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The Effects of Economic Policy Uncertainty on Tanker Shipping Freight Rates

By

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We approve the Thesis of

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CERTIFICATION OF THESIS PREPARATION

“We 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 our personal views on the subject. All the sources we 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).”

Argyridis Christodoulos ....

Germanos Konstantinos ....

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Abstract

In our research we examine the effects of Global Economic Policy Uncertainty (GEPU) on tanker freight rates (VLCC, Suezmax, Aframax and Panamax), a determinant that has not been yet utilized in the existing scientific literature for this certain purpose. Long Run Historical Earnings of the relevant segments are used as a proxy for freight rates. We create a predictive model that employs GEPU along with other established variables for the industry that we divide into two distinct categories, the Shipping Industry Related and the Economic Environment variables. To do so, we collect monthly data from January 1997 to June 2020 sourced from Clarksons Database and the Global Economic Policy Uncertainty Index.

We exclude variables through the Akaike information criterion (AIC) and Bayes information criterion (BIC) to avoid multicollinearity, and to avert the impact of outliers on our estimation results we remove the extreme observations beyond the 1st and 99th percentiles. Further, to create our model, we apply panel data Clustered Regression Analysis on a cross sectional time series dataset.

Our findings indicate that GEPU influence on LRHE is positive and statistically significant at 1% significance level, implying an unmistakable effect on tanker freight rates which suggests that uncertainty is an inflating factor for the industry. Despite LOWES graph pointing that there is an indication of non-linearity, GEPU's relationship with LRHE is a positive linear one sine $GEPU^2$ insertion to our model proves to be statistically insignificant. Additionally, GEPU influence on tanker freight rates is persistent throughout the whole period of our investigation, and not only appearing after, before or during milestone events of economic uncertainty such as the 2008 financial crisis.

1. Introduction

It is generally accepted that more than 80% of world trade in volume terms is carried by vessels (Martin Stopford, 2008), indicating the significance of the shipping sector to the world economy as a whole. To illustrate this point, in 2019 the seaborne trade was estimated to be over 11,000 million tonnes (UNCTAD, 2019). One could say that without shipping the global trade would cease to exist. Freight rates, that is the price of seaborne transportation services, are the driving force of this industry as they are the revenue of a shipping company. Shipping market's stakeholders, especially ship-owners and charterers, are affected at a great extent by the peaks and valleys of freight rates, and for this reason, freight rate models have been widely investigated by shipping economists and practitioners. A model that brings them closer to freight rate forecast helps market players to mitigate any relevant risks and get the most of benefits of arising opportunities.

According to the economic theory, the price of a product (or a service) is determined by the intersection of supply and demand. Therefore, several measures have been used to accurately reflect the demand and supply forces in the global shipping market. Tinbergen (1959) demonstrates the sensitivity of freight rate levels to different factors affecting both the demand and supply side, while Koopmans (1939) focuses on the supply curve's peculiar shape.

Despite its high importance, choosing the appropriate variables and combining them to reflect the forces of demand and supply in an accurate way for the global shipping market remains a challenging task and of primary importance for the industry. Factor-driven models that try to forecast freight rates are distinguished into micro-economic and macro-economic models (Zannetos and Polemis, 1964). Microeconomic variables are about elements that are specific and objective regarding to the characteristics of a single vessel or charter party details and so on, while macro-economic variables are factors that refer to a variety of vessels and can describe the whole or parts of the tanker market. For instance, according to Dikos et al. (2006), Randers and Göluke (2007) macroeconomic factors such as newbuilding orderbook, average building time, vessels average life, demolition and fleet utilization are found to explain the changes in freight rates, while Alizadeh and Talley (2011) suggests that vessel age, hull type, deadweight utilization and route have also a strong correlation with freight rates.

Demand in shipping is a derived demand from the transported commodities, hence there is also a strong relationship between freight rates and real economic activity (Killian, 2009). The forces of the uncertainty that prevails in Economy can have a strong impact on shipping freight rates. Baker et al. (2016) generate the Economic Policy Uncertainty (EPU) index in order to measure the predominant economic uncertainty. The index is compromised by three components. The first component quantifies policy-related economic uncertainty newspaper coverage; the second one indicates the number of expiring federal tax code provisions in future years, and finally the third part employs the disagreement among economic forecasters, as a proxy for uncertainty. The characteristics of EPU encapsulate the fact that the entire market is composed of different stakeholders with different goals that affect one another in our global economy. For this reason, an increasing number of studies use this index in order to explain the behavior of extremely volatile financial markets, commodities and returns, such as stock returns or oil prices.

This study concentrates on the tanker segment and the world seaborne trade of crude oil. Crude oil is one of the major indicators of economic activities of the world, due to its importance in the supply of the world's energy demands, thus it is transported by large quantities by the sea. Our purpose is to analyze the relationship between tanker freight rates and the different forces of demand and supply. We make an attempt to extent prior evidence by examining the effect of Global Economic Policy Uncertainty index (GEPU) on tanker freight market. A current dataset of Long Run Historical Earnings (used as proxy for freight rates) for four different types of tanker vessels (VLCC, Suezmax, Aframax, Panamax) as well as the GEPU index provided by Baker et al. over the time period 1997-2020 are used for this purpose. We firmly believe that our research will contribute to the freight rate explanatory models' literature and thus be compelling to all parties involved in the industry.

Based on this, the existing research questions are as follows:

1. Which are the factors that affect the levels of freight rates in tanker market?
2. Is there any impact from GEPU index to tanker freight rates?
3. Is this impact constant across different time regimes?
4. Is the relationship between GEPU and tanker rates linear?

This paper constitutes a useful starting point for investigating the impact of Economic Policy Uncertainty index on the shipping industry and especially on tanker freight market, as no other research is found in literature for this subject. Despite its methodological limitations, the solid economic intuition behind it suggests that there should be further research in this field, expanding and overcoming issues related to the extreme volatility and pronounced cyclicality that characterize the shipping market, in order to provide more accurate and consistent results. The rest of the paper continues as follows: Part 2 elaborates on the current literature regarding the freight market as well as the effect of EPU on different industries; part 3 summarizes the data collection and description; part 4 describes the methodological framework; part 5 analyses the results and part 6 concludes.

2. Literature Review

The main idea and the subsequent analysis are based on two main pillars which are extensively examined in the current literature. Those are described in this part as follows. Section 2.1 summarizes the research around the shipping industry in terms of freight rates and section 2.2 introduces the literature regarding the Global Economic Policy Uncertainty index and its impact on different industries.

2.1 Shipping Industry and the freight market

Generally, there are two schools of thought that arise from the shipping literature; traditional structural models and modern time series models (Eivind Molvik and Martin Stafseng, 2018).

One of the primary approaches to estimate tanker freight rates is presented by Koopmans (1939). He utilizes the traditional microeconomic theory, according to which the point of the intersection of the supply – demand curves (equilibrium point) determines the predominant freight rate and finds that the shipping industry is characterized by high cyclicality due to the time lag between ship capacity (supply) meeting demand. Moreover, Koopmans describes the dynamic behavior of tanker market, by modelling the supply and demand for tanker shipping services. A low correlation between freight rates and demand for tanker shipping services is observed, as in the short run oil demand is price inelastic and only a small part of the final product price is formed by the freight rates. As regards the elasticity of supply there are two different situations, that are considered in Koopmans analysis. When the freight rates tend to increase and the majority of the available fleet is chartered, tanker supply shows low elasticity, while in periods of low freight rate levels, many ships are laid-up and as a result an increase in rates will generate a great increase of transportation capacity.

Tinbergen (1959) examines the existence of sensitivity of freight rates to variations in the level of demand on the one hand and the variables influencing the supply side on the other. He considers that demand is perfectly inelastic related to freight rates and that the fleet size, fuel prices and operating expenses are specified to affect rates. However, regarding the latter, they remain almost unchanged over time compared to other factors and therefore their effect is taken into account as constant.

Since then, many authors have built their studies upon Koopmans and Tinbergens findings. Zannetos and Polemis (1964) evaluate a model, using the short-term freight rates as basis, in order to predict the long-term charter rates and they find that there is no interrelationship between spot and long charter rates except for recession periods. This implies that the future price of freight rates, under static expectations in both tanker demand and supply, can be explained by objective data that are derived from the tanker market such as the size of the vessels, the charter duration, the world fleet availability and the orderbook of new ships. This research provides also evidence that the factor-driven tanker models are distinguished into micro-economic and macro-economic models. Microeconomic variables are about elements that are specific and objective regarding to the characteristics of a single vessel or charter party details and so on, while macro-economic variables are factors that refer to a variety of vessels and can describe the whole or parts of the tanker market.

Platon Velonias (1995) performs a linear regression analysis in a data sample of 10 years (Jan. 1983-Dec.1992) and tries to forecast tanker freight rates, taking into consideration tanker demand and tanker availability. There is a high relationship between the industrial production of the most industrialized countries/ group of countries (U.S.A, Japan, OECD, Europe) and demanded transportation capacity, while the Gross National Product is statistically insignificant and has no explanatory power. Moreover, scrappage rates and past prevailing freight rates are used to examine the fleet availability of different size vessels and an interesting outcome shows that past prevailing freight rates give a good estimation of the capacity to be scrapped for small and medium- size vessels and a mediocre one for larger tankers.

Later on, due to innovations and advances in the field of econometrics, maritime economists started to evaluate modern time series models and as a consequence to have a better understanding of the freight rate dynamics. More specifically, Michael Beenstock and Andreas Vergiottis (1989) estimate an aggregated econometric model, in which freight rates, lay-up, new and second-hand prices and the fleet size are jointly and dynamically determined. The key feature of this model is the application of the two basic hypotheses of rational expectations of freight prices and market efficiency. On the one hand, the assumption of rational expectations drives the forecasted levels of the freight rate that are estimated by the model to be the expected values of the freight rate held by the market players. By illustrating two cases, one anticipated and one unanticipated shock, the authors find that the effects these shocks have on the shipping and freight markets are different. In the situation of an expected shock, rational expectations cushion the effects and the market can brace itself by making the appropriate adjustments. On the other hand, the assumption of market efficiency guarantees the adjustment of market prices to new market conditions as soon as they are recognized among market participants.

The tanker shipping industry is characterized by extreme volatility and due to the general world economic activity as well as seasonal factors, substantial fluctuations in freight rates are occurred. The weather conditions or calendar effects, such as the increased demand for heating oil in the winter and the rise in transportation of dry bulk commodities to Japan before the change of financial year in March, can be considered such as seasonal factors and affect the demand for shipping services. In economic time series there are two types of seasonality that can be observed. More specifically, deterministic seasonality implies an identical seasonal pattern (peaks and troughs) every year, while a time series with stochastic seasonality follows a seasonal behavior which vary across different periods. Kavussanos and Alizadeh (2002) attempt to capture the existence of seasonality in tanker freight markets, to measure it and finally compare the seasonal behavior across sub-sectors and under unusual market conditions. Although, there is no evidence for the existence of stochastic seasonality during the sample period of January 1978 to December 1996, results on deterministic seasonality imply an increase in freight rates in November and December and a decrease from January to April. Moreover, seasonal rate movements are more considerable when there is a recovery in the market, while in periods of falling the changes are smaller.

Dikos et al. (2006) and Randers and Göluke (2007) use macroeconomic factors, such as newbuilding orderbook, average building time, vessels average life, demolition and fleet utilization in order to model and estimate tanker freight rates by applying system dynamic (SD) techniques. According to their research, the past freight history can be described as the interaction of two cycle loops with different durations; a 20-year capacity adjustment loop and a 4-year capacity utilisation loop.

Grammenos and Arkoulis (2002) examine the effect of world macroeconomic factors, including industrial production, oil prices, inflation, exchange rates and laid up tonnage, on the stock returns of listed shipping companies. A positive relationship between exchange rate and stock returns is identified, whilst laid up ships and oil prices have a negative impact on shipping stock returns.

From a different perspective of view, Alizadeh and Talley (2011) focus on the significance of microeconomic variables in the estimation of tanker freight rates as well as lay can periods in shipping contracts. These variables, including vessel and voyage specific characteristics such as vessel age, hull type, deadweight utilization and route, are found to have a strong correlation with freight rates. First, on average freight rates on single hull tankers are lower compared to those of double hull tankers. Second, a system of simultaneous equations provides that the duration of lay can period is a decisive determinant of the tanker rates and vice versa. Third, the laycan periods of contracts seem to change directly with freight rates and indirectly with freight rate volatility. High levels of freight rates result in lower tanker capacity and therefore charterers who anticipate tanker shortages try to sign a contract earlier in order to ensure the fulfillment of their cargo transportation. On the contrary, when charterers' expectations for freight market are uncertain due to increased volatility of rates, they delay the hiring of ships and wait to utilize their option value to delay fixing. In addition, Alizadeh and Talley find that younger vessels have longer laycan periods than older ones, that is modern tankers are likely to be hired earlier than older tankers.

In a more theoretical approach Jugovic et al (2015) attempt to identify the fundamental factors which affect the shipping market and distinguish them into demand and supply driven factors. World economy, international maritime trade, average achieved profit, political events and transportation costs drive the demand for shipping services, while the elements which influence the supply side are world fleet and its productivity, newbuilding vessels, shipbreaking and freights. They also describe the demand and supply interaction which drives the formation of freight rates. The demand side of the shipping market is represented by the different industrial goods' maritime transport requirements. The variation of the general growth trend because of development and innovations in industrial sectors as well as the changes of shipping distances and routes create the final demand for shipping services. Meanwhile on the supply side there is a merchant fleet which create a fixed shipping capacity market. The fleet can be expanded by newbuilding or limited by demolitions. Although the findings of Jugovic et al's study succeeded in giving description about the determinants affecting the freight rates, many authors argue that it lacks descriptive research and empirical results.

Julius Anyanwu in the "Analysis of the Interrelationships between the Various Shipping Markets" (2013) explores the linkages between seaborne trade and the different market segments in the tanker shipping industry. The empirical results show that there is a positive relationship between freight rate levels and fleet size and as seaborne freight volume increases, ship owners seek to adjust their fleet size in order to meet the market demand. The prevailing freight levels play a significant role in the ship owners' decision on their shipping capacity. For instance, when freight rates are high, newbuilding orders tend to increase, which has as a result the rise in vessel prices. However, second-hand ship prices have also an upward movement as they are considered as substitutes of new building ships and can be deployed to shipping market immediately, without a time-lag period of two years that is often required in the case of new buildings.

Kavussanos and Nomikos (1999, 2003) focus on the lead-lag relationship between future forwards and spot prices of freight rates . Their findings suggest that there is a long-run relationship and significant casuality running form futures to spot prices and as a consequence future prices can provide useful information in order to better predict the spot freight rates, but not vice-versa. The authors also perform different models ,such as VAR model in first differences, the VECM (and the parsimonious Seemingly Unrelated Regressions (SUR) – VECM) and ARIMA, the Exponential Smoothing and the Random-Walk (RW), which aim to generate forecast of spot and future prices of freight rates.

A branch of empirical literature on tanker freight market concentrates on the impact that oil prices have on freight rates. Alizadeh and Nomikos (2004) examine the casual relationship between the futures of West Texas Intermediate (WTI), which is the main pricing marker for North American crude, and the spot prices of imported crudes. The authors suggest that although there is a positive long run relationship between freight rates and oil prices in US, there is no confirmation that freight rates are linked with physical crude and WTI future differentials. This implies the existence of arbitrage opportunities which can be used by tanker market participants for purposes of hedging risk. Furthermore, according to Hummels (2007) freight rates tend to be highly sensitive to variations of oil prices. A related study by Mirza and Zituna (2009), indicates how the impact of oil prices on transportation costs change over different suppliers and buyers and whether this link leads to more regionalism, that is relocation of activities in local markets. However, the results show that despite the great oil prices variations the regionalism is not feasible and globalization forces abstain more easily from oil shocks.

Angela Poulakidas and Fred Joutz (2009) concentrate on the spot oil tanker market between West Africa and the US gulf in Mexico and use cointegration and Granzer causality analysis in order to find the lead-lag relationship between oil prices and freight rates. They conclude that the demand for tanker shipping services is a derived demand and when the demand for oil increases freight rates also increase. This theory can be justified by the price inelasticity of oil demand.

Empirical results show that the association between oil prices and spot tanker rates is not clear (Glen and Martin, 2005). For instance, the increase in oil prices has a positive impact on spot rates for 130,000 dwt tanker vessels, while in the case of 250,000 dwt vessels the effect is negative. Two possible reasons for this ambiguous relationship are mentioned by Glen and Martin (2005). First, a reduction in oil supply can result in the increase of oil prices, which in turn generate a decrease in demand of oil transportation services and subsequently a fall in freight rates. Second, when oil demand increases there is a rise in oil prices and this increases also the demand for oil transportation, implying a positive dynamic relationship.

According to shipping literature, the short-term supply curve is composed of two distinct regimes; one elastic part for lower freight rates and one inelastic part for higher freight rates. Therefore, volatility in freight rates are dependent on the freight rate level (Eivind Molvik and Martin Stafseng, 2018). Abouarghoub et al. (2014) use a two-state Markov-switching distinctive volatility model by joining the two -state dependent freight volatility with the most suitable GARCH (generalized auto regressive conditional heteroskedasticity) framework. In accordance with maritime theory, they provide evidence that the low volatility regime endures on average longer than the higher freight rate state. GARCH models are used also by Kavussanos (2003) who investigates the level of risk between spot and time charter freight markets among different size tankers. According to his research, smaller size vessels are more flexible compared to bigger tanker ships in terms of their business pricing and operations.

Baltic Exchange Dirty Tanker Index (BDTI) is also examined in many papers as it is an important assessment index in world dirty tanker shipping industry. It indicates the cost of shipping unrefined petroleum oil, on a basis of the average costs of 17 routes. Fan et al. (2013) try to predict the BDTI index by analysing oil prices (Brent), a volatility index (Amex oil index) and stock indices (Dow Jones, S&P Global 2010). They are the first researchers who apply machine learning and Wavelet Neural Networks method in order to forecast tanker freight rates and achieve better results than ARIMA models which have been utilized in previous similar searches.

Moreover, a large number of maritime economists attempt to investigate the stationarity or non-stationarity phenomenon of shipping freight rates and their findings are controversial. According to Stopford (2009) there is a mean-reversion property in shipping markets, due to conditions of perfect competition. This mean-reversion can be implied also by the cyclicality in these markets, as the demand and supply dynamics force freight rates back to their mean. Adland and Cullinane (2006) find that tanker freight rates only revert to their mean in the extremes of every cycle (peak and trough) and otherwise they are exhibiting a non-stationary behavior over time. Koekebakker et al. (2006) argue that the majority of empirical studies suggest non-stationary behavior of freight rates and supports that this conclusion is mostly observed when traditional Augmented Dickey-Fuller (ADF) unit root tests are performed. They use a non-linear version of the ADF test, and their results suggest a non-linear stationary behavior of both dry-bulk and tanker freight rates.

2.2 Global Economic Policy Uncertainty Index

Baker, Bloom and Davis (2016) generate the Economic Policy Uncertainty (EPU) index from three types of underlying components. One component relies upon quantifying policy related economic uncertainty newspaper coverage. The second depicts the number of federal tax code provisions bound to expire in the forthcoming years, while the third uses as a proxy for uncertainty the controversy among economic forecasters. Their index, as indicated by numerous types of evidence inclusive of newspaper articles, is a surrogate for changes in policy associated economic uncertainty. Significant conflicts over fiscal policy like close presidential elections, the Gulf Wars, the September 11 attacks, and the failure of Lehman Brothers spike their US index. By using data on the level of firms, they discover that there is an association between policy uncertainty and higher stock price volatility as well as lowered investment and employment in sectors that are more sensitive to policy changes such as finance, defense, infrastructure construction and healthcare. When it comes to the macroeconomic level, elevated policy uncertainty predicts decrease in investment, productivity, and employment in the United States and for 12 leading economies.

