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The Shipping Orderbook: The factors affecting the world orderbook in maritime industries.

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Declaration

"We hereby declare that this particular thesis has been written by us, in order to obtain the Postgraduate Degree (MSc) 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)''

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Table of Contents

List of Abbreviations

VECM: Vector Error Correction Model

ADF: Augmented Dickey Fuller

O/F: Orderbook to fleet ratio or Orderbook as a percentage of the fleet

LIBOR: London Interbank Offered rate

ARCH: Autoregressive conditional heteroskedasticity

2SLS: Two- Stage Least Squares

OLS: Ordinary Least Squares

ETNs: Exchange- traded notes

ETFs: Exchange –traded funds

AWES: Association of European Shipbuilders

OECD: The Organization for Economic Co-operation and Development

List of Tables

Abstract

This dissertation provides an econometric analysis of Orderbook as a percentage of the fleet in the shipping market. It begins with information about the intrinsic characteristics and the specific nature of maritime industry as well as the imperative need of predicting possible changes due to alterations in shipping prices. After that, it continues with the way the model was constructed as a reasonable consequence of several econometric equations. Previous researches on models examining the newbuilding and secondhand ship prices as a series of orderbook and other factors are analyzed giving impetus for further examination. The development of an Error Correction Model using Johansen techniques and the analysis of the results provide us useful material for the reasoning behind a potential expansion of shipping companies' fleet. In particular, we found out that there is no significant relationship between the variables in the short run. On the other hand, in the long run the variables seem to have either great or slight statistical significant relationship between them.

Key words: Orderbook to fleet ratio, Johansen technique, Vector Error Correction Model (VECM), Bulk market, Tanker market, Container market

1. Introduction

Vastly recognized as it is, shipping is a derived demand and facilitator of world trade. This means that the maritime industry is driven by the powers of supply and demand and the continuously growing needs of the global economic landscape. Furthermore the great majority of commodities and products either in bulk and dry or in liquid form are mostly transported by sea. Thus trade, growth and prosperity are undoubtedly the three elements that constitute shipping.

However, the global economic growth impact is not always the same in the various sectors. Rapid changes in the fundamentals of the industry in accordance with the instinct of the shipowners in their effort to predict the market make the maritime world extremely volatile. As a consequence of the above shipping cycles that move the industry from booms to busts are noticed to be created.

Therefore, where there is capability for speculative investments, great researches and efforts take place. The desire to predict the future characteristics of the shipping industry and the key factors that seem to influence it the most are a puzzle that should be solved. Several patterns and models are created that elaborate the consequences of a possible increase in the charter rates or in the secondhand vessels, but there is no precise model that could explain why a shipowner invests in the crisis and grows its fleet becoming successful against the odds.

The last one fact, the movements of orderbook as a percentage of the fleet is thought to be a key indicator of the market and a useful predictor of future supply growth. A proportionally large orderbook may lead to a fast growing fleet, but high levels of ordering during freight rate booms may create overcapacity and collapse of the market as well . So which are the fundamentals that may affect the orderbook? Is a possible increase of the newbuilding prices or the secondhand ones having a positive effect in deliveries of ships or a positive one? The price of steel seems to affect negatively the new orders, but does it really affect it in short run? Which are the consequences of a boom in freight rates? Will the desire to build new ships be proportionate to this change or a smaller one?

All the above are questions that interest a lot the shipping companies and industry in general and are the main subject of our research. So at first we created a model with dependent variable the orderbook as a percentage of the fleet and independent variables seven other variables such as the newbuilding prices, the secondhand prices, freight rates and steel prices. Later on we examined their correlation and their linear relations in the long run using the Error Correction model and the Johansen techniques since we had previously checked the stationarity of the series. After that it followed an analysis of the process and a results discussion. Finally we came to conclusions about the behavior of the variables affecting orderbook and their significance.

2. Literature Review

The first researcher that paid attention to the determination of ship prices and ship markets was **Beenstock,M., (1985)**. Beenstock claim that since a ship is a capital asset, supply and demand analysis is appropriate for modeling ship prices. Using an asset pricing approach and implying that secondhand prices are adjusted to newbuilding prices over the time, he supports that newbuilding prices are risky whereas secondhand prices are flexible. A criticism for this opinion is open since newbuilding prices cannot be adjusted to something that is so speculative and volatile, for the simple reason that any country would make heavy investments and sunk costs in order to adjust its shipbuilding capacity. After all, the most important variables in the supply shipbuilding industry are the subsidies, the competition among shipyards and the shipbuilding capacity. Adapting portfolio theory, he comes up with the equation below:

$$\frac{F*PSt}{Wt} = f_{PS}*(\frac{Et\Pi t+1}{PSt}, \frac{EtPSt+1}{PSt}, i_t)$$

Where F and W is the fleet size and the world wealth respectively, PS_t is the price of secondhand ships, E_tPS_{t+1} is the expected price of secondhand ships for next year, $E_t\Pi_{t+1}$ is the expected earnings for the following year, which is equal to timecharter rate minus operating costs and i_t is the interest rate.

This equation follows the assumption that the demand for ships and their prices are inversely correlated, for given wealth and rate of returns, since ship price rises as the relative return on ship falls and because of price changes induce wealth effects.

Following this approach in all their following papers **Beenstock, M. & Vergottis, A., (1989)**claim that through a capital asset allocation model and given fixed risk and expected return for all assets, you can calculate the optimal asset shares in a portfolio. However, they don't give any reason why this model can be applied in calculation of ship prices. Furthermore, they support that there is a distinction between secondhand and newbuilding markets, meaning that the price of ships, which are still at their yard constructing, can differ, either by smaller or larger amount from the identical existing new ships. The main reason behind this statement is that the existing new ships are available immediately to trade while the contracted newbuilding ships will be available after a period of time, when the construction period has been lapsed. Since the contracted new ships are forward delivery, at the time of contracting the price of those ships should reflect the market expectations concerning the value of those ships at the time of delivery. However, in some countries the national policy, in order to capture market share, uses aggressive pricing or subsidies that is reflected in the prices rather than market expectations. The model that Beenstock and Vergottis uses, which is a case of an asset pricing model, for newbuilding prices is:

$LnNB=E(lnP_{t+1}) +k$ with $k=k_1+k_2$

Where NB is the price of new-build ships and k is a premium and represents a number of factors.

In their model they assume that secondhand and newbuilding ships are close substitutes. The case where $k_1>0$, reflects a premium that superior technology is embodied in the new-build ships, while $k_2<0$ is a risk premium that attract investors by taking forward position in tankers.

Hawdon, D., (1978), in his Tankship Building Model estimates an equation for newbuilding prices by including to his approach two variables, the asset pricing (freight rates) and the cost related (steel price). Through OLS and 2SLS, he estimates that the price of new tankers is related linearly with the fleet size, the freight rates, the price of steel and the average size of tankers. Firstly, he discovers that the size of the fleet has a statistically significant negative coefficient which reflects that the overcapacity has a depressing effect on ship prices. Secondly, he finds that the levels of freight rates are also statistically significant in newbuilding prices, while the freight rates with one period before is not significant. Steel price, which is used as a proxy of shipbuilding costs, is also highly significant. Last but not least, the average size of tankers has not significant effect on newbuilding prices probably due to misspecification. Concluding, due to the fact that his research is not presented in terms of supply and demand, many questions can be raised related to oversupply of the fleet and the orderbook.

As part of supply and demand approach, **Jin, D., (1993)** analyzes the newbuilding tanker market. Her study not only investigate the quantitative relationship of newbuilding prices and orders with other exogenous factors, like changes in shipping distances and other technological changes in shipbuilding industry, but also identifies the effects of these factors on supply and demand tanker market. For Jin, supply function is highly correlated with shipbuilding costs because costs may influence less than the capacity in the short run. However, there is a problem in measurement of shipbuilding costs, due to the variation in labor costs among different suppliers. In order to overcome this problem, she uses, as a cost indicator, the average number of employees in the Japanese shipbuilding industry at t21. Therefore, she is interested more about labour cost and less for the number of workers. The inverse supply function can be specifying as:

$$NB=f_s(Orderbook, Cap, EMP_{t-1}Steel, T_i,e_{2i})$$

Where NB is the price of new tankers, Orderbook is the quantity of newbuilding tankers (both in supply and demand), Cap is the shipbuilding capacity, EMP_{t-1} is the average number of employees in the Japanese shipbuilding industry at t21, Steel is the steel price, T_i are the technological changes and e_{2i} is the stochastic error term of each i observation.

In her study, both capacity, which is on the supply side and orderbook, which is on the side of demand, are statistically significant. Obviously, a high orderbook indicates a “tight” market and high prices, while excess capacity has a negative effect in ship prices. Furthermore, steel price is appeared to be statistically insignificant and therefore it was removed from the model. That means that shipbuilding market may be driven internationally by subsidies rather than competitive pressures. Finally, technological changes have a significant but negative impact. These contradictory results can be explained by the model misspecification.

By combing together two models, the cost-based model approach and the asset pricing model, (Volk, 1994) tries to explain the market cycles in shipping and shipbuilding. In order to achieve that he used a number of factors, such as shipping innovation, freight rates, speculative and physiological factor that influence shipper’s behavior and he tied to limit the endogenous effect of replacement orders.

According to Strandenes, S., (1984), average expected earnings per year substitute individuals cash flows. An unrealistic assumption, which is based on infinite economic life of a ship including a depreciation factor, triggers **Kavussanos, M. & Alizadeh, A.,(2002)**. They show that taking into account the finite life of a ship, the results are different. Using the real depreciating factor and express the expected earnings as a weighted sum of current and future expected long term earnings, they create a general formula for any ship price. Past studies by **Kavussanos, M.,(1996b)**investigate the dynamics of volatility in tankers and dry bulk markets. Using ARCH models, he discovers that prices of larger vessels are more volatile compare to smaller ones and this volatility change across sizes.

Concluding, **Haralambides, H., Tsolakis, S. & Cridland, C., (2005)**, in their study, examine the factors that determine the price of newbuilding and secondhand ships in bulk and tanker market. They claimed that the price of a ship depends on the investor’s expectations. In order words, it depends on its expected future profitability. Using an ARCH model they show that timecharter rate and newbuilding prices have the greatest influence in secondhand ship prices while the O/F has a negative effect. Moreover, shipbuilding costs is appeared to be the most important variable for newbuilding prices. Also, timecharter rate and O/F are statistical significant and have an effect in newbuilding prices. Finally, although exchange rates are no significant, cost variations, because of exchange fluctuations, are.

Considering by the above author and based more on the latter, we could say that main factors that affect the orderbook to fleet ratio are:

- Newbuilding prices
- Secondhand prices
- Freight rates
- Newbuilding costs
- Exchange rate
- LIBOR

3. METHODOLOGY, DATA COLLECTION & ANALYSIS AND MODEL SPECIFICATION

3.1 VARIABLE IDENTIFICATION

The origins of our model are going back in economic theory and specifically have to do with the concept of supply and demand of newbuilding and secondhand ship markets. Demand of secondhand ships can be seen as a function of freight rates, secondhand and newbuilding prices and LIBOR. Supply of secondhand ships can be expressed by orderbook as a percentage of the total fleet and secondhand prices. By the same, taken the demand of newbuilding prices can be assumed as a function of freight rates and secondhand and new ship's prices. Also, supply of newbuilding vessels can be expressed as a function of orderbook as a percentage of the total fleet, fluctuations in exchange rates, shipbuilding costs and newbuilding prices. Thus the newbuilding and secondhand prices can be expressed as below:

NB=f (O/F, SH, FR, C, XRATE)

SH=f (NB, FR, O/F, LIBOR)

Based on both two equations (see Haralambides, H., Tsolakis, S. & Cridland, C., (2005)) we created our model by assuming that the orderbook as a percentage of the fleet is a function of newbuilding prices (NB), secondhand prices (SH), freight rates (FR), shipbuilding costs (NB COSTS or C), exchange rate (XRATE) and LIBOR. In order to measure the market volatility we decide to add one more variable, the VIX (CBOE Volatility Index). So, our model is:

O/F=f(NB,SH,FR,NBCOSTS,XATE,LIBOR,VIX)

3.1.1 Orderbook as a percentage of the fleet

Orderbook to fleet ratio is a helpful indicator for the future supply growth. Generally, a large orderbook gives signs for a fast growing fleet. Moreover, orderbook to fleet ratio is an indicator of shipyard capacity, which is a consequential determinant of shipbuilding output. The two considerable sources of relevant information, according to shipyard capacity are OECD and AWES. Both organizations have difficulties to provide an actual capacity, as in their annual reports output seems to exceed the actual capacity. Due to the fact that O/F indicates a tighter shipbuilding market, we are expecting a positive relationship between shipbuilding prices and this variable.

3.1.2 Newbuilding and Secondhand prices

New and secondhand ships are close substitutes. In other words the variation in prices of the secondhand ships affects the prices of the newbuildings. Since the value of secondhand ships becomes higher, the new ships become more variable. For instance, an increase in the prices of new ships will lead to an increase in the demand of secondhand. Due to the fact that shipowners can easily change from newbuilding to secondhand, the demand becomes more elastic making the goods close substitutes. Another example is that if the freight rates are being increased, the demand for ships and especially for secondhand ships will increase. This will make the shipowners more willing to order new ships (ceteris paribus).

3.1.3 Freight rates

Based on our model, orderbook to fleet ratio is a function of vessel's expected revenue and is expressed as an average timecharter equivalent rate per day. Timecharter rate reflects the expectations of charters and shipowners for the things to come. As a consequence the higher the timecharter rate, the higher the future profitability of a ship and the higher its value. In addition timecharter rates determine the size as well as the type of the ship that the shipowners are willing to build, receiving the highest returns. In other words, the market of new ships for different ship size and types is not homogenous and display different characteristics according to the determinant of newbuilding prices. For instance, rates for smaller vessel are less fluctuate that the larger one. Furthermore, the timecharter rate is a better market indicator in comparison with the spot rate, as it's less volatile than the spot rate. The reason of that is that the timecharter rate is the agreement of an owner and a charterer to a given hire, over a future period of time, reflecting the market's expectation in a period ahead and thus does not reflect the lows and highs of the spot market. Moreover, shipowners prefer to express their income in terms of net voyage cost. For that reason they use the timecharter rate instead of spot rate, which only provides a gross income. Concluding, timecharter rate is much easier to understand and provide also greater stability.

3.1.4 Newbuilding costs

Measuring shipbuilding cost among different countries is a very difficult procedure, particularly over a length period of time suitable for econometric analysis. For that reason and based on Haralambides, H., Tsolakis, S. & Cridland, C., (2005), we use as an indicator for newbuilding costs, the price of steel plates in Japan. Steel plates explain approximately 30% of newbuilding prices as well as their fluctuations. So, it can be a reliable proxy for the newbuilding costs.

3.1.5 Exchange Rate

Exchange rate fluctuations give the opportunity of a shipbuilding nation to become more competitive, through the devaluation of the currencies against the U.S. dollar, by keeping the newbuilding prices low. Due to the fact that, the final product is estimated in dollars, the majority of newbuilding costs are sustained in the local currency. For instance, Korea and China have very weak domestic currency and very high import content (ex. equipment, raw materials, etc), making such imports more expensive. That's why we are expecting a negative sign for this variable with regard to newbuilding prices.

3.1.6 LIBOR

The Libor is an average of interest rates or a benchmark rate estimated by the leading banks in London. The Libor or in other words the cost of capital has been expressed as the 3- months average LIBOR. LIBOR is charged in order to cover the losses from interbank loans and usually is related with the repayment of the loan. Since LIBOR affect the secondhand prices, we are assuming that its effect over them will be negative, as the lower the interest rate, the lower the cost of capital and consequently the higher the liquidity for most shipowners.

3.1.6 The CBOE Volatility Index (VIX)

VIX measures the expectations of the markets of 30-day volatility and is alluded to as the "investor fear gauge". Firstly, it was constructed by a wide range of S&P 500 index options (at the money put and call options) but today is composed by hundreds of equities, indexes, ETNs and ETF and present to investor a more accurate view of future market volatility. Vix values lower than twenty are associated with less stressful times in the market. On the other hand, its values greater than thirty are corresponded to large amount of volatility. Moreover, VIX's moves do not track prices from the general stock market but from the SPX option market. Today, is not only a very popular and powerful tool in risk management, but also is actively traded and very flexible.

3.2 DATA SELECTION & ANALYSIS

Data collection was proved to be the most difficult and time consuming process as there was not only the problem of lack of information, but the quality of data itself as well. The first crucial problem we had to deal with was the shortage of all information in every ship category. In tankers for example there were not enough data for the whole segment as well as there were not for all the sub-segments of the category. The same happened with containerships category.

Secondly, the size class mismatching among the shipping categories was not a problem to ignore. Ship sizes do not follow some standard criteria measurements and may change over time. Even in the same database, ship sizes are reported differently, when it has to do with measurement of different variables. For example in the bulk carrier sector in the Handymax category, when it comes to the newbuilding prices there is quite different size reference than the one in the secondhand prices.

The third difficult task was to choose among the units of measurements in the sector or subcategory itself. To make things clearer if the handymax category is between 35-60 thousand tonnes deadweight, there might be estimation in million dollars for 40 thousand tonnes and a different one in dollars per gross tonnage for 60 thousand tonnes deadweight.

Additionally vessel specification caused further confusion in our effort to gather and analyze data. Some vessels of the same size maybe be referred with different denominations. A 40 thousand tonnes deadweight vessel may be regarded as a handysize by some and as handymax for others.

Furthermore great discrepancies may be caused in the tanker category mostly, because of merging special vessels' subcategories. For example some may refer to tankers as oil and chemical tankers or even a combination of the above with drills. Other platforms though take into account only the oil tankers as the main category.

Another problem was the reference to orderbook as a percentage of the fleet with two meanings. Some sources estimate the under construction ships as existing fleet while others add it in the orderbook factor. Some shipbroking houses may also value as orderbook the unexercised deals as well, while others think of orderbook only as the deals that are in process. In addition to the above there might be issues regarding the published prices of the ships. These prices derive from different sources that may not be credible. So it is easily understood that there is always a possibility of error.

Furthermore as we all know in the business environment there might be some details in deals and agreements that are never published or become known. A good example here is a possible relief of debt or a payment. Additionally in shipping the payments are staged I many cases but different procedures are followed depending on the case, the ship and the company.

Stating the main problems of our research, we can proceed now to the elaboration of the data that we actually collected and analyzed.

All the financial data that were necessary in order to perform our analysis were collected from the major shipbroking house database, Clarksons and the international financial database, Bloomberg . The time horizon of our sample is almost 20 years. More specifically our data are from the August of 1999 till the July of 2017. The frequency of the observations is in a monthly basis. This means that we had 217 observations for examination. We would like to use more, but as we elaborated before due to many problems we faced, this was unreachable. The first step in our research was to discriminate between the ship types. We had decided to do our research for the three main categories in shipping: the bulk carriers, the tankers and the containerships. The containers' sector was an extra segment in this models that none previous literature had examined and we were curious to find out the results. Initially our purpose was to examine the three general categories and then to specify in all the subsectors of each segment separately. Unfortunately it was not feasible to find data for the tankers general category as well as for all its subcategories. Our limited access to data forced to work only with the Suezmaxs and VLCCs. In the containerships segment we collected data only for the general category and not for its subcategories.

Starting with the bulk sector we collected data for the segment as an entity and then we selected the four big categories: Handysize (10,000-40,000 dwt), Handymax (40,000-65,000 dwt), Panamax (65,000-100,000) and Capesize (100,00-200,00). Tankers were classified into Suezmax (115,000-200,000) and VLCC (200,000-300,000). Finally, Containerships were collected and analyzed as a segment.

3.3 MODEL SPECIFICATION

3.3.1 Stationarity and Unit Root Testing

3.3.1.1 Necessity of non-stationarity

The concept of non-stationarity (see Brooks,C.,(2008)) is crucial for a number of reasons which will be elaborated below, explaining at the same time why it is of great importance the non-stationary variables to be treated differently from the stationary ones. First of all, it should be mentioned that the stationarity (or not) of a series can strongly influence its behaviour and properties. To clarify this, we will need the word "shock", which is used in order to indicate an unexpected change in a variable or just the value of the error term during a specific time period. When we have stationary series, “shocks” will eventually have smaller effect and smaller effect as the time passes out. This means that in time t the shock will have a more significant impact on our system than that in time t+1. On the other hand, when we have to do with non-stationary series, the persistence of “shocks” will be infinite meaning that the effect of a shock during time t will have the same effect as during time t+1 and t+2, etc. Secondly the use of non-stationary data can lead to spurious regressions. If two variables are non-stationary and totally not connected one another, the results we get might be misleading. By taking the above mentioned variables and using standard regression techniques, we could have a high R^2 and significant coefficient estimates as outcome, fact that might look good from the first sight, but is really worthless in the end. This happens because of the property of the non-stationarity of the variables, which indicates that the usual assumptions for the asymptotic analysis are incorrect. The t-ratios for t-distribution will not be the appropriate ones and the F-statistic will not follow the F-distribution etc. Concluding, if one variable is regressed on another unrelated variable -always referring to non-stationary variables- the hypothesis tests about the regression parameters cannot be performed as they will be invalid.

3.3.1.2 Types of stationarity, AR, differences

Now before moving further more to the analysis of our model it should be better to explain a few things about the types of stationarity, the AR and the differences. An autoregressive model is one where the current value of its variable y, depends only from the values that the same variable took in the previous periods plus an error term. An autoregressive model of order p, denoted as AR(p), can be expressed as

$Y_t = \mu + \varphi_1 y_{t-1} + \varphi_2 y_{t-2} + \dots + \varphi_p y_{t-p} + u_t$

where u_t is the white noise term.

The non-stationarity is explained through two models:

- The random walk model with a drift

  $y_t = \mu + y_{t-1} + u_t$
- and the trend-stationary process, which is stationary around a linear trend

$y_t = \alpha + \beta_t + u_t$

where u_t is the white noise disturbance term in both cases.

In the first case, the model could be rewritten as

$y_t = \mu + \phi y_{t-1} + u_t$

For $\varphi = 1$, shocks persist in the system and will never disappear. So the model becomes $y_t = y_0 + \Sigma u_t$

meaning that the value of y is an infinite sum of past shocks plus the starting value of y_0. This is known as the unit root case, because the root of the equation would be unity.

Now going back to our equations, we should mention that they require different treatment. The trend stationarity process (the second equation), is known as deterministic non-stationarity and what we need to do is de-trending. A regression should be run and any estimation would be done to the residuals in order remove the liner trend. As for the first case, the random walk with a drift, which is also known as stochastic non-stationarity, there is a stochastic trend in the data. For the purposes of our model we denote $\Delta y_t = y_t - y_{t-1}$ and $Ly_t = y_{t-1}$. So $(1-L)\, y_t = y_t - Ly_t = y_t - y_{t-1}$. Now if we take the random walk equation and subtract y_{t-1} from both sides we have

$$y_t - y_{t-1} = \mu + u_t$$

$$(1-L)\, y_t = \mu + u_t$$

$$\Delta y_t = \mu + u_t$$

Now the extra variable created, Δy_t,, will be stationary. The stationarity was finally caused by differencing once. This equation $(1-L)\, y_t = \mu + u_t$ also shows why y_t is also known as a unit root process. The root of the equation will be unity, $(1-z) = 0$. Since the unit root meaning was explained as well as the first difference process and reasoning, we should mention that both models, the stochastic and the deterministic, need different approach which is not always so obvious and may cause further problems. A more general model which elaborates both was created, but we will not analyze this in this paper, because the stochastic one is the best for the description of financial and economic time series.

3.3.1.3 More definitions

In case we have to do with non-stationary series, we have to difference y_t d times in order to transform it to stationary. Then it is integrated of order d. This means that it should be written as $y_t \sim I(d)$. So $\Delta y_t \sim I(0)$. So from this equation we know that if we apply Δ d times, the series will become stationary I(0), which means that will have no unit roots. So we know that I(0) is a stationary series while a I(1) series is a non-stationary. If a series is I(3) we need to differentiate 3 times in order to induce stationarity.

