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Ph.D. Thesis

Economic Modeling in Shipping and Transport:

The Case of Bulk Shipping

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Summary

The maritime sector is a capital-intensive industry in which fixed assets are instantly liquidated and employed. The ship owner must go through the decision-making process involved in acquiring a vessel and estimating all variables, both endogenous and exogenous. The valuation incorporates all future cash inflows and outflows of the vessel during the ownership of the asset. However, a significant dilemma arises in the final decision stage: whether to acquire a new ship or a secondhand vessel. New construction prices are difficult to estimate, since most of the associated costs are determined by various factors, and the available databases do not incorporate all the required (and valuable) information. Additionally, the construction period varies among shipyards because of their different slot capacities. A ship owner has the option to weigh the price of a new structure against the value of a secondhand vessel and determine which is the optimal choice for the particular period and conditions of the shipping market.

The valuation process involved in purchasing a secondhand vessel may be more feasible, since most of the variables that determine the price can be easily obtained from various databases. Secondhand vessel prices can be described in terms of supply and demand.

Considering all the above parameters and incorporating modern econometric theory, which is based on co-integration methodology, this research focused on the construction of a valuation model. Gathering monthly data for a period of 11 years, a valuation model for a secondhand vessel was constructed and evaluated using a vector error correction model (VECM). The results were consistent with those of other studies pertaining to the shipping environment, which suggest that there are indicative differences between small-sized and large-sized vessels—differences which have a significant effect on vessel prices.

Supervisor: Prof. Eleftherios Thalassinos

“Οικονομική μοντελοποίηση στην Ναυτιλία και τις Μεταφορές- Η περίπτωση του Bulk Shipping”

Ευάγγελος Δ. Πολίτης

Περίληψη

Η ναυτιλία είναι ένας κλάδος εντάσεως κεφαλαίου, στον οποίο τα πάγια περιουσιακά στοιχεία είναι άμεσα ρευστοποιήσιμα και λειτουργικά. Για την αγορά ενός πλοίου, ο πλοιοκτήτης πρέπει να ξεκινήσει μια διαδικασία, στην οποία θα πρέπει να εκτιμήσει όλες τις μεταβλητές, τόσο ενδογενείς όσο και εξωγενείς που επηρεάζουν την τιμή του πλοίου. Η αποτίμηση της αξίας ενός πλοίου συμπεριλαμβάνει όλες τις μελλοντικές ταμειακές εισροές και εκροές του, για όλη τη διάρκεια ζωής του πλοίου. Ωστόσο, ένα σημαντικό δίλημμα που έχει ο κάθε εφοπλιστής είναι: να αποκτήσει ένα νέο πλοίο ή ένα μεταχειρισμένο. Οι τιμές των νέων πλοίων είναι δύσκολο να εκτιμηθούν, με βάση τους ενδογενείς και εξωγενείς παράγοντες, αφού είναι πολύ δύσκολο να συλλεχθούν στοιχεία από τα διάφορα ναυπηγεία. Επιπλέον, η περίοδος κατασκευής του πλοίου ποικίλλει μεταξύ των ναυπηγείων, λόγω διαφορών στις χωρητικότητες τους. Ένας πλοιοκτήτης πρέπει να συγκρίνει την τιμή ενός καινούριου πλοίου και ενός μεταχειρισμένου και να καθορίσει ποια είναι η καλύτερη επιλογή για τη συγκεκριμένη περίοδο και τις συνθήκες που επικρατούν στην ναυτιλιακή αγορά .

Η αποτίμηση ενός μεταχειρισμένου πλοίου είναι περισσότερο εφικτή, δεδομένου ότι οι περισσότερες από τις μεταβλητές που καθορίζουν την τιμή ενός μεταχειρισμένου πλοίου μπορούν εύκολα να ληφθούν από διάφορες βάσεις δεδομένων . Οι τιμές των μεταχειρισμένων πλοίων μπορούν να εκφραστούν σε όρους προσφοράς-ζήτησης.

Λαμβάνοντας υπόψη όλες τις παραπάνω παραμέτρους και με την ενσωμάτωση σύγχρονων οικονομετρικών θεωριών, οι οποίες βασίζονται στην μεθοδολογία συν-ολοκλήρωσης , η έρευνα επικεντρώθηκε στην κατασκευή ενός μοντέλου αποτίμησης της αξίας ενός μεταχειρισμένου πλοίου. Συγκεντρώνοντας μηνιαία στοιχεία για μια περίοδο 11 ετών , κατασκευάστηκε ένα μοντέλο αποτίμησης για ένα μεταχειρισμένο πλοίο και αξιολογήθηκε χρησιμοποιώντας ένα μοντέλο διόρθωσης σφάλματος (Vector Error Correction Model - VECM) . Τα αποτελέσματα ήταν σύμφωνα με αυτά άλλων μελετών που αφορούν το περιβάλλον της ναυτιλίας , τα οποία δείχνουν ότι υπάρχουν ενδεικτικά διαφορές μεταξύ μικρού μεγέθους και μεγάλου μεγέθους πλοία - διαφορές που έχουν σημαντική επίδραση στις τιμές των πλοίων .

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This Ph.D. thesis is based on original research and expresses only the opinion of the researcher.

Evangelos D. Politis

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Chapter 1

Introduction

1.1. Scope of this research

The acquisition of a fixed asset is a difficult decision. The valuation of the asset is a multidimensional problem and features several stages of investigation that must be completed before determining the optimal investment plan. The risk attached with this decision can boost the returns from this investment or lead to insolvency and the loss of invested capital. Therefore, the decision process has to evaluate the different fixed-asset choices, consider which will be the most profitable and liable, as well as worth the investor's risk. There are several valuation models that calculate different parameters. Expected, or forecasted, cash flows on a straight-line basis or discounted cash flows (Evans, 2006; Vems Lun, et al., 2009; Dikos, et al., 2003; 2008; McQuilling Services LLC, 2009) with an important discount rate are the traditional and most common methodologies. However, these methodologies have a disadvantage in that they cannot use a dynamic approach to calculate changes in endogenous and exogenous environments. For that reason, there are several limitations associated with using these methodologies, which can eventually lead to biased results and, ultimately, wrong decisions.

The shipping sector is a capital-intense industry with the following unique characteristic: Fixed assets are easy to liquidate via resale of the asset or disposal of the vessel, and sale of the steel used in the construction of the hull as scrap. In cash-flow terms, there is one major outflow in the beginning and one at the end of the investment, while during the operation period, there are several cash inflows from the freight after deducting operating, voyage, and special survey costs and, in the event the vessel is financed, loan installments and interest. This decision-making process might be simple, but it is usually followed in an empirical manner by most ship owners. This valuation process can be profoundly effective, but it cannot diminish the risk taken from the investment in a volatile global industry, which is strongly related to the variances of the world economic environment. In addition, the value of the vessel has instant and tremendous fluctuations in what has been described as a volatile market (Glen, et al., 1981; Kavussanos, 1997; Alizadeh, et al., 2006; 2007; Yung-Shun Chen, et al., 2004) in both the short-term and long-term periods; the return from the sale and purchase of the fixed assets can sometimes be more profitable from the simple operation of the vessel.

In order to describe the seaborne trade, the shipping market can be separated into four integrated and interconnected markets: the new-building market, the secondhand market, the freight market, and the scrap market. From these four markets are derived the endogenous variables of a valuation model. New-building markets determine the price of a newly constructed vessel. In the same way, the secondhand market decides the price of a secondhand vessel. Freight markets set the chartering rate, and the scrap market determines the value of the steel used for the construction of a vessel. These endogenous markets are a part of a wider economic environment that defines the finance cost, the opportunity cost, and the condition of the seaborne trading volume. An all-inclusive valuation model that covers all the aspects of an investment plan should be constructed with all these sets of variables.

The shipping market is a complex and fully integrated market that operates entirely by the terms of supply and demand for the seaborne trade. This study was structured to provide answers about the organization of the market, the major forces that affect it, and the key factors that shape the price of a secondhand bulk carrier vessel. Additionally, the valuation model constructed provides, more or less, an empirical tool that the ship owner can use to examine market conditions, estimate any future changes in the market, and then decide which asset is the optimal one to acquire at a particular time. In general terms, small-sized vessels contribute to a conservative cash flow, but they hold well in the event of a market recession. Conversely, capital-intensive medium-to large-sized vessels offer better results during market peaks. These results are derived from real-time investments and policies that have been followed by ship owners during the past years.