Due to its significance in approaching the behavior of economic variables the EPU index is used in various models throughout the scientific literature and has undergone broad investigation since its construction by Baker et al. By examining the influence of the alterations in EPU in Europe on the performance of stock markets in the European Union, Croatia, Norway, Russia, Switzerland, Turkey, and Ukraine, Sum. (2012) investigates the role of EPU in interpreting stock returns. By evaluating the returns of the main stock market indices in these countries, on a monthly basis, from February 1993 to April 2012, it is evident that the changes in European EPU have a negative, statistically significant, impact on all stock market returns in the scrutinized countries except for Croatia and seven members (Bulgaria, Estonia, Latvia, Lithuania, Malta, Slovakia, and Slovenia) of the European Union. One of the implications drawn from this research is that midst periods of high economic policy uncertainty, stock market indices in these European countries can be shorted or sold by investors. On the other hand, when lower economic policy uncertainty is experienced, higher returns from investing in these European markets can be expected from stakeholders. Another crucial implication is that European markets exhibit very limited diversification of systematic risk since the heightened changes in European EPU have a negative influence across the European markets.

Sum (2012) also examines the response of stock market returns to EPU shocks, relying on the vector autoregressive (VAR) analysis of the variations in EPU index in the United States and the Center for Research in Security Prices value weighted index from February 1985 to June 2012, the findings indicate that stock returns have a negative reaction to EPU shocks during the first, fourth, fifth, eighth, ninth, tenth and eleventh months. Moreover, the Granger Causality Wald test results indicate that EPU is a useful tool in predicting stock returns, while the results from the time varying Ordinary Least Squares regression point out that changes in EPU forecast negative stock returns.

Liu and Zhang (2015) examine if the stock market volatility can be predicted by EPU. They survey if the forecasting capability of the current prediction models can be enhanced by the addition of EPU. To investigate the part of EPU they employ the S&P500 five-minute interval high frequency return to determine daily realized market volatility (RV), and eight prominent models that grasp the progression of RV. It is suggested by in-sample evidence that, regardless of which model is used, the current RV is substantially affected by the past EPU in a positive manner. The suggestion that EPU plays a significant role in forecasting RV is also drawn by the Out-of-sample results, and therefore their research indicates that market volatility can be predicted by EPU.

Crucial for the world economy are oil price shocks, explicitly for the economy of the tanker segment of the shipping industry. Kang and Ratti (2013) remark that there is a strong relation between oil price shocks and EPU and that both have an impact on stock market return. In the U.S. actual stock returns are negatively affected by an unforeseen increase in policy uncertainty. A positive demand shock in the oil market, capable of generating a higher concern about the future oil supplies, marks greater EPU and signifies a reduction in real stock returns. Endogenous policy uncertainty responses amplify the direct effects of oil price shocks on real stock returns. By utilizing a structural VAR model they investigate the relation between oil shocks, EPU and real stock returns and it is discovered that over 30% of the variation in EPU after 24 months is due to demand shocks specifically for the oil market and that in the long term this percentage grows up to 58%. EPU is responsible for 19% of the long-term variability in real stock returns while structural oil shocks for 32%. Regarding different industries, results indicate that a rise in EPU weakens returns in oil sector throughout protracted periods, decreases returns in the auto and retail industry in the short term, and has a negative effect to the returns of the gold sector in the long term. As a robustness check, real stock returns in Canada, a country that exports energy and in Europe, that is mostly an importer of crude oil, are considerably lowered by a positive innovation in U.S. EPU. Europe exhibits an aggravated effect of oil shocks on real stock returns when compared to the U.S., while for Canada demand shocks specific to the oil market have a positive relation to actual stock returns. EPU experiences long term consequences by structural oil price shocks, adding an extra channel by which these kinds of shocks can influence the stock market.

Sun et al. (2020) examine the dynamic interaction between oil prices and EPU, particularly the co-movement and Granger causality. Using linear Granger causality and wavelet coherence analysis they introduce a multi-scale correlation framework, which presents an extensive analysis of the EPU and oil prices relation in time-frequency domains. By selecting the West Texas Intermediate (WTI) oil prices from January 1997 to August 2017 and the EPU indices of China, Russia, Brazil and the G7 countries, they draw results and conclusions that illustrate two aspects. The profound relationship between EPU and oil prices is recognized, but there is a variety in their co-movement that depends upon the country and the different time periods.

Moreover, it should be mentioned that in the short-term (roughly 1 to 8 months) the interaction between EPU and oil prices is feeble but grows considerably strong in the medium- (roughly 8 to 32 months) and long-term (roughly 32 to 128 months), particularly when there is materialization of major political or financial incidents, such as the 9/11 terrorist attack, the Iraq war, the 2008 global financial crisis, the Arab Spring, and the European debt crisis. On the contrary, in the short-term, apart from the U.S., the linear Granger causality tests in the frequency domain point out that no Granger causality flows from EPU to oil prices, for the countries consisting the sample. Clear unidirectional and bidirectional Granger causality between EPU and oil prices is indicated in the medium- and long-term. Fundamentally, their findings declare, from a multi-scale perspective, the dynamic relationship between EPU and oil prices.

You et al. (2017) examine the combined effect of crude oil shocks and China's EPU on stock returns with particular attention to the return distributions. They engage in this subject by utilizing the quantile regression technique, depending upon monthly data from January 1995 to March 2016. A more accurate analysis on the varying market status, specifically, bear, normal, and bull markets, is enabled by this approach. Furthermore, since a crisis may alter the dependence relationships, the recent financial crisis is used as a focal point, to additionally investigate the relationships before and after, as well as the characteristics that differ in these two periods. The effects of oil price shocks and EPU are asymmetric and exhibit a strong relationship with the stock market conditions, as outlined by the empiric results. Furthermore, the outbreak of a crisis brings changes to the interrelationship of oil, EPU and stocks. More specific, when stock markets are bullish before a crisis, a rise in oil prices has a significant negative impact on stock returns, while under different market conditions following the outbreak of the crisis there are significantly positive effects. Before a crisis when oil prices drop, stock returns are lowered in a bullish and normal stock market environment, such is the case after the onset of the crisis as well where stock returns are reduced under different market conditions apart from extreme bullish conditions. Probably there is a relation to the optimistic or pessimistic investor sentiments that might lead investors to develop a more frightened behavior after the crisis.

Shipping is a major part of the transportation industry. Riaz et al. (2018) use the EPU index for US and world to investigate its impact on companies listed on the Dow Jones Transportation Index. They applied Autoregressive Distributed Lag bounds test method to examine the relationship between Dow Jones Transportation Average, global and domestic EPU, and macroeconomic variables based on monthly data in the period ranging from January 2000 to December 2017. The results of their research provide evidence that stock returns of the US transportation sector are negatively affected by changes in the EPU at the domestic level. Changes in global EPU have a negative influence on transportation firms in US and their stock returns as well.

3.Data collection and description

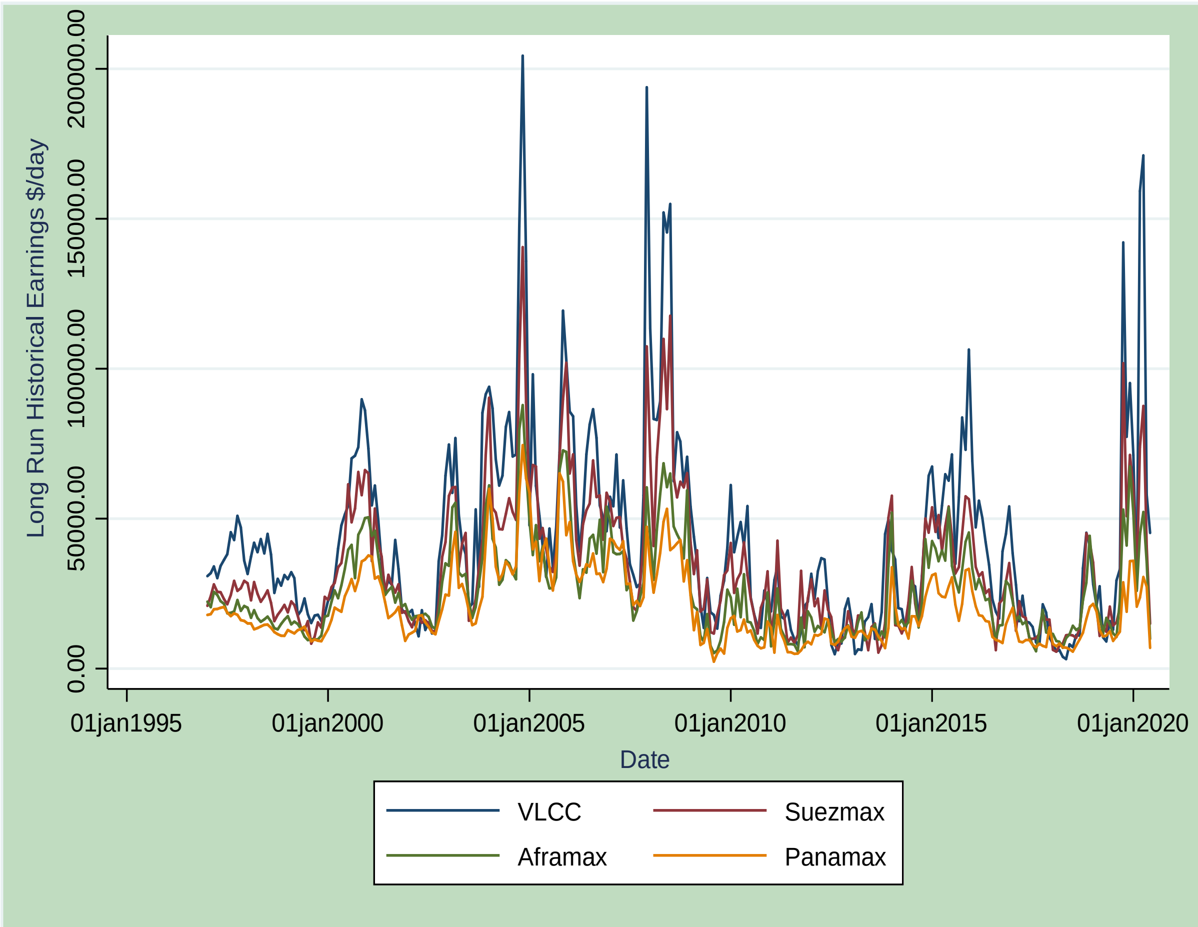
In our effort to interpret the Freight Rate Market for the tanker segment of the shipping industry we create a model that employs various determinants. We use the Historical Earnings per Day as a proxy for the state of the freight rate market and 18 variables to predict its behavior. Among those is the current Global EPU (GEPU) index provided by

Baker, Bloom and Davis (2016), a variable that has not yet been adopted in such a model. All our data, apart from the GEPU index, are collected from the Clarksons'database covering the period from January 1997 up to June 2020 on a monthly basis. Moreover, our variables are divided into two groups. The first group is consisted of the shipping industry related variables, whose data are harvested for four different tanker vessel sizes: VLCC, Suezmax, Aframax and Panamax. The second group includes the Economic Environment variables that tanker vessels operate in. Graphs that visualize the movement of the explanatory variables across the time period under review, are provided in the appendix.

Clarksons calculates the Average long run historical earnings in dollars per day for the spot market by subtracting the costs from the revenues for a single voyage and divides this result with its duration. The earnings of the spot market are aggregated with the earnings of the time charter market to create this index. Since costs do not exhibit such a volatile conduct, apart from the bunker prices, we consider that Vessel Earnings can be used as the prevailing freight rates equivalent.

In Figure 3.1 we examine the evolution of Average historical earnings in the tanker market over different time periods. We observe that vessel earnings were moving at a steady pace up to 2001 when the first of a series of peaks was appeared. The first peaks were results from the inception of single-hulled tankers withdrawals and their replacement by double-hulled alternates, due to Marpol Convention's amendment. As a consequence, there was a decrease in the size of tanker fleet as well as the supply of seaborne transportation services, which in turn led to a high growth of tanker freight rate levels. The further peaks derive from the increased demand of crude oil, the rise in oil prices and the entry of China in the World Trade Organization. China's desire to expand its economy by developing its industrial production led to a rise in Chinese oil imports and demand for shipping services. At the same time the supply of the existing tanker fleet was insufficient to cover this demand and hence tanker rates have skyrocketed. However, these cycle peaks are followed by an unanticipated collapse in the freight rate market during the financial recession of 2008. The bankruptcy of the world economy, combined with the increased deliveries of new vessels which have been ordered during previous peaks, drove the supply curve up and caused a huge drop in vessel earnings. This collapse has lasted for six years and was followed by a market recovery, with tanker earnings increasing at a low rate. Throughout 2019, the earnings line had a strong upward movement, reflecting a rapid increase in crude oil imports from the main consuming countries, and especially China.

Figure 3.1



3.1 Shipping industry related determinants

Fleet development is utilized as a variable since it describes the actual dwt in the market expressing as a result the shipping supply. Fleet development depicts the number of new ships delivered minus the ships scrapped or lost at sea. In the short-term fleet size appears constant but there is continuous change and fluctuation in the long term. Oversupply of ships translates to low freight rates and the opposite.

Orderbook in DWT, another determinant we use, presents the future changes that are bound to happen to the fleet, and it consists of the total number of newbuilding contracts currently held by shipyards. As freight rates increase or decrease, orderbook follows in the same manner, indicating the sentiment of the market in real time. But since vessels require time to be built, there is a lag effect of the orderbook in the market. As orderbook increases so will the future fleet and thus the shipping supply, having a negative effect to the freight rates market.

Fleet average age is also employed as a variable in our effort to explain freight rate behavior. In theory when there is great fleet utilization vessel scraping is lowered as shipowners tend to hold on to their ships to cover boosted demand, leading to an increased age profile. Higher average age in that sense means higher freight rates. A younger fleet suggests that new deliveries hit the market that raise the shipping supply resulting to a decline in freight rates. As discussed previously, increase in freight rates has the same effect on orderbook that leads to a rise in newbuilding prices. Higher newbuilding prices imply better market conditions. On the contrary, bust periods of the market are characterized by low newbuilding prices. Used vessel prices and newbuilding prices historically exhibit parallel behavior (Kavussanos and Visvikis, 2016). In our model we employ both newbuilding prices as well as 5-year-old secondhand vessel prices.

Scrap prices are given in dollars per lightweight tonnage and are more dependent on steel commodity prices, rather than the activity of the freight market, contrary to the newbuilding and used prices that are defined by both. Despite that, scrap prices have an indirect influence on the freight market. As scrap prices decline, the incentive for dismantlement decrease leading to the steady increase of the existing fleet, which is negative for freight rates.

3.2 Economic Environment determinants

Demand for shipping is a derived demand that stems from the demand for the commodities that need to be transferred from the place of production to the place of need. Hence, the demand for tankers is derived by the demand for crude oil and oil products. As a result, the future of the freight market is extensively influenced by it since no consumption of oil leads to no need for its transportation. So, in theory at least, growing demand for oil means elevated freight rates.

Although demand in shipping is widely covered by the term of ton-miles, places of production and places of consumption remain roughly constant throughout the period of our investigation, and for that reason we have decided to focus on the ton part of this term. We do so by concentrating on the oil imports of major consuming countries and global crude oil production, to examine the impact they have on the tanker freight market.

China, during this century, developed as the global factory that relies heavily upon its crude oil imports. India, being an emerging economy, has increased its crude oil consumption significantly and is a considerable crude oil importer. United States of America, being the most developed economy, is the leader in oil consumption and a substantial crude oil importer. Such is the case for Europe as well, where most of its oil consumption and imports is performed by its four dominant economies, France, Germany, Italy, and the United Kingdom (EU-4). We use the seaborne imports of the aforementioned countries as variables in our effort to approach the movements of the freight market individually and also, as an aggregated variable that depicts the sum of their combined imports.

Global crude oil production generally appears to have a positive effect on the tanker freight rate market. Due to OPEC's struggle to keep oil prices at a certain level, overproduction of crude oil, unless global demand for oil requests it, is not allowed. Therefore, increase in oil productivity means that there is increase for its demand, and as previously presented, surge for a commodity's demand augments the derived shipping one. Oil production captures in essence the existing attitude in the oil market and for that reason we have included it as a variable in our model analysis.

Like crude oil production, oil price's impact on tanker freight rates must be examined in the context of the drivers behind it, particularly oil supply and demand. Oil prices drop as supply rises in combination with or drop in demand. When demand is parallel to supply, the freight market gains. In times of supply growth or even steadiness and demand's decline, oil prices fall. Reduced oil prices in that sense indicate lower oil demand which in turn means lower freight rates. Such is the case in real time, but lower oil prices give incentive for increased consumption, initiating a rise in prices in the long run. The dynamics of oil price tend to have a mixed dynamic, but their influence on freight rates and world economy is undisputed, and for that reason is applied to our model. We chose Brent crude oil price to approach this variable, since it is the most common benchmark for crude oil as it is easily refined and transported.

High Sulfur Fuel Oil (HSFO) and Marine Gas Oil (MGO) are both crucial for shipping, as they are most widely used bunker fuels in the industry. Though their fluctuations are significantly shaped by those of crude oil, the effect they have on freight rates, appears to be different. Fuel contributes considerably to shipping costs, as a result increase in their price leads theoretically to a rise of freight rates, as shipowners try to compensate for the inflated costs. Under this assumption we consider the prices of Singapore for HSFO and MGO as determinants for freight rate behavior. Singapore prices are chosen since Singapore is the greatest shipping hub and HSFO/MGO prices at its port are a yardstick for the industry.

We hypothesize that the relationship between interest rates and freight rates is a negative one. Our rational behind this is that higher interest rates make investors reluctant to borrow, lower their liquidity and interest for new investments, while on the other hand higher investment willingness stems from a decline in interest rates. As London Inter-Bank Offered Rate (LIBOR) base rate is the most dominant when it comes to shipping loans, it is our determinant of choice for freight rate forecasting.

Like LIBOR interest rates, inflation is expected to have a negative effect on tanker freight rates. This theory is based on the same principle of investment averseness due to low liquidity derived from high inflation that lowers purchasing power. Contrary, lower, or even negative, inflation signifies higher purchasing power and a better sentiment on the market that pave the way to new investments, positively affecting freight rates. To capture the essence of this variable we employ OECD inflation indicator, that is derived from most of the developed economies in the world.

Finally, another determinant that we use to examine the development of tanker freight rates is the GEPU index. This is the main variable of our research and of the most interest, as it has not been used in scientific literature to interpret the behavior of freight rates. EPU encapsulates the existing tendencies in the market and for that reason is extensively used in predictive models for economic variables. Freight rates are economic variables themselves and we anticipate a positive relationship between them and GEPU. We base this theory on the fact that EPU depicts the risk that prevails on the market, higher GEPU represents higher risk which translates in a raise on freight rates in the form of a risk premium. Nonetheless, higher risk during enlarged GEPU periods means lack of interest for investments for the risk averse investors, while it is considered as an opportunity by the risk takers, both affecting freight rates in parallel ways. In that sense, the dynamics of the GEPU are inconclusive and remain to be determined during our analysis.