3.3.1.4 Testing for a Unit root

The statistical methodologies on testing for a unit root in time series was performed by Dickey and Fuller Dickey, D. & Fuller, W., (1979). The hypothesis testing in the test are Ho: series contains a unit root versus H1: series is stationary. In other words, the objective is to test the null hypothesis that $\varphi=1$ in $y_t= \varphi y_{t-1}+u_t$ against the alternative that $\varphi<1$. In fact, the regression that is used due to simplicity is $\Delta y_t= \psi y_{t-1}+u_t$, in order for the test of $\varphi=1$ to be equivalent of a test of $\psi=0$ ($\varphi-1=\psi$). The test statistics for the Dickey Fuller test is:test statistic=$\psi/SE(\psi)$. For each significance level, there is a different critical value that we compare with our value in order to see if our series are stationary or not. In case the test statistic is lower than the critical value, we reject the null hypothesis, we accept the alternative and our series are stationary. In the opposite occasion, in which the test statistic is greater than the critical value, we accept the null hypothesis of existence of a unit root and our series are non-stationary. The next thing that we have to decide is the optimal lags that the variables must have. In our case, since all the variables are non-stationary, we performed Dickey Fuller tests with one, two and three lags just to be prove that out variables will never reach the critical value and become stationary. The decision of deciding the optimum lag is very important because adding many lags will increase the coefficient standard errors while reducing the lags a lot will not remove all the autocorrelation. This happens because as we increase the parameters that need to be calculated, the degrees of freedom will be reduced and the absolute values of the test statistics will be declined as well. So, the result of the test will become less strong meaning that the null hypothesis will be rejected less often.

3.3.2 Cointegration

As we have found that our variables are I(1) (non-stationary), we expect also their combination to be I(1). In general, if variables with differing orders of integration are combined, their combination will have an order of integration equal to the largest. If $X_{i,t}\sim I(d_i)$ for i=1,2,3,…..,k so that there are k variables integrated of order d_i and $Z_t = \Sigma^{k}_{i=1}\, \alpha_i\, X_{i,t}$, then their linear combination is $z_t \sim I\ (\max d_i)$. Now if we rewrite the above equation with another range, $X_{1,t}= \Sigma_{i=2}^{k}\, \beta_t X_{i,t}+Z'_t$. Where $\beta i=-a_i/a_1$, $z'_t= z_t/a_1$, i=2,…,k. In a few words we can say that we normalized the equation on $X_{1,t}$. So far we have proved that if variables of differing orders are I(1) their linear combination will be also I(1). In the case now that the variables are not differing orders but are cointegrated, their linear combination will be I(0). This works the opposite way as well meaning that a set of I(1) variables are cointegrated if a linear combination of them is stationary. In finance and shipping as well it is common that non0-stationary series move together over time having long run relationship. This cointegrating relationship proves the existence of long run equilibrium, regardless of the variables' behaviour in the short run. In the short run it is possible for them to deviate or not be related, but in the long run their bond holds.

3.3.3 Error correction model or equilibrium correction model

The error correction model is an equation of first differenced and lagged levels of cointegrated variables that makes it feasible to have solution in the long run without leading to dead end. The error correction model is the following:

$\Delta y_t = \beta_1 \Delta X_t + \beta_2 (Y_{t-1} - \gamma X_{t-1}) + u_t$

Where $Y_{t-1}-\gamma X_{t-1}$ is the error correction term. Taking for granted that y_t and x_t are cointegrated and the coefficient γ is cointegrated as well, the error correction term will be I(0) as a combination of cointegrated variables even though they are I(1). We should mention that the error correction term $Y_{t-1}-\gamma X_{t-1}$ appears with a lag, because this would mean that y changes between t-1 and t denoting disequilibrium at time t. β_1 describes the short run relationship between changes in x and y, while γ defines the long run relationship between x and y. β_2 in front of the error correction term is the speed of adjustment to our equilibrium denoting the pace that our model uses to correct itself and fix long run equilibrium. Defining more β_2 we will say that it measures the proportion of last period's error that is corrected. Explaining furthermore the error correction model it would be useful to be mentioned that it can be estimated for more than two variables. In our thesis we used this model because we had eight variables. Having three cointegrated variables for example the model would be: $\Delta y_t = \beta_1 \Delta x_t + \beta_2 \Delta w_t + \beta_3 (y_{t-1} - \gamma_1 x_{t-1} - \gamma_2 w_{t-1}) + u_t$

3.3.4 Vector Error Correction Model and Johansen estimation

Before starting analyzing Johansen technique, (Johansen, S., (1991), Drakos K. (2002)) it should be useful to elaborate the meaning of VAR. VAR means Vector Autoregressive Models and is a systems regression model with more than one dependent variable and is used as an alternative to large scale simultaneous equations models. The great advantage of VAR is that the value of the variable depends on more than just the lags or combinations of white noise terms so the model becomes more flexible than the simple AR model. Another great advantage of VAR is that all variables are treated as endogenous. There is no need for specification which variables are exogenous and which is not. This is crucial as all the equations will be identified between the variables in the model. Now let's return to Johansen. For the needs of the test we must have g I(1) variables which are more than 2 and are thought to be cointegrated. A VAR with k lags containing these variables could be:

$Y_t = \beta_1 y_{t-1} + \beta_2 y_{t-2} + \ldots + \beta_k y_{t-k} + u_k$

So g x 1 g x gg x 1 g x gg x 1 g x gg x 1 g x 1

In order now to perform the Johansen test we must transform the VAR into a Vector Error Correction Model (VECM) :

$\Delta y_t = \Pi y_{t-k} + \Gamma_1 \Delta y_{t-1} + \Gamma_2 \Delta y_{t-2} + \ldots\ldots + \Gamma_{k-1} \Delta y_{t-(k-1)} + u_t$

Where $\Pi = (\Sigma_{i=1}^{k} \beta_i) - I_g$ and $\Gamma = (\Sigma_{j=1}^{i} \beta_j) - I_g$

We have created a VAR which contains g variables in first differenced form and k-1 lags on the dependent variable while a Γ coefficient matrix is attached. In the Johansen test, the results can be affected by the lags which are used in the VECM, so we must select them optimally. In fact in the Johansen test we focus on the Π matrix which explains the long run relationships. Π matrix is the long run coefficient matrix, since we there is equilibrium the Δy_{t-i} will become zero having as a result $\Pi y_{t-k} = 0$. Now in order to test the cointegration between the y_s, we should look at the rank of Π matrix through its characteristics roots. The rank of a matrix equals to the number of its characteristics roots that differ from zero. The roots are the λ_s and the values they get must be between one and zero without taking the one and zero values. In case the variables are cointegrated, the rank of Π will be significantly different from zero otherwise it will get values near zero. In reality the test statistics uses ln(1-λ) instead of λ but still, when λ=0, ln(1-λ) = 0. If our characteristic root (eigenvalue) is non-zero, ln(1-λ) will be <0. In Johansen test for cointegration we will use the formula:$\lambda_{trace} = -T \Sigma_{i=r+1}^{g} \ln(1-\lambda_i)$ where r is the number of cointegrating vectors under the null hypothesis and λ_i is the estimated value for the ith ordered root form the Π matrix. So from what we understand, the larger the λ_i ,the larger and more negative the ln(1-λ) and the larger the test statistic.Each root will have incorporated a different cointegrated vector. Each non zero root will have a significant vector.λ_{trace} is a joint test where the null hypothesis is that the number of cointegrated vectors is less tan or equal to r against the alternative hypothesis that there are more than r. So it starts with p values and then the largest is removed. The critical values are not constant but depend from a number of factors. The null hypothesis says that there are no cointegrating vectors (Π with zero rank). If the null is rejected, it must be tested the case that there is at least one cointegrated vector and so on until the null can no longer be rejected.

Ho: r = 0

H1: r = 1 etc….

In order to understand the Π matrix correspondence to the above model we must think of Π matrix as a matrix of two other matrices a and b’. Π=a x b’. The b’ gives the cointegrating vectors while the other gives the amount of each vector entering in the VECM, which is known as adjustment parameters. Later on, in the process of writing the equations it is common to use the normalization process on each variable at a time so that the coefficient of the variable would be one.

4. TEST RESULTS AND EMPIRICAL ANALYSIS

To prove whether the model is rightly selected, an empirical analysis and number of results all presented.

The test results and the empirical analysis contain the following statistics:

- Parameter values, standard error of estimate and corresponding z-values
- Coefficient of determination (R2), Adjusted R2 and the standard error of regression.

Results were estimated with VECM, using the statistical package of Stata SE12 (64-bit). In order to verify whether conclusions can be made from the model the following tests are performed:

- Augmented Dickey-Fuller (ADF) Unit Root Test
- Johansen cointegration test
- Vector Error Correction Model

4.1 Autocorrelation and Augmented Dickey-Fuller (ADF) Unit Root Test

The first step we performed in our research was the pursuance of the correlogram in order to have a first opinion about the autocorrelation and the stationarity of our variables. We wanted to examine the degree of linear association of each variable between its current value and its previous as well as the pace that this relation passes away. At first we will analyze the behaviour of the four variables that are common of all the categories of ships. From the graph of the LIBOR, the XRATE and the NBCOSTS we see that all of them seem to present strong autocorrelation. On the y axis there is the autocorrelation and on the x axis there are the lags. The first values of y_s for the 1^{st} lags of all the above variables are 1, indicating the possible random walk with a drift model. Therefore the series seem to be non-stationary. Then we notice that the slopes begin to decline smoothly and slowly till the correlograms' values turn to zero. This fact shows us that the value of the variables is closely related with their lags for a long time of period. So we possibly know that, until the 3 first lags that we examine, the series is non-stationary.

We continued the research a bit more and made the correlograms of the first differences of the variables. We saw that the first differences tend to be stationary as the first value is always below 1. This means that there is no autocorrelation between the first differences and its previous values.

The VIX's variable correlogram though is different than the above. For the 1^{st} lag the first value is not 1, giving us a first suspicion about the characteristics of the variable. Actually the value is below 1 showing that VIX is possibly stationary and the model is not a random walk with a drift. VIX's current and past values don't present strong autocorrelation. Furthermore in the correlogram of the first difference of VIX with its lags we saw that actually there is no pattern and the past values can not interpret the future ones. Later on we executed the correlograms of all the variables for all the categories for their current value and their first difference as well.

It is easily understood that for all the four variables OF, NB, SH and FR the correlograms indicate the existence of autocorrelation. The past prices are a good indicator of the present one and the future. The shipping sector seems to play no role in the characteristics of the variables as far as concerns the correlation. The value for the 1st lag is 1 and adding the fact of gradual decline of the slope, gives us the sign of non-stationarity.

As for the correlograms of their first differences we notice that the series are stationary, while the 1^{st} values are below 1 having no pattern. The variables in the first differences form have no autocorrelation. The above results apply for the general bulk sector, the sub sectors of bulk, the tankers sub categories and the containers segment. Although the results appear to be credible, we can not give a firm answer about the stationary existence from the correlograms. There is always the need of proofs and that's the reason of the Dickey Fuller test that comes next.

Having examined the autocorrelation of the variables and the autocorrelation of the AR model we have a first opinion about the characteristics of our series. Although it is an obvious method to test for a unit root, it is quite inappropriate. The reason for this is that although shocks may be infinite in I(1) series, the autocorrelation graph may show a very slow approach till zero value. So this process may be mistaken for a highly persistent, but still stationary process. The whole process is not formal enough to give answers about the stationarity of our model so we need to test it more.

The first test we must perform in order to decide which are the properties and the characteristics of our variables is the Augmented Dickey Fuller test. Depending on the result of the test, we know if our series are non-stationary or stationary and which is the procedure that need to be followed furthermore. The basic objective is to examine the null hypothesis according to which there is a unit root against the alternative that the series is stationary. The significance level in our tests is 5% so the critical values of that level is of our interest. We ran every test for 0, 1, 2 and 3 lags in order to be sure that the test statistic never reaches the critical value. Comparing the test statistic with that value we reject or accept the null hypothesis. Further information about the procedure of the test and the necessity of non-stationarity are elaborated in the chapter of Model specification.

Before entering each category separately we should mention that four of our variables are the same for all the categories because they have general characteristics. These variables are LIBOR, Newbuilding costs, VIX and Exchange rate. For these variables we performed the hypothesis tests

Ho: test statistic > critical value → test statistic > -2.882 → accept the hypothesis → the series is non-stationary

H1: test statistic < critical value → test statistic < -2.882 → reject the hypothesis →the series is stationary

The results of the **Table 4.1** showed that for the three of our variables, LIBOR, NB costs, XRATE, for all and every different lag, the null hypothesis is accepted since the critical values are greater than -2.882. So our series are non stationary. For the forth variable VIX the results were quite different since for all lags 0, 1, 2 and 3 the null hypothesis was rejected and the series were proved stationary. So the VIX variable was no extracted from our model since this variable could not follow the same procedure with the other non-stationary variables. Then we proceeded with the categories of bulk carriers, tankers and containers each of which contains four other variables.

Table 4.1

Dickey Fuller Test
(5% Sign. Level / Critical value: -2.882)

Variables	Test Statistic for			
	0 lags	1 lag	2 lags	3 lags
LIBOR	-1.753	-1.929	-2.104	-2.055
NBCOST	-1.742	-2.296	-2.307	-2.735
XRATE	-1.259	-1.472	-1.723	-1.660
VIX	-4.084	-4.079	-3.416	-3.150

4.1.1 ADF Bulk Carriers

Firstly we ran the test for the general category of bulk carriers for 0,1,2 ad 3 lags. As we see in the table the critical value for 5% significance level is -2.882. So

Ho: test statistic > critical value → test statistic > -2.882 → accept the hypothesis →the series is non-stationary

H1: test statistic < critical value → test statistic < -2.882 → reject the hypothesis →the series is stationary

As we can notice from the results of the **Table 4.2** for all the variables except of the Freight rate, the test statistic is always greater than the critical value for all the number of lags tested. Concluding for 0,1,2,3 lags Orderbook/Fleet, Newbuilding Prices and Secondhand Prices were proved to be non-stationary. For all these variables the null hypothesis was accepted since the test statistic was greater than -2.882. For example for 0 lags the test statistic for OF was -0.337 > -2.882, for 1 lag test statistic for NB prices was -1.475 > -2.882, for 2 lags the test statistic for SH prices was -2.157 > -2.887. Now as for the Freight rate we can see that for lags 1 and 2 the variables is stationary while the test statistic is smaller than the critical value of -2.882. So these values can not be entered in the model, excluding lags 1 and 2 as well, from the tests in the Error Correction Model for cointegration. Lag's 3 values is -2.654 which is greater than the critical one so it is accepted as non-stationary. As a result the only acceptable number of lags in the VECRANK test for this category is lag 3.

Table 4.2

Dickey Fuller Test
(5% Sign. Level / Critical value: -2.882)
General Bulk Carriers

Variables	Test Statistic for			
	0 lags	1 lag	2 lags	3 lags
OF	-0.337	-0.964	-1.455	-1.881
NB	-1.001	-1.475	-1.645	-1.960
SH	-1.431	-2.365	-2.157	-2.148
FR	-2.018	-3.129	-2.993	-2.654

Afterwards we ran the Dickey Fuller test for every subsector of bulk category according to their size.

4.1.1.1 ADF Handysize

We ran DF test for Handysize for 0,1,2 and 3 lags as above. Looking at the table the critical value for 5% significance level is -2.882. So

Ho: test statistic > critical value → test statistic > -2.882 → accept the hypothesis → the series is non-stationary

H1: test statistic < critical value → test statistic < -2.882 → reject the hypothesis →the series is stationary

We see from the results of the **Table 4.3** that for all the variables except the Freight rates for the 1st lag, the test statistic is always greater than the critical value for all the number of lags tested. Concluding for 0,1,2,3 lags Orderbook/Fleet, Newbuilding

Prices and Secondhand Prices were proved to be non-stationary. For all these variables the null hypothesis was accepted since the test statistic was greater than -2.882. For example for 0 lags the test statistic for NB prices was -1.120 > -2.882, for 1 lag the test statistic for OF was -0.982 > -2.882, for 2 lags the test statistic for SH prices was -2.215 > -2.887. As for the Freight rates the values for 0,2 and 3 lags were non-stationary while only for 1 lag freight rates were stationary. The test statistic for this lag was -3.002 < -2.882 and had as a result the rejection of null hypothesis and stationarity for this lag. So lag 1 and this test statistic were excluded from the VECRANK due to model's incompatibility.

Table 4.3

Dickey Fuller Test (5% Sign. Level / Critical value: -2.882) **Handysize**				
Variables	Test Statistic for			
	0 lags	1 lag	2 lags	3 lags
OF	-0.780	-0.982	-1.221	-1.415
NB	-1.120	-1.449	-1.600	-1.799
SH	-1.567	-2.069	-2.215	-2.159
FR	-1.673	-3.002	-2.763	-2.621

4.1.1.2 ADF Handymax

We ran DF test for Handymax for 0,1,2 and 3 lags. Looking at the table the critical value for 5% significance level is -2.882. So

Ho: test statistic > critical value → test statistic > -2.882 → accept the hypothesis → the series is non-stationary

H1: test statistic < critical value → test statistic < -2.882 → reject the hypothesis →the series is stationary

We see from the results of the **Table 4.4** that for all the variables, the test statistic is always greater than the critical value for all the number of lags tested. Concluding for 0,1,2,3 lags Orderbook/Fleet, Newbuilding Prices, Secondhand Prices and Freight rates were proved to be non-stationary. For all these variables the null hypothesis was accepted since the test statistic was greater than -2.882. For example for 0 lags the test statistic for SH prices was -1.412 > -2.882, for 1 lag the test statistic for FR was -2.837 > -2.882, for 2 lags the test statistic for OF was -1.203 > -2.887 and for 3 lags for NB prices the test statistic was -1.761> -2.887.

Table 4.4

Dickey Fuller Test (5% Sign. Level / Critical value: -2.882) Handymax				
Variables	Test Statistic for			
	0 lags	1 lag	2 lags	3 lags
OF	-0.263	-0.668	-1.203	-1.351
NB	-1.084	-1.491	-1.554	-1.761
SH	-1.412	-2.325	-2.137	-2.035
FR	-1.676	-2.837	-2.605	-2.465

4.1.1.3 ADF Panamax

We ran DF test for Panamax for 0,1,2 and 3 lags. Looking at the table the critical value for 5% significance level is -2.882. So

Ho: test statistic > critical value → test statistic > -2.882 → accept the hypothesis → the series is non-stationary

H1: test statistic < critical value →test statistic < -2.882 →reject the hypothesis → the series is stationary

We see from the results of the Table 4.5 that for all the variables except for Freight rates' lag 1, the test statistic is always greater than the critical value for all the number of lags tested. Concluding for 0,1,2,3 lags Orderbook/Fleet, Newbuilding Prices, Secondhand Prices were proved to be non-stationary. For all these variables the null hypothesis was accepted since the test statistic was greater than -2.882. For example for 0 lags the test statistic for FR was -1.688 > -2.882, for 1 lag the test statistic for SH prices was -2.359 > -2.882, for 2 lags the test statistic for NB prices was -1.537 > -2.887 and for 3 lags for OF the test statistic was -1.346> -2.887. Freight rates' 1st lag was proved to be stationary as its test statistic was smaller than the critical value having as a result its rejection from the model together with the 1st lag.

Table 4.5

Dickey Fuller Test (5% Sign. Level / Critical value: -2.882) Panamax				
Variables	Test Statistic for			
	0 lags	1 lag	2 lags	3 lags
OF	0.056	-0.567	-0.985	-1.346
NB	-0.952	-1.429	-1.573	-1.936
SH	-1.563	-2.359	-2.197	-2.188
FR	-1.688	-3.387	-2.606	-2.529

4.1.1.4 ADF Capesize

The last category of bulks we ran DF test is Panamax . We subsequently performed the test for 0,1,2 and 3 lags. Looking at the table the critical value for 5% significance level is -2.882. So

Ho: test statistic > critical value → test statistic > -2.882 → accept the hypothesis → the series is non-stationary

H1: test statistic < critical value → test statistic < -2.882 → reject the hypothesis →the series is stationary

We see from the results of the **Table 4.6** that for all the variables, the test statistic is always greater than the critical value for all the number of lags tested. Concluding for 0,1,2,3 lags Orderbook/Fleet, Newbuilding Prices, Secondhand Prices and Freight rates were proved to be non-stationary. For all these variables the null hypothesis was accepted since the test statistic was greater than -2.882. For example for 0 lags the test statistic for OF was -0.456 > -2.882, for 1 lag the test statistic for SH prices was -1.439 > -2.882, for 2 lags the test statistic for NB prices was -1.642 > -2.887 and for 3 lags for FR the test statistic was -2.462 > -2.887.

Table 4.6

Dickey Fuller Test
(5% Sign. Level / Critical value: -2.882)
Capesize

Variables	Test Statistic for			
	0 lags	1 lag	2 lags	3 lags
OF	-0.456	-0.995	-1.430	-1.968
NB	-0.970	-1.371	-1.642	-1.992
SH	-1.439	-2.549	-2.215	-2.306
FR	-1.829	-2.848	-2.664	-2.462

Concluding, in the general bulk category as well as in the sub categories every variable, except the Freight rates, is non-stationary for every lag level. Freight rates for lags 1 and 2 in the General bulk category as well as for lag 1 in Handysize and Panamax categories are stationary. Consequently we can perform the test in the Vector Error Correction Model for 3 lags for our variables together with LIBOR, XRATE, NB costs testing for cointegration since all of them are non-stationary.

4.1.2 ADF Tankers

Since we didn't find data for the general tankers category as well as all the sub categories we performed the test for the following ones: Suezmax, VLCC.

4.1.2.1 ADF Suezmax

We performed the DF test for the Suezmax for 0,1,2 ad 3 lags. As we see in the table the critical value for 5% significance level is -2.882. So

Ho: test statistic > critical value → test statistic > -2.882 → accept the hypothesis → the series is non-stationary

H1: test statistic < critical value → test statistic < -2.882 → reject the hypothesis →the series is stationary

As we can notice from the results of the **Table 4.7** for all the variables, the test statistic is always greater than the critical value for all the number of lags tested. Concluding for 0,1,2,3 lags Orderbook/Fleet, Newbuilding Prices, Secondhand Prices and Freight rates were proved to be non-stationary. For all these variables the null hypothesis was accepted since the test statistic was greater than -2.882. For example for 0 lags the test statistic for OF was -0.828 > -2.882, for 1 lag test statistic for NB prices was -1.699 > -2.882, for 2 lags the test statistic for SH prices was -1.614 > -2.887 and for 3 lags for FR the test statistic was -2.224 > -2.887.

Table 4.7

Dickey Fuller Test
(5% Sign. Level / Critical value: -2.882)
Suezmax

Variables	Test Statistic for			
	0 lags	1 lag	2 lags	3 lags
OF	-0.828	-1.208	-1.625	-1.845
NB	-1.248	-1.699	-2.275	-2.054
SH	-1.318	-1.437	-1.614	-1.749
FR	-1.620	-2.352	-2.153	-2.224

4.1.2.2 ADF VLCC/ULCC

We performed the DF test for the VLCC for 0,1,2 ad 3 lags. As we see in the table the critical value for 5% significance level is -2.882. So

Ho: test statistic > critical value → test statistic > -2.882 → accept the hypothesis → the series is non-stationary

H1: test statistic < critical value → test statistic < -2.882 → reject the hypothesis →the series is stationary

As we can notice from the results of the **Table 4.8** for all the variables, the test statistic is always greater than the critical value for all the number of lags tested. Concluding for 0,1,2,3 lags Orderbook/Fleet, Newbuilding Prices, Secondhand Prices and Freight rates were proved to be non-stationary. For all these variables the null hypothesis was accepted since the test statistic was greater than -2.882. For example for 0 lags the test statistic for OF was -0.630 > -2.882, for 1 lag test statistic for NB prices was -1.371 > -2.882, for 2 lags the test statistic for SH prices was -1.893 > -2.887 and for 3 lags for FR the test statistic was -2.281 > -2.887.

Table 4.8

Dickey Fuller Test (5% Sign. Level / Critical value: -2.882) VLCC				
Variables	Test Statistic for			
	0 lags	1 lag	2 lags	3 lags
OF	-0.630	-0.949	-1.287	-1.360
NB	-0.949	-1.371	-1.886	-2.001
SH	-1.387	-1.673	-1.893	-1.907
FR	-1.920	-2.489	-2.338	-2.281

The conclusion of DF tests in the sub categories of tankers is that every variable is non-stationary for all the lags tested. Consequently we can perform the test in the Vector Error Correction Model for 2 and 3 lags for our variables together with LIBOR, XRATE and NB costs since all of them are non-stationary and can follow the same procedure.