1.2. Contribution and related researchers

This study provides insight into the valuation process of a secondhand bulk carrier vessel. The valuation of vessels is usually done by ship-broking companies, which do not disclose information about the methodologies they apply to estimate the price of a vessel. In fact, they do not complete a physical audit of the vessel's condition. If we consider the various designs of vessels, the differences in their tank capacities, and the actual condition of each vessel, the actual prices of vessels having the same cargo capacity might have large-scale differences. Neglecting all these technical parameters and focusing on the market terms, the valuation of an asset must follow certain criteria, which should be available to the public. Therefore, several cases have been reported in which two or three ship-broking companies provided extremely different prices for the same vessel. This type of error can cause major problems for the shipping companies, because valuation certificates are used in various financial agreements, such as in loan agreements. As Evans (1994) concluded, the ship owners seem to work close to perfect competition, while in the long term, overcapacity and the speculative nature of tramp shipping prevents them from efficiently adapting to demand. Additionally, Raiswell (1978) suggested that pricing strategy is a failure of management control systems, which neglect to dynamically forecast situations such as market pricing and delivery delays.

Starting from the point that acknowledges the failure of ship-broking companies to provide their valuation criteria, there is a need to determine the actual economic parameters that affect the price of a ship. Consequently, the economic environment in which a vessel operates has to be analyzed in detail, and the weight of each economic factor affecting the ship's value must be determined. This is another contribution of the present study: separating the trading environment of the vessel and the four market segments, which were described in detail by Beenstock, et al. (1985; 1989a; 1989b; 1993), Stopford (1996), Tsolakis, et al. (2003) and Theotokas (2011), and determining the variables that affect a ship's value. These variables are interconnected in terms of supply and demand for secondhand vessels and the equilibrium that must be maintained in the long-term period, as proposed by Jin (1993), Beenstock, et al. (1985; 1989a; 1989b; 1993), Tsolakis, et al. (2003), Dikos, et al. (2003), Ming Zhong, et al. (2007), Adland, et al. (2007) and McQuilling Services LLC (2009).

Following the valuation model proposed by Tsolakis, et al. (2003), maintaining key parameters from this model, adding some key parameters, and altering a few others, the final valuation model constructed has certain similarities with the whole life-cycling cost proposed by Liapis, et al. (2011; 2014). This valuation model is used with monthly average data, which are low-frequency observations, in order to encapsulate the volatility of the market. Beenstock, et al. (1985; 1989a; 1989b; 1993) applied linear solutions for this kind of model; Veenstra moved one step further and applied co-integration techniques, and Tsolakis, et al. (2003) followed the same co-integration procedure while estimating an error correction model. Co-integration methodology has been established as an outstanding methodology in both micro and macro models. This study was based on co-integration methodology, but it moved one step further, by searching for more co-integration relations between the variables. In order to define the best co-integration model, we used Pantula's (1989) time series unit root testing model for the specification of the co-integration model, as proposed by Johansen (1992). In this way, we examined for the general model of co-integration to a more restrictive; in the same manner, we determined the rank of the co-integration equations. The VECM has an advantage over other error correction models with respect to capturing more dynamics between variables in the long-term period.

There is a vast amount of literature surrounding studies that feature these unique characteristics and which describe the operation of the shipping industry. The most significant works for the valuation of a vessel are the works of Beenstock and Vergottis (1985; 1989a; 1989b; 1993), Veenstra (1999), and Tsolakis, et al. (2003). The models derived from these researches were tested with methodologies from the simple ordinary least square model to co-integration methodologies. The results were rather satisfactory, and were in line with the real terms of the shipping market.

The scope of this research begins from a tested basis (described by previous researchers) and enhances the valuation process with the addition of some important variables while using a modern co-integration methodology and without losing the simplicity of the direct cash flow models. Tsolakis, et al. (2003) managed to construct a well-based model that incorporates the most key variables. However, researchers left enough space for evolution of the model. In brief, the freight rate variable is supplemented with the deduction of operating cost from the freight rate earnings. This new variable is actually the operating profit of the vessel. Another enhancement is the introduction of the loan margin in the valuation model. Libor is only a part of the financial cost (and actually a small portion). The loan margin charged by the financial institution increases the interest expense paid. Finally, a global variable that affects the trading is introduced in this valuation model.

As the major variables of the valuation model were defined, the next step was to gather the sample. The frequency of data can solve many problems, but it can also cause major ones. The data streams providers are not able to continuously observe daily data. The same problem exists for the monthly and yearly data, but not to the same degree as the daily data. Because this research wanted to capture the dynamic of the shipping industry and avoid substantial statistical limitations from variable frequencies, monthly data were preferred as an optimal frequency. Moreover, there is no existing valuation model in shipping literature that uses monthly data. Also, the period covered in this research, which includes some major events in the shipping industry and in the global economic environment, has not been examined in previous research.

Another innovation of this research is the methodology used to examine the proposed valuation model. It has been acknowledged that correlation methodologies provide biased results. Linear methodologies have the same disadvantages, and fail to describe and capture the dynamic of the variables. On the other hand, a co-integration approach overwhelms all the prior methodologies in the stability of, and the dynamic approach to, the data. This is not a new field in shipping literature, but the VECMs and their ability to estimate more co-integration ranks are definitely a new methodology applied in shipping theory. Johansen's co-integration approach is described in detail and is implemented in an efficient way with the use of the statistical package EViews 7.

1.3.Structure

The structure of this research was based on a pattern created by each valuator in order to construct an optimal valuation model, which includes any substantial information that could alter the price of the estimated acquisition price. A short summary of each chapter of this research, starting with chapter 2, as well as a literature review, follows in the next section.

The second chapter consists of a detailed literature review of all the past research done in the field of shipping and valuation. Based on the subject and on the scope of the research, the literature review is separated into three distinctive categories: market valuation and efficient market hypothesis; vessel valuation and investing models; and freight valuation models. The purpose of concentrating on the prior literature is to maintain all the powerful tools and results, and to discard any deficiency that arose, and avoid repeating it, in this research. An interesting point of the literature review is the rotation of the models, initially from multiparametric models, to univariate models, and back again to multiparametric.

In the third chapter, we provide a detailed analysis of the methodology used, starting from the first co-integration methodologies and their advantages and disadvantages. After that, we describe in detail our methodology and all the basic econometric and statistic tools that we applied in our model in order to maintain the stability and non-bias results.

In the fourth chapter, a market analysis of the shipping sector is conducted in order to highlight the forces that shape the shipping industry environment. There is also a brief review of the conditions of the shipping market as they existed in the last decade and of how changes in trade and global economy affected the shipping industry.

In the fifth chapter, we deconstruct the past valuation models and extract all the major variables. We then define which variable is appropriate to include in our model and provide reasons for why we rejected the remaining variables. In addition to the deconstruction of the past valuation models, we try to maintain any valuation model structure that is close to our conception of the valuation process. After concluding which variables should be used in our valuation model and explaining why they have been chosen as appropriate for our research, we move on to the data collection. In addition, we define the vessel categories by various factors and how important this segmentation is in the shipping industry. The last part comprises a collection of the variables data from renowned shipping and economic databases.

In the sixth chapter, we present the results from the estimation of the valuation model. The first stage of the analysis is to determine the rank of integration of the time series and then the optimal lag specification of the VECM. After determining the optimal lag, we check the optimal model specification for our set of data. Finally, we present the long-term and short-term part of the co-integration integration model, followed by a causality test and impulse response.

The research ends with the conclusions and the appendices. In the appendices, there is a more detailed statistical analysis of our model, which tests the residuals, the lags, and the general stability of the model.

1.4. Expectations and Misspecifications

This research demonstrates differences between the characteristics of the model used to valuate small- to medium-sized vessels and those in the model used to valuate medium- to large-sized vessels. Medium- to large-sized vessels involve more risk to the ship owner, because the capital needs are significantly higher than those for smaller vessels. Furthermore, the size of the vessels, and more specifically their capacity, causes problems when the market is facing recession and there is a lack of cargoes, or a reduction in the quantity of cargoes. A negative relation between new-building prices and secondhand prices is a signal that the market is concentrated and that the aged vessels are working competitively against the new ones. Also, a positive and significant co-integration relation of freight rates with secondhand prices provides a clear signal that the secondhand prices are market-driven.