4. Methodology

The aim of this study is to build a model in order to determine the relationship between the selected influential factors and the Long Run Historical Earnings for the tanker markets, focusing on our main variable which is the Economic Policy Uncertainty index. Moreover, we attempt to investigate the impact of these factors on the freight rate levels for four different tanker vessel sizes; Panamax, Aframax, Suezmax and VLCC. For this reason, we use a panel data analysis on a cross sectional time series dataset. According to Baltagi (2000) and Hsiao (1986), by using panel data, a larger number of observations is allowed, and the corresponding standard errors are lower compared to those estimated with cross sectional data analysis, implying a higher possibility of statistically significant estimates. Also, it allows us to explore the cause-and-effect relationship between the Long Run Historical Earnings and independent variables, as we are able to explore the dynamic variations of the relationships due to the time dimension of our dataset.

Correlation and regression analyses are being applied, in line with the objectives of our research. The directions and powers of relationships are indicated by correlation analysis, helping us making inferences, while the econometric relationship is modelled by regression analysis, which leads us into more precise results.

The general regression model of our panel data can be expressed as follows:

$Y_{it}= \beta_0 + \beta_1 x_{it,1}+\beta_2 x_{it,2} +\ldots\ldots +\beta_k x_{it,}+ e_{j,t}$, i=1,….., N; t=1,…..,T; k=1,…..,K

The error term, denoted by e, is applied to the equation in order to make the model more realistic. There are five assumptions for the linear regression model and our error term:

1. Linearity assumption, the interpretation is that the error has mean zero E(μt)=0
2. Homoscedasticity assumption, the interpretation is that the variance of the error terms is constant on entire value of the independent variable Var(μt)=σ2
3. Autocorrelation assumption, which means that the errors are statistically independent of each other Cov (μt ,μj)=0
4. The error has no relationship with the corresponding x variants Cov (μt ,xt)=0
5. The errors are normally distributed.

The first step of our analysis is to select the appropriate variables that are going to be included in the above equation. However, by estimating the correlation matrix we observe that some of our explanatory variables are highly correlated to each other and there are pairwise correlation values that exceed 0.5. More specifically, these pairs are EU4 crude oil imports- Combined crude oil imports, China crude oil imports-Combined crude oil imports, Brent crude oil prices-MGO bunker prices, Brent crude oil prices-HFO bunker prices and MGO bunker prices-HFO bunker prices. This multicollinearity problem can result in a high sensitivity of regression estimators to small changes in our data and subsequently in inappropriate conclusions. Therefore, we construct four different equations with all the possible combinations and calculate Akaike information criterion (AIC) and Bayes information criterion (BIC), which are designed explicitly for model selection. We choose the model with the lower AIC and BIC values, as according to the theory the lower values of these criteria indicate a more likely close to the truth model. We conclude that Brent crude oil prices, EU4 crude oil imports and China crude oil imports should be used in our analysis instead of MGO bunker prices, HFO bunker prices and Combined crude oil imports.

In our analysis, we transform our time series by calculating percentage changes. A reason to justify this is to avoid a non-stationary variance in our data. A time series is non-stationary if its mean, variance and auto-covariance change over time. A model based on non-stationary data is not reliable and can result in misleading as well as spurious conclusions.

After these transformations the model we estimate can be written in its final form as follows:

$$LRHE_{it}=\beta_0+\beta_1NBP_{it}+\beta_2SHP_{it}+\beta_3SV_{it}+\beta_4FD_{it}+\beta_5FAA_{it}+\beta_6OB_{it}+\beta_7LIBOR_{it}+\beta_8INF_{it}+$$

$$\beta_9COPit+\beta_{10}GOPit+\beta_{11}USI_{it}+\beta_{12}CI_{it}+\beta_{13}II_{it}+\beta_{14}EUI_{it}+\beta_{15}GEPU_{it}+ e_{j,t} \quad (1)$$

where $LRHE_{it}$ represents Long Run Historical Earnings for a vessel size i in period t; NBP is Newbuilding vessel prices; SHP stands for Second-hand ship prices; SV is Scrapping value; FD indicates the fleet development; FAA is the average age of the fleet; OB is Orderbook of newbuilding vessels; LIBOR is the interest rate; INF stands for inflation rate in period t; COP shows Brent crude oil prices; GOP is global oil production; USI represents crude oil imports made by U.S.A; CI is Chinese oil imports; II is Indian oil imports; EUI indicates crude oil imports by the group of Europa Universalis countries; GEPU indicates Global Economic Policy Uncertainty index and finally, e is the standard error. The regression coefficients ($\beta_1, \beta_2,..,\beta_{16}$) represent the slope of the line and quantify the effect of our independent variables on Long Run Historical Earnings. The subscript i indexes size categories of tanker vessels, and t time, where t=01 Jan 1997-01 April 2020, the period under review.

Beenstock and Vergiotis (1993) have estimated empirical models based on aggregated data. However, Glen (1990) finds that the tanker market is no longer homogeneous and refers to the assumption of route and size differentiation. According to his research, the low levels of port capacity growth have as a consequence a limited port availability and hence route flexibility. Therefore, large oil tankers are considered as risky assets to own, due to their limited flexibility and, thus the existence of size differentiation is necessary. This conclusion is also supported by Kavussanos (1996 and 1997) in "Comparisons of volatility in the dry-cargo ship sector: Spot versus time charters, and smaller versus larger vessels". Following the abovementioned literature, we also make our analysis at a disaggregate level and distinguish the oil tanker market into four categories: Panamax (50-79,999 dwt), Aframax (80-120,000 dwt), Suezmax (120-199,999 dwt), and Very Large Crude Carriers (200,000+).

Moreover, in order to investigate whether the impact of our main explanatory variable, GEPU, on Long Run Historical Earnings is linear or not, we plot a LOWES (Locally Weighted Smoothing) graph which depicts the line that best fits to the scatterplot of our dataset. However, this graph does not take into account the rest of the explanatory factors that we use in our analysis and we assume that after running the regression models the relationship between the two variables may change. Thus, we add the non-linearity to our model by calculating the quadratic GEPU and run a new model which takes the following form:

$$LRHE_{it}=\beta_0+\beta_1 NBP_{it}+\beta_2 SHP_{it}+\beta_3 SV_{it}+\beta_4 FD_{it}+\beta_5 FAA_{it}+\beta_6 OB_{it}+\beta_7 LIBOR_{it}+\beta_8 INF_{it}+$$

$$\beta_9 COPit+\beta_{10} GOPit+\beta_{11} USI_{it}+\beta_{12} CI_{it}+\beta_{13} II_{it}+\beta_{14} EUI_{it}+\beta_{15} GEPU_{it}+\beta_{16} GEPU^2_{it}\ e_{j,t} \quad (2)$$

Regarding the estimation method, there are three different options in order to estimate the above panel data specification: pooled Ordinary Least Squares (OLS) model, fixed effects estimator (known as the within estimator, as well) and random effects model. However, two potential sources of bias should be taken into consideration, in order to choose the appropriate estimation method: individual vessel effects and the correlation of independent variables with the residual. Initially, we estimate the above equation using a pooled OLS model for the full sample and then we run separate regressions for each size group. But OLS estimates are likely to suffer from biases because of unobserved vessel – specific heterogeneity and possible endogeneity of the regressors. As a result, a better option would be the fixed or random effects model. In order to decide which of the two is the most appropriate, we use Hausman Test (1978) in Stata. Hausman Test is used to differentiate between fixed effects and random effects model. It tests basically for the statistical significance of the difference between the coefficient estimates obtained by the two models. Random effects is preferred under the null hypothesis that the random effects estimates are efficient and consistent, while under the alternative hypothesis fixed effects is at least as consistent and therefore the preferred estimator. In our case, the random effect estimator is the most appropriate, as the null hypothesis is accepted. However, the main assumption of random effects model is that the observations within each size group are i.i.d (independently and identically distributed). In other words, a random variation within the size groups is assumed and is considered to be uncorrelated with our independent variables. A way to deal with this, is to rerun the random effects model by using the cluster option and allowing for differences in the variance/standard errors which attributed to this arbitrary intra-group correlation.

Last but not least, we test the GEPU effect across different time regimes. Undoubtedly, the global financial crisis of 2007-2009 has been a crucial period for the whole world economy and had a strong impact on the shipping industry as well. For this reason, we separate our analysis into two regimes, before and after the financial recession, and try to observe if the impact of GEPU on Earnings has changed due to the negative spillover effects of financial crisis on the world economy. We define a dummy variable, $crisis_{it}$, which captures the existence of the financial crisis and equals to 1 if the year of examination is after 2008 and 0 otherwise. Then we include this variable in the equation and interact it with the explanatory variable GEPU,

$$LRHE_{it}=\beta_0+\beta_1 NBP_{it}+\beta_2 SHP_{it}+\beta_3 SV_{it}+\beta_4 FD_{it}+\beta_5 FAA_{it}+\beta_6 OB_{it}+\beta_7 LIBOR_{it}+\beta_8 INF_{it}+\beta_9 COP it+ \beta_{10} GOPit+\beta_{11} USI_{it}+\beta_{12} CI_{it}+\beta_{13} II_{it}+\beta_{14} EUI_{it}+\beta_{15} GEPU_{it}+ \beta_{16}\, GEPU*crisis_{it} + e_{j,t} \quad (3)$$

5. Analysis

5.1 Kernel Density graphs

We create kernel density plots for our dependent variable, in order to illustrate the distribution of the data over the time period under examination. All graphs are plotted after transforming our data by calculating the first differences and by using the Stata default bandwidths.

Figure 5.1 visualizes the distribution of the long run historical earnings for the full sample of data. As one can see there are some observations that can be considered as outliers. In order to overcome the problem that these outliers may have a large impact on the estimation results we remove the extreme observations beyond the 1st and 99th percentiles. The new probability density distribution is shown in Figure 5.2.

Figure 5.1

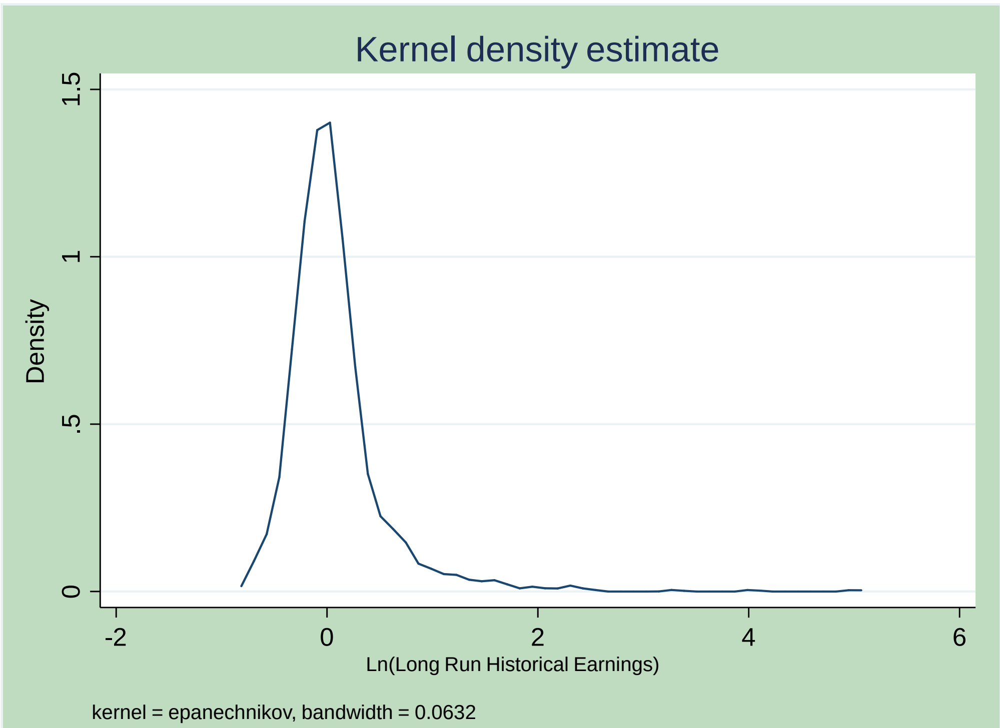
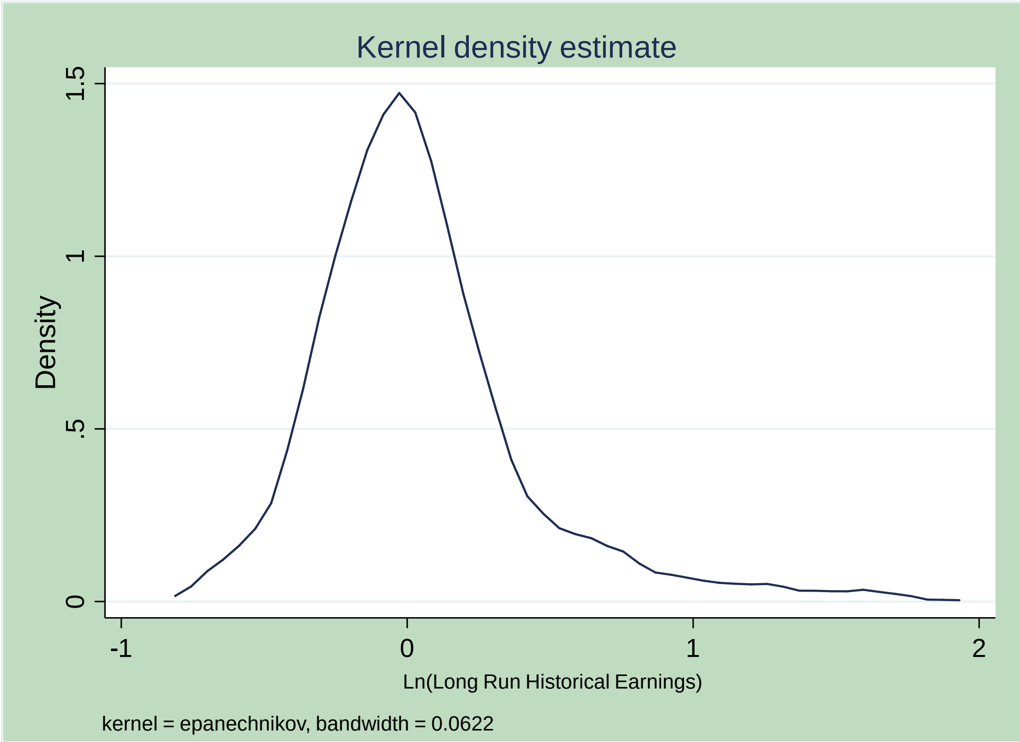
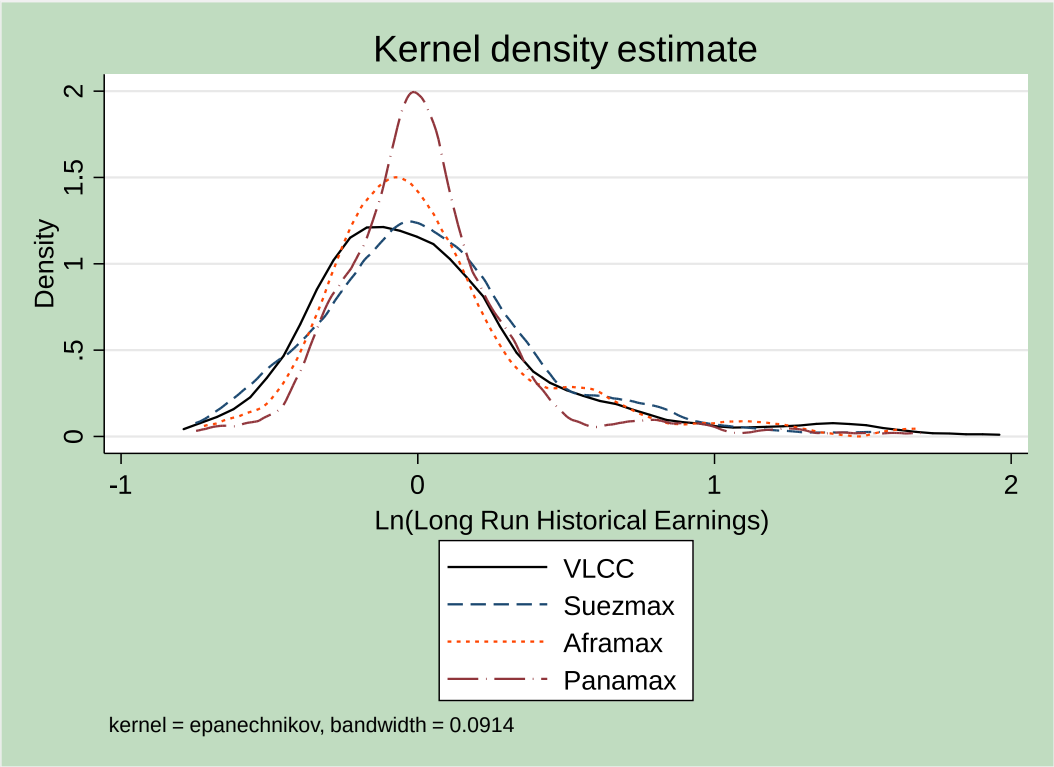


Figure 5.2



In Figure 5.3 we plot on the same graph the kernel densities for the long run historical earnings of VLCC, Suezmax, Aframax and Panamax vessels with a bandwidth of 0.0914. We observe that the distribution of vessel earnings is positively skewed for all the four size groups, creating curves that are not symmetrical, which means that there is a higher probability to observe positive compared to negative returns. This is expected, as the supply curve for the tanker services is almost flat in the long run before being curved steeply, implying that in "good" years of increased demand the earnings for ship owners are very high. The kurtosis of the four distributions is large, indicating that the probability of observing extreme values is higher compared to the case of a normal distribution. This can be explained again by the shape of the supply curve as well as by the large length of shipping cycles. Furthermore, the distribution for smaller vessels (Panamaxes and Aframaxes) is more variable, while in the case of larger vessels there is more homogeneity with a more shared dataset.

Figure 5.3



5.2 Descriptive statistics

In this section we provide a summary of the descriptive statistics for our data. For the original data the descriptive statistics vary as they are related to the metrics of each variable we take into consideration. By calculating the first differences, the data are normalized, and we are able to examine and compare their characteristics.

As we can see in table 5.1 , the average mean for the different sized tanker ships ranges between 5.1% (VLCCs) and 3.5% (Panamaxes). This demonstrates that larger vessels earn higher earnings than smaller ones, which is logical as they take advantage of the economies of scale and keep sea transport costs low. The standard deviations do not exceed 42%, indicating that our data has low degree of dispersion around the mean and are enough reliable for our analysis. Moreover, the higher standard deviation of larger vessels can be attributed to their limited flexibility as they cannot operate on many routes and hence, they are more exposed to the prevailing freight rates of the corresponding routes.

Figure 5.4 illustrates the evolution of tanker earnings across the time period under review. We provide graphs for each of the size categories and we observe a high volatility for all of them. As we discussed in section , during the period of 2001-2007, the capacity down adjustments of the supply curve and the increase in demand for seaborne transportation of crude oil, due to the increased industrial production of China led to rise in tanker freight rates. As the size of the vessels decreases, a smaller fluctuation of ship-owners' earnings is observed. However, there was an extreme volatility of all the four categories from 2008 and later which was the spill over of the global financial crisis and the collapse of the world economy. It is clear on the graph that the larger the vessel, the higher the average earnings. Although, there is not a large spread between our dataset, different maximum and minimum observations are found across different vessel sizes. The highest observed earnings return is 187% and is detected in VLCCs' data, implying again the advantage of economies of scale for large vessels., while the lowest observation equals to -74.9% for Aframax earnings.

Furthermore, in Figures 5.5 and 5.6 we observe that both vessel earnings on the aggregated level and GEPU present extreme volatility throughout the period under review as their standard deviations also confirm. 2008, the year of the recent global financial crisis, is a year where volatility is high for both as seen on their diagrams, but the highest spike for GEPU is during 2001, the year that United States of America experienced the terrorist attack of 9/11.