4.1.3 ADF Containership

Due to lack of data we could perform DF test only for the general category of containers. We performed the DF test for the category of containers as a whole for 0,1,2 ad 3 lags. Looking at the table, we notice that the critical value for 5% significance level is -2.882. So

Ho: test statistic > critical value → test statistic > -2.882 → accept the hypothesis → the series is non-stationary

H1: test statistic < critical value →test statistic < -2.882 →reject the hypothesis → the series is stationary

As we can notice from the results of the **Table 4.9** for all the variables, the test statistic is always greater than the critical value for all the number of lags tested. Concluding for 0,1,2,3 lags Orderbook/Fleet, Newbuilding Prices, Secondhand Prices and Freight rates were proved to be non-stationary. For all these variables the null hypothesis was accepted since the test statistic was greater than -2.882. For example for 0 lags the test statistic for OF was -0.304 > -2.882, for 1 lag test statistic for NB prices was -1.830 > -2.882, for 2 lags the test statistic for SH prices was -1.711> -2.887 and for 3 lags for FR the test statistic was -2.191 > -2.887.

Table 4.9

Dickey Fuller Test
(5% Sign. Level / Critical value: -2.882)
Containers

Variables	Test Statistic for			
	0 lags	1 lag	2 lags	3 lags
OF	-0.304	-0.931	-1.381	-1.409
NB	-0.733	-1.830	-1.918	-1.938
SH	-0.614	-1.115	-1.711	-1.967
FR	-0.847	-1.978	-2.181	-2.191

The conclusion of DF tests in the containers category is that every variable is non-stationary for all the lags tested. Consequently we can perform the test in the Vector Error Correction Model for 2 and 3 lags for our variables together with LIBOR, XRATE and NB costs since all of them are non-stationary and can follow the same procedure.

4.2 Johansen Cointegration Test and the Vector Error Correction Model

Since this study is using time series data from three major shipping sectors- Bulk Carriers, Tanker & Containership- and having verified that all model's variables are non- stationary, the next step is to perform cointegration test in order to perceive stationary cointegrating relationships and to avoid the spurious regression problem. Due to the fact that there are multivariate time series, we are using the multivariate Johansen Cointegration technique. It should be mentioned that the cointegration test has to be performed before the Vector Error Correction Model (VECM) for the simple reason that the cointegration vectors will be applied in the VECM. When the variables are cointegrated and non-stationary, the VECM model is the appropriate method to examine the long run relationship as well as the short run relationship between them.

4.2.1 Bulk Carrier Sector

In this sub chapter we are going to analyze one of the three major sectors in shipping, The Bulk Carriers, as well as the four sub- segment of that sector. Firstly, we examine the orderbook to fleet ratio for the sector generally and then for its sub categories. In order to carry out the cointegration test we use a data sample of two hundred fifteen observations. The model consists of seven variables, of which orderbook to fleet ratio is the dependent variable and the others six the independent variables. Conducting the

Johansen cointegration test, in which the null hypothesis of the trace test is H_o: rank (Π) =r against the alternative hypothesis of H_A: rank (Π) =n, which **n** is a full rank, with three number of lags, we conclude to five out of eight vectors for the eight model's equations. The **Table 4.10** shows that the first row test is the hypothesis of no cointegration, the second row test is the hypothesis of one cointegrating relation, the third row test is the hypothesis of two cointegrating relations and so on until the ninth row, all against the alternative hypothesis, that is full rank. Studying the **Table 4.10** we can observe that the trace statistic is higher than the 5% critical value till the rank 5, which means that we have five cointegrating vectors, which explain the long run relationship of the variable.

Table 4.10

Bulk Carriers		
Johansen tests for cointegration (vecrank)		
	Lags (3)	
Maximum rank	Trace statistic	5% critical value
0	*275.1834*	*124.24*
1	*151.3458*	*94.15*
2	*96.4468*	*68.52*
3	*63.3562*	*47.21*
4	*32.9493*	*29.68*
5	*12.7752**	*15.41*

**the original tables are in Appendixes

After estimating **r**, the second step is to identify the beta (**β**). In order to do that we run the VECM[1] with rank 5 and number of lags(1)[2]. For simplicity of analysis[3], we will separate the results in two categories, the long run relationship and the short run relationship. We will start the analysis from the short run to the long run relationship**.** Running the model we didn't take any results for the short run **[Appendix 2].** For that reason we will continue with the analysis of the long run, which is more important for our model. **Table 4.11** shows the results of the five cointegrating equations. The null hypothesis is H_o: Π=0, which $\Pi=\sum_{i=1}^{6} \beta i$, against the alternative of $\Pi \neq 0$.

[1] We care only for the orderbook to fleet ratio, as it's our dependent variable.
[2] We run firstly the VECM model with three and two lags respectively. The model didn't present any results, as our sample is too small. Then we continue with one lag.
[3] All the tables of all variables are in the Appendix at the end of the paper.

Table 4.11

Bulk Carriers Vector Error Correction model (Long run)	Coefficient	p>│z│
Ce1		
L1.	-0.0191568	*0.000*
Ce2		
L1.	3.087382	*0.011*
Ce3		
L1.	-213.821	*0.000*
Ce4		
L1.	-0.001409	*0.017*
Ce5		
L1.	0.0000164	*0.211*
CONS	-1.00e-07	*1.000*

**the original tables are in Appendixes

Since the p- value is lower than 0.05 in ce1, ce2, ce3 and ce4, we reject the null hypothesis and we accept the alternative. That means that ce1, ce2, ce3 and ce4 are statistically significant. On the other hand, p- value of ce5 is higher than 0.05, which means that we do not reject the null hypothesis, meaning that these vectors are not statistically significant for the model and considering removing from the model. In addition, the error term in the first, second and the fourth cointegrating equation is negative, which lead us to the conclusion that orderbook to fleet ratio decreases in order to approach the equilibrium. Respectively for ce2, the error term in the second cointegration equation is positive, which means that the orderbook to fleet ratio increases to approach the equilibrium. For the constant, the null hypothesis is c=0 against the alternative of c≠0. It's obvious that p-value is higher than 0.05 which means that constant is not statistically significant for the model. Concluding, the Bulk Carrier Sector depends on four cointegrating equations in long run. The beta in **Table 4.12** describes the speed of adjustment back to equilibrium, while the coefficient error term (γ) defines the long run relationship. Furthermore it is very common to "normalize" a particular variable; in order the coefficient on that specific variable in the cointegrating vector is one. Thus, the long run relationship with the speed of adjustment and the long-run cointegrating relationship, according to (**Brooks,C.,(2008)**) is respectively:

Ce1: *-0.0191568*(OF-0.0194121*NBBULKS-0.1194097*SHBULKS+1.63e-19*FRBULKS -8.67e-18*NBCOSTS-9.09e-13*XRATE-7.11e-15*LIBOR)*

Ce2: *3.087382*(LIBOR+0.0002485*NBBULKS-0.0014142*SHBULKS-1.06e-21*FRBULKS -7.45e-20*NBCOSTS+1.78e-15*XRATE)*

Ce3: *-213.821*(XRATE+3.15e-06*NBBULKS-0.0000356*SHBULKS-5.29e-23*FRBULKS - 1.06e-22*NBCOSTS-8.67e-19*LIBOR)*

Ce4: *-0.001409*(NBCOSTS-4.44e-16OF-0.3458952*NBBULKS-0.6015758*SHBULKS +1.30e-18 *FRBULKS -9.09e-13*XRATE-1.28e-13*LIBOR)*

&

Ce1: *OF=0.0194121*NBBULKS+0.1194097*SHBULKS-1.63e-19*FRBULKS +8.67e-18*NBCOSTS+9.09e-13*XRATE+7.11e-15*LIBOR*

Ce2: *LIBOR=-0.0002485*NBBULKS+0.0014142*SHBULKS+1.06e-21*FRBULKS +7.45e-20*NBCOSTS-1.78e-15*XRATE*

Ce3: *XRATE=-3.15e-06*NBBULKS+0.0000356*SHBULKS+5.29e-23*FRBULKS+1.06e-22*NBCOSTS +8.67e-19*LIBOR*

Ce4: *NBCOSTS=+4.44e-16OF+0.3458952*NBBULKS+0.6015758*SHBULKS-1.30e-18 *FRBULKS +9.09e-13*XRATE+1.28e-13*LIBOR*

Table 4.12

Bulk Carriers
Johansen normalization restrictions (betas)
Coefficient

	Ce1	*Ce2*	*Ce3*	*Ce4*
OFBULKS	*1*	*0*	*0*	-4.44e-16
NBBULKS	-0.0194121	0.0002485	3.15e-06	-0.3458952
SHBULKS	-0.1194097	-0.0014142	-0.0000356	-0.6015758
FRBULKS	1.63e-19	-1.06e-21	-5.29e-23	1.30e-18
NBCOSTS	-8.67e-18	-7.45e-20	-1.06e-22	*1*
XRATE	-9.09e-13	1.78e-15	*1*	-9.09e-13
LIBOR	-7.11e-15	*1*	-8.67e-19	-1.28e-13
CONS	25.08345	-0.2365944	-0.0093144	150.4826

**the original tables are in Appendixes

4.2.1.1 The Handysize

Now we are going to analyze the first segment of the Bulk carrier sector, The Handysize. To begin with, the Johansen cointegration test. We assume that the null hypothesis of the trace test is H_o: rank (Π) =r against the alternative hypothesis of H_A: rank (Π) =n, which **n** is a full rank, with number of lags two and three respectively. The **Table 4.13** shows that the trace statistic is higher than the 5% critical value till the rank 5 out of seven, which means that we have five cointegrating vectors, which explain the long run relationship of the variable.

Table 4.13

Handysize Johansen tests for cointegration (vecrank)					
	Lags (2)			Lags (3)	
Maximum rank	Trace statistic	5% critical value	Maximum rank	Trace statistic	5% critical value
0	*237.5178*	*124.24*	*0*	*276.6254*	*124.24*
1	*152.3175*	*94.15*	*1*	*139.8627*	*94.15*
2	*94.5225*	*68.52*	*2*	*91.3655*	*68.52*
3	*60.9704*	*47.21*	*3*	*59.1721*	*47.21*
4	*34.2343*	*29.68*	*4*	*33.1655*	*29.68*
5	*11.5634**	*15.41*	*5*	*12.0368**	*15.41*

**the original tables are in Appendixes

Our next step is to estimate the beta **(β)**, through the VECM model with rank five and lag(3). We will start the analysis from the short run to the long run**.** The **Table 4.14** shows the results of the conducting test, with one and two lags for all the seven variables. Conducting the test, in which the null hypothesis is H_o: $\Gamma_i = 0$, which $\Gamma_i = (\sum_{j=1}^{6} \beta j) - I$ against the alternative of H_A: $\Gamma_i \neq 0$ we can observe that the p-value of secondhand prices, newbuilding costs, Exchange rate and Libor variables in both one and two lags is greater than 0.05 (significant level 95%), so we do not reject the null hypothesis. That indicates that all variables are not statistically significant for O/F. Moreover, in newbuilding prices and freight rates the p-value -with one lag- is higher than 0.05, meaning that we do not reject the null hypothesis and the variables are not statistically significant for the model. On the other hand, the p-value with two lags is lower than 0.05. Since it is lower the variables are statistically significant for the model. Last but not least, for the constant the null hypothesis is c=0 against the alternative of c≠0. It's obvious that p-value is higher than 0.05 which means that constant is not statistically significant for the model.

Table 4.14

Handysize Vector Error Correction model (Short run)	Coefficient	p>|z|
NBHANDYSIZE		
LD.	*0.0013761*	*0.320*
L2D.	*-0.0035664*	*0.006*
SHHANDYSIZE		
LD.	*-0.0391149*	*0.248*
L2D.	*-0.0287962*	*0.429*
FRHANDYSIZE		
LD.	*0.0000169*	*0.655*
L2D.	*0.0000854*	*0.045*
NBCOSTS		
LD.	*0.0009534*	*0.375*
L2D.	*0.0018895*	*0.068*
XRATE		
LD.	*-109.2145*	*0.545*
L2D.	*40.42056*	*0.820*
LIBOR		
LD.	*-42.07304*	*0.145*
L2D.	*-5.331425*	*0.844*
CONS	*-5.95e-08*	*1.000*

**the original tables are in Appendixes

In long run, our model contains five cointegrating equations, shown in **Table 4.15**. Likewise, from above the null hypothesis now is H_o: Π=0, which $\Pi=\sum_{i=1}^{5}\beta i$, against the alternative of Π ≠0. Since the p- value is lower than 0.05 in ce1 and ce3, we reject the null hypothesis and we accept the alternative. That means that ce1 and ce3 are statistically significant. On the other hand, p- value of ce2, ce4 and ce5 is higher than 0.05, which means that we do not reject the null hypothesis, meaning that these vectors are not statistically significant for the model and considering removing from the model.

Table 4.15

Handysize Vector Error Correction model (Long run)	Coefficient	p>|z|
Ce1		
L1.	*-0.017723*	*0.012*
Ce2		
L1.	*-5.86e-06*	*0.767*
Ce3		
L1.	*-5.86e-06*	*0.043*
Ce4		
L1.	*0.0203892*	*0.388*
Ce5		
L1.	*0.0203892*	*0.399*

**the original tables are in Appendixes

In addition, the error term in both the first and the third cointegrating equation is negative, which lead us to the conclusion that orderbook to fleet ratio decreases to approach the equilibrium. Concluding, the Handysize segment depends only on two cointegrating equations in long run. The beta in **Table 4.16** describes the speed of adjustment back to equilibrium, while the coefficient error term (γ) defines the long run relationship. Furthermore it is very common to "normalize" a particular variable; in order the coefficient on that specific variable in the cointegrating vector is one. Thus, the long run relationship with the speed of adjustment and the long-run cointegrating relationship for the Handysize sector is respectively:

Ce1: *-0.017723*(OFHANDYSIZE-7.59e-18*NBHANDYSIZE-1.67e-16*SHHANDYSIZE +2.17e-19*FRHANDYSIZE-1.67e-16*NBCOSTS-8362.067*XRATE+361.3714*LIBOR)*

Ce3: *-5.86e-06*(NBHANDYSIZE-2.66e-15*SHHANDYSIZE-5.55e-17*NBCOSTS-245611.7 *XRATE+10783.84*LIBOR)*

&

Ce1:*OFHANDYSIZE=+7.59e-18*NBHANDYSIZE+1.67e-16*SHHANDYSIZE -2.17e-19*FRHANDYSIZE+1.67e-16*NBCOSTS+8362.067*XRATE-361.3714*LIBOR*

Ce3: *NBHANDYSIZE=+2.66e-15*SHHANDYSIZE+5.55e-17*NBCOSTS+245611.7 *XRATE -10783.84*LIBOR)*

Table 4.16

Handysize
Johansen normalization restrictions (betas)

	Coefficient	
	Ce1	*Ce3*
OFHANDYSIZE	*1*	*0*
NBHANDYSIZE	*-7.59e-18*	*1*
SHHANDYSIZE	*-1.67e-16*	*-2.66e-15*
FRHANDYSIZE	*2.17e-19*	*0*
NBCOSTS	*-1.67e-16*	*-5.55e-17*
XRATE	*-8362.067*	*-245611.7*
LIBOR	*361.3714*	*10783.84*
CONS	*52.14025*	*475.6553*

**the original tables are in Appendixes

4.2.1.2 The Handymax

The second sub- segment of the Bulk Carrier Sector is, The Handymax. In the Johansen cointegration test we assume that the null hypothesis of the trace test is H_o: rank (Π) =r against the alternative hypothesis of H_A: rank (Π) =n, which **n** is a full rank, with number of lags two and three respectively. The **Table 4.17** shows that the trace statistic is higher than the 5% critical value, till the rank 4 out of seven for two and three lags respectively, which mean that we have four cointegrating vectors, which explain the long run relationship of the variable.

Table 4.17

Handymax
Johansen tests for cointegration (vecrank)

	Lags (2)			Lags (3)	
Maximum rank	Trace statistic	5% critical value	Maximum rank	Trace statistic	5% critical value
0	*207.2439*	*124.24*	*0*	*255.5875*	*124.24*
1	*116.5959*	*94.15*	*1*	*137.5090*	*94.15*
2	*80.5256*	*68.52*	*2*	*77.4522*	*68.52*
3	*48.7121*	*47.21*	*3*	*48.9552*	*47.21*
4	*24.4999**	*29.68*	*4*	*24.8945**	*29.68*

**the original tables are in Appendixes

The second step is to examine the long and short run relationship, though the VECM model. Firstly, we ran the model with rank 4 and lags(3). Examining the results we can observe that there is not long run relationship, so we decide to ran the model again with rank 4 but lags(2). The output was the follow. In short run the null hypothesis is H_o: Γ_i =0 , which Γ_i= $(\sum_{j=1}^{6} \beta j) - I$ against the alternative of H_A: $\Gamma_i \neq 0$. **Table 4.18** shows the results of the conducting test. Since, p-value of all variables is higher than 0.05 (significant level 95%), we do not reject the null hypothesis. That indicates that all variables are not statistically significant for O/F. Furthermore, the null hypothesis for the constant is c=0 against the alternative of c≠0. Again the p-value is higher than 0.05 which means we do not reject the null hypothesis and the constant is not statistically significant for the model.

Table 4.18

Handymax
Vector Error Correction model (Short run)

		Coefficient	p>|z|
NBHANDYMAX			
	LD.	*0.010431*	*0.927*
SHHANDYMAX			
	LD.	*0.0114549*	*0.820*
FRHANDYMAX			
	LD.	*-0.000013*	*0.770*
NBCOSTS			
	LD.	*-0.0009527*	*0.594*
XRATE			
	LD.	*74.3232*	*0.804*
LIBOR			
	LD.	*34.20604*	*0.376*
CONS		*0.004006*	*0.953*

**the original tables are in Appendixes

Similarly from above, in long run the null hypothesis now is H_o: $\Pi=0$, which $\Pi=\sum_{i=1}^{4}\beta i$, against the alternative of $\Pi \neq 0$. **Table 4.19** shows the results. Since the p- value is lower than 0.05 in ce1 and ce4, we reject the null hypothesis and we accept the alternative. That means that ce1 and ce4 is statistically significant. On the other hand, p- value of ce2 and ce3 is higher than 0.05, which means that we do not reject the null hypothesis, meaning that these vectors are not statistically significant for the model and considering removing from the model. In addition, the error term in the first cointegrating equation is negative, which lead us to the conclusion that O/F decreases to approach the equilibrium. On the same way, the error term in the fourth cointegrating equation is positive, meaning that the O/F increases in order to approach the equilibrium.

Table 4.19

Handymax
Vector Error Correction model (Long run)

		Coefficient	p>|z|
Ce1			
	L1.	*-0.0140201*	*0.037*
Ce2			
	L1.	*-4.00e-07*	*0.963*
Ce3			
	L1.	*0.0216613*	*0.598*
Ce4			
	L1.	*0.0470716*	*0.004*

**the original tables are in Appendixes

Concluding, the Handymax segment depends on two cointegrating equations in long run. The beta describes the speed of adjustment back to equilibrium, while the coefficient error term (γ), in **Table 4.20** defines the long run relationship. Furthermore it is very common to "normalize" a particular variable; in order the coefficient on that specific variable in the cointegrating vector is one. Thus, the long run relationship with the speed of adjustment and the long-run cointegrating relationship for the Handymax segment is respectively:

Ce1: *-0.0140201*(* OFHANDYMAX+*8.88e-16**NBHANDYMAX-*2.22e-16*SHHANDYMAX* -*2.17e-19**FRHANDYMAX-*0.210764**NBCOSTS+*15833.3**XRATE-*699.4481**LIBOR -*46.30054)*

Ce4*: 0.0470716*(SHHANDYMAX+1.39e-16*NBHANDYMAX* -*0.0639374**NBCOSTS +*1188.884**XRATE-*45.7794**LIBOR+*45.7794)*

&

Ce1: OFHANDYMAX=-*8.88e-16**NBHANDYMAX+*2.22e-16*SHHANDYMAX* +*2.17e-19**FRHANDYMAX+*0.210764**NBCOSTS-*15833.3**XRATE+*699.4481**LIBOR+*46.30054*

Ce4: *SHHANDYMAX=-1.39e-16*NBHANDYMAX+-0.0639374**NBCOSTS-*1188.884**XRATE +*45.7794**LIBOR+*45.7794*

Table 4.20

	Handymax Johansen normalization restrictions (betas) Coefficient	
	Ce1	*Ce4*
OFHANDYMAX	*1*	*0*
NBHANDYMAX	*8.88e-16*	*1.39e-16*
SHHANDYMAX	*-2.22e-16*	*1*
FRHANDYMAX	*-2.17e-19*	*0*
NBCOSTS	*-0.210764*	*-0.0639374*
XRATE	*15833.3*	*1188.884*
LIBOR	*-699.4481*	*-45.7794*
CONS	*-46.30054*	*-45.7794*

**the original tables are in Appendixes

4.2.1.3 The Panamax

The third segment of the Bulk Carrier Sector is The Panamax. In the Johansen cointegration test we assume that the null hypothesis of the trace test is H_o: rank (Π) =r against the alternative hypothesis of H_A: rank (Π) =n, which **n** is a full rank, with number of lags two and three respectively. The **Table 4.21** shows that the trace statistic is higher than the 5% critical value, till the rank 4 out of seven for lags(2) and till rank 3 out of seven for lags(3). In our case we prefer the maximum number of rank, which means that we have four cointegrating vectors, which explain the long run relationship of the variable.

Table 4.21

Panamax Johansen tests for cointegration (vecrank)					
	Lags (2)			Lags (3)	
Maximum rank	Trace statistic	5% critical value	Maximum rank	Trace statistic	5% critical value
0	*228.6567*	*124.24*	*0*	*244.0293*	*124.24*
1	*126.6807*	*94.15*	*1*	*114.8680*	*94.15*
2	*81.7596*	*68.52*	*2*	*70.6257*	*68.52*
3	*47.4880*	*47.21*	*3*	*41.6787**	*47.21*
4	*21.5223**	*29.68*	*4*	*21.6062*	*29.68*

**the original tables are in Appendixes

Our next step is to estimate the relationship of the variables, through the VECM model. We started the analysis with rank 4 and lags(3), but we noticed that there is not long run relationship. For that reason we decided to ran again the model with rank and lags(2). Starting the analysis from the short run to the long run, the **Table 4.22** shows the results of the conducting test, in which the null hypothesis is H_o: $\Gamma_i = 0$, which $\Gamma_i = (\sum_{j=1}^{6} \beta j) - I$ against the alternative of H_A: $\Gamma_i \neq 0$. Since the p-value of newbuilding prices, secondhand prices, freight rates, newbuilding costs and Libor is greater than 0.05 (significant level 95%), we do not reject the null hypothesis. That indicates that all variables are not statistically significant for O/F. Moreover, in exchange rate the p-value is lower than 0.05. Since it is lower, the variable is statistically significant for the model. Concluding, for the constant the null hypothesis is c=0 against the alternative of c≠0. It's obvious that p-value is higher than 0.05 which means that constant is not statistically significant for the model.

Table 4.22

Panamax Vector Error Correction model (Short run)		
	Coefficient	p>∣z∣
NBPANAMAX		
LD.	*0.0420376*	*0.649*
SHPANAMAX		
LD.	*-0.0058553*	*0.847*
FRPANAMAX		
LD.	*-1.95e-06*	*0.947*
NBCOSTS		
LD.	*-0.0009591*	*0.537*
XRATE		
LD.	*615.2018*	*0.024*
LIBOR		
LD.	*37.0843*	*0.262*
CONS	*-0.0090617*	*0.885*

**the original tables are in Appendixes

Continuing the analysis with the long run relationship, which is more important for our model, **Table 4.23** shows the results of the four cointegrating equations. In similar manner with above the null hypothesis now is H_o: $\Pi=0$, which $\Pi=\sum_{i=1}^{4} \beta i$, against the alternative of $\Pi \neq 0$. Since the p- value is lower than 0.05 only in ce1, we reject the null hypothesis and we accept the alternative. That means that ce1 is statistically significant. On the contrary, p- value of ce2, ce3 and ce4 is higher than 0.05, which means that we do not reject the null hypothesis. That means that these vectors are not statistically significant for the model and considering removing from the model. In addition, the error term in the first cointegrating equation is positive, which lead us to the conclusion that O/F increases in order to approach the equilibrium.