As far as concerns the short-term part of the co-integration model, we expected most of the lagged variables to be nonsignificant, because the valuation procedure is designed to be more sensitive to long-term changes. All the variables used were on a long-term basis, with only operating costs changing in the short-term period.

Fluctuations in operating costs were not significant, and in the valuation procedure, operating costs changed yearly because of inflation effects. The error correction term addressed the volatility problem, with large vessels having the highest rates of adjustment in the short term.

The estimated valuation model managed to accurately depict real-market characteristics. Surely, the best result would be to perfectly simulate the real conditions. This would be the ideal case, but the model specifications have limitations for several reasons.

First, the shipping sector is a rather volatile model; this problem is infused in data. Extreme fluctuations in shipping variables cannot be corrected with all the advanced econometric methodologies. Traditional procedures, such as omitting extreme prices, is not considered to be an optimal option, because if the extreme prices are maintained for a long-term period, the omission will create a gap in data sample. A log formation could smooth the data, but normality problems in residuals cannot be eradicated from this model. Unfortunately, this is a common problem faced by a majority of the researchers whose studies are described in shipping literature. Even though the residuals have this deficiency, the valuation model is considered stable, but it is not efficient to use for forecasting purposes. For that reason, forecasting is excluded from this research.

Another problem is the multicollinearity of the variables. The variables used in this valuation model, and, generally, from all previous valuation models, were gathered from the same market, and their correlation is inevitable. We believe that there should be correlation between the variables, because if a correlation does not exist between the variables, there is no reason to search for any relation between the data. Therefore, we consider that correlation between variables should exist, and that this correlation is not considered as a deficiency to be addressed.

Finally, more variables could have been added to enhance the model, or existing variables could have been modified before being used in this valuation procedure. Even the model specification might not be efficient; There might be a more efficient model specification or a more detailed estimation methodology. As mentioned earlier, this research intended to construct a valuation model that is simple, and which accurately depicts the market conditions. There are sufficient opportunities for future researchers to modify and evolve the valuation models and provide better results.

Chapter 2

Literature Review

2.1. Introduction

The investment decision of a ship-owner to acquire a vessel relies on various factors interrelated and interconnected. The shipping market is very competitive and the theory of the equilibrium in demand and supply implements in the operation of sale and purchase of vessels. The valuation procedure of an investment has to encounter all the major variables that can support the decision to acquire a vessel of this type or this size and not another choice. In order to evaluate the decision about a vessel acquisition, the ship-owner can analyze the market as a whole and determine the trend. According to this procedure, the ship-owner can end up with the best offer at this point, which encompasses all the potential prospects of the future course of the seaborne trade and the shipping market.

However, in case the market is working in an efficient way, everyone has access to the same information at the same time and subsequently, it is difficult to diversify yourself from this common trend. If we do not override the efficient market hypothesis, the valuation process is meaningless, since no one can produce excessive income and there is no need for market research, since the valuation of an asset at that time is rational and includes all the available information.

Nevertheless, if we set aside all this holistic procedure and focus on certain key parameters that define the potential earnings from the investment, we have to focus only on the earning potentials and valuate a future acquisition based only on the earnings estimations and the volatility that it inherits. This quest of determining the most appropriate valuation procedure is well reflected in shipping literature.

In the first years, the literature review in valuation wanders around the efficient market hypothesis theorem (Beenstock et al., 1989; Hale, et al., 1992;Evans, 1994; Glen,1997;Kavussanos, et al., 2002) trying to determine whether a valuation model can be created and if it is effective. At the same time, various journals started to decompose all the variables that affect the shipping market. The outcome was the segmentation in interrelated markets (Charezma, 1981; Beenstock ,1985; Beenstock ,et al., 1989a, 1989b, 1993). More specifically, the shipping market was segmented in the Freight market, the New building market, the Second hand market and the Scrap market. Since the shipping market was specialized and described in more detail, there was a focused research in valuation of new building and second hand Vessel prices (Garod, et al.1985; Strandeness, 1985; Tvedt, 1997). Due to the fact that the valuation models started to be complex and researchers faced the problem of over-parameterized or under-parameterized models, they started to investigate the future cash flows and how it can be used in valuation procedure. Provided that the key point of the research was the freight rates and how they can be formulated and forecasted, there was a mass literature concerning the forecast and explanation of freight rates trends and prices (Kavussanos,1996; Kavussanos, et al.,2001,2006; Cullinane,1992,1995; Cullinane, et al., 1999). In recent years, there has been a turning point to valuation models again, which are based on micro and macro economy of the shipping market (Veenstra,1999; Tsolakis, et al,.2003; Jane Jing Xu, et al., 2011) depicted again the market with structural models.

The statistic and econometric methodology used in previous reasearch, starts from simple ordinary least squares and stepwise regression methodology. Due to the evolution of econometrics, the researchers faced the problem of non-stationarity of shipping data, which set a borderline in simple linear and geometric models estimation, because these models actually produced spurious outcomes. A previous research overpassed stationarity test, autocorrelation test, heteroskedasticity test and normality test (Glen, et al. 2005). The solution to the non-stationarity problem was found by virtue of the Engle Granger theorem and later on, the Johansen co-integration test. Engle Granger suggests that if two variables reach the same level of integration, then, there must be a long-term linear combination of the variables that produces stationary residuals. The first efforts concerning the co-integration theory approach were made in view of the examination of the Efficient Market Hypothesis (Hale, 1992). Later on, the criterion of the same order of integration was successfully surpassed with a mixture of different rank of integration series. The Engle Granger linear co-integration model includes a limitation; it investigates only one rank of co-integration and it does not provide any further clues about more than one co-integration relations, especially when the model is multivariate. The Johansen co-integration technique and the application of Vector Autoregressive Models provided a solution to multilevel co-integration equations. Even though the statistic properties of the residuals in all these models have to conform to certain rules, there are several cases in literature that these rules are neglected.

On the other hand, a new approach started to be proposed as a best fit solution, the ARIMA, the Arch and the Garch methodology (Glen, et al., 1998;Kavussanos, et al. ,2002;Alizadeh, et al.,2002;Yung-Shun Chen, et al.,2004;Syriopoulos,2006;Merikas et al., 2008;Jing Xu, et al.,2011). The advantage of these models is that they were concentrating on the volatility of the time series and could produce univariate models. There were some cases of non–parametrical methodology and stock market technical trading with medium outcomes in market modeling (Adland,2000;Alizadeh et al.,2007).

The literature review has the following structure: First, we identify the attempts concerning the evaluation of the shipping market through segmentation and the Efficient Market Hypothesis theorem appliance. The next step is the gathering and analysis of the various specialized valuation models for Second hand and New building prices. The last part refers to the freight valuation models and the measurement of volatility. In each group, the research is sorted by the year of publication, so as to highlight the evolution in this field of study.

2.2. Market valuation and Efficient Market Hypothesis

Charemza et al. (1981) uses a combination of equations to describe the various aspects of shipping and shipbuilding. The data depict the operation of the market very well. However, it suffers from a non-dynamic approach of a volatile market.

Beenstock (1985) was a pioneer of the idea to consider the ship as a capital asset, which can be treated as a stock. Beenstock orients shipping market in two different segments, the freight market and the market for ships. Freight market works in compliance with the rules of supply and demand:

$Qd=Qs$, whereas $Qd=F1\ (WT, F)$ and $QS=a\beta\sigma K$ (1)

WT is the seaborne World trade, F is the freight rates, 1-a is the number of vessels laid up, β is the carrying capacity, σ speed and K is the fleet size. Market for ships, in terms of supply and demand, is the following:

$$\Delta K=F(P,Ps,K) \quad (2)$$

The supply side consists of ΔK (i.e. the change in fleet size), P (i.e. the price of a new ship) and Ps (i.e. the scrap value). The demand size can be easily explained, as proposed by Markowitch theorem:

$$K^{d}P/W=F_{s}(R,R^{*}), \quad (3)$$

W is the real wealth, R is the expected returns of the vessel and R^{*} is the returns of a competing asset.

A general equilibrium is where the fleet size does not alter and the ship prices do not vary. The general equilibrium consists of a three equation system, where each equation describes the freight rates, the fleet size and the ship prices, all as depended variables. Inserting shocks in to the system, Beenstock tests the three-equation model and how it adjusts to equilibrium conditions. The shocks are categorized in anticipated and unanticipated. If the shock is anticipated, the model adjusts to its initial general equilibrium condition. In case of an unanticipated shock, the system becomes stable again in higher levels.