The summary statistics for all the variables are presented below in table 5.2. Earnings take the lead with a standard deviation of 37.946% and GEPU follows with 19.742%. Historical earnings changes vary from a minimum of -74.918% to a maximum 186.87% with a mean of 4.624%. Extreme values for GEPU exhibit alterations from -39.112% up to 111.9% where the mean is 2.196%. It is worth mentioning that the most extreme volatility of our determinants is expressed by inflation rates of OECD countries with a standard deviation of 49.25%, vindicated by the highest alteration in values that vary from -200% to 550% with a mean of 2.154%. It is also remarkable that the Orderbook produces the greatest kurtosis, something explained by the fact that during some years there are no orders for new vessels but during some periods there is a boom market for the shipyards.

Figure 5.4

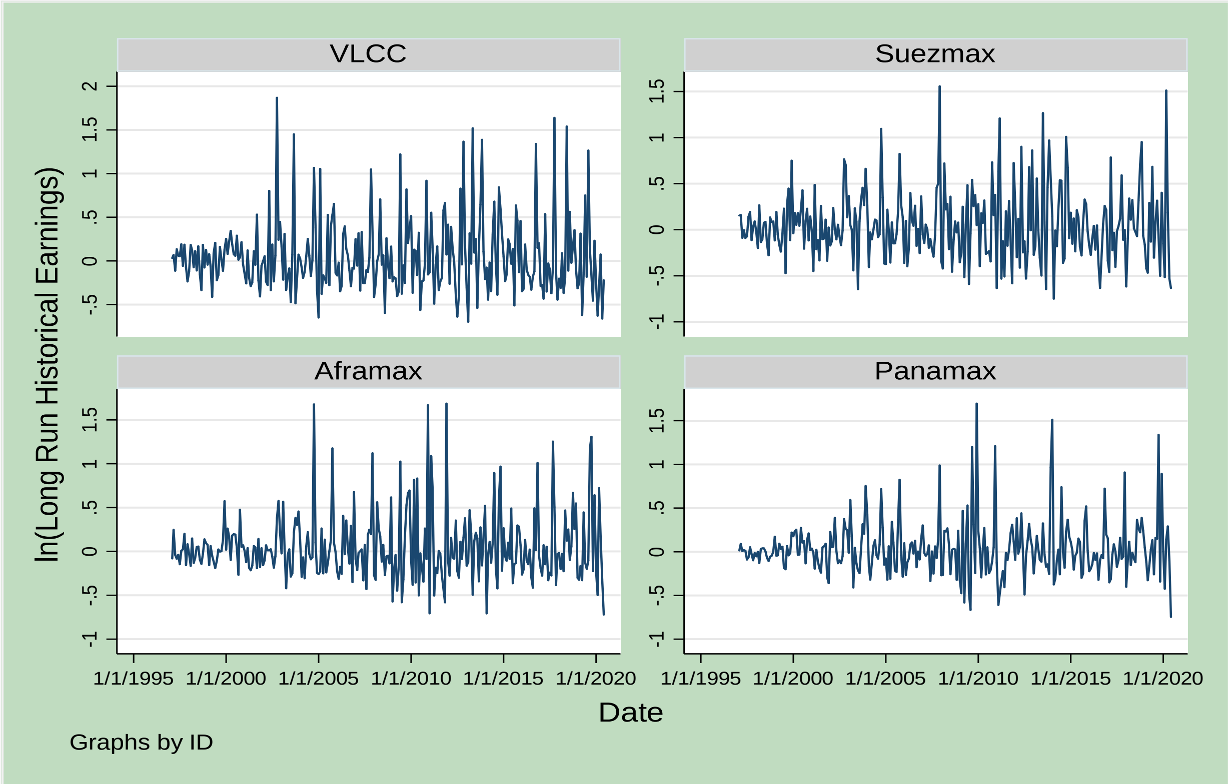


Figure 5.5

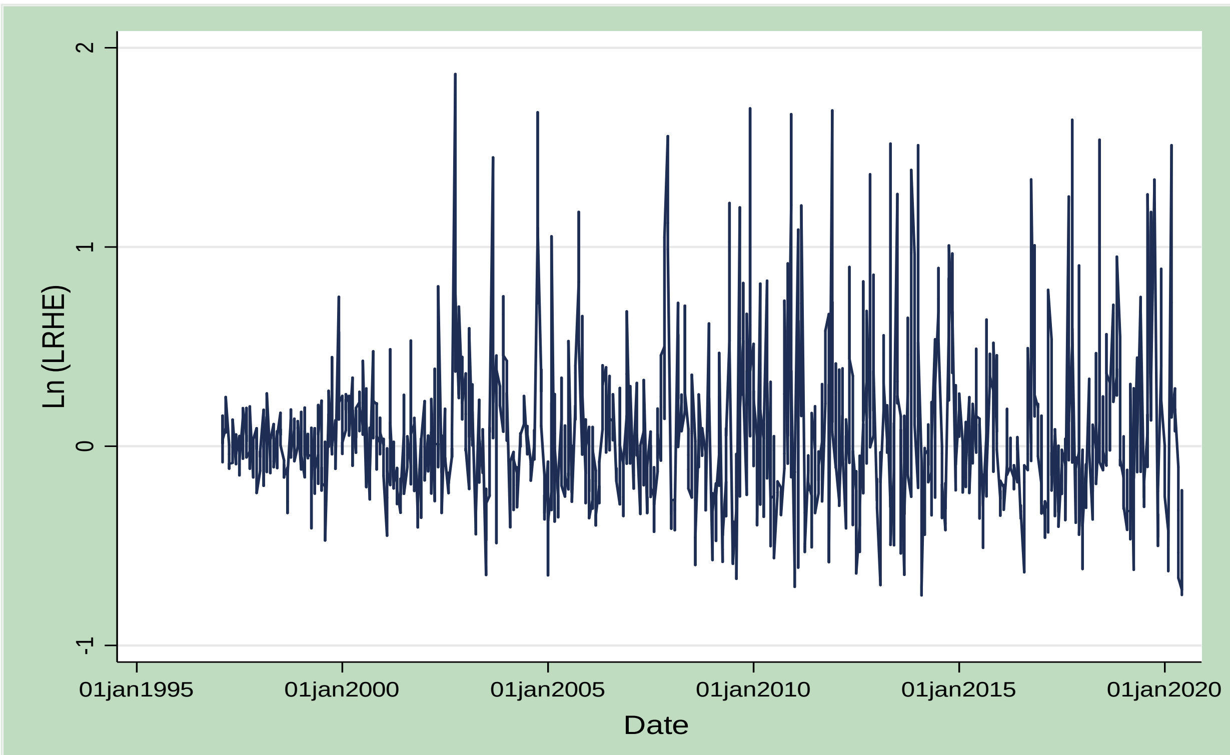


Figure 5.6

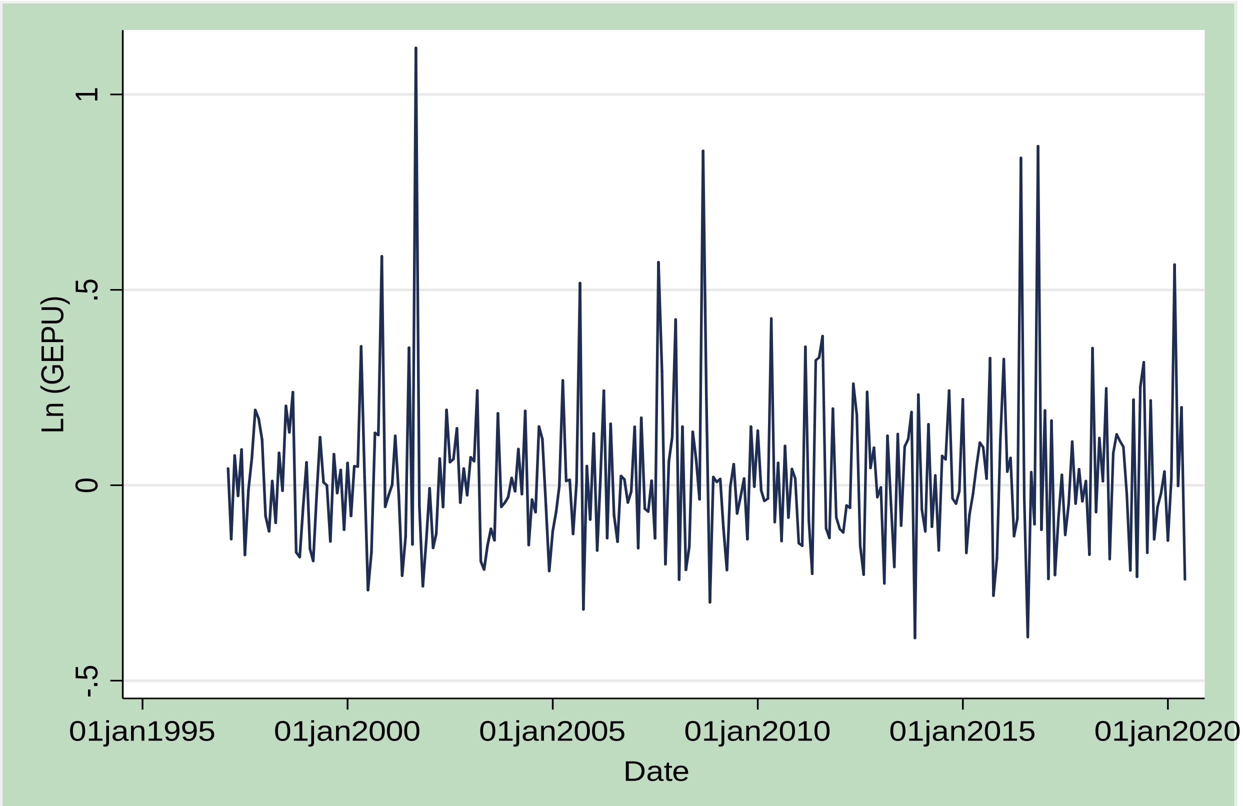


Table 5.1 Descriptive Statistics for Long Run Historical Earnings (by size)

	VLCC	Suezmax	Aframax	Panamax
Observations	276	277	279	280
Mean	0.051059	0.047812	0.050668	0.035542
Std. Dev.	0.426150	0.379730	0.387358	0.319519
Variance	0.181603	0.144195	0.150046	0.102092
Min	-0.697567	-0.749182	-0.720889	-0.747124
Max	1.868751	1.557147	1.686226	1.696298
Skewness	1.483557	0.881818	1.513436	1.721343
Kurtosis	6.003758	4.555609	6.406961	8.733294

Table 5.2 Descriptive Statistics for panel data

Variables	Obs	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis
LRHE	1,112	0.04624	0.37946	-0.74918	1.8687	1.4076	6.3455
GEPU	1,124	0.02196	0.19742	-0.39112	1.1190	1.6556	8.5690
NBP	1,124	0.00074	0.01832	-0.12698	0.09302	-.13853	8.4321
SHP	1,124	0.00109	0.03862	-0.29447	0.17241	-.69773	11.336
SV	1,066	0.00607	0.07829	-0.58395	0.32653	-1.0806	15.569
FD	1,124	0.00278	0.00555	-0.03514	0.02306	-.50756	6.4810
FAA	1,124	-0.00078	0.00728	-0.04960	1.9635	-1.424	6.8000
OB	1,124	0.00833	0.09428	-0.24615	1.9635	9.6167	175.75
LIBOR	1,124	-0.00482	0.08876	-0.44258	0.39597	-0.76477	8.9636
INF	1,124	0.02154	0.49250	-2	5.5	8.1667	0.9387
COP	1,124	0.006622	0.09459	-0.39190	0.2549317	-0.53050	4.1495
GOP	1,124	0.00065	0.01118	-0.12386	0.02519	-4.9944	55.963
USI	1,124	-0.000036	0.07219	-0.23952	0.48492	937672	10.189
CI	1,124	0.036673	0.23319	-0.67073	1.4098	1.64805	10.390
II	884	0.007521	0.09423	-0.26348	0.37471	0.329843	3.5900
EUI	1,104	0.001747	0.00174	-0.22156	0.32148	0.369817	3.9421

5.3 Correlation Analysis

Table 5.3 presents the correlation matrix which includes the correlation between Long Run Historical Earnings and influential factors as well as the pair wise correlation values between all the independent variables. The correlation coefficients have been calculated after taking the first differences of our data.

Table 5.3 Correlation between variables

	LRHE	NBP	SHP	SV	FD	FAA	OB	LIBOR	INF	COP	GOP	USI	CI	II	EUI	GEPU
LRHE	1															
NBP	0.09	1														
SHP	0.04	0.36	1													
SV	-0.01	0.05	0.21	1												
FD	-0.10	-0.11	-0.08	0.03	1											
FAA	0.03	-0.04	0.01	-0.13	-0.09	1										
OB	-0.03	0.12	0.16	-0.01	-0.28	0.19	1									
LIBOR	0.01	0.27	0.06	-0.25	-0.03	0.06	0.06	1								
INF	-0.05	-0.11	0.04	0.05	-0.01	-0.03	-0.01	-0.03	1							
COP	-0.03	0.07	0.02	0.21	0.06	-0.08	-0.07	-0.01	0.01	1						
GOP	0.08	0.09	0.01	-0.04	0.01	-0.07	0.03	0.01	0.06	-0.01	1					
USI	0.07	-0.01	-0.04	-0.11	-0.08	0.02	0.07	0.04	0.01	-0.07	0.11	1				
CI	0.01	-0.01	0.02	0.06	-0.04	-0.04	0.01	-0.01	-0.01	-0.09	0.01	0.01	1			
II	-0.01	0.06	-0.01	-0.02	-0.02	0.02	0.01	0.11	-0.05	0.07	0.11	0.01	-0.16	1		
EUI	-0.07	-0.02	-0.01	-0.01	005	-0.02	-0.02	0.01	0.04	-0.1	008	-0.03	0.21	-0.1	1	
GEPU	0.07	0.02	-0.04	-0.16	-0.05	0.11	0.04	0.11	0.01	-0.19	-0.01	0.04	0.05	-0.01	0.1	1

We observe some correlation between tanker vessel earnings and prices of new ships and secondhand ships. Koopmans (1939) and Velonias (1995) state that when freight rates are high, ship owners order new building vessels which in turn causes an increase both in newbuilding and secondhand prices. However, in our sample, the correlation does not seem to be high which can be explained by the time lag between the rise in freight rates and newbuilding prices. On the other hand, there is a negative correlation coefficient between scrapping value and vessel earnings, as scrapping volume increases in low freight markets. Also, demolition prices are more dependent on steel commodity prices compared to freight rate levels, hence the correlation between scrapping prices and our dependent variable is relatively low.

A negative correlation between vessel earnings and fleet development is also observed. This variable affects directly the level of supply in the freight market and when supply surpasses the demand for shipping transportation services, freight rates will decrease.

The relationship between tanker vessel earnings and orderbook is negative, besides the rational that new order activities are occurred in booming periods, when freight rates are high. The oil tanker orderbook represents also ship-owners' expectations about the industry's future market conditions. Therefore, they may order new ships during periods of low freight rate levels, because they anticipate an upswing, the time that the new vessels are going to be delivered.

Average fleet age and our dependent variable seem to move into the same direction, indicating a positive association between an increased age tanker fleet and freight rates. Moreover, the inflation rate is negatively related to vessel earnings and a possible explanation is provided by Ringheim and Stenslet (2017), who find that a low inflation rate, implies an increase in consumer's purchasing power and subsequently in oil demand.

In contrast with our initial hypothesis, Libor inflation rate seems to move together with tanker freight rates as implies the positive correlation coefficient. On the other hand, the negative correlation coefficients of global crude oil production and Brent crude oil price indicate a negative association among them and vessel earnings.

As regards the world seaborne trade of crude oil which in our analysis is measured by the oil imports of the major oil consuming countries, we find that although US and Chinese crude oil imports are positively associated with tanker vessel earnings, there is an opposite direction in the case of Indian and EU4 countries' oil imports.

Last but not least, our main independent variable, GEPU, has a positive correlation with the dependent variable. As mentioned in a previous section, GEPU is positively related with tanker freight rates because the uncertainty that prevails in the economic environment is translated into a risk premium for tanker industry and consequently higher earnings for ship-owners.

However, the correlation coefficients are insufficient in order to safely conclude whether there is a significant relationship between our variables and a further regression analysis is necessary.

All the above relationships between the dependent variable and the selected explanatory factors are illustrated in scatterplots with a hypothetical regression line indicating the direction of the relationship. The graphs are listed in the appendix of this study.

5.4 Regression results

The results from estimating the OLS models for each vessel size category as well as the models in which we use random and fixed effects estimators are presented in the table 6.4. In the same table the standard errors, R-squared and F-statistics are also reported.

First, we make a brief analysis of the results from separate regressions for the four different vessel types. Furthermore, we examine the regression estimations for the panel dataset using Random effects. As we have mentioned in section 4, however, the Random effects may suffer from biases, because of the assumption of homoscedasticity and arbitrary intra-group correlation. The last column of the table provides the outputs obtained using the cluster option that controls for these biases. As we believe that this model is the most representative and reliable for our analysis, we discuss and pay attention only to the corresponding estimations.

Table 5.4 Estimation Results

Variables	RE	FE	VLCC	Suezmax	Aframax	Panamax	RE with clustering
Newbuilding Prices	1.699**	1.693**	0.475	0.315	3.166*	2.613*	1.699**
	[0.841]	[0.842]	[2.030]	[1.749]	[1.623]	[1.517]	[0.762]
Second-hand Prices	0.313	0.314	0.903	1.352	-0.469	0.134	0.313
	[0.386]	[0.387]	[0.951]	[0.855]	[0.743]	[0.667]	[0.419]
Scrapping Value	0.008	0.007	-0.208	-0.043	0.091	0.007	0.008
	[0.186]	[0.186]	[0.437]	[0.380]	[0.388]	[0.309]	[0.059]
Fleet Development	-7.833***	-8.152***	-6.218	-6.968	-5.891	-12.241***	-7.833***
	[2.694]	[2.736]	[6.328]	[5.950]	[8.093]	[4.212]	[1.166]
Fleet Average age	2.084	1.937	3.009	0.406	2.982	1.129	2.084***
	[1.935]	[1.947]	[4.601]	[4.003]	[5.949]	[2.997]	[0.401]
Orderbook	-0.674***	-0.678***	-1.251**	-0.288	-0.227	-0.785**	-0.674***
	[0.253]	[0.254]	[0.608]	[0.497]	[0.620]	[0.386]	[0.233]
LIBOR Interest rate	-0.134	-0.133	-0.301	-0.145	0.028	-0.183	-0.134*
	[0.181]	[0.182]	[0.419]	[0.363]	[0.382]	[0.304]	[0.747]
Inflation rate	-0.041	-0.041	-0.063	-0.031	-0.000	-0.069	-0.041**
	[0.025]	[0.025]	[0.058]	[0.050]	[0.054]	[0.044]	[0.014]
Crude Oil Price	-0.125	-0.125	-0.226	0.014	-0.032	-0.167	-0.125**
	[0.171]	[0.172]	[0.392]	[0.344]	[0.358]	[0.295]	[0.051]
Oil Production	4.756***	4.765***	8.551**	3.909	4.410	2.234	4.756***
	[1.789]	[1.791]	[4.101]	[3.609]	[3.722]	[3.045]	[1.435]
US imports	0.360*	0.356*	0.977**	0.511	-0.249	0.205	0.360
	[0.213]	[0.214]	[0.490]	[0.423]	[0.446]	[0.368]	[0.261]
China imports	0.024	0.024	0.265	-0.039	-0.283	0.172	0.024
	[0.092]	[0.092]	[0.212]	[0.185]	[0.194]	[0.157]	[0.122]
Indian imports	-0.130	-0.131	-0.267	0.157	-0.443	0.073	-0.130
	[0.154]	[0.154]	[0.354]	[0.303]	[0.318]	[0.270]	[0.144]
EU4 imports	-0.406**	-0.404**	-0.696*	-0.454	-0.457	0.021	-0.406**
	[0.167]	[0.168]	[0.381]	[0.336]	[0.351]	[0.285]	[0.150]
GEPU	0.178**	0.178**	0.102	0.154	0.290*	0.181	0.178***
	[0.076]	[0.076]	[0.176]	[0.151]	[0.159]	[0.131]	[0.038]
Diagnostics							
R-squared(overall)	0,0528	0.0528	0,1	0,0596	0,0753	0,1028	0,0528
R-squared(within)	0,0533	0.0533	-	-	-	-	0,0533
R-squared(between)	0,2076	0.2112	-	-	-	-	0,2076
Wald	46.65	3.13	1.45	0.83	1.07	1.52	46.65
p-value (Wald)	0.0	0.0001	0.1267	0.645	0.3821	0.1008	0.0
Number of obs	853	853	212	212	214	215	853
Number of groups	4	4	-	-	-	-	4
Obs per group: min	212	212	-	-	-	-	212
avg	213.3	213.3	-	-	-	-	213.3
max	215	215	-	-	-	-	215

*** p<0.01, ** p<0.05, * p<0.1

Notes: *Standard errors in brackets*

RE stands for Random Effects

FE stands for Fixed Effects

5.4.1 Estimation results for different vessel types

As one can see, there is not a strong statistically significant relationship between all of the independent variables and average earnings of different vessel types. In particular, Newbuilding price coefficients are statistically significant at 1% significance as well as positively associated with the Aframax and Panamax average earnings. Changes in newbuilding prices have the greatest impact on Aframax vessels where a 1% increase in prices will raise freight rates by 3.16%. For VLCCs and Suezmaxes this variable is found to be statistically insignificant. The fleet development is statistically significant only for Panamax freight rates and the negative coefficient of -12.24 indicates a decline of 12.2% in average earnings for a 1% increase in Panamax fleet size.