Table 4.23

	Panamax Vector Error Correction model (Long run) Coefficient	p>│z│
Ce1		
L1.	*0.0160232*	*0.032*
Ce2		
L1.	*0.0000166*	*0.283*
Ce3		
L1.	*0.0021772*	*0.951*
Ce4		
L1.	*0.0091313*	*0.658*

**the original tables are in Appendixes

Concluding, the Panamax segment depends only on one cointegrating equation in long run. The beta in describes the speed of adjustment back to equilibrium, while the coefficient error term (γ), in **Table 4.24** defines the long run relationship. Furthermore it is very common to "normalize" a particular variable; in order the coefficient on that specific variable in the cointegrating vector is one. Thus, the long run relationship with the speed of adjustment and the long-run cointegrating relationship for the Panamax segment is respectively:

Ce1: *0.0160232*(OFPANAMAX+3.33e-16 *NBPANAMAX-1.08e-19*FRPANAMAX -0.0095213*NBCOSTS-10878.13*XRATE-97.52135*LIBOR+83.63525*

&

Ce1: *OFPANAMAX=-3.33e-16 *NBPANAMAX+1.08e-19*FRPANAMAX +0.0095213*NBCOSTS+10878.13*XRATE+97.52135*LIBOR-83.63525*

Table 4.24

Panamax Johansen normalization restrictions (betas)	Coefficient *Ce1*
OFPANAMAX	*1*
NBPANAMAX	*3.33e-16*
SHPANAMAX	*0*
FRPANAMAX	*-1.08e-19*
NBCOSTS	*-0.0095213*
XRATE	*-10878.13*
LIBOR	*-97.52135*
CONS	*83.63525*

**the original tables are in Appendixes

4.2.1.4 The Capesize

The fifth segment of the Bulk Carrier Sector is The Capesize. To begin with, the Johansen cointegration tests we assume that the null hypothesis of the trace test is H_o: rank (Π) =r against the alternative hypothesis of H_A: rank (Π) =n, which **n** is a full rank, with number of lags two and three respectively. The **Table 4.25** shows that the trace statistic is higher than the 5% critical value till the rank 5 out of seven for lags(2) and rank 4 for lags(3). In our case we prefer the maximum number of rank, which means that we have five cointegrating vectors, which explain the long run relationship of the variable.

Table 4.25

Capesize
Johansen tests for cointegration (vecrank)

	Lags (2)			Lags (3)	
Maximum rank	Trace statistic	5% critical value	Maximum rank	Trace statistic	5% critical value
0	*264.1937*	*124.24*	*0*	*278.2772*	*124.24*
1	*150.1899*	*94.15*	*1*	*149.9655*	*94.15*
2	*95.9858*	*68.52*	*2*	*94.6119*	*68.52*
3	*52.7416*	*47.21*	*3*	*50.6696*	*47.21*
4	*30.2108*	*29.68*	*4*	*28.1826**	*29.68*
5	*8.1893**	*15.41*	*5*	*9.6220*	*15.41*

**the original tables are in Appendixes

After estimating the rank the next step is to survey the short and the long run relationship of the variables, via the VECM model with rank 5 and lags(3). Starting the analysis from the short run to the long run, the **Table 4.26** shows the results of the conducting test, with one and two lags for all the six variables. Carrying out the test, in which the null hypothesis is H_o: Γ_i =0 , which Γ_i= $(\sum_{j=1}^{6} \beta j) - I$ against the alternative of H_A: $\Gamma_i \neq 0$, the p-value of all variables in both one and two lags is greater than 0.05 (significant level 95%), thus we do not reject the null hypothesis. That indicates that all variables are not statistically significant for O/F. For the constant, the null hypothesis is c=0 against the alternative of c≠0. It's obvious that p-value is higher than 0.05 which means that constant is not statistically significant for the model.

Table 4.26

	Coefficient	$p>\|z\|$
Capesize Vector Error Correction model (Short run)		
NBCAPESIZE		
LD.	*0.1211945*	*0.092*
L2D.	*0.1068439*	*0.160*
SHCAPESIZE		
LD.	*-0.0261424*	*0.428*
L2D.	*-0.0017114*	*0.953*
FRCAPESIZE		
LD.	*0.0000138*	*0.460*
L2D.	*0.00002*	*0.309*
NBCOSTS		
LD.	*-0.0041328*	*0.086*
L2D.	*0.0029014*	*0.218*
XRATE		
LD.	*270.2665*	*0.489*
L2D.	*32.75984*	*0.932*
LIBOR		
LD.	*-66.82097*	*0.257*
L2D.	*-6.804836*	*0.900*
CONS	*7.41e-07*	*1.000*

**the original tables are in Appendixes

In long run, our model consists of five cointegrating equations as shown in **Table 4.27**. Like above the null hypothesis now is H_o: Π=0, which $\Pi=\sum_{i=1}^{5} \beta i$, against the alternative of Π ≠0. Since the p- value is lower than 0.05 in ce1, we reject the null hypothesis and we accept the alternative. That means that ce1 is statistically significant. On the other side, p- value of ce2, ce3, ce4 and ce5 is higher than 0.05, which means that we do not reject the null hypothesis, meaning that these vectors are not statistically significant for the model and considering removing from it. In addition, the error term in the first cointegrating equation is negative, which lead us to the conclusion that O/F decreases to approach the equilibrium.

Table 4.27

Capesize Vector Error Correction model (Long run)		
	Coefficient	p>|z|
Ce1		
L1.	*-0.0255184*	*0.000*
Ce2		
L1.	*2.28e-06*	*0.850*
Ce3		
L1.	*0.0435362*	*0.065*
Ce4		
L1.	*0.0187522*	*0.339*
Ce5		
L1.	*-0.0005735*	*0.621*

**the original tables are in Appendixes

Concluding, the Capesize segment depends only on one cointegrating equation in long run. The beta in describes the speed of adjustment back to equilibrium, while the coefficient error term (γ), **Table 4.28** defines the long run relationship. Furthermore it is very common to "normalize" a particular variable; in order the coefficient on that specific variable in the cointegrating vector is one. Thus, the long run relationship with the speed of adjustment and the long-run cointegrating relationship for the Capesize segment is respectively:

Ce1: *-0.0255184*(OFCARESIZE-1.67e-16*NBCAPESIZE-1.73e-18*NBCOSTS-22783.91*XRATE -325.1592*LIBOR+183.8806*

&

Ce1: *OFCARESIZE=+1.67e-16*NBCAPESIZE+1.73e-18*NBCOSTS+22783.91*XRATE +325.1592*LIBOR-183.8806*

Table 4.28

Capesize Johansen normalization restrictions (betas)	
	Coefficient *Ce1*
OFCAPESIZE	*1*
NBCAPESIZE	*-1.67e-16*
SHCAPESIZE	*0*
FRCAPESIZE	*0*
NBCOSTS	*-1.73e-18*
XRATE	*-22783.91*
LIBOR	*-325.1592*

**the original tables are in Appendixes

4.2.2 Tanker Sector

In this sub chapter we are going to examine the second major shipping sector, which is the Tankers. Due to the fact that we are not having available data for the orderbook to fleet ratio for the general category of the Tankers as well as for its three sub - segments (Handysize, Panamax, Aframax), we will examine only two sub-segments, the Suezmax and VLCC/ULCC.

4.2.2.1 The Suezmax

We are going to analyze now the first segment of the Tanker sector, The Suezmax. To start with, the Johansen cointegration test. We assume that the null hypothesis of the trace test is H_o: rank (Π) =r against the alternative hypothesis of H_A: rank (Π) =n, which **n** is a full rank, with number of lags two and three respectively. The **Table 4.29** displays that the trace statistic is higher than the 5% critical value till rank 1 out of seven, which means that we have one cointegrating vector, which explain the long run relationship of the variable.

Table 4.29

Suezmax
Johansen tests for cointegration (vecrank)

	Lags (2)			Lags (3)	
Maximum rank	Trace statistic	5% critical value	Maximum rank	Trace statistic	5% critical value
0	*126.5223*	*124.24*	*0*	*194.98*	*139.0263*
1	*90.9781**	*94.15*	*1*	*127.81*	*93.8443**

**the original tables are in Appendixes

Carrying on the analysis, we will use the VECM model with rank 1 and lags(3), in order to estimate the short and the long run. Due to the fact that with lags(3), we don't have any long run relationship, we took the decision to run again the model but now with lags(2).Starting from the short to the long run, **Table 4.30** present the results of the conducting test, in which the null hypothesis is H_o: Γ_i =0 , which $\Gamma_i = (\sum_{j=1}^{6} \beta j) - I$ against the alternative of H_A: $\Gamma_i \neq 0$. Since the p-value for all variables is higher than 0.05 (significant level 95%), we do not reject the null hypothesis. That indicates that all variables are not statistically significant for O/F. Concluding, for the constant the null hypothesis is c=0 against the alternative of c≠0. It's obvious that p-value is higher than 0.05 which means that constant is not statistically significant for the model.

Table 4.30

Suezmax Vector Error Correction model (Short run)		Coefficient	p>|z|
NBSUEZMAX			
	LD.	*0.0602108*	*0.454*
SHSUEZMAX			
	LD.	*0.0672831*	*0.110*
FRSUEZMAX			
	LD.	*-3.71e-06*	*0.930*
NBCOSTS			
	LD.	*0.0004905*	*0.814*
XRATE			
	LD.	*299.6158*	*0.434*
LIBOR			
	LD.	*-29.54531*	*0.555*
CONS		*0.0132873*	*0.878*

**the original tables are in Appendixes

In long run, our model contains two cointegrating equations, shown in **Table 4.31**. Similarly with above the null hypothesis now is H_o: Π=0, which $\Pi=\sum_{i=1}^{2}\beta i$, against the alternative of Π ≠0. Since the p- value is lower than 0.05 in both ce1 and ce2 we reject the null hypothesis and we accept the alternative. That means that ce1 and ce2 are statistically significant. In addition, the error term in the first cointegrating equation is negative, which lead us to the conclusion that O/F decreases to approach the equilibrium. On the other hand, the error term in the second cointegrating equation is positive, meaning that O/F increase as to approach the equilibrium.

Table 4.31

Suezmax Vector Error Correction model (Long run)		Coefficient	p>|z|
Ce1			
	L1.	*-0.0306137*	*0.004*
Ce2			
	L1.	*0.0000305*	*0.041*

**the original tables are in Appendixes

So, the Suezmax segment depends only on two cointegrating equation in long run. The beta in describes the speed of adjustment back to equilibrium, while the coefficient error term (γ), **Table 4.32** defines the long run relationship. Furthermore it is very common to “normalize” a particular variable; in order the coefficient on that specific variable in the cointegrating vector is one. Thus, the long run relationship with the speed of adjustment and the long-run cointegrating relationship for the Suezmax segment is respectively:

***Ce1:**-0.030613*(OFSUEZMAX+1.841526*NBSUEZMAX-2.119902*SHSUEZMAX +0.0255142*NBCOSTS-4281.532*XRATE+100.4376*LIBOR+4.245019)*

***Ce2:**0.0000305*(FRSUEZMAX+1211.153*NBSUEZMAX-1602.671*SHSUEZMAX +10.47742*NBCOSTS-146414.1*XRATE+122905*LIBOR-22459.73)*

&

***Ce1:**OFSUEZMAX=-1.841526*NBSUEZMAX+2.119902*SHSUEZMAX-0.0255142*NBCOSTS +4281.532*XRATE-100.4376*LIBOR-4.245019*

***Ce2:**FRSUEZMAX=-1211.153*NBSUEZMAX+1602.671*SHSUEZMAX -10.47742*NBCOSTS +146414.1*XRATE-122905*LIBOR+22459.73*

Table 4.32

Suezmax
Johansen normalization restrictions (betas)

	Coefficient	
	Ce1	*Ce2*
OFSUEZMAX	*1*	*0*
NBSUEZMAX	*1.841526*	*1211.153*
SHSUEZMAX	*-2.119902*	*-1602.671*
FRSUEZMAX	*0*	*1*
NBCOSTS	*0.0255142*	*10.47742*
XRATE	*-4281.532*	*-146414.1*
LIBOR	*100.4376*	*122905*
CONS	*4.245019*	*-22459.73*

**the original tables are in Appendixes

4.2.2.2 The VLCC/ULCC

The second segment of the Tanker is The VLCC/ULCC. In the Johansen cointegration test we assume that the null hypothesis of the trace test is H_o: rank (Π) =r against the alternative hypothesis of H_A: rank (Π) =n, which **n** is a full rank, with number of lags two and three respectively. The **Table 4.33** shows that the trace statistic is higher than the 5% critical value, till the rank 3 out of seven, which means that we have three cointegrating vectors, which explain the long run relationship of the variable.

Table 4.33

VLCC/ULCC Johansen tests for cointegration (vecrank)					
	Lags (2)			Lags (3)	
Maximum rank	Trace statistic	5% critical value	Maximum rank	Trace statistic	5% critical value
0	*166.2000*	*124.24*	*0*	*161.3361*	*124.24*
1	*107.4751*	*94.15*	*1*	*110.9860*	*94.15*
2	*72.9684*	*68.52*	*2*	*71.0661*	*68.52*
3	*44.9676**	*47.21*	*3*	*45.6097**	*47.21*

**the original tables are in Appendixes

Continuing the analysis and running the VECM model with rank 3 and lags(3), we figure out that there is no long run relationship. Likewise, we above situations we ran the model again but this time with lag(2).The **Table 4.34** shows the results of the conducting test, in which the null hypothesis is H_o: Γ_i =0 , which $\Gamma_i = (\sum_{j=1}^{6} \beta j) - I$ against the alternative of H_A: $\Gamma_i \neq 0$. Since the p-value of secondhand prices, freight rates, newbuilding costs, exchange rate and libor is greater than 0.05 (significant level 95%), we do not reject the null hypothesis. That indicates that all variables are not statistically significant for O/F. Furthermore, in newbuilding prices the p-value is lower than 0.05, meaning that we do reject the null hypothesis and the variable is statistically significant for the model. Concluding, for the constant the null hypothesis is c=0 against the alternative of c≠0. It's obvious that p-value is lower than 0.05

Table 4.34

VLCC/ULCC Vector Error Correction model (Short run)			
		Coefficient	p>|z|
NBVLCC			
	LD.	*0.0908246*	*0.043*
SHVLCC			
	LD.	*0.0113731*	*0.599*
FRVLCC			
	LD.	*-0.0000129*	*0.517*
NBCOSTS			
	LD.	*-0.00147*	*0.417*
XRATE			
	LD.	*-142.32*	*0.658*
LIBOR			
	LD.	*-49.24626*	*0.234*
CONS		*1.946407*	*0002*

**the original tables are in Appendixes

which means that constant is statistically significant for the model.

The next step is to investigate the long run relationship of the variables, shown in **Table 4.35.** In similar manner with above the null hypothesis now is H_o: Π=0, which $\Pi = \sum_{i=1}^{3} \beta i$, against the alternative of $\Pi \neq 0$. Since the p- value is lower than 0.05 in ce1 and ce3, we reject the null hypothesis and we accept the alternative. That means that ce1 and ce3 is statistically significant. On the other side, p- value of ce2 is higher than 0.05, which means that we do not reject the null hypothesis. That means that these vectors are not statistically significant for the model and considering removing from the model. In addition, the error term in the first cointegrating equation is negative, which means that O/F decreases in order to reach the equilibrium. Similarly with previous the error term in the third cointegrating equation is positive, which lead us to the conclusion that orderbook to fleet ratio increases in order to approach the equilibrium.

Table 4.35

VLCC/ULCC		
Vector Error Correction model (Long run)		
	Coefficient	p>∣z∣
Ce1		
L1.	*-0.0228137*	*0.007*
Ce2		
L1.	*-3.49e-06*	*0.722*
Ce3		
L1.	*0.040009*	*0.004*

**the original tables are in Appendixes

Concluding, the VLCC/ULCC segment depends on two cointegrating equations in long run. The beta describes the speed of adjustment back to equilibrium, while the coefficient error term (γ), **Table 4.36** defines the long run relationship. Furthermore it is very common to "normalize" a particular variable; in order the coefficient on that specific variable in the cointegrating vector is one. Thus, the long run relationship with the speed of adjustment and the long-run cointegrating relationship for VLCC/ULCC sub- segment is respectively:

Ce1:-0.0228137*(OFVLCC-112.654*NBVLCC-7.11e-15*SHVLCC+19.01609*NBCOSTS -1216164*XRATE+34720.22+62.64716)

Ce3: 0.040009*(SHVLCC+7.11e-15*OFVLCC-74.9917*NBVLCC-6.94e-18*FRVLCC +12.53296*NBCOSTS -798278.7*XRATE+22825.35*LIBOR-19.36481)

&

Ce1:OFVLCC=+112.654*NBVLCC+7.11e-15*SHVLCC-19.01609*NBCOSTS-1216164*XRATE -34720.22-62.64716)

Ce3: SHVLCC=-7.11e-15*OFVLCC+74.9917*NBVLCC+6.94e-18*FRVLCC -12.53296*NBCOSTS +798278.7*XRATE-22825.35*LIBOR+19.36481

Table 4.36

VLCC/ULCC Johansen normalization restrictions (betas)		
	Coefficient	
	Ce1	*Ce3*
OFVLCC	*1*	*7.11e-15*
NBVLCC	*-112.654*	*-74.9917*
SHVLCC	*-7.11e-15*	*1*
FRVLCC	*0*	*-6.94e-18*
NBCOSTS	*19.01609*	*12.53296*
XRATE	*-1216164*	*-798278.7*
LIBOR	*34720.22*	*22825.35*
CONS	*62.64716*	*-19.36481*

**the original tables are in Appendixes

4.2.3 Containership Sector

In this sub chapter we are going to examine the third major shipping sector, which is the Containership. Similarly with the tanker sector, we were not having available data for the orderbook to fleet ratio variable for the sub- segments of the Containers, so we will examine only the general sector of it.

Conducting the Johansen cointegration test, in which the null hypothesis of the trace test is H_o: rank (Π) =r against the alternative hypothesis of H_A: rank (Π) =n, which **n** is a full rank, with number of lags two and three respectively. **Table 4.37** displays that the trace statistic is higher than the 5% critical value, till the rank 0 out of seven for lags(2) and till rank 1 out of seven for lags(3). In our case we prefer the maximum number of rank, which means that we have one cointegrating vectors, which explain the long run relationship of the variable.

Table 4.37

Containership Johansen tests for cointegration (vecrank)					
	Lags (2)			Lags (3)	
Maximum rank	Trace statistic	5% critical value	Maximum rank	Trace statistic	5% critical value
0	*114.3669**	*124.24*	*0*	*128.7921*	*124.24*
1	*67.8632*	*94.15*	*1*	*83.5729**	*94.15*

**the original tables are in Appendixes

Continuing the analysis, we will use the VECM model with rank 1 and lags(3), in order to investigate the long and the short run relationship. Beginning from the short run to the long run, **Table 4.38** present the results of the conducting test, in which the null hypothesis is H_o: Γ_i =0 , which Γ_i= $(\sum_{j=1}^{6} \beta j) - I$ against the alternative of H_A:

$\Gamma_i \neq 0$. Since the p-value of newbuilding prices, secondhand prices, newbuilding costs, exchange rate, libor in both one and two lags is higher than 0.05 (significant level 95%), we do not reject the null hypothesis. That indicates that all variables are not statistically significant for O/F. Moreover in freight rates the p-value –with one lag- is lower than 0.05, so we do reject the null hypothesis. That means that the variable is statistically significant. On the other hand, with two lags the p-value is higher than 0.05, so we do not reject the null hypothesis and the variable is not statistically significant for the model. Concluding, for the constant the null hypothesis is c=0 against the alternative of c≠0. It's obvious that p-value is higher than 0.05 which means that constant is not statistically significant for the model.

Table 4.38

Containership
Vector Error Correction model (Short run)

		Coefficient	p>|z|
NBCONTAINERS			
	LD.	0.0554657	*0.207*
	L2D.	-0.0088406	*0.852*
SHCONTAINERS			
	LD.	-0.0027928	*0.870*
	L2D.	0.0039474	*0.825*
FRCONTAINERS			
	LD.	0.000205	*0.046*
	L2D.	-0.0000296	*0.786*
NBCOSTS			
	LD.	-0.000246	*0.888*
	L2D.	-0.002199	*0.173*
XRATE			
	LD.	6.352505	*0.982*
	L2D.	323.2831	*0.240*
LIBOR			
	LD.	23.09356	*0.566*
	L2D.	-60.13016	*0.141*
CONS		-0.0106709	*0.863*

**the original tables are in Appendixes

The third step of the analysis is the analysis of the long run relationship, which is more important for our model. **Table 4.39** shows the results of one cointegrating vector. In similar manner with above the null hypothesis now is H_o: Π=0, which $\Pi=\sum_{i=1}^{1}\beta i$, against the alternative of Π ≠0. Since the p- value is lower than 0.05 in ce1, we reject the null hypothesis and we accept the alternative. That means that ce1 is statistically significant. In addition, the error term in the first cointegrating equation is negative, which lead us to the conclusion that O/F decreases in order to approach the equilibrium.

Table 4.39

Containership Vector Error Correction model (long run)		
	Coefficient	p>│z│
Ce1		
L1.	*-0.0189267*	*0.000*

**the original tables are in Appendixes

Last but not least, the containership sector depends only on one cointegrating equation, which comes to the conclusion that the variable has strong long run relationship. The beta describes the speed of adjustment back to equilibrium, while the coefficient error term (γ), in **Table 4.40** defines the long run relationship. Furthermore it is very common to "normalize" a particular variable; in order the coefficient on that specific variable in the cointegrating vector is one. Thus, the long run relationship with the speed of adjustment and the long-run cointegrating relationship for the Container sector is respectively:

Ce1: *-0.0189267*(OFCONTAINERS-1.005204*NBCONTAINERS+0.7264335*SHCONTAINERS -0.0049005*FRCONTAINERS +0.0043959*NBCOSTS-4535.77*XRATE -165.585*LIBOR+106.301)*

&

Ce1: *OFCONTAINERS=+1.005204*NBCONTAINERS-0.7264335*SHCONTAINERS +0.0049005*FRCONTAINERS -0.0043959*NBCOSTS+4535.77*XRATE +165.585*LIBOR-106.301*

Table 4.40

Containership Johansen normalization restrictions (betas)	
	Coefficient
	Ce1
OFCONTAINERS	*1*
NBCONTAINERS	*-1.005204*
SHCONTAINERS	*0.7264335*
FRCONTAINERS	*-0.0049005*
NBCOSTS	*0.0043959*
XRATE	*-4535.77*
LIBOR	*-165.585*
CONS	*106.301*

**the original tables are in Appendixes

5. Conclusions

Beginning with the short run analysis, it should be mentioned that no significant results were found. The econometric model indicated that there is no actual pattern between the fundamentals of our series and orderbook as a percentage of the fleet. The only variables that found out to have effect on orderbook were the newbuilding prices in handysize and VLCC vessels as well as the exchange rate and freight rates in panamax and containers respectively. These results though are not enough to lead us in to an overall conclusion about the variation of orderbook to fleet ratio in relation to the examined shipping segments.

In the long run the results are quite different. Shipbuilding costs were found to have a statistically significant effect for all ship types. More specifically it has a positive impact in the general bulk category and its sub segments, while in tankers and containers the effect is negative. For instance, a 1% increase in NBCOSTS incurs a 20% increase in O/F in handymax and a 2.5% decline in O/F in suezmax. The results were quite arguable as we expected that for all ship categories a possible increase in the steel price would incur a decrease in the orderbook to fleet ratio. Athough, everything is related to the shipping cycle's phase that we run through . The positive relationship of the steel needed to build a vessel with the orderbook may be due to the fact of the high future expectations or even the attitude of the shipowner to invest while in depressing periods.

Freight rates are proved to have a slight impact on our model for all three major shipping categories for quite all the segments. Although we expected freight rates to have greater effect on the series, its influence is present but not significant. The theory tells us that as freight rates increase the orders of new ships are increased as well. The shipowners are willing to invest in new ships that will boost their earnings.

Exchange rate fluctuations are indicated as very important in our model. The fact that shipbuilding projects are initially carried out in the local currency of the shipbuilding nation, but finally quoted in the buyer's currency which is in dollars, composes a great incentive for the shipowning companies. The shipowners knowing that they are going to buy cheap, are ordering more vessels.

As far as concerns the other three variables of our research the results are twofold. The newbuilding prices seem to influence orderbook both positively and negatively. As we notice in handysize and capesize categories of bulk sector, the orderbook is positively related to the NB, whereas the handymax and panamax are negatively. In the tankers sector, the suezmax seem to be effected negatively from a possible increase in the newbuilding prices while the VLCC positively. Finally the containers general's category orderbook is noticed to be influenced positively from a positive change in the NB price. These results may come from the attitude of the shipowner to invest regardless of the current economic situation or even the phase of the shipping cycle. A risk lover shipowner may proceed to the order of a new vessel in bad economic periods or an orthodox one would prefer to order a new ship, if the prices of secondhand vessel arise a lot instead of buying an expensive SH vessel.

In our model, the secondhand prices affect orderbook either positively in a very low level or not at all in every shipping category. This may be the case, because we chose to examine 5year old vessel's secondhand prices. These vessels are quite new and maybe not the most characteristic ones for analyzing secondhand prices influence on orderbook to fleet.