Following the previous work, Beenstock et al. (1989) continue to investigate the Efficient Market Hypothesis and the rational expectations implications. Enhanching the model specified in his previous research, he tries to investigate whether it can be applied in dry bulk market. Beenstock uses simple systems of linear equation models to describe the operation of the market. The research is based on elasticity. Anticipated and unanticipated shocks are introduced into the system of equations to highlight the changes in equilibrium. The general result that can be easily implied is that unanticipated shocks produce stronger short run responses, which can be compared to the milder and more time evenly distributed anticipated shocks. In the end, the market reaches equilibrium.

Beenstock et al. (1989) continue the same research pattern (Beenstock, et al., 1985,1989) and evaluate the price of a second hand tanker as an equilibrium of future cash flows and future vessel prices and inversely with the return on competing investments. This equation is a part of a system of equations that describes all the main parts of the shipping market, like freight rates, scrap and lay-up. The equation is solved with a simple, ordinary least square methodology. Once again, the most interesting part is the simulation of the model in various anticipated and unanticipated shocks. Under the rational expectations theory, an unanticipated demand shock causes the rise of second hand vessel prices and an increase in new building orders in the first year. The anticipated demand shock has the same effect in second hand prices, but this merely lies upon the speculative forecasts of the ship agents. Another interesting point is that tanker prices are less sensitive in the long term in the anticipated shocks than the unanticipated, which reflects that the tanker market is well braced. An unanticipated shock affects indirectly the second hand values through freight rise and causes a strong increase in prices, in contrast with the modest increase of prices in second hand vessels resulting from an anticipated shock. All the research of Beenstock et al. was later summarized and published under a single frame concerning the analysis of shipping market (Beenstock, et al,. 1993).

Glen (1990) evaluates the vessels based on gross profit margin for different routes and different size of vessels. The period analyzed (1970- 1978) is the period, during which the different size of vessels entered the shipping market.

The Efficient Market Hypothesis examination continues with the work of Chris Hale et al. (1992), who tried to evaluate the second hand market regarding Handysize, Panamax and Capesize dry bulk vessels prices testing the assumption that current values of vessels incorporate all current information. Accumulating the results of two different co-integration tests, namely co-integration regression Dickey Fuller and co-integration regression Durbin Watson, he found that there is no co-integration in any pair of vessel prices. However, Granger causality test could not be rejected regarding Handysize and Panamax. The next step was to test whether all variables are co-integrated. Co-integration could not be rejected and consequently, the efficiency market hypothesis is being questioned. Chris Hale et al.(1992) suggests that dry bulk market should be treated as single integrated market in the long run, since there should be a set of similar exogenous forces affecting the market.

The Demand and Supply equilibrium in shipping market has been researched by Jin (1993), in order to describe the tanker sector market. The Demand side function has as dependent, the demand for new building tankers and the supply function has as dependent, the price of new build tankers. The Demand function is mainly composed of variables from the seaborne trade. On the other hand, the supply function is composed of variables describing the construction of the vessel. This system of equations is solved with a two least squares technique. The major factors are well described in the system of equations, with freight rates, oil prices and second hand vessel prices to influence equilibrium at the highest degree.

The Efficient Market Hypothesis is investigated again by Evans (1994), with regard to the short term and the long term period frame. The ship-owners seem to work close to perfect competition, while in the long term, overcapacity and the speculative nature of tramp shipping disinclines the owners from adapting efficiently to demand.

Kavussanos (1996) estimates a model, which can explain the bilateral seaborne trade flows, using data concerning the five types of cargo and the trading regions. The model under consideration can determine which cargo should be traded and which ship lane the vessel should operate.

Glen (1997) extends the research of Hale et al. (1992) to the tanker sector and re-examines the bulk sector. The sample of data used in this research for bulk carriers, is covering a larger period. The Johansen co-integration test is preferred as a more established methodology, instead of the Durbin Watson and Dickey Fuller co-integration test. The results concerning the same sample as the one used by Hale are different, as far as the bivariate models of the bulk carriers are concerned, but in line with the trivariate models. Extending the sample of bulk carrier, Glen re estimates Johansen co-integration and finds pairwise co-integration for rank one, but he rejects rank two. The same results also concern the tanker vessels. Since all models are connected by one single co-integration relation, they could be re estimated using the Engle Granger technique. The final models are also tested for causal relationship, using the Granger causality test, but they maintain poor results.

The research concludes that the findings are not resolving the question about efficiency, but they could lead to the same speculation as the one of Hale et al. (1992), i.e. that there are some common exogenous factors affecting the prices.

Stradeness (1997) et al. reports the functionality of Norship software regarding the provision of a glimpse in complex and dynamic situations. Concentrating data from shipping industry, Norship creates curves through simple linear models.

The volatility of ship prices is being examined by Kavussanos (1997), who uses ARCH models to compare volatility estimates between three different size bulk carriers, namely Handysize, Panamax and Capesize bulk carrier vessels. The empirical results suggest that there are different dynamic volatilities, i.e. Capesize is the most volatile, Panamax follows and finally, Handysize.

Veenstra et al. (2001) are using the vector error correction model, in order to forecast the seaborne trade flows. The trade flows are separated in bulk and crude oil commodities. Using multivariate models for trade flows, they produce long-term forecasts with very small error.

Following the work of previous researchers, the Efficient Market Hypothesis is tested again. Kavussanos et al. (2002) are testing the efficient market hypothesis using three different hypotheses, which are common in the vast literature. These hypotheses are for rational investors, with no room for excess return and lastly, all parties are equally informed. In a trivariate VAR model, they use monthly prices from Capesize, Panamax and Handysize dry bulk vessels for the following variables: new building vessels prices, five-year-old second hand prices and scrap. The co-integration methodology outcomes suggest that the efficient market hypothesis is rejected regarding the marginal ten percent level, but not the five percent of new building prices. In relation to the second hand vessel prices, the efficient market hypothesis is rejected at five percent significance for all types of vessels. The second hypothesis is tested using the ARIMA methodology and the outcome is the rejection of the Efficient Market Hypothesis. The final estimation is an Arch-Garch-M model, regarding which the Efficient Market Hypothesis implication is rejected once again. The researchers have been led to the conclusion that the Efficient Market Hypothesis failure is mainly caused by time varying risk premium.

Jia et al. (2002) applies the correlation technique between the returns of a VLCC tanker vessel, a Handymax Product Tanker, a Capesize bulk carrier and a 1600 TEU container ship. All vessels found to have strong and positive correlation overtime, which increase in period of downturn, suggesting that it is difficult for a ship-owner to diversify the fleet, while lowering the risk, and evaluate the best type of vessel.

A rather different approach of shipping market is proposed by Tvedt (2003), who opposes to the general perception that freight rates and second hand prices are non-stationary. By converting prices into Japanese Yen from US Dollars and detrending them, he manages to create non stationary variables for Handysize, Panamax and, in some degree, Capesize dry bulk vessels.

Yung-Shun Chen et al. (2004) examine the volatility in shipping industry by using four different routes returns for the three main bulk carrier vessels. The main purpose of this research is to examine the asymmetric volatility. The data series suffer from non-normality and unit root problem. Therefore, the researchers suggest that the application of an EGarch model to the data could explain this irregularity. Asymmetry volatility exists and it is more intensive in a downsizing market. The investors react faster in negative news and due to that reason, they should always consider the leverage effect in volatility, when prices are changing. If volatility is calculated, the ship-owners can increase their investment performance.

The Real option analysis concerning the determination of the best strategy to be adopted by a certain containership vessel in a certain route is used by Bendall et al. (2005). The Real option analysis, as per authors, provides the best results against the traditional net present value techniques.

Evans (2006) uses discounted cash flows techniques, in order to investigate the best investing policy. This work reflects the efficiency of simple finance techniques to accumulate results, which can be applied by simple financiers in order to evaluate a project.

Scarsi (2007) bases the investment policy to short period cyclic patterns and ship-owner mistakes. The researcher describes a period of ten years in Handysize dry bulk vessel sector and makes certain references to cyclicality characteristics in this period. The writer criticizes the decision on investments made by ship-owners during the period in question and concludes that the missed investments are caused by three factors, namely the lack of experience, the lack of managerial culture and lastly, the mistakes connected to the decision-making attitude.