Orderbook has a statistically significant negative impact on VLCC and Panamax average earnings. A 1% rise in the number of newbuilding VLCC contracts will make the average earnings fall by 1.2%, while when the orderbook of Panamaxes increases by 1% in one month, the Panamax earnings decrease by approximately 0.8%.

Global oil production seems to be positively related with the average earnings of VLCCs' owners. This association is statistically significant at 5% significance level with a coefficient of 8.55. For the other types of tanker vessels, the coefficients are insignificant.

Moreover, only the changes in seaborne crude oil imports of US and EU4 countries are found to have an effect on vessel earnings. The corresponding coefficients are statistically significant only for the determination of VLCCs' average earnings. A 1% rise in the volume of crude oil imported from US, will cause a 0.9% increase in the earnings, while in the case of EU4 countries a 1% increase in their imports decrease average VLCCs' earnings by 0.69%.

Finally, regarding our main variable, GEPU, we find that there is a positive relationship between the GEPU coefficients and long run earnings of the four types of tanker vessels. However, GEPU is statistically significant only for Aframaxes. More specifically, at 10% significance level, the corresponding variable coefficient of 0.29 indicates that a 1% increase in GEPU index will result in a 0.29% growth of average Aframax earnings.

R^2 which indicates the proportion of the variance of long run historical earnings that is explained by our selected explanatory factors, is not very high and ranges from 0.06

(Suezmaxes) to 0.103 (Panamaxes) with the rest equal to 0.1 for VLCCs and 0.075 for Aframaxes.

5.4.2 Estimation results for Random effects by clustering

The overall R^2 that is the weighted average of the between and within R^2 and examines how well the regression model represents the data, suggests that 5.28% of the total variance of the long run vessel earnings is explained by the model. The between R^2 equals to 0.2, indicating that the 20% of the variance between separate vessel sizes is described by our model, while the same model accounts for the 5.33% of the variance within the panel units.

The F-test probability value is 0.00. Therefore, all the fifteen independent variables are jointly significant, as the null hypothesis that all of the coefficients are jointly zero is rejected.

The findings show that the coefficients of Secondhand prices, Scrapping values, US, Chinese and Indian crude oil imports are not statistically significant and fail to capture the changes in the long run vessel earnings.

The fleet development coefficient of -7.833 indicates that there is a negative association between the growth of the size of world fleet and vessel earnings. More specifically, if the total dwt capacity in the market increases by 1% in one month, the average earnings of ship- owners will decrease by 7.83 %. This relationship is strongly statistically significant at 1% significance level which is approved from the t-statistic test (t-stat= -2.91< -1.96) as well as from the very low p-value of 0.004. These results are in line with maritime theory according to which there is positive and negative relationship to freight rates for capacity down-adjustments (demolitions, removals) and up-adjustments (dwt increase, deliveries), respectively. As the price in the shipping freight market is formed by the interaction between the demand and supply side, if the capacity supply exceeds the demand for transportation services, there will be a drop in freight rate levels.

According to our analysis, the coefficient of Orderbook is highly statistically significant at 1% significance level and seems to have a strong negative effect on average vessel earnings. In particular the coefficient of corresponding variable suggests that a 1% rise in the newbuilding contracts of shipyards is related with a 0.675% decline in tanker vessel earnings. These finding are in contradiction with those of the majority of relative studies that find a positive relationship. When new orders of ships are taking place, prevailing freight rates are high, and people involved in the shipping market anticipate an expansion of the tanker fleet in the upcoming period. This expectation affects the supply side of the demand-supply mechanism and causes an increase in the tanker freight rates. However, that is not always the case. Since vessels require time to be built, there is a lag effect of the orderbook in the market. As orderbook increases so will the future fleet and thus the shipping supply, having a negative effect to the freight rates market.

As we expected, global oil production has explanatory power over average tanker vessel earnings, as it is an explicit indicator of tanker demand, but also a positive and significant relationship. The GOP’s coefficient is 4.76, implying a positive impact of 4.7% on average vessel earnings every time that oil production increases by 1%. The p-value of the coefficient is 0.008, hence we have a strong relationship at 1% significance level. This outcome is in line with Zacharioudakis and Lyridis (2011) who state that increasing oil production is positively associated with tanker freight rates and that OPEC oil production is the most fundamental non-supply external factor influencing tanker market.

Newbuilding prices variable is statistically significant at 5% significance level and a 1% increase in newbuilding prices, causes an approximately 1.7% change in the average vessel earnings. According to Volk (2002), when buyers are eager to make a new investment decision will pay the same price for the same new vessel. High levels of freight rates mean high profits, which will drive ship- owners to invest in new building vessels. Therefore, in a booming period ship- owners rush to order new ships, which causes an increase in prices. However, the new-building prices reflect not only the extend of future investments in the shipping industry, but also the sentiment about the future market conditions. During good years ship- owners feel more confident and this positive sentiment determines the supply curve so that for any given balance of supply and demand they get higher earnings, which in turn leads to higher levels of freight rates (Stopford, 2009).

Moreover, the estimation results show a statistically significance at 5% significance level for the coefficient of OECD inflation indicator. A 1% increase in the corresponding inflation rate means a 0.04% decline in average vessel earnings. This is in consistent with the findings of Ringheim and Stenslet (2017), who investigate the relationship between US CPI and Baltic Dirty Tanker Index (BDTI). Although they expect the two variables to move into the same direction, they suggest that there is a negative association between them, and this can be attributed to the fact that a reduced CPI leads to an increased consuming power and thus, a greater demand for oil products.

At 5% significance level the interrelation between crude oil price and tanker freight rates is statistically significant, suggesting a high explanatory power. The coefficient of -0.125 suggests crude oil price has a negative impact on tanker freight rates. Despite the assumption that increased oil price illustrates, in real time, an increase for its demand, which translates in a rise for its shipping demand and augmentation of freight rates, our research draws a different picture. This is possibly because, in the long run, drops in oil prices lead to an incentivized demand and vice versa. In addition, bunkers are a significant cost for a vessel, and an increase in oil price leads to their inflation as oil products. Our approach of freight rates through the Long Run Historical Earnings, where costs are subtracted from the original freight, might also explain the negative interaction between crude oil price and freight rates for our model.

Our findings point out that Libor interest rates are of great use when it comes to forecasting the behavior of tanker freight rates. There appears to be a negative link where a 1% change in LIBOR rate has a contrary effect of 0.134% for freight rates. Our assumption that as interest rates grow investors grow reluctant to borrow, their liquidity and interest for new investments lowers and leads to a diminishing output for the shipping industry as well, was correct. It is the opposite case of course for declining interest rates.

Oil Imports of the EU-4 countries present a substantial statistical significance at 5% significance level, exhibiting that it is a determinant we can employ in our effort to forecast the movement of our dependent variable. Its coefficient of -0.406 points out to a negative influence upon tanker freight rates. Our results prove our original approach wrong. We expected that increase in oil imports would mean a rise in freight rates as demand escalates, but after examination the opposite is revealed. This totally contradicts our theory, and we believe that it might be explained by the fact that EU relies heavily on crude oil imported by land pipes through Russia and other Caspian states. It would be a very interest topic for further investigation as it is a quite unexpected result that needs to be reasoned.

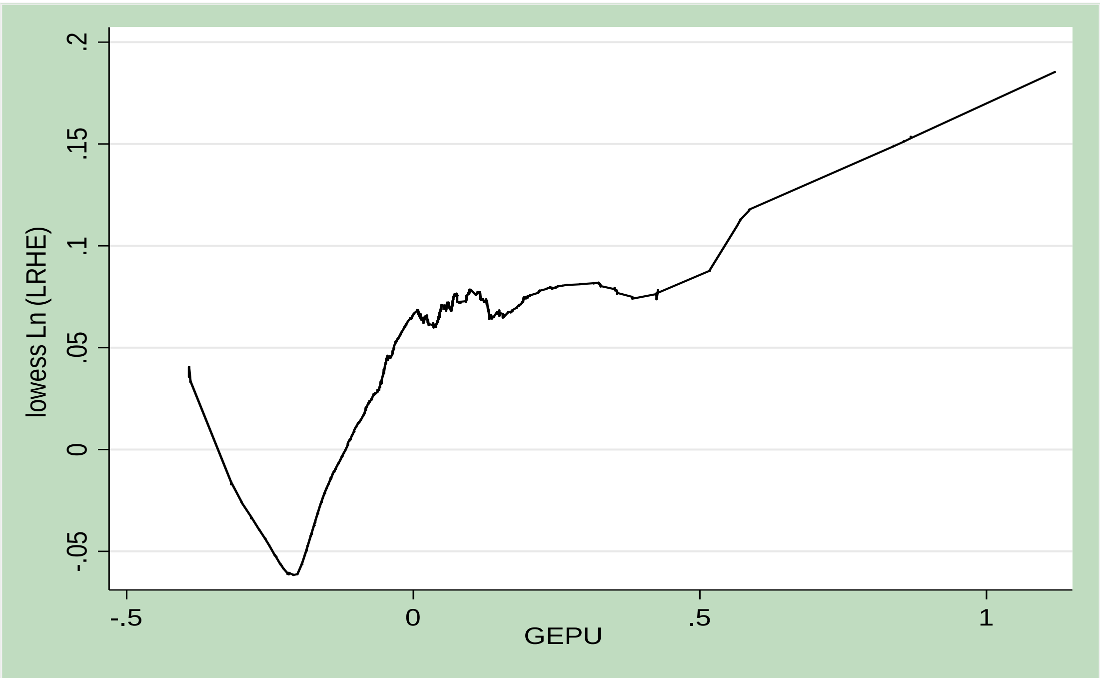
Fleet average age proves to have a positive impact on tanker freight rates. More specifically, its coefficient of 2.084 signifies that for a 1% change in the average age of the fleet, freight rates will have an increase of 2.084%. Moreover, the relationship between the two variables is strongly statistically significant at 1% significance level confirming their profound connection. Our model confirms our theory that, since demand keeps steady and high with advantageous freight rates, scraping is not an option and the fleet ages, as shipowners tend to hold on to their assets to get the most out of such favourable situations.

As already mentioned, the most important variable in our research is the GEPU. Our model validates the existence of a strong relationship between our major determinant and freight rates as their interaction demonstrates an unmistakeable statistical significance at 1% significance level. GEPU's coefficient of 0.178 exhibits a positive link between the two. This, as we previously theorized, is probably due to the risk premium that is embedded in freight rates during times of increased economic uncertainty. Furthermore, shipping is a high-risk investment due to its nature. This in turn suggests that shipping attracts risk taking investors who will probably try to take benefit of increased uncertainty in the market and invest in the industry, which will eventually lead to a rise for the freight rates.

5.5 Relationship between Long Run Historical Earnings and GEPU

The figure below represents the LOWES graph between GEPU and Long Run Historical Earnings.

Figure 5.5

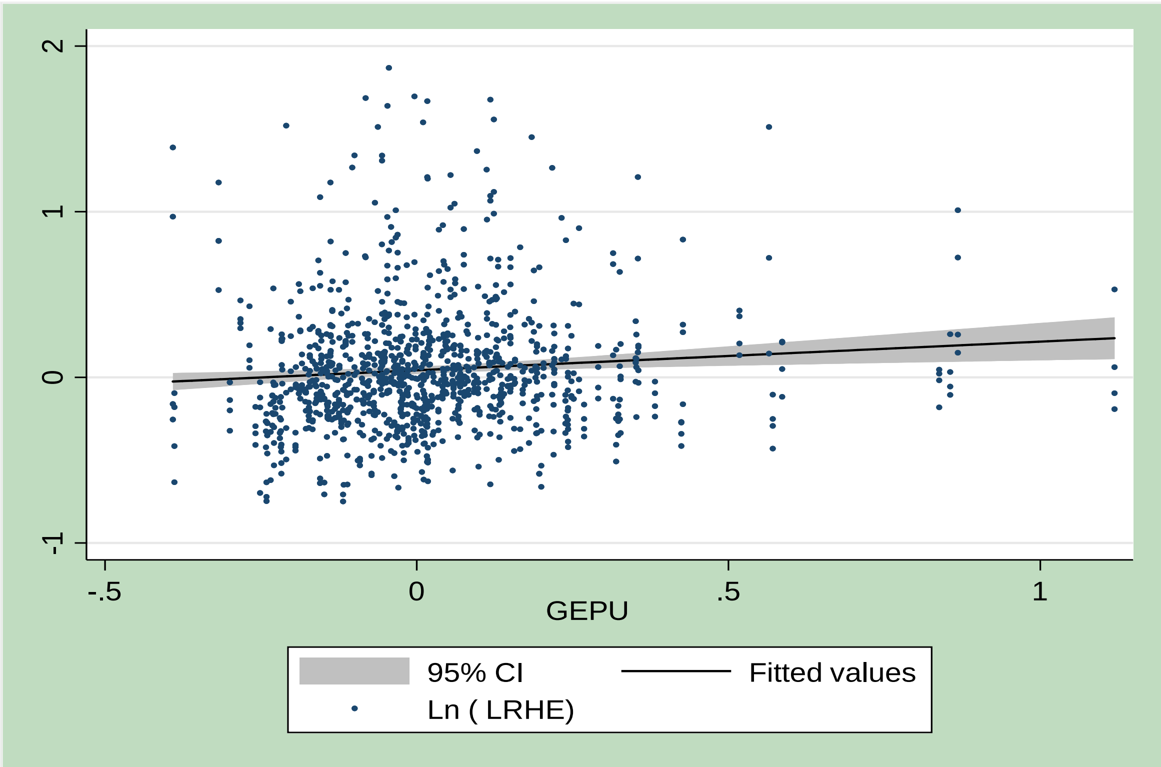


The diagram indicates a negative relationship between the two variables for GEPU's lower values. Despite that, their interaction evolves into an overall positive one. Although there is an indication of non-linearity, a positive linear connection is the one that dominates after involving in our model the rest of explanatory variables. More specifically, we add the non-linearity to the model by adding the $GEPU^2$ and we run the following model:

$$LRHE_{it}=\beta_0+\beta_1 NBP_{it}+\beta_2 SHP_{it}+\beta_3 SV_{it}+\beta_4 FD_{it}+\beta_5 FAA_{it}+\beta_6 OB_{it}+\beta_7 LIBOR_{it}+\beta_8 INF_{it}+\beta_9 COP_{it}+\beta_{10} GOP_{it}+\beta_{11} USI_{it}+\beta_{12} CI_{it}+\beta_{13} II_{it}+\beta_{14} EUI_{it}+\beta_{15} GEPU_{it}+\beta_{16} GEPU^2_{it}\, e_{j,t} \quad (2)$$

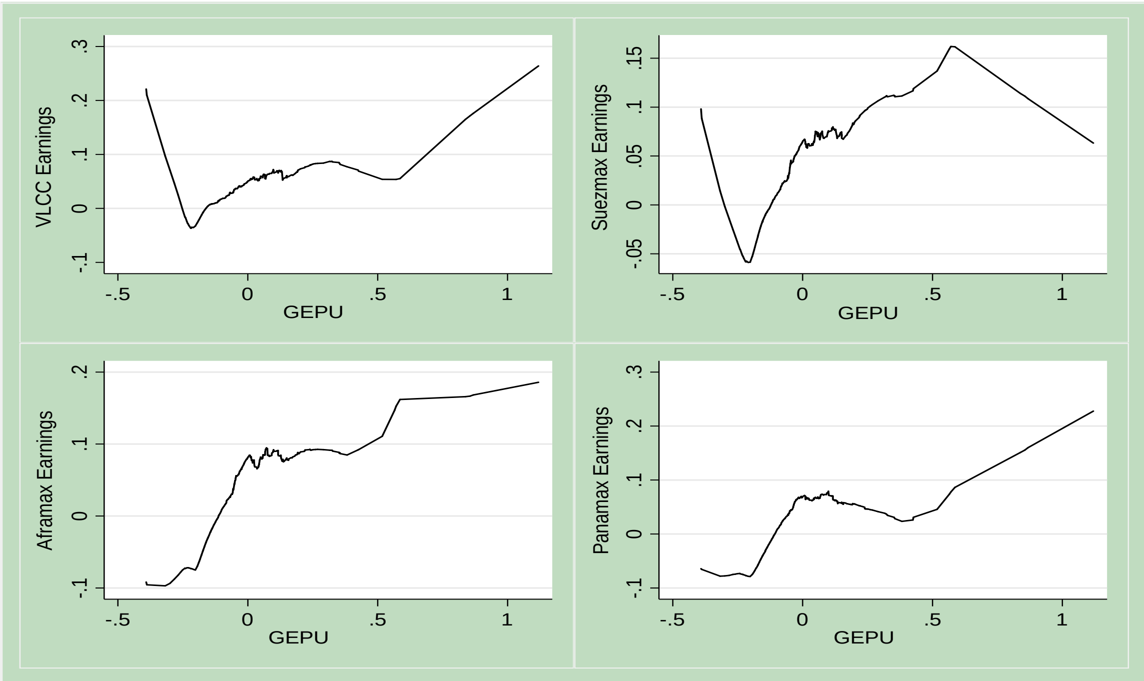
The results suggest that the coefficient of $GEPU^2$ is statistically insignificant at 5% significant level. Therefore, our assumption that the association between the two variables changes from a non-linear to a linear one, after taking consideration all the factors, is confirmed. This relationship is illustrated in Figure 5.7, in which one can see the linear regression line, implying the positive relationship as proven by our results.

Figure 5.7



GEPU's interaction within the four different segments is depicted in the following Figure. Non-linearity indications are demonstrated, particularly for the Suezmax segment, but generally a positive linear relation is the one that prevails in the segments. This is can be seen in our aggregated model as previously discussed where positive linearity was confirmed by our examination.