The cost of capital is the last variable included in our model. In the bulk carrier and container sector the impact of an increase in LIBOR will incur a significant increase in orderbook. On the other side, an opposite change is incurred in the tanker sector. A possible high interest rate will impact negatively the demand for new ships. The opposite however could be the case where the bankers rush by all means to accumulate money quickly. As a result investors deposit money now in order to buy vessels in the long run.

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6. Appendixes

Appendix 1 - Johansen cointegration test in Bulk Carriers. ***Source:*** StataSE12

```
. vecrank OF NBCOSTS FRBULKS SHBULKS NBBULKS XRATE LIBOR, trend(constant) lags(3)

                     Johansen tests for cointegration
Trend: constant                                        Number of obs =     214
Sample:  Nov 1999 - Aug 2017                                    Lags =       3
```

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	105	-2517.2873	.	275.1834	124.24
1	118	-2455.3685	0.43936	151.3458	94.15
2	129	-2427.919	0.22627	96.4468	68.52
3	138	-2411.3737	0.14327	63.3562	47.21
4	145	-2396.1703	0.13246	32.9493	29.68
5	150	-2386.0832	0.08996	12.7752*	15.41
6	153	-2382.3161	0.03459	5.2409	3.76
7	154	-2379.6956	0.02419		

Appendix 2 – Vector error correction model in Bulk Carriers. ***Source:*** StataSE12

```
Vector error-correction model

Sample:  Sep 1999 - Aug 2017                    No. of obs      =        216
                                                AIC             =   25.30458
Log likelihood = -2680.895                      HQIC            =   25.63286
Det(Sigma_ml)  =  142.3037                      SBIC            =   26.11715
```

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_OF	6	.74748	0.6147	333.469	0.0000
D_LIBOR	6	.00183	0.1380	33.45218	0.0000
D_XRATE	6	.000226	0.0711	15.99961	0.0138
D_NBCOSTS	6	39.9246	0.2489	69.2478	0.0000
D_FRBULKS	6	3123.91	0.1589	39.49753	0.0000
D_SHBULKS	6	15.5279	0.2869	84.10434	0.0000
D_NBBULKS	6	34.1784	0.4555	174.8717	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
D_OF						
_ce1 L1.	-.0191568	.0046715	-4.10	0.000	-.0283128	-.0100008
_ce2 L1.	3.087382	1.214584	2.54	0.011	.7068406	5.467923
_ce3 L1.	-213.821	40.19913	-5.32	0.000	-292.6099	-135.0322
_ce4 L1.	-.001409	.0005928	-2.38	0.017	-.0025709	-.0002471
_ce5 L1.	.0000164	.0000131	1.25	0.211	-9.30e-06	.000042
_cons	-1.00e-07	.0511469	-0.00	1.000	-.1002461	.1002459

Appendix 3 – Johansen normalization restrictions (betas) in Bulk Carriers. ***Source:*** StataSE12.

Johansen normalization restrictions imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce1						
OF	1	.	.	.	.	.
LIBOR	-7.11e-15	.	.	.	.	.
XRATE	-9.09e-13	.	.	.	.	.
NBCOSTS	-8.67e-18	.	.	.	.	.
FRBULKS	1.63e-19	.	.	.	.	.
SHBULKS	-.1194097	.0574782	-2.08	0.038	-.2320649	-.0067544
NBBULKS	-.0194121	.0110341	-1.76	0.079	-.0410385	.0022144
_cons	25.08345	.	.	.	.	.
_ce2						
OF	0	(omitted)				
LIBOR	1	.	.	.	.	.
XRATE	1.78e-15	.	.	.	.	.
NBCOSTS	-7.45e-20	.	.	.	.	.
FRBULKS	-1.06e-21	.	.	.	.	.
SHBULKS	-.0014142	.0002173	-6.51	0.000	-.0018401	-.0009883
NBBULKS	.0002485	.0000417	5.96	0.000	.0001668	.0003303
_cons	-.2365944	.	.	.	.	.
_ce3						
OF	0	(omitted)				
LIBOR	-8.67e-19	.	.	.	.	.
XRATE	1	.	.	.	.	.
NBCOSTS	-1.06e-22	.	.	.	.	.
FRBULKS	-5.29e-23	.	.	.	.	.
SHBULKS	-.0000356	4.99e-06	-7.13	0.000	-.0000453	-.0000258
NBBULKS	3.15e-06	9.57e-07	3.29	0.001	1.27e-06	5.03e-06
_cons	-.0093144	.	.	.	.	.
_ce4						
OF	-4.44e-16	.	.	.	.	.
LIBOR	-1.28e-13	.	.	.	.	.
XRATE	-9.09e-13	.	.	.	.	.
NBCOSTS	1	.	.	.	.	.
FRBULKS	1.30e-18	.	.	.	.	.
SHBULKS	-.6015758	.3496652	-1.72	0.085	-1.286907	.0837554
NBBULKS	-.3458952	.0671253	-5.15	0.000	-.4774584	-.2143321
_cons	150.4826	.	.	.	.	.
_ce5						
OF	0	(omitted)				
LIBOR	1.27e-11	.	.	.	.	.
XRATE	-3.49e-10	.	.	.	.	.
NBCOSTS	4.44e-16	.	.	.	.	.
FRBULKS	1	.	.	.	.	.
SHBULKS	-83.79104	19.37407	-4.32	0.000	-121.7635	-45.81855
NBBULKS	-3.290766	3.719245	-0.88	0.376	-10.58035	3.99882
_cons	3618.453	.	.	.	.	.

Appendix 4 - Johansen cointegration test in Handysize. ***Source:*** StataSE12

```
. vecrank OFHANDYSIZE FRHANDYSIZE NBHANDYSIZE SHHANDYSIZE NBCOSTS XRATE LIBOR, trend(constant)

                         Johansen tests for cointegration
Trend: constant                                         Number of obs =     215
Sample:  Oct 1999 - Aug 2017                                     Lags =       2
-------------------------------------------------------------------------------
                                                        5%
maximum                                      trace    critical
  rank    parms       LL       eigenvalue  statistic    value
    0      56     -1920.1931        .       237.5178   124.24
    1      69      -1877.593    0.32718     152.3175    94.15
    2      80     -1848.6955    0.23571      94.5225    68.52
    3      89     -1831.9194    0.14449      60.9704    47.21
    4      96     -1818.5514    0.11693      34.2343    29.68
    5     101     -1807.2159    0.10008      11.5634*   15.41
    6     104     -1803.6773    0.03238       4.4862     3.76
    7     105     -1801.4342    0.02065
-------------------------------------------------------------------------------
```

```
. vecrank OFHANDYSIZE FRHANDYSIZE NBHANDYSIZE SHHANDYSIZE NBCOSTS XRATE LIBOR, trend(constant) lags(3)

                         Johansen tests for cointegration
Trend: constant                                         Number of obs =     214
Sample:  Nov 1999 - Aug 2017                                     Lags =       3
-------------------------------------------------------------------------------
                                                        5%
maximum                                      trace    critical
  rank    parms       LL       eigenvalue  statistic    value
    0     105     -1835.1761        .       276.6254   124.24
    1     118     -1766.7947    0.47222     139.8627    94.15
    2     129     -1742.5461    0.20278      91.3655    68.52
    3     138     -1726.4494    0.13967      59.1721    47.21
    4     145     -1713.4461    0.11443      33.1655    29.68
    5     150     -1702.8817    0.09401      12.0368*   15.41
    6     153     -1699.1204    0.03454       4.5140     3.76
    7     154     -1696.8634    0.02087
-------------------------------------------------------------------------------
```


```
. vecrank OFHANDYSIZE FRHANDYSIZE NBHANDYSIZE SHHANDYSIZE NBCOSTS XRATE LIBOR, trend(constant) lags(3)

                         Johansen tests for cointegration
Trend: constant                                         Number of obs =     214
Sample:  Nov 1999 - Aug 2017                                     Lags =       3
-------------------------------------------------------------------------------
                                                        5%
maximum                                      trace    critical
  rank    parms       LL       eigenvalue  statistic    value
    0     105     -1835.1761        .       276.6254   124.24
    1     118     -1766.7947    0.47222     139.8627    94.15
    2     129     -1742.5461    0.20278      91.3655    68.52
    3     138     -1726.4494    0.13967      59.1721    47.21
    4     145     -1713.4461    0.11443      33.1655    29.68
    5     150     -1702.8817    0.09401      12.0368*   15.41
    6     153     -1699.1204    0.03454       4.5140     3.76
    7     154     -1696.8634    0.02087
-------------------------------------------------------------------------------
```

Appendix 5 - Vector error correction model in Handymax. ***Source:*** StataSE12

Vector error-correction model

Sample: Nov 1999 - Aug 2017 No. of obs = 214

AIC = 17.31922

Log likelihood = -1703.156 HQIC = 18.2726

Det(Sigma_ml) = .0192973 SBIC = 19.67854

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_OFHANDYSIZE	20	.553311	0.5422	228.607	0.0000
D_FRHANDYSIZE	20	1319.28	0.4460	155.3791	0.0000
D_NBHANDYSIZE	20	29.1674	0.6033	293.5005	0.0000
D_SHHANDYSIZE	20	1.58022	0.4033	130.4522	0.0000
D_NBCOSTS	20	32.4078	0.5428	229.0968	0.0000
D_XRATE	20	.00021	0.2416	61.47969	0.0000
D_LIBOR	20	.001311	0.5895	277.1856	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
D_OFHANDYSIZE						
_ce1						
L1.	-.017723	.0070423	-2.52	0.012	-.0315256	-.0039203
_ce2						
L1.	-5.86e-06	.0000197	-0.30	0.767	-.0000445	.0000328
_ce3						
L1.	.0007769	.000384	2.02	0.043	.0000242	.0015296
_ce4						
L1.	.0203892	.0236069	0.86	0.388	-.0258796	.066658
_ce5						
L1.	-.0004673	.0005542	-0.84	0.399	-.0015535	.0006189
OFHANDYSIZE						
LD.	.1856322	.0715126	2.60	0.009	.0454701	.3257942
L2D.	.1395567	.0734733	1.90	0.058	-.0044483	.2835617
FRHANDYSIZE						
LD.	.0000169	.0000379	0.45	0.655	-.0000573	.0000911
L2D.	.0000854	.0000426	2.00	0.045	1.84e-06	.0001689
NBHANDYSIZE						
LD.	.0013761	.0013828	1.00	0.320	-.0013343	.0040864
L2D.	-.0035664	.0012976	-2.75	0.006	-.0061097	-.001023
SHHANDYSIZE						
LD.	-.0391149	.0338728	-1.15	0.248	-.1055043	.0272745
L2D.	-.0287962	.0364196	-0.79	0.429	-.1001773	.0425849
NBCOSTS						
LD.	.0009534	.0010747	0.89	0.375	-.0011528	.0030597
L2D.	.0018895	.001037	1.82	0.068	-.0001429	.0039219
XRATE						
LD.	-109.2145	180.3335	-0.61	0.545	-462.6616	244.2327
L2D.	40.42056	177.79	0.23	0.820	-308.0415	388.8826
LIBOR						
LD.	-42.07304	28.90075	-1.46	0.145	-98.71748	14.57139
L2D.	-5.331425	27.14142	-0.20	0.844	-58.52764	47.86479
_cons	-5.95e-08	.039793	-0.00	1.000	-.077993	.0779929

Appendix 6 - Johansen normalization restrictions (betas) in Handysize. ***Source:*** StataSE12.

Johansen normalization restrictions imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce1						
OFHANDYSIZE	1	.	.	.	.	.
FRHANDYSIZE	2.17e-19	.	.	.	.	.
NBHANDYSIZE	-7.59e-18	.	.	.	.	.
SHHANDYSIZE	-1.67e-16	.	.	.	.	.
NBCOSTS	3.47e-18	.	.	.	.	.
XRATE	-8362.067	1857.097	-4.50	0.000	-12001.91	-4722.225
LIBOR	361.3714	127.9074	2.83	0.005	110.6774	612.0653
_cons	52.14025	.	.	.	.	.
_ce2						
OFHANDYSIZE	2.84e-14	.	.	.	.	.
FRHANDYSIZE	1	.	.	.	.	.
NBHANDYSIZE	2.22e-16	.	.	.	.	.
SHHANDYSIZE	-1.60e-13	.	.	.	.	.
NBCOSTS	-1.78e-15	.	.	.	.	.
XRATE	-3020088	772625.3	-3.91	0.000	-4534405	-1505770
LIBOR	86695.57	53214.52	1.63	0.103	-17602.97	190994.1
_cons	14645.31	.	.	.	.	.
_ce3						
OFHANDYSIZE	0	(omitted)				
FRHANDYSIZE	0	(omitted)				
NBHANDYSIZE	1	.	.	.	.	.
SHHANDYSIZE	-2.66e-15	.	.	.	.	.
NBCOSTS	-5.55e-17	.	.	.	.	.
XRATE	-245611.7	62928.03	-3.90	0.000	-368948.3	-122275
LIBOR	10783.84	4334.164	2.49	0.013	2289.036	19278.65
_cons	475.6553	.	.	.	.	.
_ce4						
OFHANDYSIZE	0	(omitted)				
FRHANDYSIZE	0	(omitted)				
NBHANDYSIZE	-9.76e-19	.	.	.	.	.
SHHANDYSIZE	1	.	.	.	.	.
NBCOSTS	-8.67e-19	.	.	.	.	.
XRATE	-5492.767	1100.22	-4.99	0.000	-7649.16	-3336.375
LIBOR	138.4683	75.77762	1.83	0.068	-10.05314	286.9897
_cons	29.21741	.	.	.	.	.
_ce5						
OFHANDYSIZE	1.78e-15	.	.	.	.	.
FRHANDYSIZE	1.73e-18	.	.	.	.	.
NBHANDYSIZE	5.20e-18	.	.	.	.	.
SHHANDYSIZE	-1.30e-14	.	.	.	.	.
NBCOSTS	1	.	.	.	.	.
XRATE	-139781.4	25318.69	-5.52	0.000	-189405.1	-90157.68
LIBOR	4800.149	1743.824	2.75	0.006	1382.318	8217.981
_cons	647.8041	.	.	.	.	.

Appendix 7 – Johansen cointegration test in Handymax. ***Source:*** StataSE12.

```
                       Johansen tests for cointegration
Trend: constant                                         Number of obs =     215
Sample:  Oct 1999 - Aug 2017                                     Lags =       2
-------------------------------------------------------------------------------
                                                          5%
maximum                                      trace    critical
  rank    parms       LL       eigenvalue  statistic    value
    0      56     -1343.235        .       207.2439    124.24
    1      69     -1297.911     0.34402    116.5959     94.15
    2      80    -1279.8758     0.15445     80.5256     68.52
    3      89    -1263.9691     0.13754     48.7121     47.21
    4      96     -1251.863     0.10651     24.4999*    29.68
    5     101    -1244.9251     0.06250     10.6241     15.41
    6     104    -1241.4542     0.03177      3.6823      3.76
    7     105     -1239.613     0.01698
-------------------------------------------------------------------------------
```

```
. vecrank OFHANDYMAX SHHANDYMAX NBHANDYMAX FRHANDYMAX NBCOSTS XRATE LIBOR, trend(constant) lags(3)

                       Johansen tests for cointegration
Trend: constant                                         Number of obs =     214
Sample:  Nov 1999 - Aug 2017                                     Lags =       3
-------------------------------------------------------------------------------
                                                          5%
maximum                                      trace    critical
  rank    parms       LL       eigenvalue  statistic    value
    0     105    -1267.2344        .       255.5875    124.24
    1     118    -1208.1951     0.42407    137.5090     94.15
    2     129    -1178.1668     0.24470     77.4522     68.52
    3     138    -1163.9183     0.12468     48.9552     47.21
    4     145    -1151.8879     0.10634     24.8945*    29.68
    5     150    -1144.6858     0.06509     10.4903     15.41
    6     153    -1141.4273     0.02999      3.9734      3.76
    7     154    -1139.4406     0.01840
-------------------------------------------------------------------------------
```

Appendix 8 – Vector error correction model in Handymax. ***Source:*** StataSE12.

```
. vec OFHANDYMAX FRHANDYMAX NBHANDYMAX SHHANDYMAX NBCOSTS XRATE LIBOR, trend(constant) rank(4)

Vector error-correction model

Sample:  Oct 1999 - Aug 2017                        No. of obs      =       215
                                                    AIC             =  12.53709
Log likelihood = -1251.737                          HQIC            =  13.14519
Det(Sigma_ml)  =  .0002689                          SBIC            =  14.04212

Equation           Parms      RMSE     R-sq      chi2     P>chi2
----------------------------------------------------------------
D_OFHANDYMAX         12     .985805   0.4793   185.9111   0.0000
D_FRHANDYMAX         12     2336.41   0.4048   137.3654   0.0000
D_NBHANDYMAX         12     .598668   0.4956   198.4968   0.0000
D_SHHANDYMAX         12     2.08194   0.4305   152.7046   0.0000
D_NBCOSTS            12     37.9674   0.3433   105.6192   0.0000
D_XRATE              12     .000219   0.1298   30.12142   0.0027
D_LIBOR              12     .001439   0.4841   189.5837   0.0000
----------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
D_OFHANDYMAX |
        _ce1 |
         L1. |  -.0140201   .0067062    -2.09   0.037     -.027164   -.0008762
             |
        _ce2 |
         L1. |  -4.00e-07   8.66e-06    -0.05   0.963    -.0000174    .0000166
             |
        _ce3 |
         L1. |   .0216613   .0410639     0.53   0.598    -.0588225     .102145
             |
        _ce4 |
         L1. |   .0470716   .0162097     2.90   0.004     .0153012    .0788419
             |
  OFHANDYMAX |
         LD. |   .2057566   .0696799     2.95   0.003     .0691866    .3423267
             |
  FRHANDYMAX |
         LD. |   -.000013   .0000444    -0.29   0.770    -.0000999    .0000739
             |
  NBHANDYMAX |
         LD. |    .010431   .1134121     0.09   0.927    -.2118526    .2327146
             |
  SHHANDYMAX |
         LD. |   .0114549   .0504624     0.23   0.820    -.0874496    .1103594
             |
     NBCOSTS |
         LD. |  -.0009527   .0017891    -0.53   0.594    -.0044593     .002554
             |
       XRATE |
         LD. |    74.3232   300.0811     0.25   0.804    -513.8249    662.4713
             |
       LIBOR |
         LD. |   34.20604   38.63467     0.89   0.376    -41.51654    109.9286
             |
       _cons |    .004006   .0680765     0.06   0.953    -.1294216    .1374335
------------------------------------------------------------------------------
```

Appendix 9 - Johansen normalization restrictions (betas) in Handymax. ***Source:*** StataSE12.

Johansen normalization restrictions imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce1						
OFHANDYMAX	1	.	.	.	.	.
FRHANDYMAX	-2.17e-19	.	.	.	.	.
NBHANDYMAX	8.88e-16	.	.	.	.	.
SHHANDYMAX	-2.22e-16	.	.	.	.	.
NBCOSTS	-.210764	.0318685	-6.61	0.000	-.2732251	-.148303
XRATE	15833.3	5282.313	3.00	0.003	5480.152	26186.44
LIBOR	-699.4481	321.7329	-2.17	0.030	-1330.033	-68.86327
_cons	-46.30054	.	.	.	.	.
_ce2						
OFHANDYMAX	-5.68e-14	.	.	.	.	.
FRHANDYMAX	1	.	.	.	.	.
NBHANDYMAX	1.14e-12	.	.	.	.	.
SHHANDYMAX	0	(omitted)				
NBCOSTS	-151.2933	22.65445	-6.68	0.000	-195.6952	-106.8914
XRATE	1.48e+07	3755058	3.95	0.000	7459557	2.22e+07
LIBOR	-549706.1	228711.5	-2.40	0.016	-997972.3	-101439.8
_cons	-58720.49	.	.	.	.	.
_ce3						
OFHANDYMAX	1.39e-17	.	.	.	.	.
FRHANDYMAX	-6.78e-21	.	.	.	.	.
NBHANDYMAX	1	.	.	.	.	.
SHHANDYMAX	0	(omitted)				
NBCOSTS	-.05083	.0041467	-12.26	0.000	-.0589574	-.0427027
XRATE	2602.994	687.3277	3.79	0.000	1255.857	3950.132
LIBOR	-60.91776	41.86346	-1.46	0.146	-142.9686	21.13311
_cons	-22.251	.	.	.	.	.
_ce4						
OFHANDYMAX	0	(omitted)				
FRHANDYMAX	0	(omitted)				
NBHANDYMAX	1.39e-16	.	.	.	.	.
SHHANDYMAX	1	.	.	.	.	.
NBCOSTS	-.0639374	.0056403	-11.34	0.000	-.0749921	-.0528826
XRATE	1188.884	934.8963	1.27	0.203	-643.4786	3021.247
LIBOR	-45.7794	56.94226	-0.80	0.421	-157.3842	65.82537
_cons	.5821209	.	.	.	.	.

Appendix 10 – Johansen cointegration test in Panamax. ***Source:*** StataSE12.

Johansen tests for cointegration

Trend: constant Number of obs = 215

Sample: Oct 1999 - Aug 2017 Lags = 2

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	56	-1441.3091	.	228.6567	124.24
1	69	-1390.3211	0.37768	126.6807	94.15
2	80	-1367.8605	0.18855	81.7596	68.52
3	89	-1350.7248	0.14735	47.4880	47.21
4	96	-1337.7419	0.11376	21.5223*	29.68
5	101	-1332.2694	0.04963	10.5772	15.41
6	104	-1328.52	0.03428	3.0785	3.76
7	105	-1326.9808	0.01422		

```
. vecrank OFPANAMAX FRPANAMAX NBPANAMAX SHPANAMAX NBCOSTS XRATE LIBOR, trend(constant) lags(3)
```

Johansen tests for cointegration

Trend: constant Number of obs = 214

Sample: Nov 1999 - Aug 2017 Lags = 3

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	105	-1359.8409	.	244.0293	124.24
1	118	-1295.2603	0.45314	114.8680	94.15
2	129	-1273.1392	0.18677	70.6257	68.52
3	138	-1258.6656	0.12652	41.6787*	47.21
4	145	-1248.6294	0.08953	21.6062	29.68
5	150	-1243.3157	0.04845	10.9788	15.41
6	153	-1239.6852	0.03336	3.7178	3.76
7	154	-1237.8263	0.01722		

Appendix 11 – Vector error correction model in Panamax. ***Source:*** StataSE12.

```
. vec OFPANAMAX FRPANAMAX NBPANAMAX SHPANAMAX NBCOSTS XRATE LIBOR, trend(constant) rank(4)

Vector error-correction model

Sample:  Oct 1999 - Aug 2017                    No. of obs      =        215
                                                AIC             =   13.33017
Log likelihood = -1336.993                      HQIC            =   13.93827
Det(Sigma_ml)  =  .0005944                      SBIC            =   14.83519
```

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_OFPANAMAX	12	.892071	0.4064	138.3115	0.0000
D_FRPANAMAX	12	2557.53	0.5364	233.7259	0.0000
D_NBPANAMAX	12	.669416	0.5305	228.2336	0.0000
D_SHPANAMAX	12	2.68437	0.5073	207.9542	0.0000
D_NBCOSTS	12	36.7184	0.3858	126.9034	0.0000
D_XRATE	12	.000209	0.2085	53.20584	0.0000
D_LIBOR	12	.001402	0.5101	210.3253	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
D_OFPANAMAX						
_ce1						
L1.	.0160232	.0074651	2.15	0.032	.0013919	.0306544
_ce2						
L1.	.0000166	.0000154	1.07	0.283	-.0000137	.0000468
_ce3						
L1.	.0021772	.035294	0.06	0.951	-.0669977	.0713521
_ce4						
L1.	.0091313	.0205996	0.44	0.658	-.0312432	.0495059
OFPANAMAX						
LD.	.2518022	.0700594	3.59	0.000	.1144883	.3891161
FRPANAMAX						
LD.	-1.95e-06	.0000293	-0.07	0.947	-.0000594	.0000555
NBPANAMAX						
LD.	.0420376	.092341	0.46	0.649	-.1389475	.2230227
SHPANAMAX						
LD.	-.0058553	.0303595	-0.19	0.847	-.0653589	.0536482
NBCOSTS						
LD.	-.0009591	.0015519	-0.62	0.537	-.0040007	.0020824
XRATE						
LD.	615.2018	272.5011	2.26	0.024	81.1095	1149.294
LIBOR						
LD.	37.0843	33.03689	1.12	0.262	-27.66681	101.8354
_cons	-.0090617	.0624226	-0.15	0.885	-.1314077	.1132844

Appendix 12 - Johansen normalization restrictions (betas) in Panamax. ***Source:*** StataSE12.