Vems Lun et al. (2009) separate shipping in four markets, namely the Freight market, the Second hand vessel market, the New building vessel market and the Demolition market, which are closely associated and can be linked by cash flows. Using data from these markets, they test the link between the four markets with the ordinary least squares and correlation technique. The findings of this study suggest that seaborne trade positively affects the fleet size and freight rate. In addition, the fleet size is mainly determined by seaborne trade, freight rate and vessel scrapping price, whereas seaborne trade plays the leading role.

Jing Xu et al. (2011) try to find if there is a link between the time varying volatility of dry bulk shipping freights and the change in fleet size. Volatility is initially estimated by using the AR-Garch model. The AR component includes four freight rates for Panamax and Capesize bulk carrier vessels. The outcome is that volatility is varying. The researchers apply General Methods of Movement, in order to investigate whether some key variables in shipping have any relation with fleet size. They justify the opinion that an increase in vessel fleet causes the increase in freight volatility, while the Capesize is suffering more from these changes.

2.3. Vessel valuation and investing models

Raiswell (1978) bases his work on Zanetos (1966) and Metaxas (1971) methodology, in order to define the pricing strategy in shipbuilding. The researcher specifies the problem and focuses on the failure of management control systems, in order to dynamically forecast situations such as market pricing and delivery delays.

As far as the design of a new vessel is concerned, Jansson et al.(1982) construct a model to calculate the optimum ship size by using some characteristics of the operation and finance. More specifically, they calculate the handling rate, the capital costs, the operating cost, the fuel cost, the port cost and the distance of the trip.

The methodology of investment planning behavior is analyzed by Miyashita (1982), which is defined as a process of two stages, where the service sales and the growth of service sales are declining and then, an order is given regarding a new vessel. The investment plan is finalized, when the marginal efficiency of the capital is achieved and the broken up tonnage is carefully examined for fluctuations.

Focusing on second hand ship value, Strandeness (1984) uses the model of NorShip to estimate the value of second hand vessels and time charters. The researcher suggest that the current profits and long term profit explain by seventy seven percent to ninety seven percent the variations in second hand value of Tanker vessels and Panamax dry bulk vessels. The most interesting outcome is the conclusion that Panamax vessels are affected more from changes in the long-term profits, whereas VLCC vessels are affected by variations in current market.

Also, with regard to the design of a new vessel, Garrod (1985) extends the research of Jansson et al. (1981) and constructs four scenarios that have in common the large size of the vessel, in contrast with the existing bulk carrier vessels. The outcome suggests that the user cost and the limitations on drafts at the ports have a significant impact on the ship size.

The notion that larger vessels are riskier and long-term charter periods are safer is justified by the work of Glen et al. (1998). A Garch model was applied in a data set of spot and time charter rates that covered a period from 1973 to 1996 regarding three different types of crude tankers, namely 40-70.000 dwt, 70-150.000 dwt and 200-299.000 dwt. Except from these variables, the model was enriched with bunker prices and industrial production and tanker fleet data. The Johansen co-integration test revealed only one co-integration relationship exists in all cases and thus, it is appropriate to include the bunker prices data, which were stationary in levels and were not included a priori. The final model was tested with Garch methodology, in order to measure the volatility. The outcomes reassign previous work's outcomes, i.e. that volatility is increasing, when the vessel size increases and longtime charter rates are safer.

Veenstra (1999) examines the second hand ship market, not only from the aspect of the replacement of an old vessel, but also from an underlying speculation motive from future appreciation of the second hand vessel value and the significant gain from the procedure of sale and purchase. For this reason, the researcher concentrates on monthly data concerning a ten year period and referring to tankers and bulk carrier vessels, of five and ten year old, whereas the five-year-old vessels represent the replacement motive and the other one the speculative motive. Except from these two variables, each model consists of new building prices, scrapping and time charter rates. All variables found to be non-stationary and found to have three co-integration equations relation in a set of four variables in all types of vessels and both motives. The next step is, to examine the existence of a common stochastic trend that drives the three variables. In particular, in the case of the replacement model, the trend explains the evaluation of the new building prices against second hand prices and scrapping prices. The case of speculative model reflects the influence of scrapping prices and time charter rates against second hand vessels. This statistic variation in the two markets is more obvious in Panamax and Capesize bulk carriers and VLCC. Finally, by combining the variables of the second hand with order book, voyage charter rates, trade flows and second hand prices, Veenstra creates a structural VAR model that interprets a direct short run relation between second hand prices, time charter rates and voyage rates.

A different approach of ship valuation is manifested by Adland (2000), who employs stock market trading rules for the sale and purchase of second hand dry bulk carriers. Technical trading outperforms the market, but there is no guarantee that this trading model will produce results in the future or that is the best choice. Furthermore, the buy and sell signals in a such a thin market may not have any impact on real market, because there is no guarantee that there will be a vessel for sale, when the model signals a purchase and vice versa.

A number of different methodologies are employed by Alizadeh et al. (2002), in order to investigate the relationship between the ship prices and the sale and purchase volume of dry bulk ships. The regression analysis indicates that a positive relationship exists between the changes in second hand prices of vessels and the volume. The Granger causality indicates that the volume does not Granger cause trading volume in the Handymax and Panamax dry bulk sector and the overall dry bulk index. Measuring the volatility with an E-Garch X model, they find that negative forecast errors have greater impact on ship prices, except for Handysize dry bulk market. Another interesting outcome is that the large shocks in volatility have smaller impact on market due to thin trading.

Dikos et al. (2003) define the dynamic of freight rates, new building vessel prices and scrap decision as dependent variables, from supply and demand for seaborne trade, for new vessels and for demolition. Secondhand vessel prices are only affected by the future cash flows, which are maximized with optimal chartering decisions. By using the real options methodology, they manage to construct a set of differential equations that integrate all the aforementioned variables. Limited data and lack of certain variables real observations limit the empirical testing of the above model.

Tsolakis et al. (2003) represents the second hand market as an equilibrium of demand and supply of second hand vessels; more specifically:

$$\left.\begin{aligned} Q_{SH}^{S} &= f(Orderbook/fleet, \sec ondhand) \\ Q_{SH}^{D} &= f(freight, \sec ondhand, nb, libor) \\ Q_{SH}^{S} &= Q_{SH}^{D} \end{aligned}\right\} \qquad (4)$$

$$\sec ondhand = f(\overset{+}{nb}, \overset{-}{libor}, \overset{+}{freight}, \overset{+/-}{Orderbook/fleet}), \qquad (5)$$

Second hand vessel values are affected by new building vessel prices, freight rates and a rate of order book to fleet. Apart from these variables, the researchers are introducing dummy variables in periods, during which major events have caused a drastic change in the economic and shipping environment. The data used in this research are annual and concern the period from 1968 to 2001. Variables were transformed into their logarithmic form and tested with the general model of the Augmented Dickey Fuller stationarity test (1981). Variables are a mixture of, integration rank of order one I (1) and no integration I (0). The researchers overcome the different lags of the variables by using a model of Brooks (2001), which uses first differences for the non-stationary series and the lagged values for all the others. In fact, this is an Error Correction Model. This model was tested with the Johansen (1991) approach for co-integration. The outcomes suggest for all vessels, there are at least four co-integration relations. With regard to the tanker vessels, time charter rates are significant in the short run in all market segments. New building prices are significant in the long run and short run for all the vessels, except for Aframax vessels, which are significant only in the long run. The Order book to fleet ratio found to be significant only in the long run for VLCC, Suezmax and Panamax tanker vessels. The dummy variable found to be significant in all segments, except for Aframax tankers. The bulk carriers time charter rate and the new building prices found to be significant in the short run for all vessels, except for Handysize bulk carrier vessels, where the new building prices found to be significant in all segments in the long run. The order book to fleet ratio found to be insignificant. The dummy variable found to be significant only for Handymax and Panamax bulk carrier vessels. Finally, the researchers compare the Structured Error Correction Model with a simple Autoregressive Model forecast ability. In all cases, the AR model outperforms.

Dikos (2004) tries to define whether new building prices are inelastic to demand for new vessels, which is a consequence of an increase in time charter rates and generally, in demand for shipping capacity. The author justifies this assumption by using linear models for demand and supply. The outcomes are in line with Zannetos's ones (1966), i.e. new building prices are suboptimal and inelastic to demand for new vessels. In the second part of the paper, the author tries to investigate if the market of new building supply is perfectly competitive. The outcomes suggest that supply side of the new buildings construction seems to work in a competitive equilibrium. Finally, the author manifests that new building prices should be estimated from the side of the retailer.