Figure 5.8



5.6 GEPU index and Financial crisis of 2008

The financial crisis of 2008 is a milestone concerning the uncertainty of the world's economy. Few times in history there are so profound events that ripple across the globe, and the one of 2008 is in the middle of our period of investigation. Since the very nature of our main determinant is the economic uncertainty, we regard of high interest to investigate whether GEPU effects on our model are different before and after this year. Our analysis shows that the interaction of the dummy variable we created with GEPU (eq. 3) is not of statistical significance. This finding illustrates that such an extreme case of uncertainty does not affect our main variable's explanatory power and that GEPU's influence is steady through the timeline of our examined period.

6. Conclusion

In our effort to examine the behavior of tanker freight rates (VLCC, Suezmax, Aframax and Panamax) we examine various determinants that are widely adopted in the existing scientific literature and one that we consider of high interest to introduce to our model. This determinant is GEPU, and while it is extensively applied in financial and economic forecasting models, since it encapsulates the sentiment of uncertainty in the economic environment, it has not yet been incorporated in Shipping Freight Rates ones. To approach tanker freight rates, we utilize LRHE of the four studied segments as a proxy.

Moreover, we divide our variables into two distinct categories. The first is the Shipping Industry Related Variables that include Fleet Development, Orderbook, Fleet Average Age, New Building Price, 5-year-old Secondhand Prices and Scrap Value. The second category is the Economic Environment Variables that compromise of LIBOR Interest Rates, Inflation Rate of OECD countries, Global Oil Production, Brent Crude Oil Price, US, China, India an EU-4 Seaborne Oil Imports as well as their Combined Seaborne Oil Imports, MGO and HFO Bunker Price at Singapore and finally, GEPU. The period of our investigation stretches from January 1997 to June 2020 with data sourced from Clarksons Database and the Global Economic Policy Uncertainty Index.

To avoid multicollinearity problem in our model we apply AIC and BIC criteria, and we exclude MGO bunker prices, HFO bunker prices and Combined crude oil imports from our model. We remove the extreme observations beyond the 1st and 99th percentiles to avert the impact of outliers on our estimation results. Further, we apply panel data Clustered Regression Analysis on a cross sectional time series dataset to create our model. Our estimation Results yield that LRHE behavior is statistically significantly positively affected by Newbuilding Prices, Fleet Average Age, Oil Production and GEPU. Contrary, Fleet Development, Orderbook, LIBOR Interest Rate, Inflation Rate, Brent Crude Oil Price, and EU-4 Imports have a statistically significant negative impact on LRHE.

It is important to highlight that our findings indicate that GEPU is statistically significant at 1% significance level, implying a strong positive effect on freight rates that suggests that uncertainty is an inflating factor for the industry. Despite LOWES graph pointing that there is an indication of non-linearity, GEPU's relationship with LRHE is a positive linear one sine $GEPU^2$ insertion to our model proves to be statistically insignificant. Additionally, GEPU influence on tanker freight rates is persistent throughout the whole period of our investigation, and not only appearing after, before or during milestone events of economic uncertainty such as the 2008 financial crisis.

Although our research leads to clear results, we should mention that it is subject to certain limitations. We choose LRHE as a surrogate for freight rates, which has a certain impact on our findings. LRHE depict freight rates minus costs, but costs have some fluctuations of their own, particularly bunker prices, which might explain the negative influence of Brent Crude Oil Price on LRHE. EU-4 Crude Oil Imports negative impact on LRHE is surprising and is a subject that should be further researched. In addition, we rely heavily on Clustered Regression Analysis leaving space for other analytic methods to draw their own results. Although we include GEPU in a model of established determinants for the industry, enriching in such matter the existing literature for tanker freight rates, there is room for improvement, to even better approach the behavior of our dependent variable.

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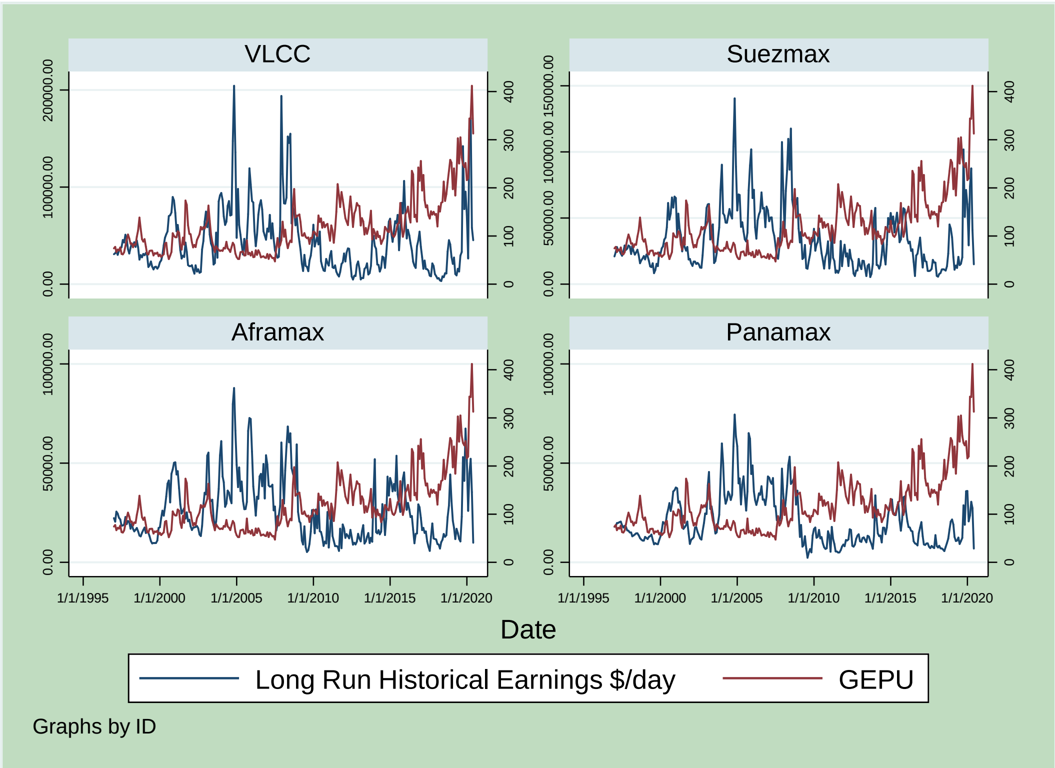
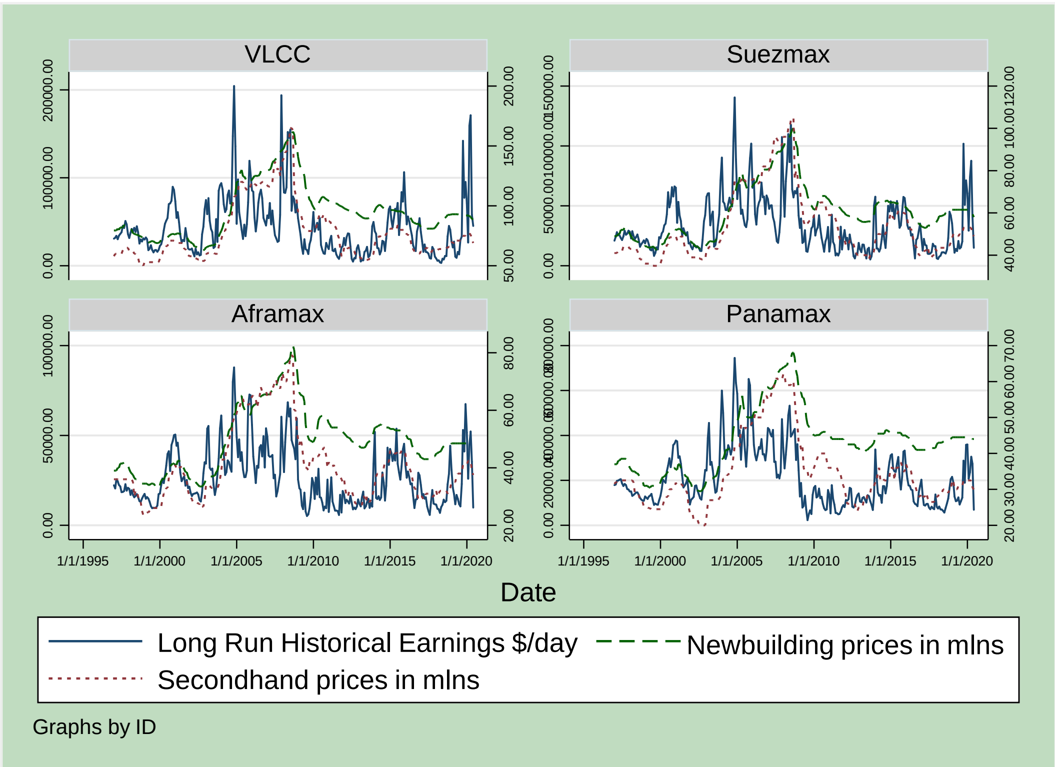
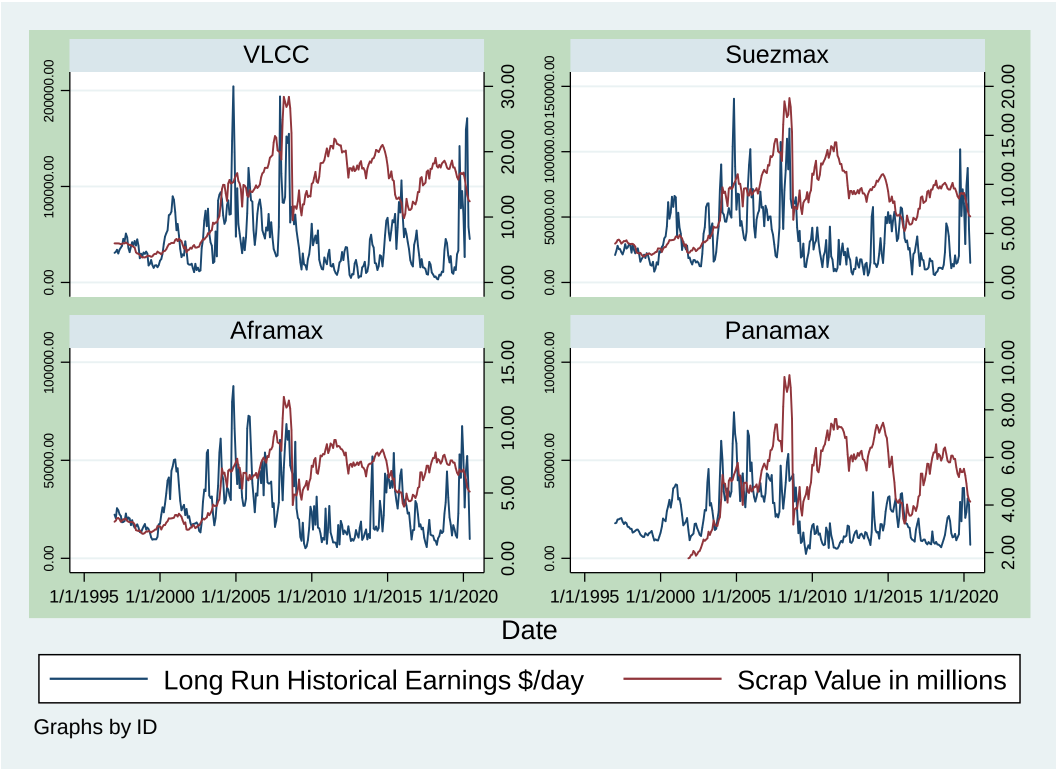
Appendix