Johansen normalization restrictions imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce1						
OFPANAMAX	1	.	.	.	.	.
FRPANAMAX	-1.08e-19	.	.	.	.	.
NBPANAMAX	3.33e-16	.	.	.	.	.
SHPANAMAX	0	(omitted)				
NBCOSTS	-.0095213	.0080336	-1.19	0.236	-.0252668	.0062242
XRATE	-10878.13	1333.39	-8.16	0.000	-13491.53	-8264.735
LIBOR	-97.52135	76.36025	-1.28	0.202	-247.1847	52.142
_cons	83.63525	.	.	.	.	.
_ce2						
OFPANAMAX	0	(omitted)				
FRPANAMAX	1	.	.	.	.	.
NBPANAMAX	0	(omitted)				
SHPANAMAX	0	(omitted)				
NBCOSTS	-48.33044	7.236543	-6.68	0.000	-62.5138	-34.14708
XRATE	-144773.3	1201099	-0.12	0.904	-2498884	2209337
LIBOR	-71922.03	68784.22	-1.05	0.296	-206736.6	62892.56
_cons	11424	.	.	.	.	.
_ce3						
OFPANAMAX	0	(omitted)				
FRPANAMAX	-5.42e-20	.	.	.	.	.
NBPANAMAX	1	.	.	.	.	.
SHPANAMAX	0	(omitted)				
NBCOSTS	-.0429512	.0033918	-12.66	0.000	-.049599	-.0363035
XRATE	725.5671	562.9566	1.29	0.197	-377.8075	1828.942
LIBOR	-57.05979	32.23925	-1.77	0.077	-120.2476	6.127981
_cons	-11.95829	.	.	.	.	.
_ce4						
OFPANAMAX	0	(omitted)				
FRPANAMAX	0	(omitted)				
NBPANAMAX	2.22e-16	.	.	.	.	.
SHPANAMAX	1	.	.	.	.	.
NBCOSTS	-.0719537	.0062757	-11.47	0.000	-.0842539	-.0596536
XRATE	77.534	1041.622	0.07	0.941	-1964.008	2119.076
LIBOR	-119.3147	59.65134	-2.00	0.045	-236.2291	-2.400183
_cons	13.65462	.	.	.	.	.

Appendix 13 – Johansen cointegration test in Capesize. ***Source:*** StataSE12.

Johansen tests for cointegration

Trend: constant — Number of obs = 215

Sample: Oct 1999 - Aug 2017 — Lags = 2

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	56	-1945.3157	.	264.1937	124.24
1	69	-1888.3138	0.41154	150.1899	94.15
2	80	-1861.2117	0.22284	95.9858	68.52
3	89	-1839.5896	0.18220	52.7416	47.21
4	96	-1828.3242	0.09949	30.2108	29.68
5	101	-1817.3135	0.09735	8.1893*	15.41
6	104	-1814.3411	0.02727	2.2447	3.76
7	105	-1813.2188	0.01039		

```
. vecrank OFCAPESIZE FRCAPESIZE NBCAPESIZE SHCAPESIZE XRATE LIBOR NBCOSTS, trend(constant) lags(3)
```

Johansen tests for cointegration

Trend: constant — Number of obs = 214

Sample: Nov 1999 - Aug 2017 — Lags = 3

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	105	-1868.9206	.	278.2772	124.24
1	118	-1804.7647	0.45096	149.9655	94.15
2	129	-1777.0879	0.22792	94.6119	68.52
3	138	-1755.1168	0.18563	50.6696	47.21
4	145	-1743.8733	0.09975	28.1826*	29.68
5	150	-1734.593	0.08308	9.6220	15.41
6	153	-1731.1336	0.03181	2.7033	3.76
7	154	-1729.782	0.01255		

Appendix 14 – Vector error correction model in Panamax. ***Source:*** StataSE12.

```
. vec OFCAPESIZE FRCAPESIZE NBCAPESIZE SHCAPESIZE NBCOSTS XRATE LIBOR, trend(constant) rank(5) lags(3)

Vector error-correction model

Sample:  Nov 1999 - Aug 2017                      No. of obs      =       214
                                                  AIC             =  17.61306
Log likelihood = -1734.598                        HQIC            =  18.56644
Det(Sigma_ml)  =  .0258888                        SBIC            =  19.97239
```

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_OFCAPESIZE	20	1.19226	0.6446	349.9809	0.0000
D_FRCAPESIZE	20	7003.94	0.3729	114.7887	0.0000
D_NBCAPESIZE	20	1.21488	0.4578	162.9815	0.0000
D_SHCAPESIZE	20	3.90866	0.5681	253.9072	0.0000
D_NBCOSTS	20	31.6889	0.5628	248.4666	0.0000
D_XRATE	20	.000212	0.2242	55.75968	0.0000
D_LIBOR	20	.001429	0.5124	202.8542	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
D_OFCAPESIZE						
_ce1						
L1.	-.0255184	.0062507	-4.08	0.000	-.0377695	-.0132672
_ce2						
L1.	2.28e-06	.0000121	0.19	0.850	-.0000214	.0000259
_ce3						
L1.	.0435362	.0236175	1.84	0.065	-.0027531	.0898256
_ce4						
L1.	.0187522	.0196142	0.96	0.339	-.0196909	.0571952
_ce5						
L1.	-.0005735	.0011591	-0.49	0.621	-.0028453	.0016982
OFCAPESIZE						
LD.	.0918674	.071946	1.28	0.202	-.0491441	.2328788
L2D.	.1218745	.0710599	1.72	0.086	-.0174004	.2611494
FRCAPESIZE						
LD.	.0000138	.0000187	0.74	0.460	-.0000229	.0000505
L2D.	.00002	.0000197	1.02	0.309	-.0000186	.0000585
NBCAPESIZE						
LD.	.1211945	.0719605	1.68	0.092	-.0198455	.2622345
L2D.	.1068439	.0760553	1.40	0.160	-.0422217	.2559095
SHCAPESIZE						
LD.	-.0261424	.032963	-0.79	0.428	-.0907487	.0384639
L2D.	-.0017114	.0292667	-0.06	0.953	-.0590731	.0556503
NBCOSTS						
LD.	-.0041328	.0024055	-1.72	0.086	-.0088475	.0005819
L2D.	.0029014	.0023538	1.23	0.218	-.0017119	.0075147
XRATE						
LD.	270.2665	390.1973	0.69	0.489	-494.5061	1035.039
L2D.	32.75984	384.0514	0.09	0.932	-719.9672	785.4868
LIBOR						
LD.	-66.82097	59.00532	-1.13	0.257	-182.4693	48.82733
L2D.	-6.804836	54.13537	-0.13	0.900	-112.9082	99.29854
_cons	7.41e-07	.0843566	0.00	1.000	-.1653352	.1653367

Appendix 15 - Johansen normalization restrictions (betas) in Capesize. ***Source:*** StataSE12.

Johansen normalization restrictions imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce1						
OFCAPESIZE	1	.	.	.	.	.
FRCAPESIZE	0	(omitted)				
NBCAPESIZE	-1.67e-16	.	.	.	.	.
SHCAPESIZE	0	(omitted)				
NBCOSTS	-1.73e-18	.	.	.	.	.
XRATE	-22783.91	5335.783	-4.27	0.000	-33241.85	-12325.97
LIBOR	-325.1592	348.6274	-0.93	0.351	-1008.456	358.1378
_cons	183.8806	.	.	.	.	.
_ce2						
OFCAPESIZE	0	(omitted)				
FRCAPESIZE	1	.	.	.	.	.
NBCAPESIZE	-2.27e-13	.	.	.	.	.
SHCAPESIZE	2.27e-13	.	.	.	.	.
NBCOSTS	-1.78e-15	.	.	.	.	.
XRATE	-1.54e+07	3565971	-4.33	0.000	-2.24e+07	-8440581
LIBOR	-212256.7	232992	-0.91	0.362	-668912.7	244399.3
_cons	115438.7	.	.	.	.	.
_ce3						
OFCAPESIZE	0	(omitted)				
FRCAPESIZE	-1.08e-19	.	.	.	.	.
NBCAPESIZE	1	.	.	.	.	.
SHCAPESIZE	0	(omitted)				
NBCOSTS	8.67e-19	.	.	.	.	.
XRATE	-11634.35	2310.437	-5.04	0.000	-16162.72	-7105.974
LIBOR	-4.253277	150.9584	-0.03	0.978	-300.1264	291.6198
_cons	54.96269	.	.	.	.	.
_ce4						
OFCAPESIZE	-1.67e-16	.	.	.	.	.
FRCAPESIZE	-1.08e-19	.	.	.	.	.
NBCAPESIZE	3.33e-16	.	.	.	.	.
SHCAPESIZE	1	.	.	.	.	.
NBCOSTS	3.47e-18	.	.	.	.	.
XRATE	-18178.83	3438.786	-5.29	0.000	-24918.72	-11438.93
LIBOR	-191.8653	224.6821	-0.85	0.393	-632.2341	248.5035
_cons	125.4615	.	.	.	.	.
_ce5						
OFCAPESIZE	4.44e-16	.	.	.	.	.
FRCAPESIZE	-4.34e-19	.	.	.	.	.
NBCAPESIZE	4.11e-15	.	.	.	.	.
SHCAPESIZE	0	(omitted)				
NBCOSTS	1	.	.	.	.	.
XRATE	-177147.5	25662.25	-6.90	0.000	-227444.6	-126850.5
LIBOR	745.3101	1676.71	0.44	0.657	-2540.981	4031.601
_cons	1083.217	.	.	.	.	.

Appendix 16 – Johansen cointegration test in Suezmax. ***Source:*** StataSE12.

Johansen tests for cointegration

Trend: constant — Number of obs = 215

Sample: Oct 1999 - Aug 2017 — Lags = 2

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	56	-1583.1587	.	126.5223	124.24
1	69	-1565.3866	0.15238	90.9781*	94.15
2	80	-1551.3015	0.12280	62.8078	68.52
3	89	-1538.7746	0.11000	37.7540	47.21
4	96	-1530.0748	0.07774	20.3544	29.68
5	101	-1523.4286	0.05995	7.0621	15.41
6	104	-1521.0288	0.02208	2.2624	3.76
7	105	-1519.8976	0.01047		

```
. vecrank OFSUEZMAX FRSUEZMAX SHSUEZMAX NBSUEZMAX NBCOSTS XRATE LIBOR, trend(constant) lags(3)
```

Johansen tests for cointegration

Trend: constant — Number of obs = 214

Sample: Nov 1999 - Aug 2017 — Lags = 3

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	105	-1513.1837	.	139.0263	124.24
1	118	-1490.5927	0.19033	93.8443*	94.15
2	129	-1471.1646	0.16604	54.9880	68.52
3	138	-1460.9481	0.09106	34.5551	47.21
4	145	-1453.8563	0.06413	20.3714	29.68
5	150	-1448.1621	0.05183	8.9831	15.41
6	153	-1445.3924	0.02555	3.4437	3.76
7	154	-1443.6706	0.01596		

Appendix 17 – Vector error correction model in Suezmax. ***Source:*** StataSE12.

```
Vector error-correction model

Sample:  Oct 1999 - Aug 2017                        No. of obs      =        215
                                                    AIC             =   15.17427
Log likelihood = -1551.234                          HQIC            =   15.68102
Det(Sigma_ml)  =   .004361                          SBIC            =   16.42846
```

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_OFSUEZMAX	10	1.25092	0.1793	44.5747	0.0000
D_FRSUEZMAX	10	2196.93	0.1999	50.95243	0.0000
D_SHSUEZMAX	10	2.68473	0.1139	26.21909	0.0035
D_NBSUEZMAX	10	1.06017	0.4216	148.7074	0.0000
D_NBCOSTS	10	38.4703	0.3192	95.6431	0.0000
D_XRATE	10	.000221	0.1102	25.26038	0.0049
D_LIBOR	10	.001453	0.4685	179.8168	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
D_OFSUEZMAX						
_ce1						
L1.	-.0306137	.0106369	-2.88	0.004	-.0514615	-.0097658
_ce2						
L1.	.0000305	.0000149	2.05	0.041	1.28e-06	.0000598
OFSUEZMAX						
LD.	.2184305	.0657606	3.32	0.001	.089542	.3473189
FRSUEZMAX						
LD.	-3.71e-06	.0000422	-0.09	0.930	-.0000865	.0000791
SHSUEZMAX						
LD.	.0672831	.0421171	1.60	0.110	-.0152649	.1498311
NBSUEZMAX						
LD.	.0602108	.0803809	0.75	0.454	-.0973329	.2177545
NBCOSTS						
LD.	.0004905	.002083	0.24	0.814	-.0035921	.0045732
XRATE						
LD.	299.6158	383.2793	0.78	0.434	-451.5977	1050.829
LIBOR						
LD.	-29.54531	50.03467	-0.59	0.555	-127.6115	68.52085
_cons	.0132873	.0867405	0.15	0.878	-.156721	.1832957

Appendix 18 - Johansen normalization restrictions (betas) in Suezmax. ***Source:*** StataSE12.

Johansen normalization restrictions imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce1						
OFSUEZMAX	1	.	.	.	.	.
FRSUEZMAX	0	(omitted)				
SHSUEZMAX	-2.119902	.3535227	-6.00	0.000	-2.812794	-1.42701
NBSUEZMAX	1.841526	.4949574	3.72	0.000	.8714275	2.811625
NBCOSTS	.0255142	.0164881	1.55	0.122	-.0068018	.0578302
XRATE	-4281.532	1574.128	-2.72	0.007	-7366.766	-1196.298
LIBOR	100.4376	91.29462	1.10	0.271	-78.49655	279.3718
_cons	4.245019	.	.	.	.	.
_ce2						
OFSUEZMAX	0	(omitted)				
FRSUEZMAX	1	.	.	.	.	.
SHSUEZMAX	-1602.671	270.454	-5.93	0.000	-2132.751	-1072.591
NBSUEZMAX	1211.153	378.6552	3.20	0.001	469.0025	1953.304
NBCOSTS	10.47742	12.61379	0.83	0.406	-14.24516	35.2
XRATE	-146414.1	1204248	-0.12	0.903	-2506698	2213870
LIBOR	122905	69842.75	1.76	0.078	-13984.27	259794.3
_cons	-22459.73	.	.	.	.	.

Appendix 19 – Johansen cointegration test in VLCC/ULCC. ***Source:*** StataSE12.

Johansen tests for cointegration

Trend: constant — Number of obs = 215

Sample: Oct 1999 - Aug 2017 — Lags = 2

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	56	-1867.3919	.	166.2000	124.24
1	69	-1838.0295	0.23901	107.4751	94.15
2	80	-1820.7762	0.14828	72.9684	68.52
3	89	-1806.7757	0.12211	44.9676*	47.21
4	96	-1797.3446	0.08399	26.1053	29.68
5	101	-1788.8621	0.07587	9.1402	15.41
6	104	-1785.3019	0.03258	2.0199	3.76
7	105	-1784.2919	0.00935		

```
. vecrank OFVLCC FRVLCC SHVLCC NBVLCC NBCOSTS XRATE LIBOR, trend(constant) lags(3)
```

Johansen tests for cointegration

Trend: constant — Number of obs = 214

Sample: Nov 1999 - Aug 2017 — Lags = 3

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	105	-1796.5766	.	161.3361	124.24
1	118	-1771.4015	0.20965	110.9860	94.15
2	129	-1751.4415	0.17018	71.0661	68.52
3	138	-1738.7133	0.11215	45.6097*	47.21
4	145	-1728.8091	0.08841	25.8011	29.68
5	150	-1721.1898	0.06873	10.5626	15.41
6	153	-1717.4529	0.03432	3.0888	3.76
7	154	-1715.9085	0.01433		

Appendix 20 – Vector error correction model in VLCC/ULCC. ***Source:*** StataSE12.

Vector error-correction model

Sample: Oct 1999 - Aug 2017 — No. of obs = 215

AIC = 17.64171

Log likelihood = -1807.484 — HQIC = 18.20547

Det(Sigma_ml) = .0472956 — SBIC = 19.037

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_OFVLCC	11	1.03559	0.2530	68.76084	0.0000
D_FRVLCC	11	3922.55	0.1620	39.24868	0.0000
D_SHVLCC	11	4.04868	0.2207	57.49383	0.0000
D_NBVLCC	11	1.54621	0.4718	181.3317	0.0000
D_NBCOSTS	11	38.9995	0.3037	88.55945	0.0000
D_XRATE	11	.000222	0.1034	23.21242	0.0165
D_LIBOR	11	.00147	0.4589	167.9038	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
D_OFVLCC						
_ce1 L1.	-.0228137	.0084026	-2.72	0.007	-.0392824	-.006345
_ce2 L1.	-3.49e-06	9.82e-06	-0.36	0.722	-.0000227	.0000158
_ce3 L1.	.040009	.0138981	2.88	0.004	.0127692	.0672488
OFVLCC LD.	.1725806	.067658	2.55	0.011	.0399734	.3051878
FRVLCC LD.	-.0000129	.0000199	-0.65	0.517	-.0000519	.0000261
SHVLCC LD.	.0113731	.0216328	0.53	0.599	-.0310264	.0537726
NBVLCC LD.	.0908246	.0448467	2.03	0.043	.0029267	.1787225
NBCOSTS LD.	-.00147	.0018108	-0.81	0.417	-.0050192	.0020791
XRATE LD.	-142.32	321.176	-0.44	0.658	-771.8134	487.1734
LIBOR LD.	-49.24626	41.4054	-1.19	0.234	-130.3994	31.90684
_cons	1.946407	.6396966	3.04	0.002	.6926245	3.200189

Appendix 21 - Johansen normalization restrictions (betas) in VLCC/ULCC. ***Source:*** StataSE12.

Johansen normalization restrictions imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce1						
OFVLCC	1	.	.	.	.	.
FRVLCC	0	(omitted)				
SHVLCC	-7.11e-15	.	.	.	.	.
NBVLCC	-112.654	25.85855	-4.36	0.000	-163.3359	-61.97221
NBCOSTS	19.01609	2.892364	6.57	0.000	13.34716	24.68502
XRATE	-1216164	1557.117	-781.04	0.000	-1219216	-1213112
LIBOR	34720.22	18219.96	1.91	0.057	-990.2433	70430.68
_cons	62.64716	.	.	.	.	.
_ce2						
OFVLCC	0	(omitted)				
FRVLCC	1	.	.	.	.	.
SHVLCC	0	(omitted)				
NBVLCC	-113538.3	26019.89	-4.36	0.000	-164536.4	-62540.29
NBCOSTS	19134.64	2910.401	6.57	0.000	13430.35	24838.92
XRATE	-1.22e+09	.	.	.	.	.
LIBOR	3.50e+07	1.83e+07	1.91	0.056	-917825.7	7.09e+07
_cons	0	(omitted)				
_ce3						
OFVLCC	7.11e-15	.	.	.	.	.
FRVLCC	-6.94e-18	.	.	.	.	.
SHVLCC	1	.	.	.	.	.
NBVLCC	-74.9917	17.04635	-4.40	0.000	-108.4019	-41.58146
NBCOSTS	12.53296	1.90669	6.57	0.000	8.795921	16.27001
XRATE	-798278.7	962.5883	-829.30	0.000	-800165.4	-796392.1
LIBOR	22825.35	12010.88	1.90	0.057	-715.5429	46366.24
_cons	-19.36481	.	.	.	.	.

Appendix 22 – Johansen cointegration test in Containers. ***Source:*** StataSE12.

Johansen tests for cointegration

Trend: constant — Number of obs = 215

Sample: Oct 1999 - Aug 2017 — Lags = 2

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	56	-1432.1019	.	114.3669*	124.24
1	69	-1408.85	0.19450	67.8632	94.15
2	80	-1395.9412	0.11315	42.0456	68.52
3	89	-1388.1942	0.06953	26.5515	47.21
4	96	-1382.2279	0.05399	14.6190	29.68
5	101	-1378.2211	0.03659	6.6054	15.41
6	104	-1376.1563	0.01902	2.4758	3.76
7	105	-1374.9184	0.01145		

```
. vecrank OFCONTAINERS NBCONTAINERS SHCONTAINERS FRCONTAINERS NBCOSTS XRATE LIBOR, trend(constant) lags(3)
```

Johansen tests for cointegration

Trend: constant — Number of obs = 214

Sample: Nov 1999 - Aug 2017 — Lags = 3

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	105	-1378.4036	.	128.7921	124.24
1	118	-1355.794	0.19047	83.5729*	94.15
2	129	-1340.5422	0.13285	53.0693	68.52
3	138	-1330.2587	0.09163	32.5023	47.21
4	145	-1323.8839	0.05784	19.7528	29.68
5	150	-1319.1463	0.04331	10.2775	15.41
6	153	-1315.6712	0.03196	3.3273	3.76
7	154	-1314.0075	0.01543		

Appendix 23 – Vector error correction model in Containers. ***Source:*** StataSE12.

Vector error-correction model

Sample: Nov 1999 - Aug 2017		No. of obs	= 214
		AIC	= 13.77387
Log likelihood = -1355.804		HQIC	= 14.52387
Det(Sigma_ml) = .000751		SBIC	= 15.62988

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_OFCONTAINERS	16	.893601	0.4760	179.8793	0.0000
D_NBCONTAINERS	16	1.46012	0.5904	285.4098	0.0000
D_SHCONTAINERS	16	3.81309	0.3732	117.8825	0.0000
D_FRCONTAINERS	16	662.736	0.4255	146.6524	0.0000
D_NBCOSTS	16	38.1764	0.3524	107.749	0.0000
D_XRATE	16	.000222	0.1332	30.42487	0.0159
D_LIBOR	16	.001576	0.3950	129.2551	0.0000

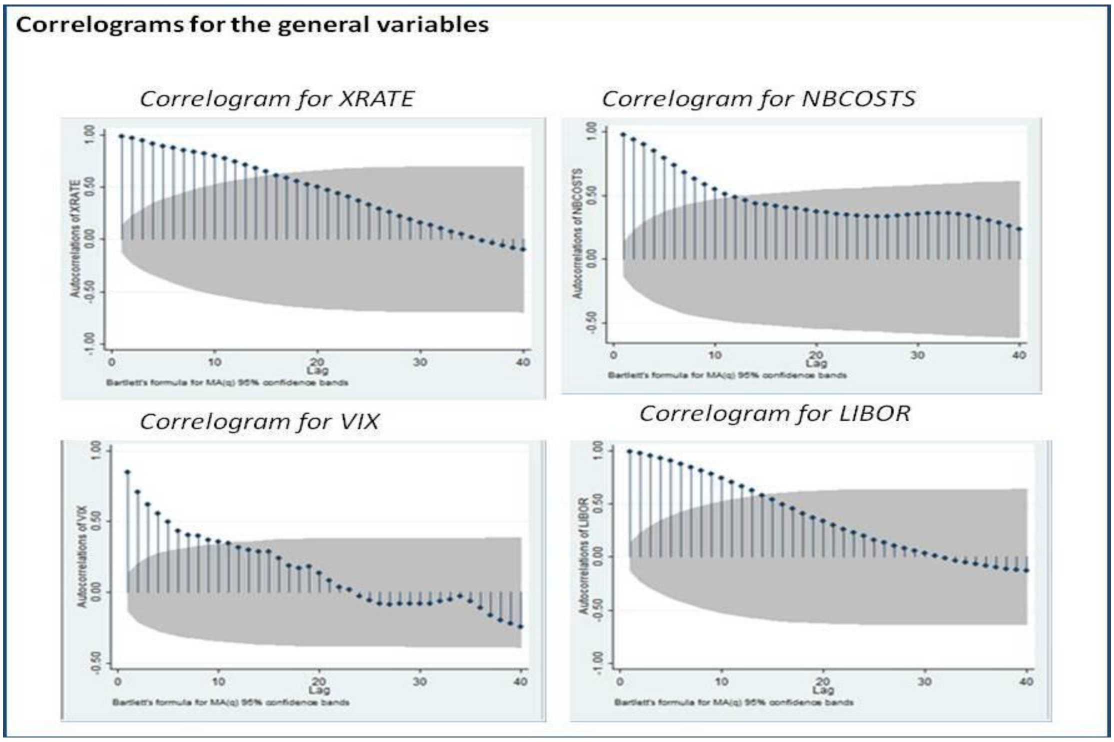
	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
D_OFCONTAINERS						
_ce1						
L1.	-.0189267	.0052112	-3.63	0.000	-.0291405	-.0087129
OFCONTAINERS						
LD.	.2344383	.0669992	3.50	0.000	.1031222	.3657544
L2D.	.2666707	.0670675	3.98	0.000	.1352208	.3981206
NBCONTAINERS						
LD.	.0554657	.0439767	1.26	0.207	-.0307271	.1416586
L2D.	-.0088406	.047485	-0.19	0.852	-.1019096	.0842283
SHCONTAINERS						
LD.	-.0027928	.0171291	-0.16	0.870	-.0363652	.0307796
L2D.	.0039474	.0178468	0.22	0.825	-.0310316	.0389264
FRCONTAINERS						
LD.	.000205	.0001028	1.99	0.046	3.57e-06	.0004065
L2D.	-.0000296	.0001089	-0.27	0.786	-.000243	.0001838
NBCOSTS						
LD.	-.000246	.0017419	-0.14	0.888	-.0036601	.0031681
L2D.	-.002199	.001615	-1.36	0.173	-.0053644	.0009664
XRATE						
LD.	6.352505	280.1241	0.02	0.982	-542.6807	555.3857
L2D.	323.2831	274.9065	1.18	0.240	-215.5236	862.0899
LIBOR						
LD.	23.09356	40.24285	0.57	0.566	-55.78098	101.9681
L2D.	-60.13016	40.83933	-1.47	0.141	-140.1738	19.91345
_cons	-.0106709	.0616878	-0.17	0.863	-.1315768	.110235

Appendix 24 - Johansen normalization restrictions (betas) in Containers. ***Source:*** StataSE12.

