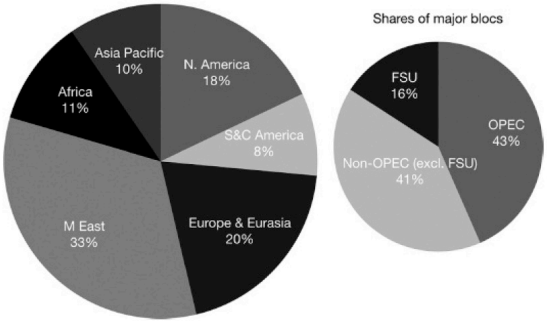
Chart 6: World crude oil trade flows



Source: Tamvakis, 2014

Chart 6 provides information on the global trade flows and shows the important role of Middle East and FSU as oil producers and exporters. This is further indicated by Chart 7 which shows the role not only of Middle East Countries but also of OPEC. As discussed previously, this is mainly the reason that any political conflicts in this region do have strong impacts on oil prices and subsequently the global economy.

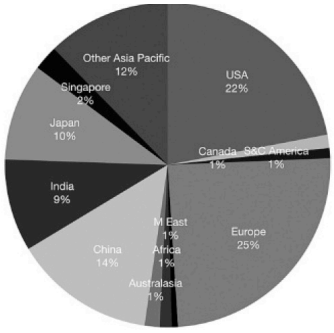
Chart 7: Oil production shares



Source: Tamvakis, 2014

Following that, Chart 8 provides details about oil importing economies. As it is indicated, Europe and USA are the two major importers, followed by China. Oil is significant for these major economies, not only for their industries but also to support the daily necessities of their citizens, such heating oil or oil for transportation with vehicles. This can give further insight on the geopolitical importance of oil and how OPEC and oil producers can exert economic and political pressure on oil consuming countries.

Chart 8: Crude oil Imports (2012)

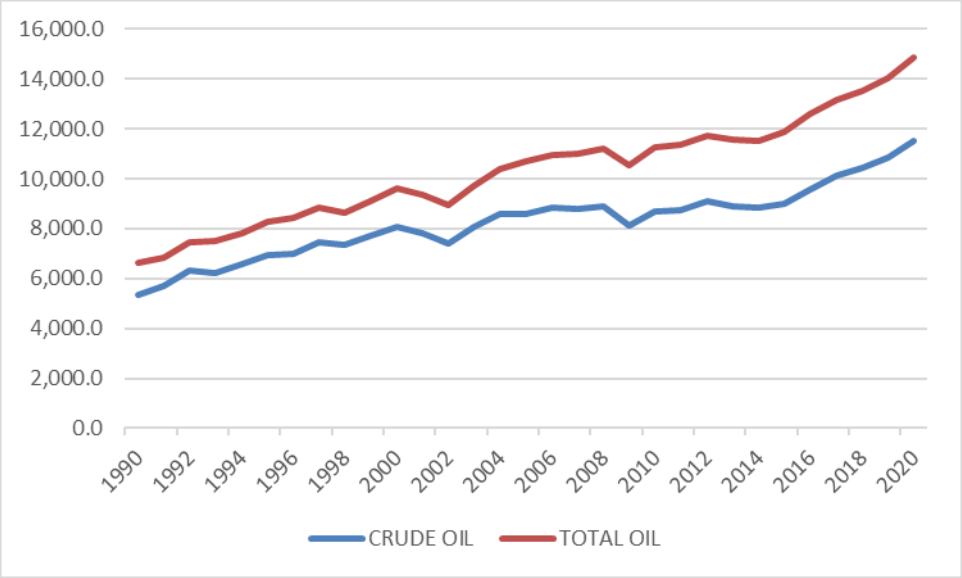


Source: Tamvakis, 2014

The demand for sea transport services can be shown through the variable of ton-miles (Chart 9). Ton-miles are calculated by multiplying the tonnage of cargo transferred with vessels times the average haul. This is considered as a better proxy for the demand of sea transport services since it avoids making assumptions about the efficiency of vessels that are used for the trade (Stopford, 2009). As it can be seen, the ton-miles for oil transport are in a constant growth since the 1990s. Some exceptions, where ton-miles have declined, can be noticed and can be attributed to geopolitical reasons, such as the invasion of Iraq by the USA in 2001 or the global financial crisis of 2008. On the other hand, the continuous growth for oil demand in the long term can be attributed to factors such as the collapse of Soviet Union and the participation of these countries in global trade, the trend of globalization and the emergence of China and India as new industrial economies that require oil in order to support their production

(Anandan and Ramaswamy, 2015). These events increased demand for vessels to transfer this commodity via sea, considering the long distances between the producing and consuming countries.