The efficiency of Forward Ship Value Agreements (FOSVA), in order to minimize the risk deriving from sale and purchase of vessels, is investigated by Adland et al. (2006). Considering that a vessel can be both traded and held for sale, there is a cash generation and a cost-of-carry relationship. If the forward price of the vessel is higher than this amount, then, the ship-owner can keep the asset trading and sell FOSVA agreements with maturity equal to the end of Time Charter contract. However, the vice versa hypothesis is eliminating the effectiveness of FOSVA agreements. Since this is a newly formed market and consequently, there are no sufficient data, the researchers estimate hypothetical forward prices, based on

Clarkson's Research Studies. They gather monthly data concerning two five-year-old second hand Tanker vessels, namely a VLCC and an Aframax tanker vessel and two same age second hand Bulk carrier vessels, namely a Capesize and a Panamax bulk carrier. The data cover a period from December 1991 to March 2003 regarding the VLCC and the Capesize and from January 1990 to March 2003 for the other two vessels. The estimated forward prices and the spot prices found to be rank of order one integration I(1), using ADF test and to be all co-integrated. Based on Johansen's VECM, the co-integration coefficients were varying from one to minus one, except for Aframax sector. In the forecast error, a risk premium is implied; varying from constant risk premium to time varying and in some cases both types of risk premium exist. The results reject the hypothesis of the unbiasedness for all sectors and all horizons analyzed. The results vary widely, but they cannot be granted as a reason of market insufficiency. The main conclusion is the defiance to the ability of the FOSVA to catch and minimize the risk of vessels sale and purchase process, as a consequence of the volatility of this market.

Syriopoulos (2006) et al. tried to investigate the impact of sale and purchase volume of second hand vessels and the effect of trading dynamic on vessel prices. This research focus on the second hand bulk carrier vessels, namely Handysize, Panamax and Capesize, and the second hand tankers, namely Handysize, Aframax, Suezmax and VLCC. Prices and the trading volume of sale and purchase of vessels data are covering a period of thirteen years starting from September 1991. A simple statistic analysis of data suggests that they are not normal with excess kurtosis, while price returns and trading volumes are stationary. The Granger causality test revealed a positive bidirectional relationship between prices and trading volumes. However, past trading volume does not Granger cause shipping returns. Egarch-X revealed a negative relationship between trading volumes and price volatility. Finally, Panamax and Capesize prices in the dry bulk market, as well as Handysize prices in the tanker market, have an asymmetric response in shocks in the market.

As Jansson et al. (1982) and Garrod (1985) focus on the ship design, likewise Veenstra et al. (2006) investigate the value of the vessel as a relation between the economic performance of the ship and the design. The design of the vessel is highly dependent on the ship-owner's needs and expectations. However, the decision to invest in a vessel depends on how it answers four main questions. The first question is which is the price of the ship and the time of the purchase. The second question refers to the size of the vessel and the optimal speed. The third question is related to the operation tactic of the vessel, as far as the daily service routine and chartering decisions are concerned. Finally, the fourth question is which is the earning potential, since there are some fixed costs, which are related to the design of the vessel and a marginal cost determined by the type of cargoes, the technical aspects of the cargo load, the carrying capacity, the speed and finally the versatility.

Alizadeh et al. (2006) uses the prices to earnings ratio and the sale and purchase of tanker vessels. A Vector Error Correction model evaluates the co -movement of ship prices and earnings. In order to create a trading rule for this spread, one short term and two long-term average models are used. The results are quite promising for the period examined. Larger tanker vessels are more volatile. For this reason, the asset playing strategies are more profitable for this size of vessels.

Adland et al. (2006) test the existence of a super cycle between 2003 and 2005 by estimating a VECM, which defines the theoretical price of a second hand vessel resulting to an equilibrium with new building vessel prices, freight rates and actual price of second hand vessels. A breakthrough in this analysis is the accumulation of a time varying delivery lag in new building vessels. The co-integration model consists of new building vessel prices, second hand vessel prices regarding a five year old vessel, one and three year time charter rates, annual average scrapping age and the risk free rate T-Bond. Operating costs assume to be constant and payments in yard have standard dates. Actual and theoretical values of the examined capsize vessel move closely in that period, without having any short deviation from equilibrium.

Stock market trading rules and fundamental analysis are applied by Alizadeh et al. (2007), in order to evaluate the performance of trading strategies in the sale and purchase market for second hand vessels. They estimate an equation that defines the current price of the vessel as the expected price of the vessel, the expected operational profits and the expected rates of return. After substitutions, logarithmic transformations and non-stationarity test, the result is an equilibrium of the actual spread of logarithm price to earnings ratio and a logarithm of resale price to earnings ratio. Using the Johansen co-integration technique, the researchers derive the same outcome. With regard to all the dry bulk vessels, there is only one co-integration equation. Since there is undoubtedly a long-term relation and a deviation of the logarithm of price to earnings from its long run mean, they formulate three different period moving averages, namely one slow, i.e. a Moving average of twelve months or a Moving average of six months and one fast, i.e. a Moving average of one month. The difference between the slow and the fast moving average series signals a sale decision if positive or vice versa. This strategy found to overwhelm in all cases simple buy and hold policies. Moreover, the gain from these investments is greater in Capesize and Panamax, since these markets are more volatile.

The use of an equilibrium of supply and demand, in order to evaluate second hand tanker prices, is used again by Ming Zhong et al. (2007). The equilibrium equation is estimated regarding Aframax, Suezmax and VLCC tanker vessels by using stepwise regression methodology. The model under examination is checked for autocorrelation. However, it fails in some key parameters. Using Durbin Watson statistics, in order to check for autocorrelation, high order correlation problem is being neglected. Furthermore, many researchers have found that shipping data are suffering from stationarity problem.

Non-parametric techniques are proposed by Adland et al. (2007), in order to evaluate the price of the vessel. Instead of using data from databases, which might include brokers' estimations about the value of the ships at these data, in case of its sale, they concentrate a sample of 1960 transactions, covering a period from 1993 to 2003 and with regard to a Handysize Bulk carrier vessel. The non-parametric procedure MDE used in this research tries to minimize the weighted residual pricing error of a micro model. The micro model is a sort of a linear equation, whereas the estimated price of the ship is a function of a small number of fundamental economic and physical factors. In this research, the physical factors are the dead weight tonnage, the age of the vessel and the state of the freight market. Comparing the estimation outputs with the values reported from Clarkson's Research, the writers identify the inability of the model to capture the volatility and the downward trend. The outcome of the researchers is that more vessel specification factors should be included in a semi parametric framework.

Sodal et al. (2008) constructed a real option model with stochastic prices, in order to evaluate the option of an Ore-bulk-oil carrier vessel to operate in Dry Bulk market and/or Wet Bulk market. The results of the research suggest that, under the current market conditions, it might be profitable in the future to operate an O-b-o carrier vessel, since the shipbuilding of this type of vessel has faded out for several years.

Dikos (2008) points out that the uncertainty enclosed behind an investment in shipping, since there are various non-expected incidents that cannot be imprinted in a simple discounted cash flow. Furthermore, there is a strong heterogeneity between shipping firms due to the adoption of various methods of operation and chartering tactics. Considering the investment decision as a maximization process, the researcher creates two different models and test them with Poisson likelihood estimation, negative binomial with random effects and ordinary least squares with robust errors. The results demonstrate that the real option model is sufficient to adopt all the non-expected parameters of operation and invest in shipping.

Instead of actual ship values, Merikas et al. (2008) use the second hand prices to new building prices ratio for Tanker vessels as a dependent variable in equilibrium with all the major shipping market indicators, in order to evaluate the investment decision. After determining the model specification, they apply a GARCH model. The results suggest that the tanker market is not for risk averse investors. Suezmax and Aframax vessels reflect a higher market risk. As far as the VLCC's vessel is concerned, the investors found to be indifferent about whether to build a new vessel or turn to the second hand market.

A simple equation model is used by Mulligan (2008) and consists of the producer price index, the dead weight tonnage and the different dummy variables for various types of vessels. Bulk carriers, tankers and containers ships cost less, while the LNG tankers are the most expensive. The price of the vessel and the cost of the vessel are separated by a reasonable profit margin.