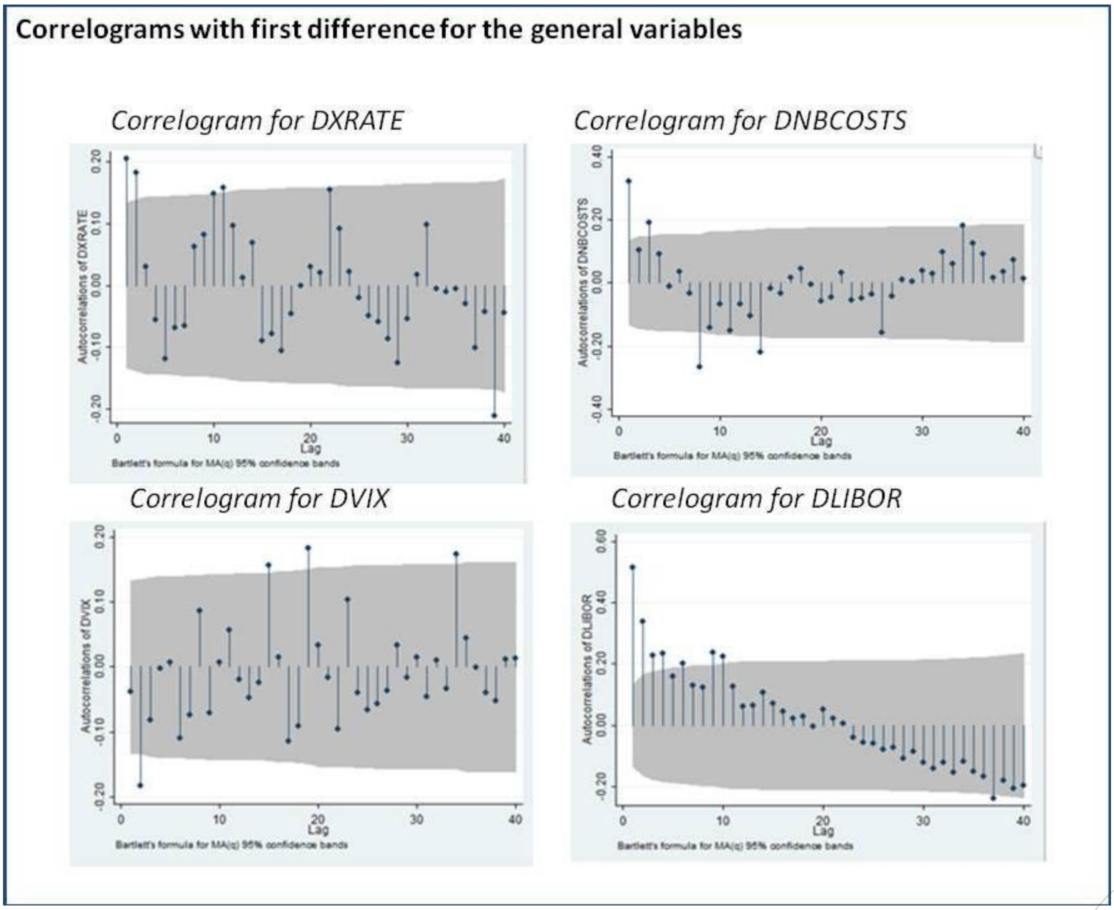
Johansen normalization restriction imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
_ce1						
OFCONTAINERS	1	.	.	.	.	.
NBCONTAINERS	-1.005204	.4145282	-2.42	0.015	-1.817664	-.1927435
SHCONTAINERS	.7264335	.192588	3.77	0.000	.348968	1.103899
FRCONTAINERS	-.0049005	.0008909	-5.50	0.000	-.0066466	-.0031544
NBCOSTS	.0043959	.0210803	0.21	0.835	-.0369208	.0457126
XRATE	-4535.77	1895.582	-2.39	0.017	-8251.042	-820.4984
LIBOR	-165.585	134.2992	-1.23	0.218	-428.8066	97.63673
_cons	106.301	.	.	.	.	.

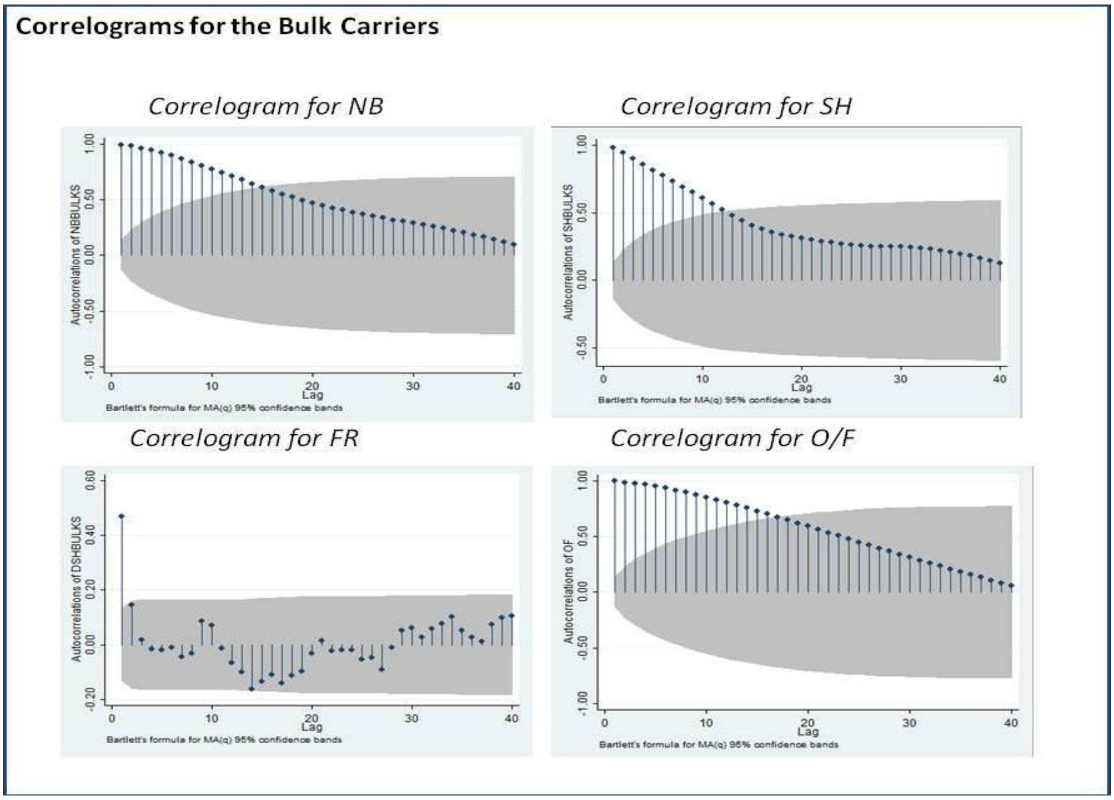
Appendix 25 – Correlograms for the general variables. ***Source:*** StataSE12.



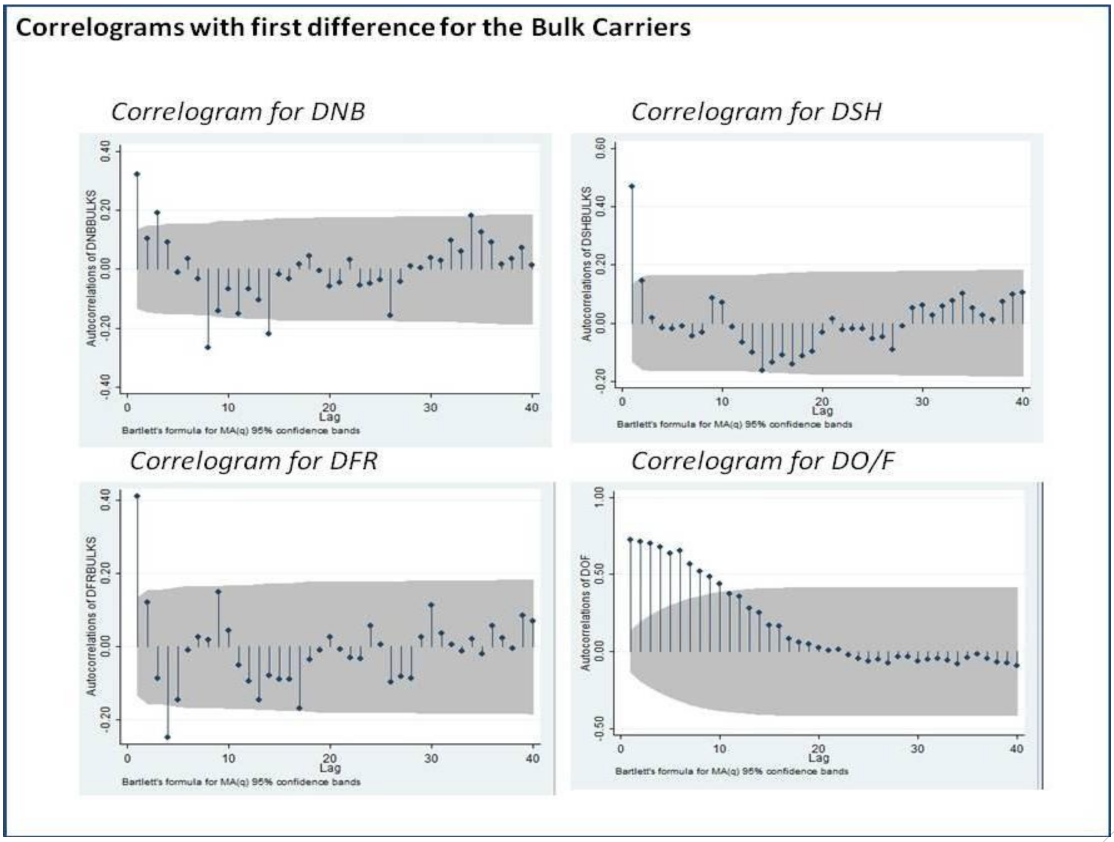
Appendix 26 – Correlograms with first difference for the general variables. ***Source:*** StataSE12.



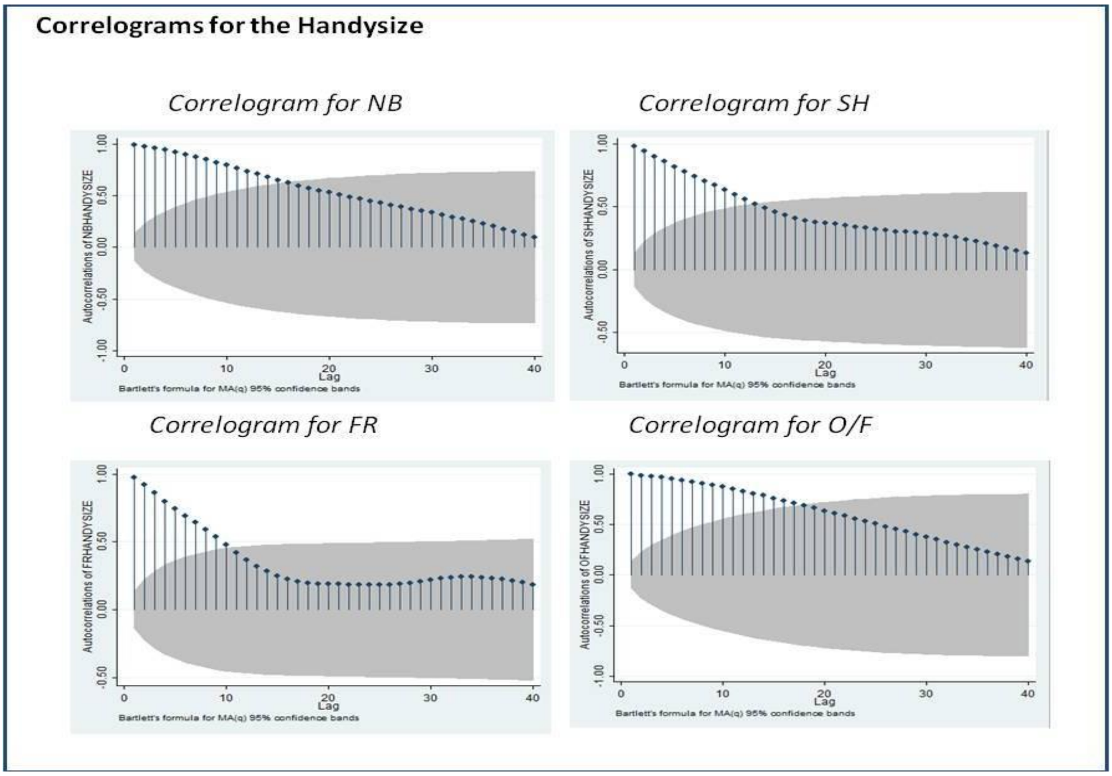
Appendix 27 – Correlograms for the Bulk carrier sector. ***Source:*** StataSE12.



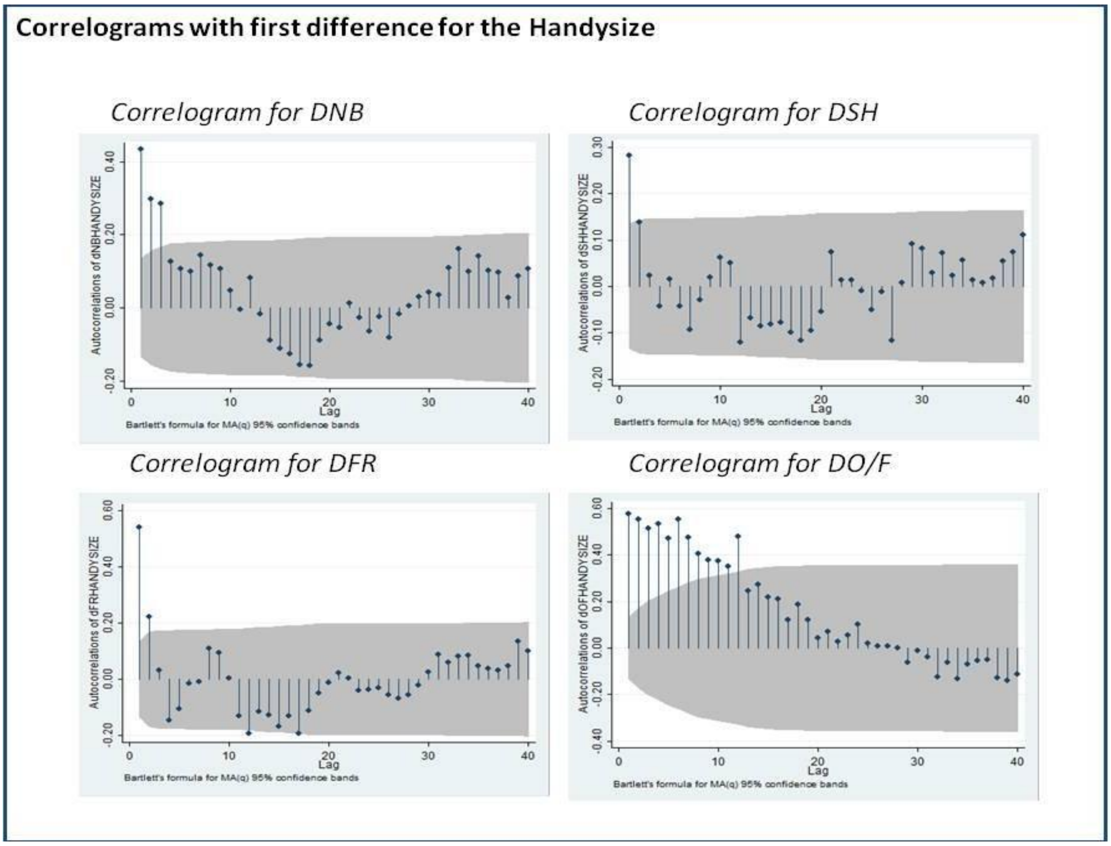
Appendix 28 - Correlograms with first difference for Bulk carrier sector. ***Source:*** StataSE12.



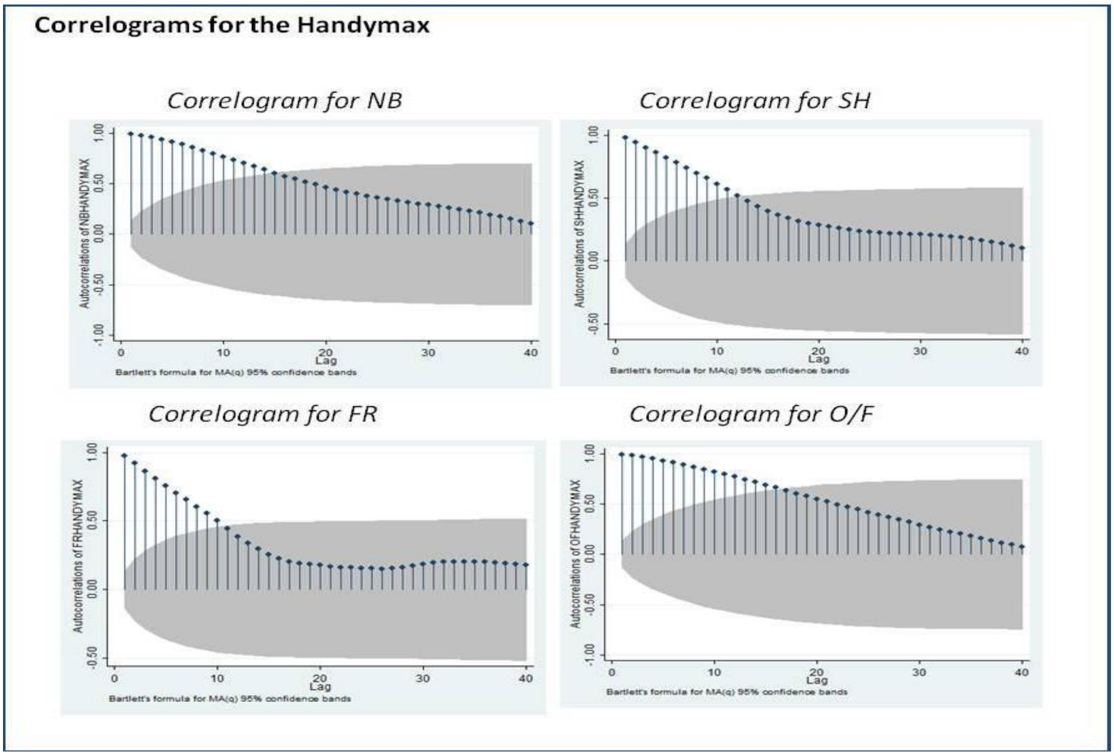
Appendix 29 – Correlograms for the Handysize sub segment. ***Source:*** StataSE12.



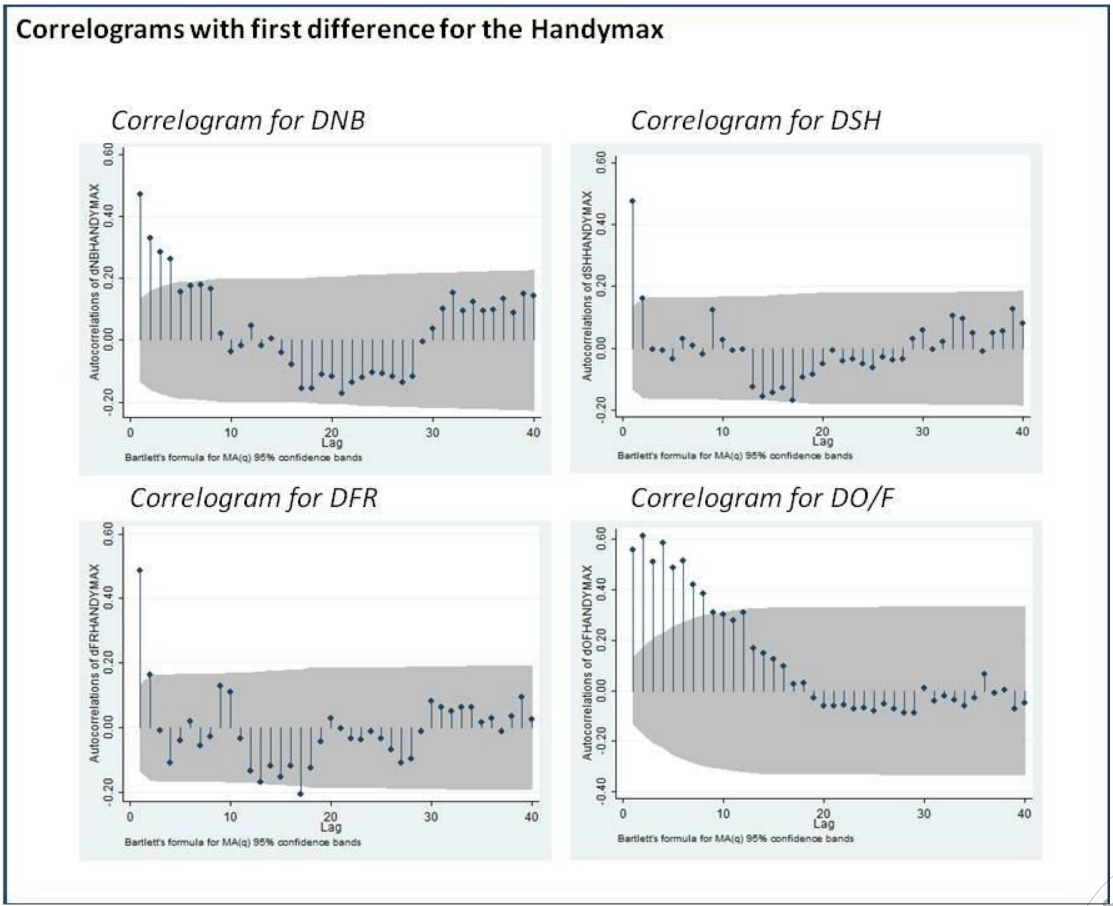
Appendix 30 - Correlograms with first difference for the Handysize sub segment. ***Source:*** StataSE12.



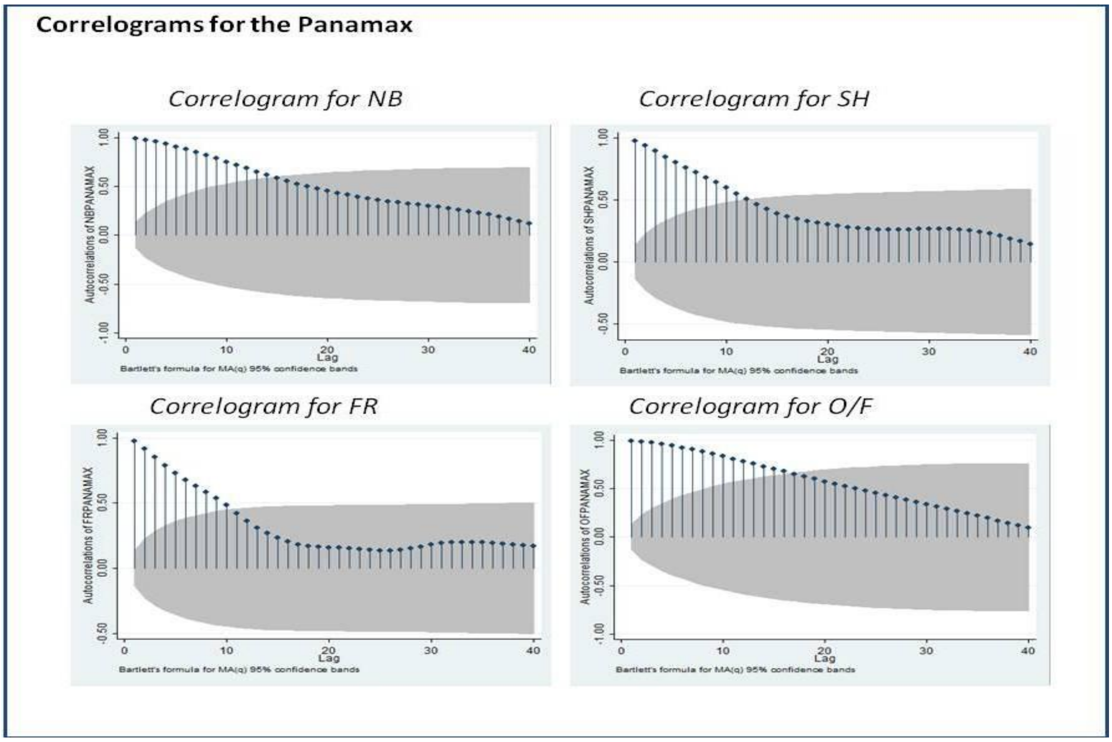
Appendix 31 – Correlograms for the Handymax sub segment. ***Source:*** StataSE12.