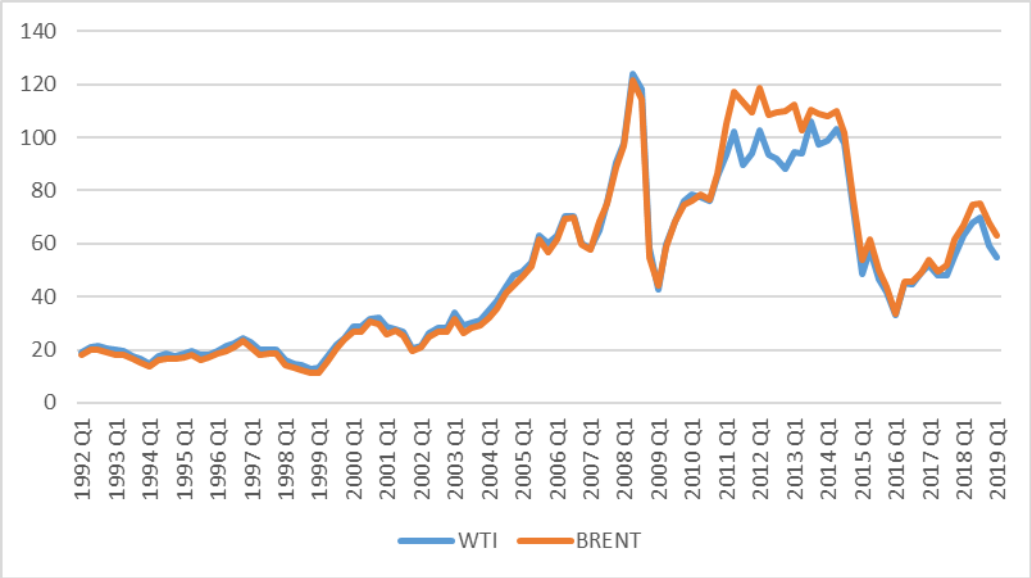
Chart 9: Ton-miles for crude oil and total oil (crude oil + oil products), 1990 – 2020



Source: Created by author with data from Clarksons S.I.N

The volatility of oil prices and the various oil crises can be seen in Chart 10. Before that however, it is important to provide additional details on the two prices presented in this chart. "Brent oil" is produced on a system of oilfields in the North Sea, with its first consignments being loaded during 1976. Its extraction could be considered costly especially due to the dangerous rough North Sea waters. However, after the first two oil price shocks, its production was boosted, since its extraction was deemed as profitable, always considering the alternative of oil price shocks. It's an oil of high quality and the UK government uses a licensing system that permits its widespread ownership. This means that no individual producer can manipulate production and artificially raise its price. Its high marketability is the reason that its price is used as a benchmark for the international oil market, both for the physical markets (transport of oil) and for the paper markets (financial derivatives). (Tamvakis, 2014).

Chart 10: WTI and Brent Oil Prices, 1992Q1– 2019Q1 in $/bbl



Source: Created by author using data from Clarkson S.I.N and EIA

While Brent oil price is used a benchmark for international markets, the price of Western Texas Intermediate (WTI) oil is used as a benchmark mainly for the USA domestic market. Its physical trading takes price at the pipeline hub which exists in Cushing, Oklahoma. There, oil is delivered at the end of one of the pipelines or in a suitable storage tank within this area. Just like the Brent Oil price, WTI price is used both for physical and paper trading (Tamvakis, 2015). While the Brent and WTI have very similar quality characteristics, WTI is a bit lighter. This characteristic makes it more suitable to be used for oil refinement to oil products (Geyer-Klingeberg and Rathgeber, 2018).

The spot prices of both Brent and WTI are generally considered to be affect by three factors. In the short-term period, their prices are the result of the equilibrium between supply and demand while in the medium term they are the result of the current structure in the oil market. Finally, in the long-term their prices are affected by the marginal production in relation to the global demand for oil (Angelier, 1991).

As it can be noted from Chart 10, up until 2008 the prices of WTI and Brent move close together. WTI was traded at a premium against Brent, which was based on the transportation costs of transferring oil from the North Sea to the US Gulf Coast refineries (Kaminski, 2014). Since 2010, their prices were decoupled with the main factors affecting the spread being the local WTI inventories in USA, shipping costs and the effects of paper markets on the crude oil physical trading and its spot prices.

Having discussed both the characteristics of the tanker market and the oil market, the next section presents the questions that this project will seek to provide an answer.

1.4 Research Questions

The previous sections showed that the tanker freights and the oil prices are affected by various factors and exhibit large volatilities. The main goal of this project is to investigate whether the volatilities of oil price have an effect on the freight rates of various tanker vessels. WTI will be used as the proxy for oil price with 1-year time charter rates being used as the proxy for tanker earnings.

- The main question is: Which factors affect the volatility of tanker freight rates?
- The sub-questions are:
    - Are tanker freight rates affected by the volatility of oil prices?
    - Are tanker freight rates affected by the volatility of oil supply and demand?