The McQuilling Services LLC (2009) report denotes a shift from traditional market value or last transaction valuation models to more accounting solutions, such as discounted future cash flows of the vessel. The McQuilling also highlights that the vessel value is always the equilibrium of the current market conditions concerning supply and demand estimations of the buyer and the seller.

The relationship between freight rates and vessel prices regarding the three main dry bulk carriers (Handysize, Panamax and Capesze) and the three types of tanker vessels (Aframax, Suezmax, and VICC) is investigated by Kou et al. (2010) by using co-integration theory and Granger causality. The estimated model consists of the new building prices, the price of a five year old vessel and three different time charter rates concerning a six month, a one year and a three year period, which are alternating in the model. Since all series found to be of the same order of integration I(1), the Johansen co-integration test is being applied. Co-integration exists in all cases in the dry bulk sector, except of the dry bulk vessel carrier and the time charter rate of six months. On the other hand, tanker vessels do not have any co-integration relation, except of VLCC tanker vessel, which has one co-integration relation for each time charter rate. The Granger causality results suggest that temporal relationships between freight rates and ship markets differ in the two segments. More specifically, the researchers define that the dry bulk sector depends more on the freight rates changes than the tanker sector. Nevertheless, the asset play is more likely to happen in tanker sector.

The vessel price formation in a shipyard is analyzed by Jiang (2010). By using a multiple linear model on data acquired directly from Chinese Shipyards, he tries to identify the most important determinants of ship prices, which are price to cost margin, shipbuilding capacity utilization, credit rate and time charter rate. Time charter rate found to be the most important determinant.

Jane Jing Xu et al. (2011) tried to investigate the directional relationship between freight rates and new building prices. Freight rates in this research paper refer to Baltic dry index, one year time charter rate and three year time charter rate regarding Capesize, Panamax and Handymax dry bulk vessels. In order to estimate this interrelationship, they used panel data. The results suggest that there is co-integration between the variables. Additionally, the Granger causality test results imply that freight rates lead new building prices in one-way direction. Finally, the researchers conclude that there is interdependence across markets and the Efficient Market Hypothesis is questioned.

Chang et al. (2011) decomposes time series in trend cycle component, a cyclical component and an irregular component. By using the Phase average trend methodology, they separate cyclicality from trend, in order to isolate business cycles. The findings are staggering, since this three-cycle-system of equations in Panamax bulk carriers market manage to accumulate high quality predictions.

2.4. Freight valuation models

Hawdown (1978) uses system equation linear models to explain the shipping market for tankers. The outcome of the research is that the investment policy of a ship-owner is barely affecting the long-term profitability, since the oil companies define the volume of oil exports and consequently, the freight rates of seaborne trade.

Glen et al. (1981) derive a reduced form of equations, in order to test Zannetos (1966) hypothesis about price elastic expectations, which he finally rejects. In accordance with the findings, the weight of the estimated equations coefficients follows a geometric progression. The results are quite opposite to Zannetos (1966) hypothesis about the two barriers in the upper and the lower side, reflecting the volatile parts of the market and subsequently, time charter is better than expected, to charter spot in the near future at higher rates.

The Box-Jenkins methodology is used by Cullinane (1992), in order to employ a forecasting model of Baltic Freight index and find out how it could be used for speculative investments on BIFFEX. A suitable model for a short term period forecast is an Auto regression model rank of order three AR (3).

The effectiveness of Markovitz portfolio theory in Bulk carrier investments decision is described by Cullinane (1995). The ship-owner is trying to reduce the risk by deciding between three different types of charter and having an option to hedge this decision with a BIFFEX contract. The results suggest that the optimum portfolio narrows the Euclidian distance between the efficient portfolio and the modeled optimum. By subcategorizing all the available routes, the researcher choses three specific routes for a dry bulk vessel. The best-estimated portfolio mixture for the first route is a non-operating choice of the ship-owner and an investment in freight futures. In the other two routes the optimal mixture consists of voyage charter and freight futures. A noticeable outcome is the lack of physical hedging strategy with time charter contracts and the sole use of future contracts. Cullinane describes this phenomenon as an outcome of the maximization of returns in a hypothetical portfolio, in contrast with the industry norm to use the physical hedging strategy. Finally, the researcher suggests that the derivation of an optimum chartering policy from the complete dry bulk sector might enlighten the insufficiency of the modeling theory or the suboptimal decision policy of the ship-owner.

In order to measure the volatility of the shipping market and more specifically, the freight rates and the spot rates volatility, Kavussanos(1996) applies an ARCH model in Handysize, Panamax, Capesize bulk carrier vessels spot and time charter rates aiming at the relevant comparison between them. The time charter rates found to be more volatile than the spot freight rates. Due to their small size and flexibility, Handysize vessels are less volatile than the other two larger size vessels.

Chang et al. (1996) use the ordinary least squares methodology with Baltic Freight Index as depended variable and the BIFFEX as independent variable, in order to estimate the predictability of the derivative over the physical market. The researchers conclude that BIFFEX has a very strong predictability in short term. However, the methodology used suffers from high order autocorrelation, which is not treated with the analogous tools.

Regarding the estimation of the price of the VLCC, Tvedt (1997) investigates the volatility of freight rates, preferring the geometric mean reversion rather than the Ornstein-Uhlenbeck process. Both methodologies are carrying out for the operation of the vessel, the operation or scrapping, the operation or lay-up and finally full flexibility. In all cases, Ornstein-Uhlenbeck prices are increasing more than the geometric mean reversion specification, which is closely related with the stochastic nature of the freight rates. Finally, the author concludes that the better model specification for the stochastic nature of freight rates leads to better results regarding the asset valuation process.

The Johansen co-integration methodology to estimate freight rates is used by Veenstra et al. (1997), using data from a number of ocean bulk freight rate series. The outcomes of this research are concentrated to the fact that, although there is a long run relationship between freight rates of Panamax and Capesize vessels, the stochastic trend proved to be more significant. Due to this phenomenon, making forecasts in compliance with the model is not efficient. The final mark is that further research and more exogenous variables are needed for these models.

Haigh (1998) tried to resolve the viability of Biffex contracts, despite that the trading volume concerning them has been very low for so long. Using the Johansen co-integration methodology, he tried to estimate the long term relationship between future freight contracts and spot prices over a period of nine years, starting from 1988. Haigh found that the future freight contracts are an unbiased predictor of the spot market only in the long term.

The effectiveness of ARIMA models to forecast BFI after the changes made in the synthesis of the index is being researched by Cullinane et al. (1999). This model was originally constructed by Cullinane (1992) and it seems to be adapted properly to the new synthesis of the index.

On an extended work, Tamvakakis et al. (2000) search the possibility of the existence of a two tier freight market depending on the age of the vessel. A multiple regression model is being applied in the data, which clears out that no certain diversification between freight rates for younger vessels and old ones exists.

Haigh et al. (2001) gathered daily data concerning a period of five years and seven seaborne trade routes composing BPI from Baltic Exchange. The purpose of this research was to verify that the dry bulk shipping market is efficient and all freight rates are interconnected. This interconnectivity of the freight rates was examined by applying the Johansen's co-integration theory. The outcomes of the Johansen test were three co-integration equations. Then, three different processes were used for a more detailed insight of this interconnection of freight rates, namely decomposition of forecast errors, directed acyclic graphs and impulse response. In conclusion, the results of this research are that shipping markets are highly efficient and freight rates are adjusted from the continuous shift of vessels from the one route to the other.

The paper of Kavussanos et al. (2001) investigate if there exists a deterministic and stochastic seasonality in dry bulk freight for three different size vessels, namely Handysize, Panamax, Capesize dry bulk vessels. The comparison of seasonality across sectors and contract durations varies across vessels sizes. However, from spot to long time charter rates seasonality becomes equal across vessels sizes. Also, the market conditions affect the seasonality. Finally, they conclude that there exists no stochastic seasonality and VAR and ARMA models are adequate for the analysis of freight market.

Adland et al. (2005) evaluate a number of factors, which support the notion of applicability of the expectations theory in freight markets for bulk carrier vessels. Furthermore, they investigate, through logic, the risk premium sign and its significance. Finally, they propose that the risk premium must be time varying and depending from the duration of a time charter period.

Dikos et al. (2005) focus on the structural relationship between freight rates for tanker vessels and a set of exogenous inputs. The model created is based on the economic theory, the Garch methodology and the innovative hybrid model.