Relationship between Long Run Historical Earnings and explanatory variables



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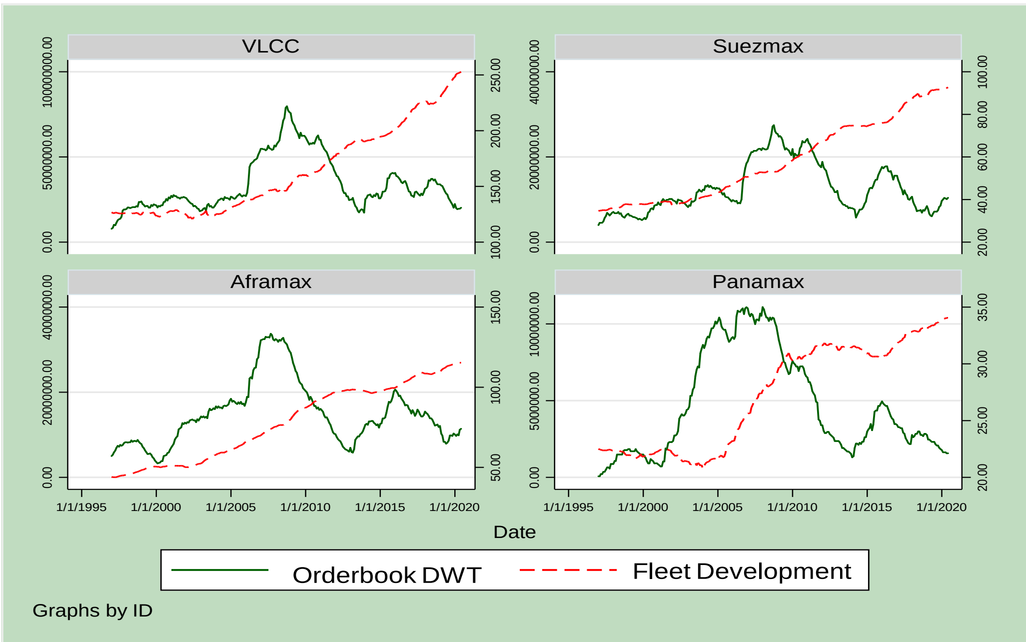
Date
Long Run Historical Earnings $/day
Scrap Value in millions
Graphs by ID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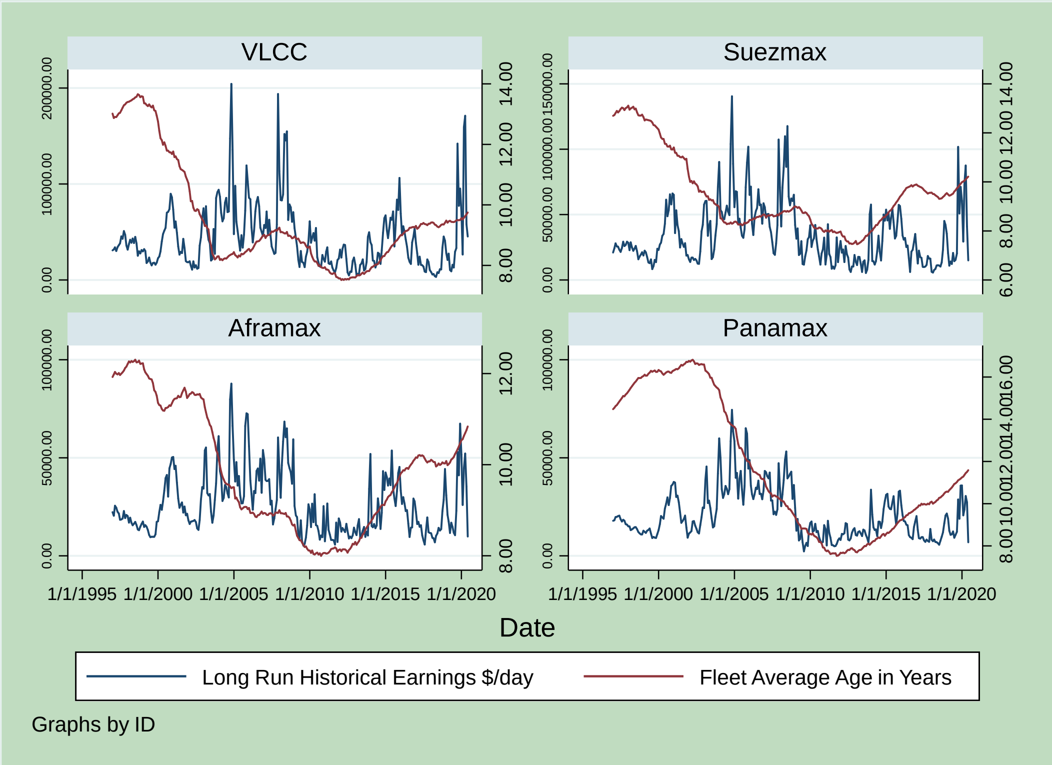
Date
Orderbook DWT
Fleet Development
Graphs by ID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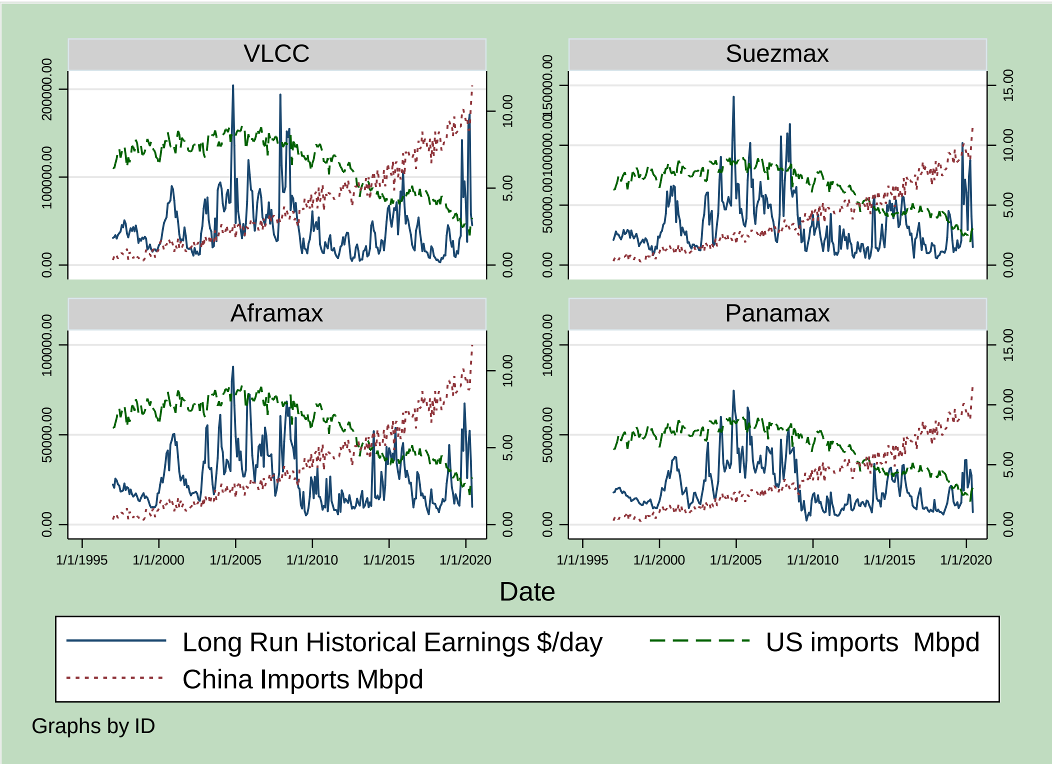
Fleet Average Age in Years
Graphs by ID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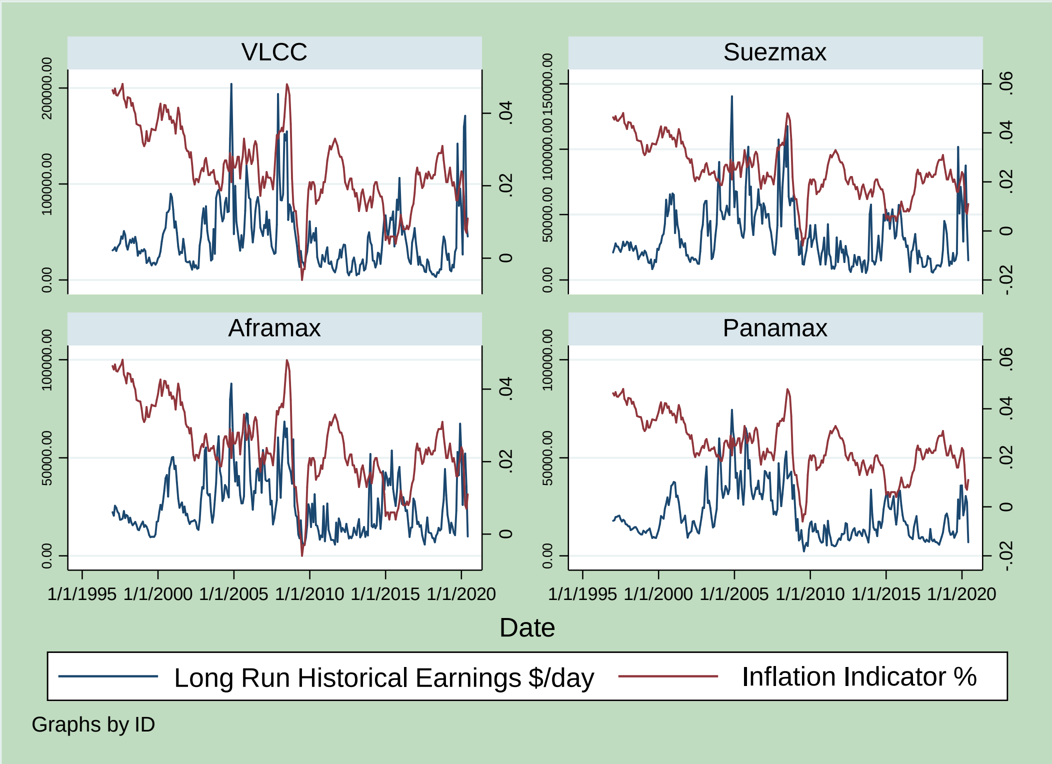
Date
Long Run Historical Earnings $/day
US imports Mbpd
China Imports Mbpd
Graphs by ID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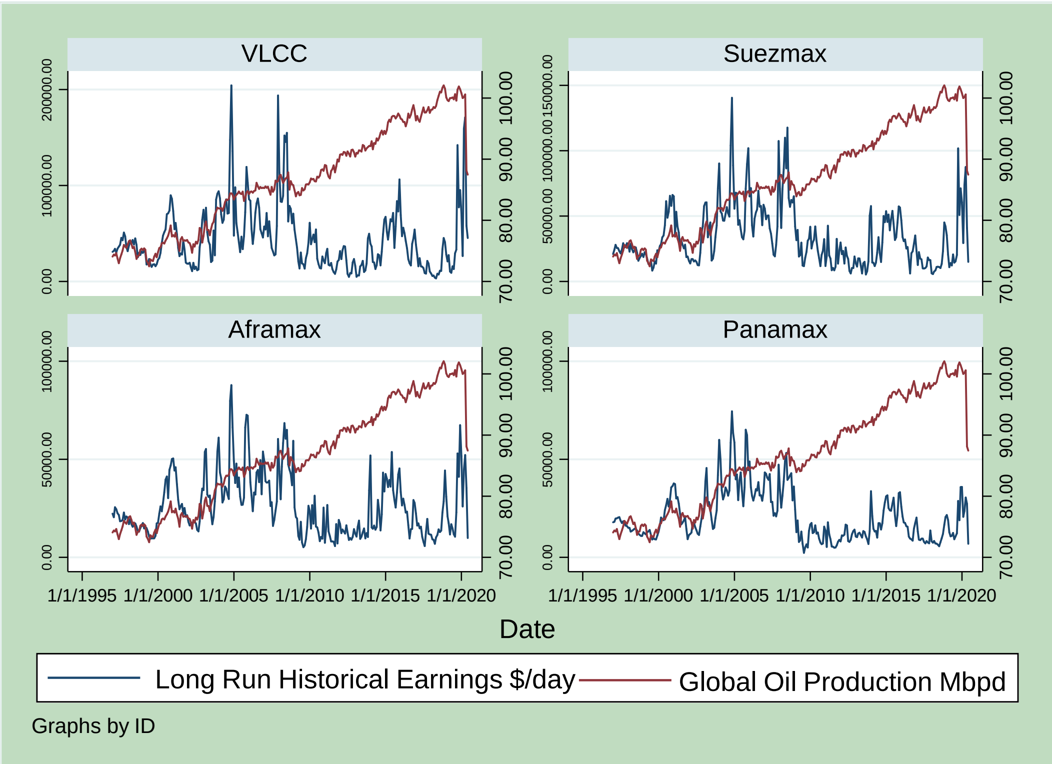
Long Run Historical Earnings $/day
Inflation Indicator %
Graphs by ID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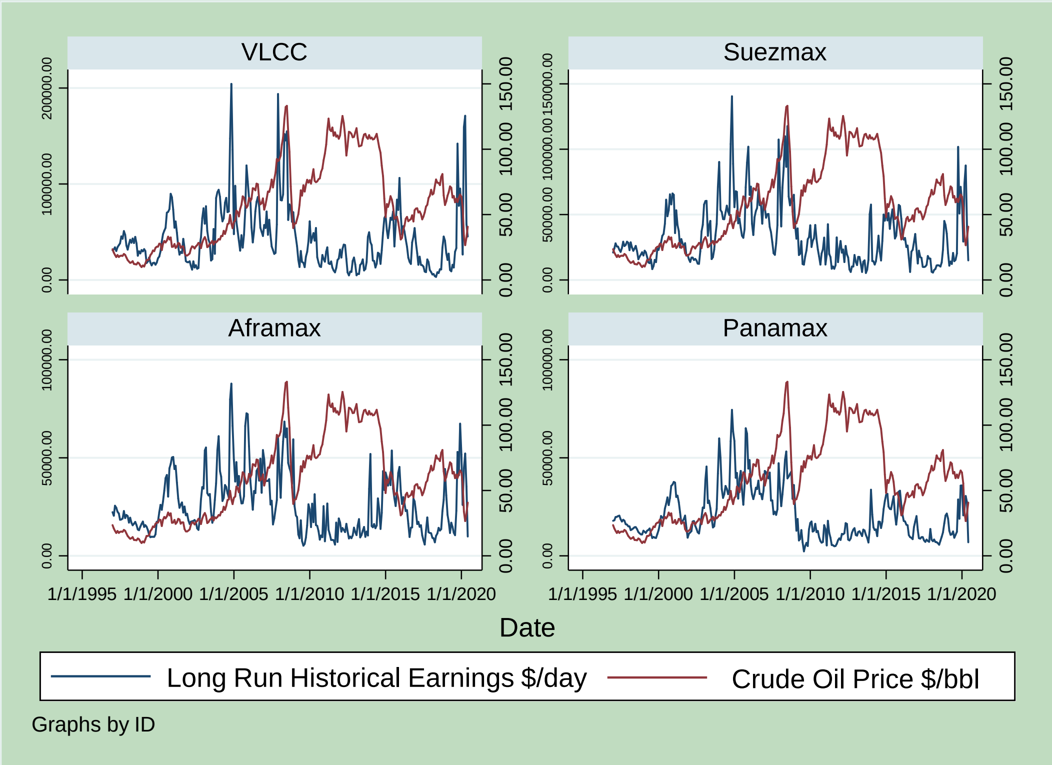
Date
Long Run Historical Earnings $/day
Global Oil Production Mbpd
Graphs by ID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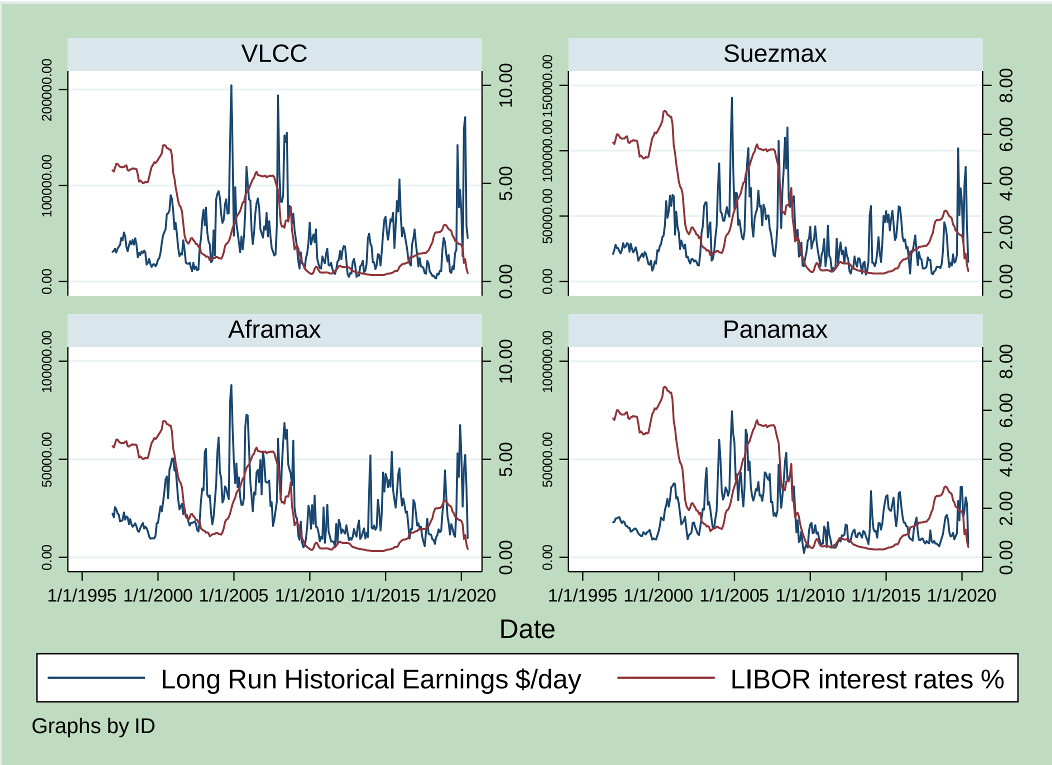
Date
Long Run Historical Earnings $/day
Crude Oil Price $/bbl
Graphs by ID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4.00
6.00
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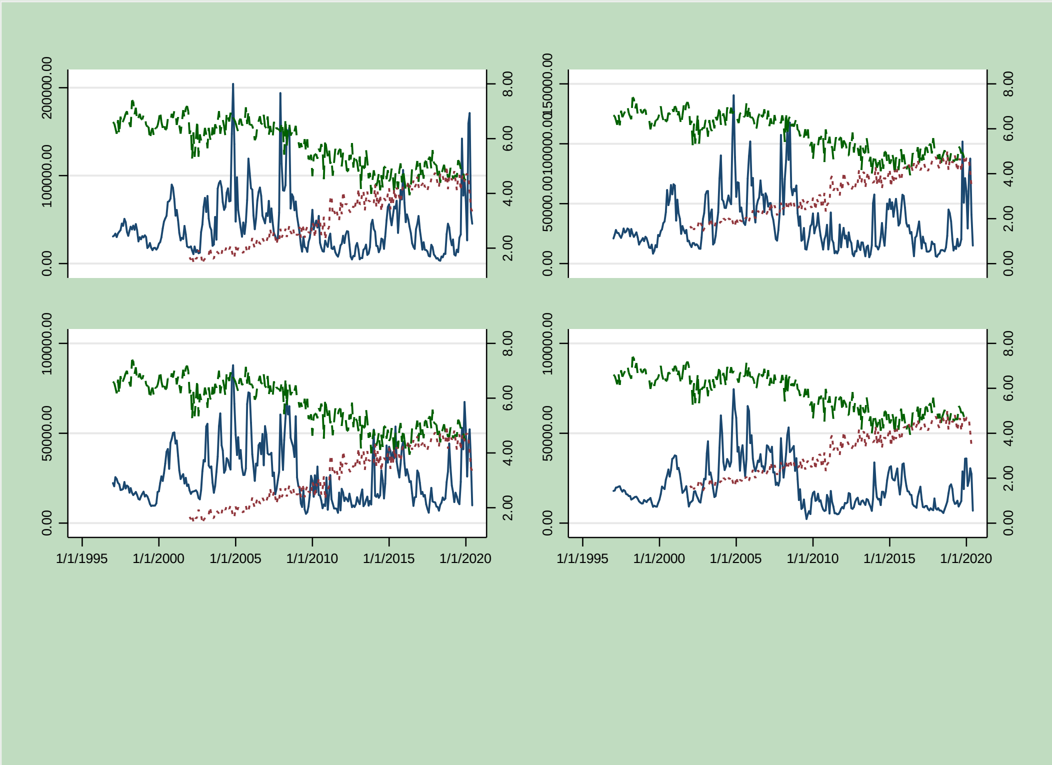
1/1/1995 1/1/2000 1/1/2005 1/1/2010 1/1/2015 1/1/2020
Date
Long Run Historical Earnings $/day
LIBOR interest rates %
Graphs by ID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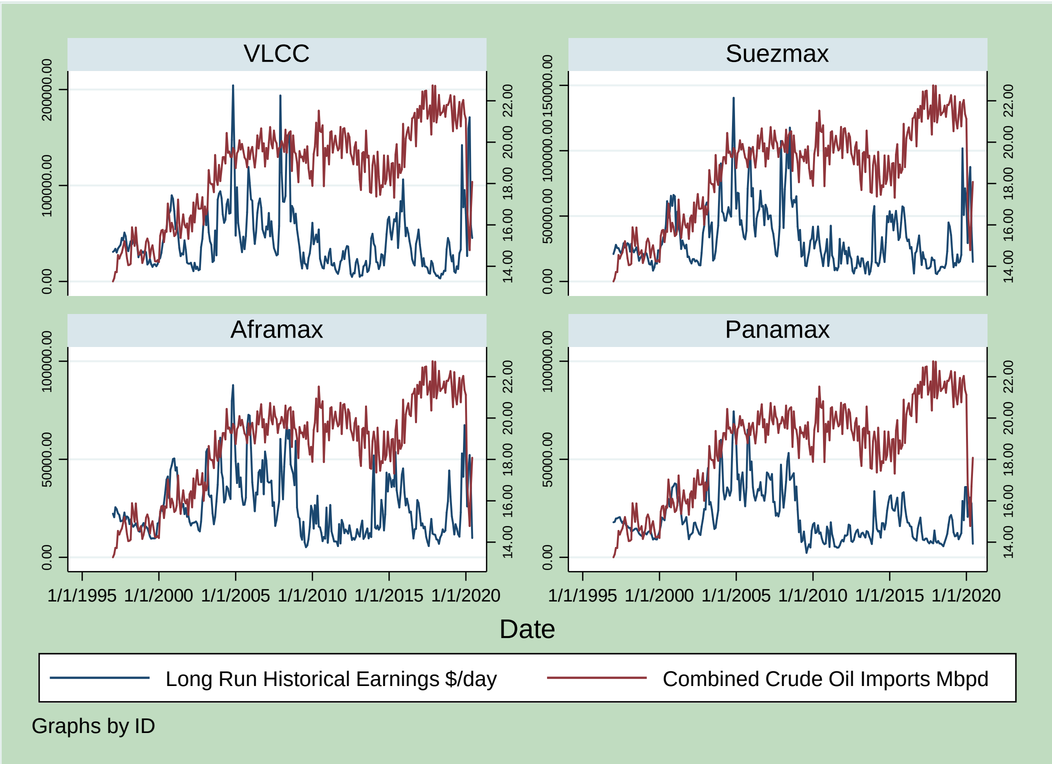
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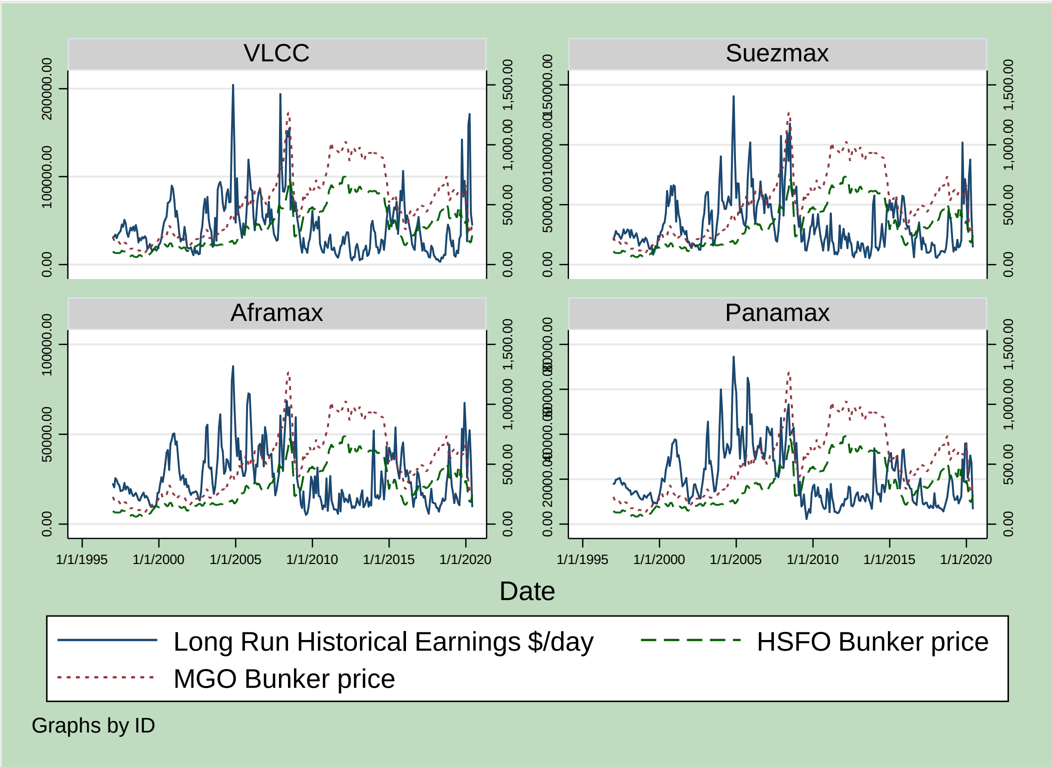
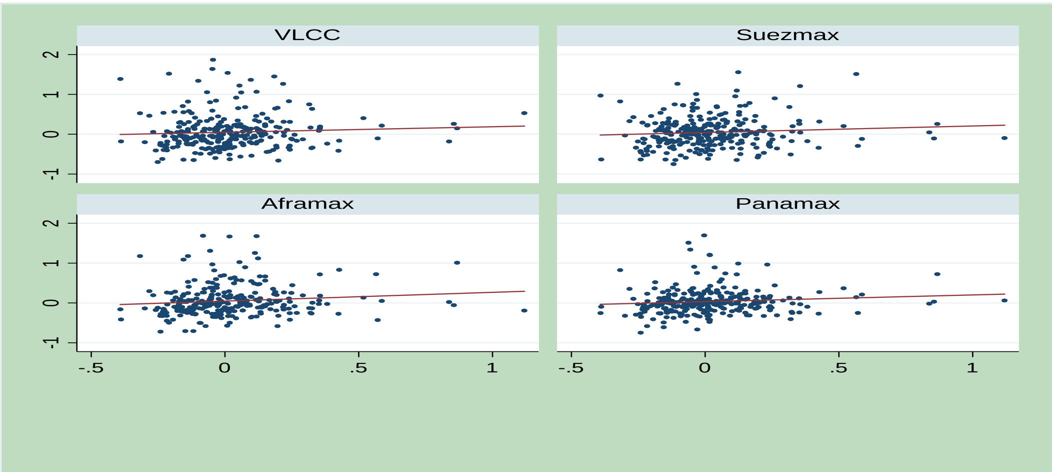
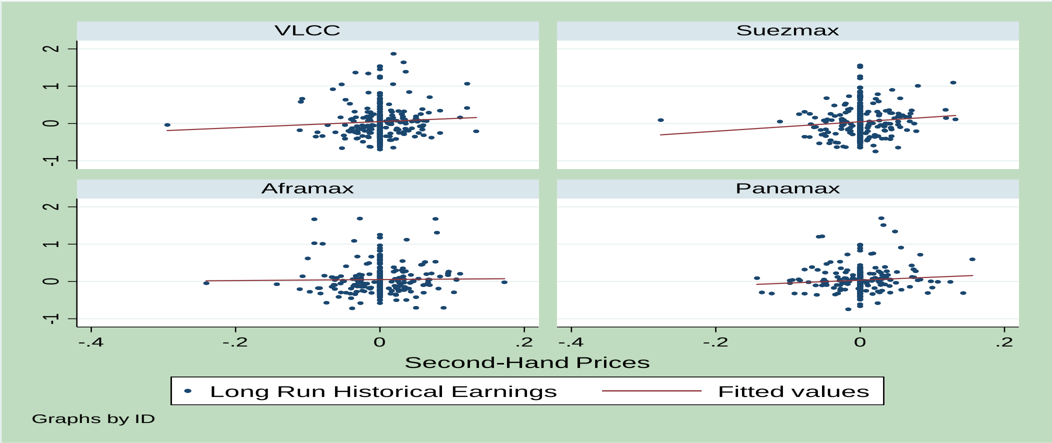
Date
Long Run Historical Earnings $/day
Combined Crude Oil Imports Mbpd
Graphs by ID