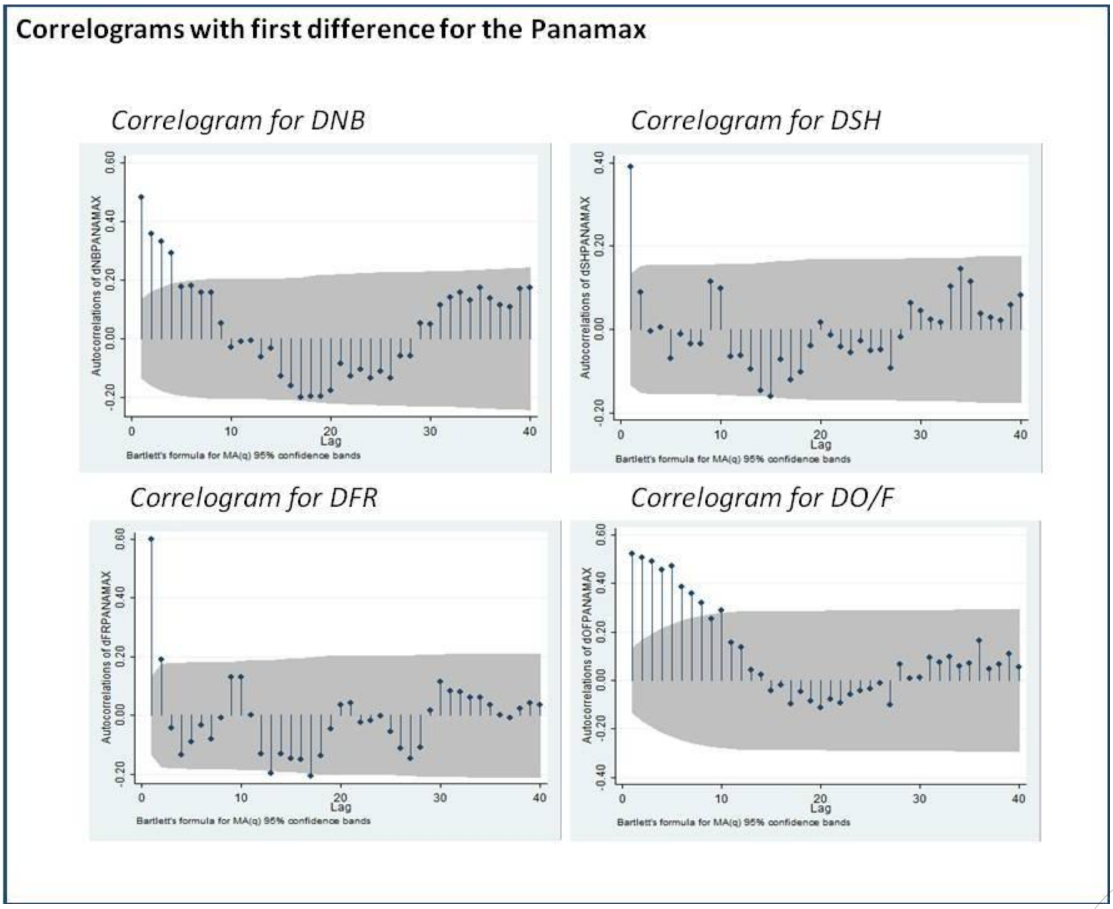
Appendix 32 - Correlograms with first difference for the Handymax sub segment. ***Source:*** StataSE12.



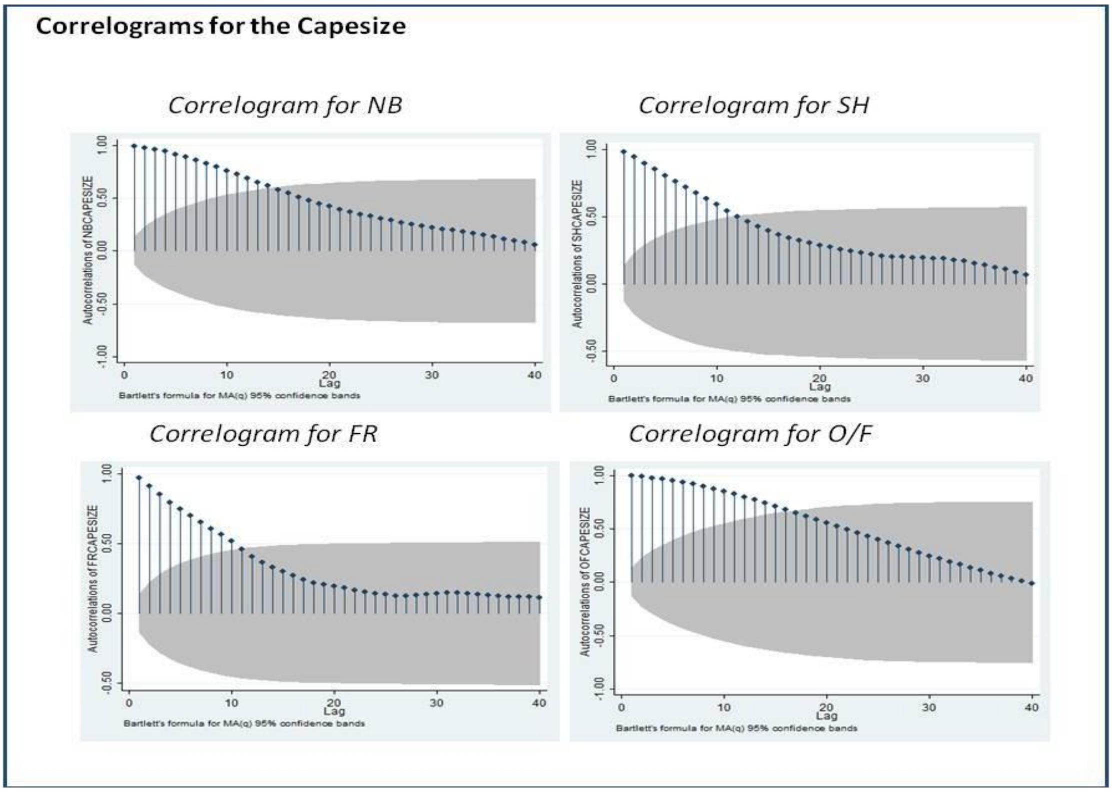
Appendix 33 – Correlograms for the Panamax sub segment. ***Source:*** StataSE12.



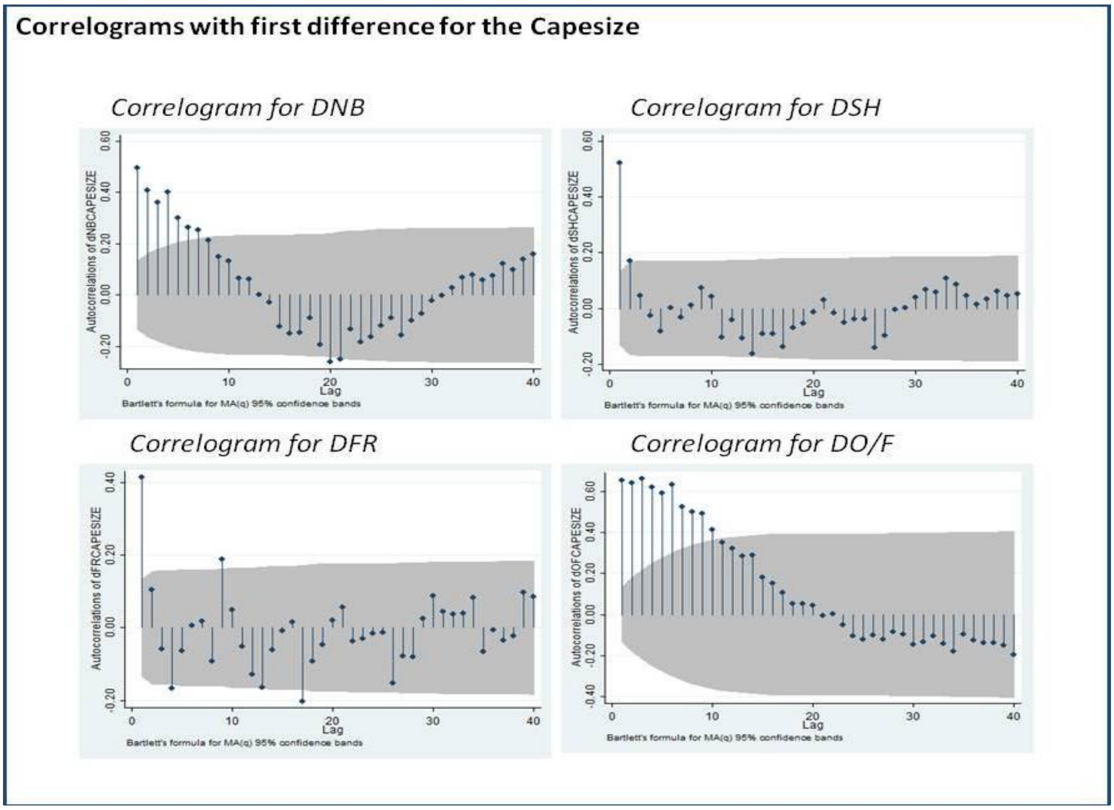
Appendix 34 - Correlograms with first difference for the Panamax sub segment. ***Source:*** StataSE12.



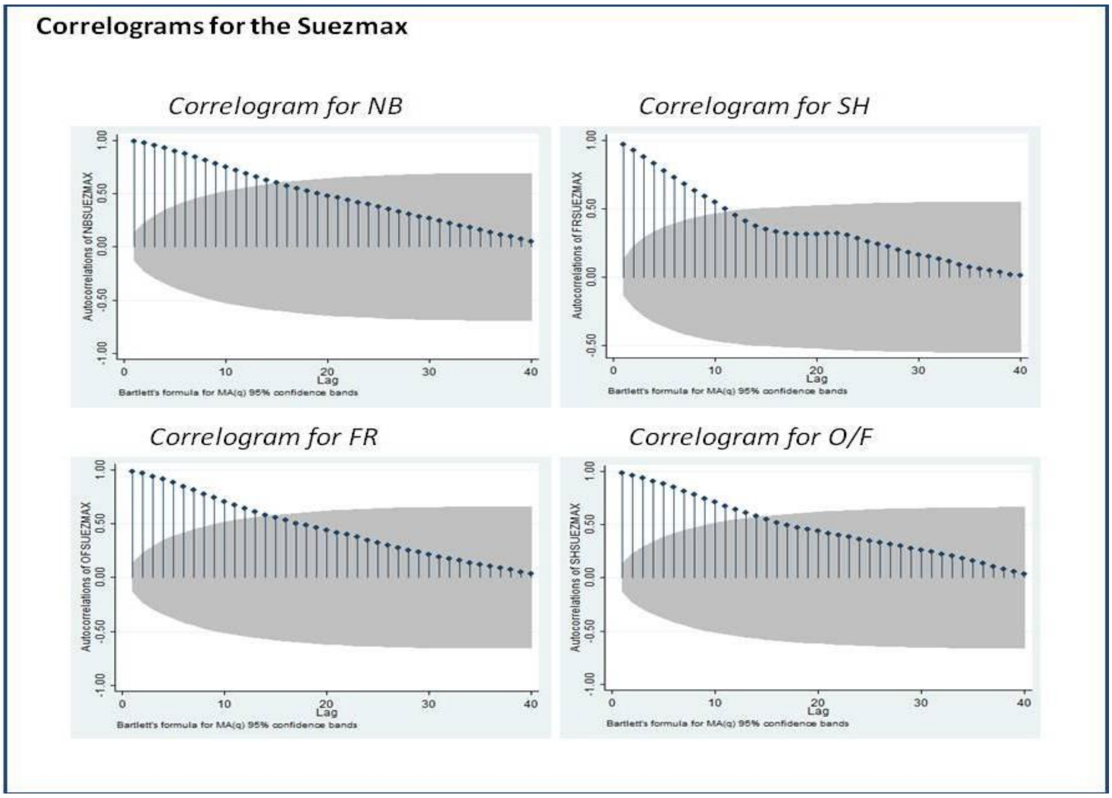
Appendix 35 – Correlograms for the Capesize sub segment. ***Source:*** StataSE12.



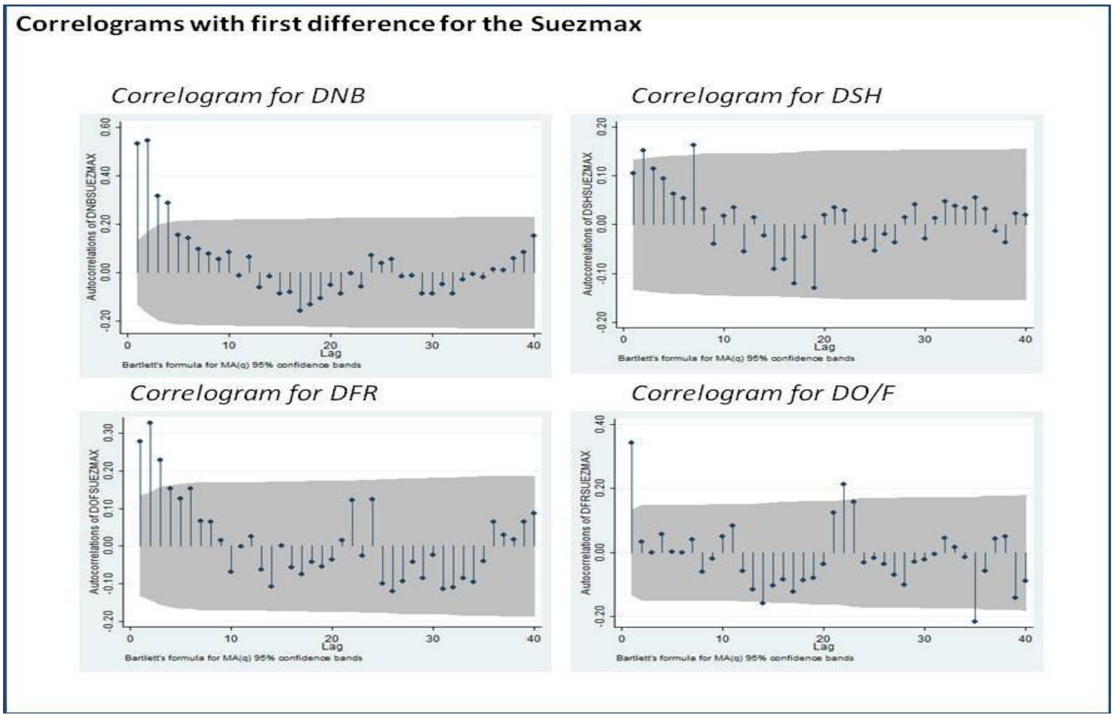
Appendix 36 - Correlograms with first difference for the Capesize sub segment. ***Source:*** StataSE12.



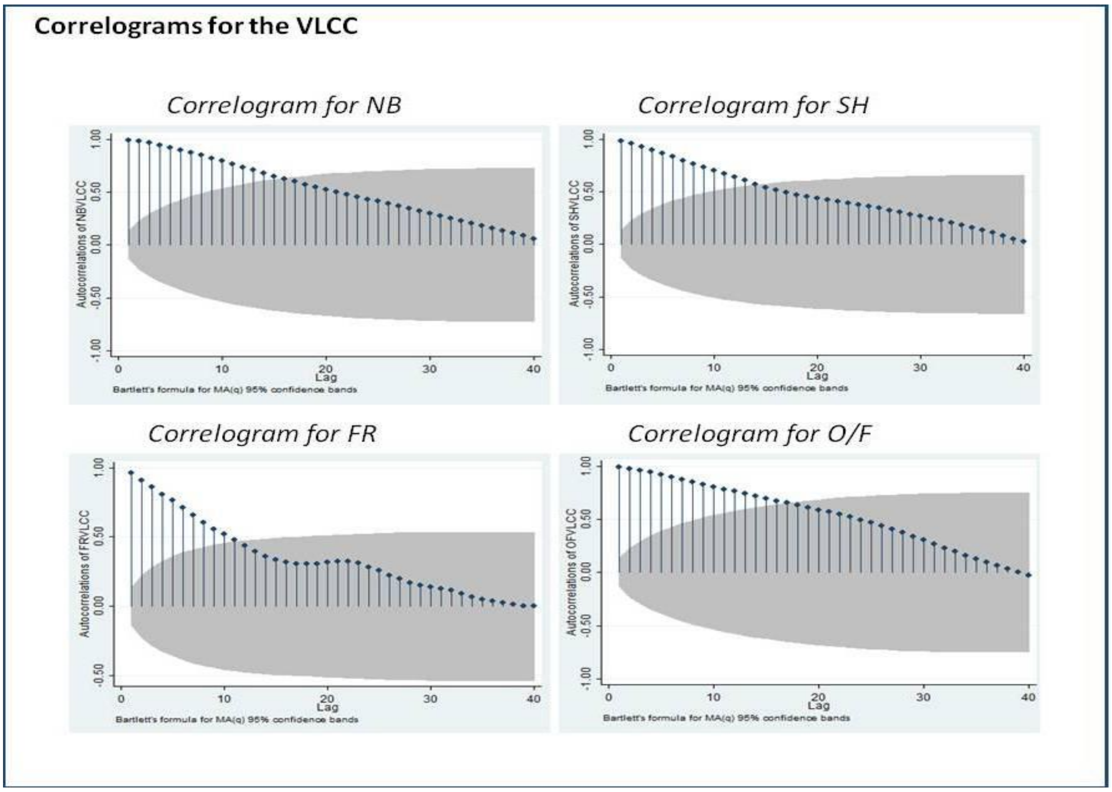
Appendix 37 – Correlograms for the Suezmax sub segment. ***Source:*** StataSE12.



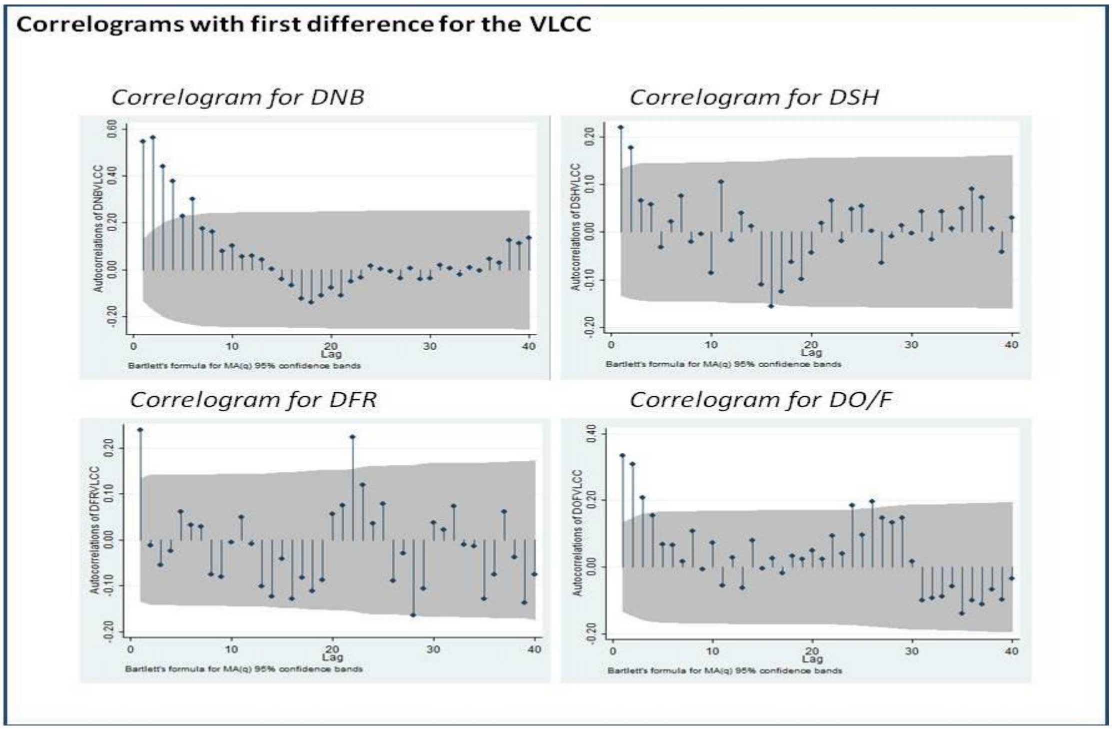
Appendix 38 - Correlograms with first difference for the Suezmax sub segment. ***Source:*** StataSE12.



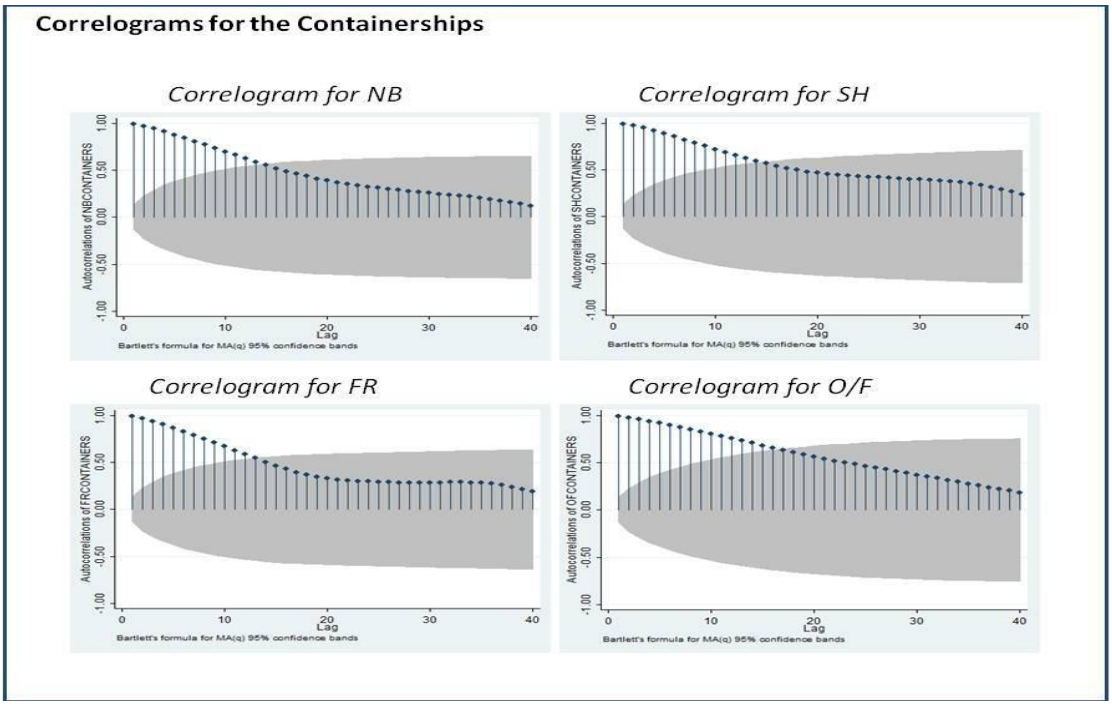
Appendix 39 – Correlograms for the VLCC/ULCC sub segment. ***Source:*** StataSE12.



Appendix 40 - Correlograms with first difference for the VLCC/ULCC sub segment. ***Source:*** StataSE12.



Appendix 41 – Correlograms for the Containers segment. ***Source:*** StataSE12.



Appendix 42 - Correlograms with first difference for the Containers. ***Source:*** StataSE12.