Scatterplots with hypothetical Regression lines

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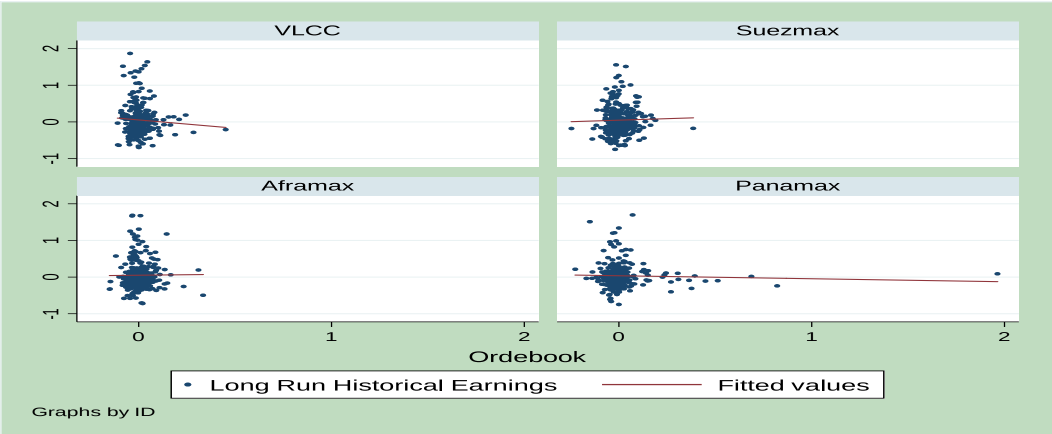
Second-Hand Prices
Long Run Historical Earnings
Fitted values
Graphs by ID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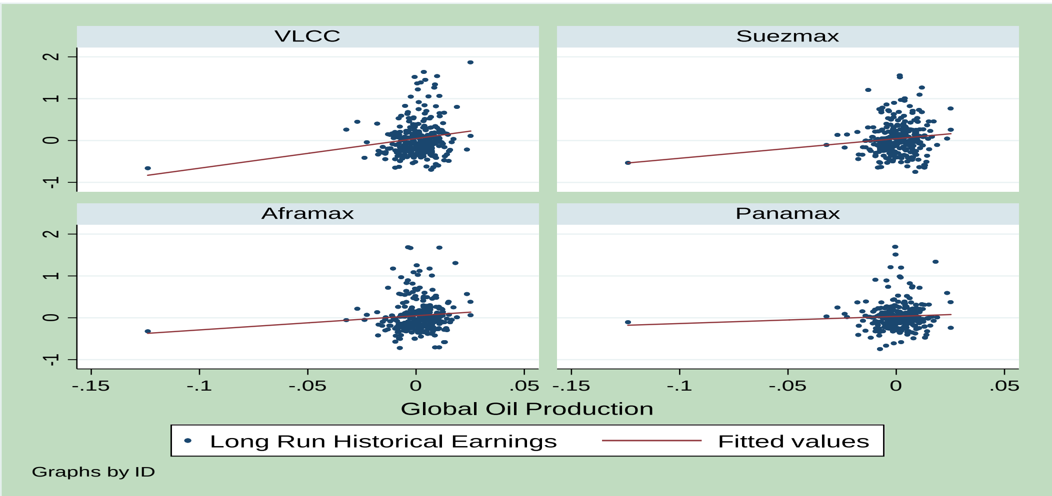
Ordebook
Long Run Historical Earnings
Fitted values
Graphs by ID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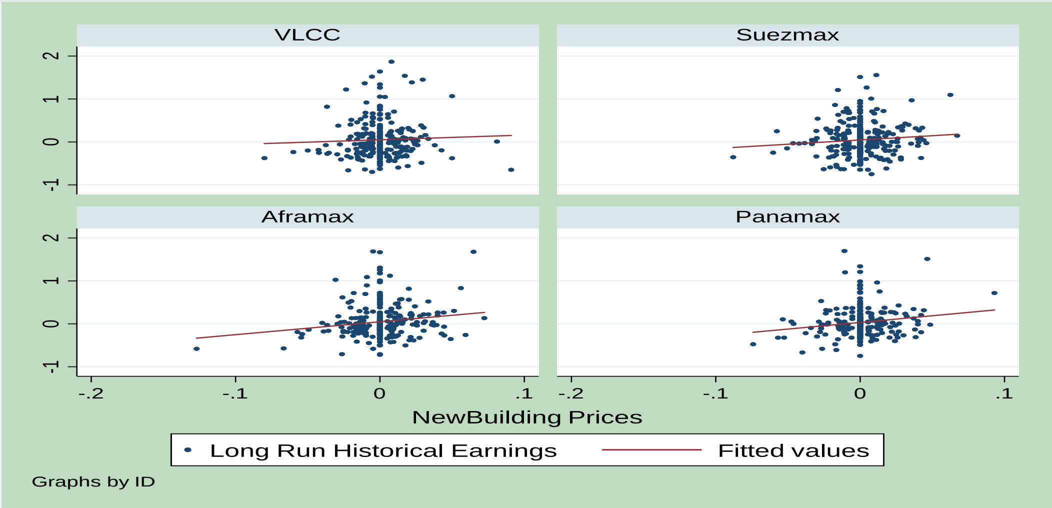
Global Oil Production
Long Run Historical Earnings
Fitted values
Graphs by ID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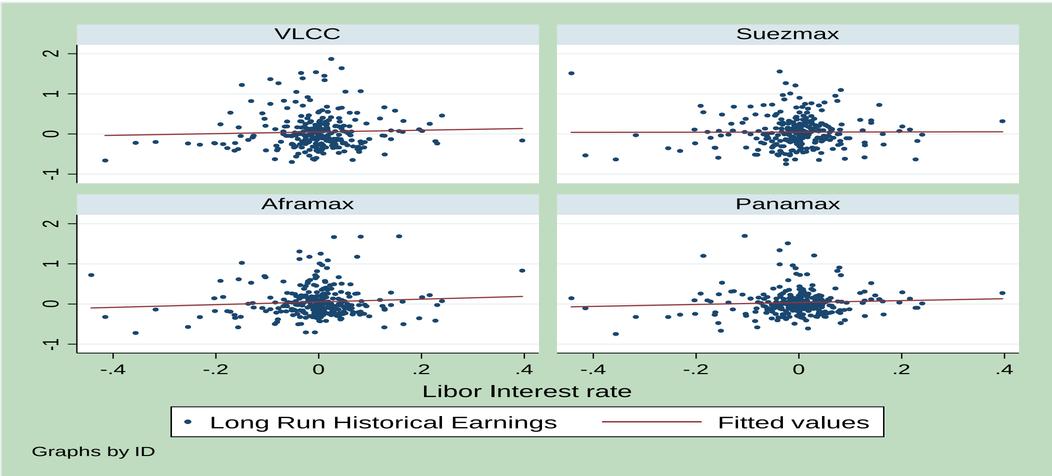
NewBuilding Prices
Long Run Historical Earnings
Fitted values
Graphs by ID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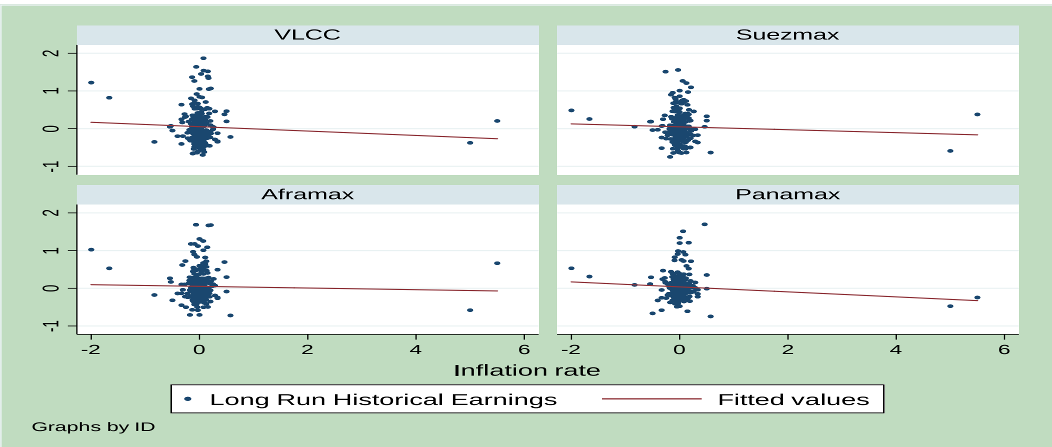
Libor Interest rate
Long Run Historical Earnings
Fitted values
Graphs by ID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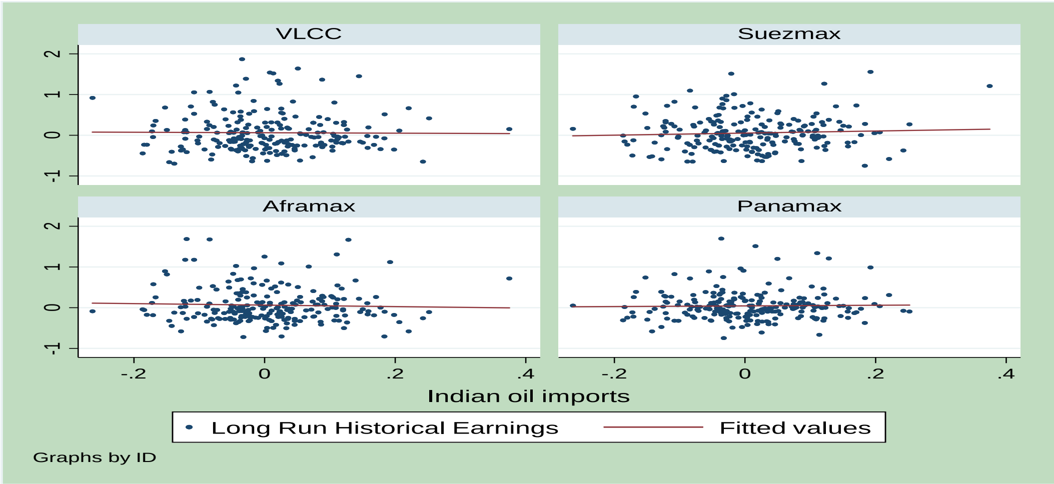
Inflation rate
Long Run Historical Earnings
Fitted values
Graphs by ID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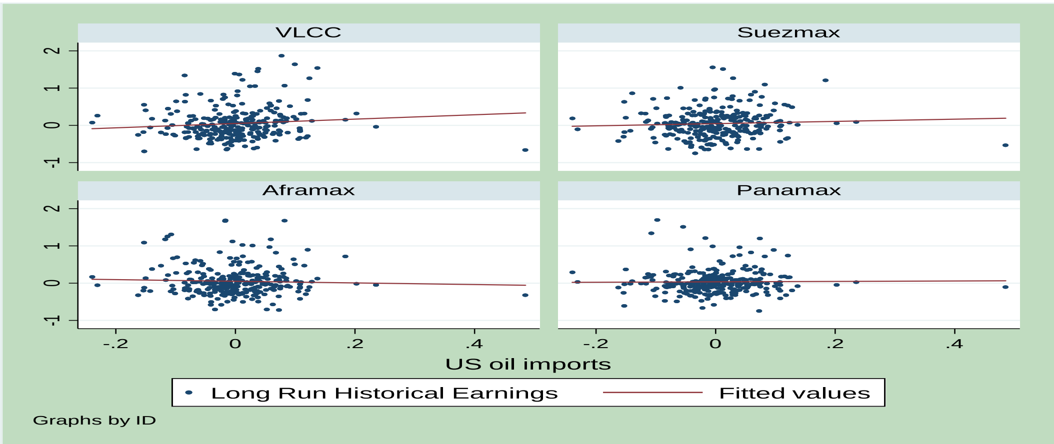
Indian oil imports
Long Run Historical Earnings
Fitted values
Graphs by ID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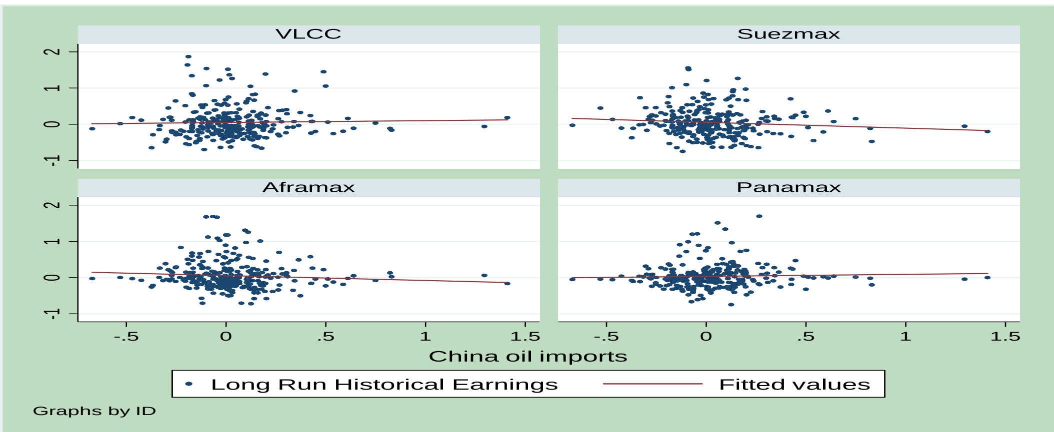
US oil imports
Long Run Historical Earnings
Fitted values
Graphs by ID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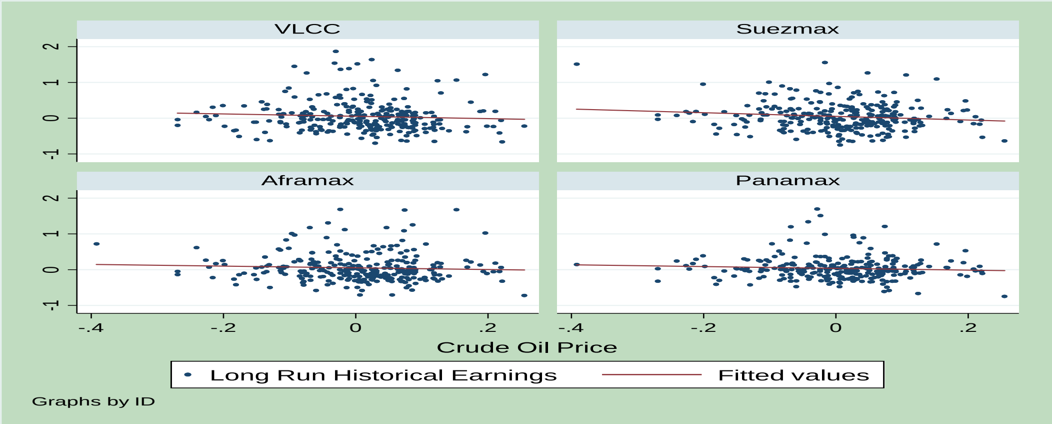
China oil imports
Long Run Historical Earnings
Fitted values
Graphs by ID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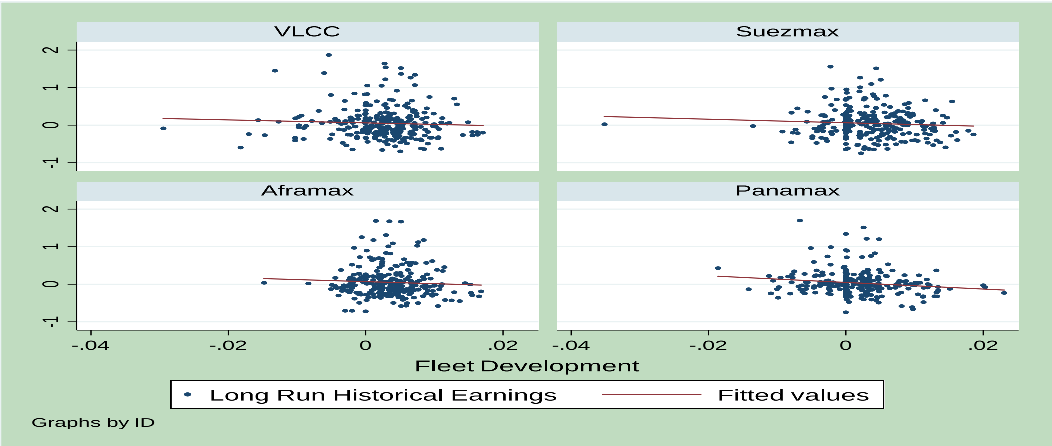
Crude Oil Price
Long Run Historical Earnings
Fitted values
Graphs by ID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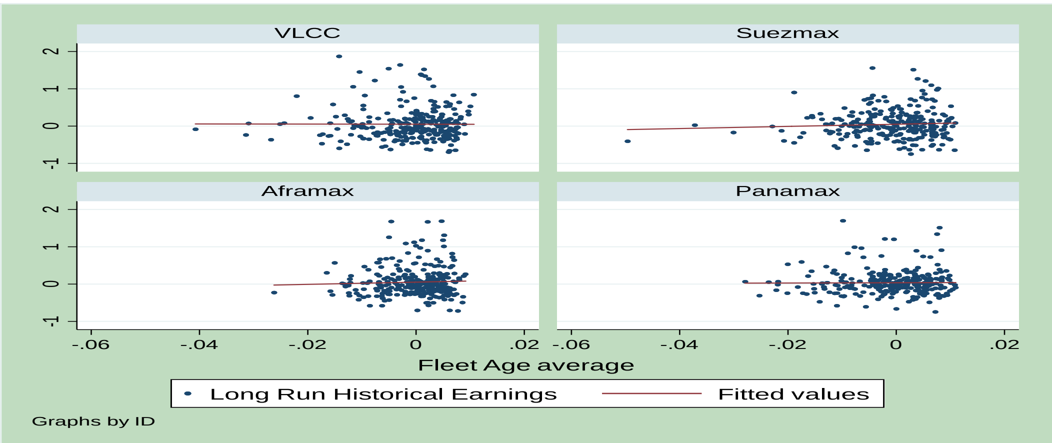
Fleet Development
Long Run Historical Earnings
Fitted values
Graphs by ID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Fleet Age average
Long Run Historical Earnings
Fitted values
Graphs by ID