The dynamics of the freight rate in oil transportation markets, by using nonlinear stochastic models, were investigated by Adland et al. (2006). Focusing on a period starting from January 1990 to October 2004, they gather spot freight rates weekly observations for three types of tanker vessels, namely VLCC, Suezmax and Aframax. The spot rates are examined for the hypothesis of non-stationarity with ADF, KPSS and PP test. The general model with constant and trend is stationary in all cases and all tests for 1% and 5% significance. The constraint model with intercept is stationary only in KPSS test and 1% significance in all cases. Empirical evidence suggest that the spot rate is locally non stationary, but the existence of a nonlinear mean reverting drift at the edges restores again the global stationarity. In the end, the researchers support the hypothesis of a drift induced mean reversion, but along with the provision that the extreme upper range dynamic needs further attention, where the spot rates are non-stationary.

A survey over the past twenty years has been conducted by Kavussanos et al. (2006) regarding the development in research for hedging strategy in freight rates. However, the volume of the derivative market is very low, though the revenues of hedging are unique in comparison to other markets derivatives. Derivatives are a stepping-stone for non-shipping players, who are interested in getting involved in shipping business. The shipping community is becoming more and more familiar with this kind of complex financial products.

A freight market equilibrium model with the innovation of inserting scrapping and contracting activity in the model was developed by Adland et al. (2007). They define the market in terms of supply and demand for VLCC tanker vessels.

The Vector Error Correction Model to predict spot and forward rates is used by Batchelor et al. (2007). This method provides the best-fit estimation outside the sample. The forecasting values for forward rates are disappointing, but more accurate than a simple random walk model. A comparison of VECM with an ARIMA and a VAR model suggests that VECM model suffers in predicting forward rates.

The research of Poulakidas and Joutz (2009) tries to examine the relationship between weekly spot tanker prices and oil market. They gather weekly data concerning a period of ten years (1998-2006). The variables are examined in their natural logarithms form and are namely West Africa-Us Gulf tanker spot price (BDTI4), West Texas Intermediate crude spot prices (RWTC), 3months (3mo) future contract rate (RCLC3) and US weekly petroleum inventories. The procedure followed is a general to specific modeling. A Vector autoregressive model of order three VAR (3) is formed based on AIC criterion, because it is more conservative than SBC and HQ test. The residuals suffer from non-normality and ARCH effect, but they are not auto correlated and only one residual series suffers from Heteroskedasticity. Prior to VAR formation, all series found to be of rank one Integration I (1) using the ADF test. Since all of them had the same order of integration, they use Johansen procedure to identify if there is any form of integration. The outcome was one co-integration equation, which determines the relation of tanker rates with 3mo future prices as positive and with inventories as negative. These findings reflect the idea that, when the need for oil is rising, tanker rates are pushed upwards and vice versa. WTI spot prices have negative trend, which may reflect the growing tanker capacity on the spot market. The researchers prefer not to move on to an Error Correction Model for more detailed analysis of the short term effects.

In the paper of Sodal et al. (2009), the researchers try to estimate a real option valuation model according to stochastic freight rates, which will determine the investment strategy of a ship-owner to switch from Dry Bulk market to Tanker market. Considering that both markets are integrated, the ship-owner has the option to invest and de-invest from the one market to the other at the same time, when the conditions are more favorable in Dry bulk market or Tankers market. This hypothesis leads them to test the market efficiency criterion in a relative sense. The results are rather divided and a general outcome about the efficiency could not be extracted from this model.

Drobetz et al. (2012) deploys an EGARCH-X model for the freight rate, by using data from Baltic Exchange concerning dry bulk carriers vessels and tanker vessels and incorporating macroeconomic factors and asymmetric effects, not in the conditional variance equation, but in the conditional mean equation.

Conclusion

After continuous research based on various models formation, the major explanatory variables that should be used in a valuation model have already been well described and generally defined. Unfortunately, there is a lack of a unified model including all this major variables. As Pruyn et al. (2011) suggest for vessel valuation models, ''It is a subject not often investigated, but it is of importance when considering the capital cost of the vessel''. The Pruyn et al. (2011) opinion about the future trend in valuation model in shipping is in line with us, i.e. that there is a move back to more complex parametric and semi parametric structural models by virtue of the use of modern multivariate econometric methodologies.

Chapter 3

Methodology

3.1. Introduction

There are various methodologies in the case of a multi variable model; some of them have been described in detail in previous researches. The most common methodologies used in past literature are simple linear models, ordinary least squares and two least squares. Determining the model as a system of equations, they chose those simple methodologies, in order to define the relations of variables. This specification process suffered from various statistic errors and led, in most cases, in spurious models. In addition to that, most of the shipping and financial variables are non-stationary; this is something tended to be ignored by the researchers at that time or the stationarity problem was in early stages and it did not applied in maritime sector researches.

As we have mentioned before, after the system of equations and multi variable models, there is a great gap in describing the shipping market with multi variable approaches, as the research in shipping tended more to univariable specification models, models estimating the variance and risk and finally non parametric or semi parametric models. The results are rather significant, but they focus only on the one side of the problem and they do not take into account impacts from several forces shaping the maritime industry and the valuation procedure.

Since the methodology in econometrics evolved and the term of non-stationarity became a major factor in deciding the best approach for this kind of series, the co-integration methodology started to arise as the most appropriate pattern to analyze the market. The co-integration theory is a very simple approach, which manage to manipulate various economic variables and produce realistic models for the shipping industry. It is a step further from simple correlation techniques, which produced unreliable outcomes many times. Additionally, the co-integration technique can combine different market variables and determine the adjustment caused separately and jointly by them in the valuation model. Using an ordinary least squares methodology, to explain the power of one variable over the others, we limit the spectrum of the research. There might be several underlying forces inside a model, which could substantially expose any interfering relationship of the variables. Vector Autoregressive models VAR and Vector error correction models VECM constitute the simplest and easiest way to include several parameters in a matrix concept and test whether there are by directional relations. Except for that VECM models have the advantage of isolating non-significant terms in the estimation process.

However, we must note that there are several tests that have to be applied in the specification procedure, in order to determine the best-fit approach without leading to spurious results. A VAR model or a VECM model might not say anything about the market in some cases, but it does differ from all other available multi variable models, because of it is simplicity and clearness.

In the following sections we analytically expose the procedure, which must be followed by a researcher, in order to accomplish a well-arranged specification model. In brief, the data examination for statistic particularities is the first step of the specification. Then, we will describe the simple co-integration methodology, in contrast with multi ranking co-integration methodologies. Finally, there is a set of tests to be conducted, in order to be confident for the best-fit model specification. Additional methodologies will apply in the variables, in order to describe the causality of the variables and response in shocks caused in the error term. Our intention is to articulate a sufficient methodology of econometrics without procrastinating in detailed mathematical analysis.

3.2. Data examination

The first test before we begin the econometric approach is to synchronize the data. In case we have different frequencies, we will use a polynomial quadratic model to transform the data from low frequency to low. Data frequencies vary from monthly to annually. In order to transform these variables into monthly data, we have used a frequency data conversion methodology, which interpolates prices based on a quadratic logic model with an average price and more specifically, the monthly series are filled by using a quadratic equation with the average of the low frequency series matching the high frequency series.

Using the observations $(x_0, y_0),(x_1, y_1),......,(x_{n-1}, y_{n-1}),(x_n, y_n)$, a polynomial quadratic model fits through the data. The splines are given by:

$$f(x) = a_1x^2 + b_1x + c_1, \qquad x_0 \le x \le x_1 \tag{6}$$

$$= a_2x^2 + b_2x + c_2, \qquad x_1 \le x \le x_2$$

$$= a_nx^2 + b_nx + c_n, \qquad x_{n-1} \le x \le x_n$$

which satisfies f(xi) = yi, for i = 0, 1, 2

Using techniques to solve this system of equations (Lagrange, Substitutions, Derivatives), we get the low frequency point, which is between one point before and one point after the high frequency, with the average of this points matching the low frequency.

The next step is to convert all the observations in their log form, in order to enrich all the variables with their prolific characteristics and smooth the series, in case there are obsolete observations arisen in our sample. Furthermore, log formation will contribute to the omission of the different units of measurement.

Through the decades, the types of ships used as a measurement point have changed. The technology evolved the cargo quantity of the ship and its deadweight. For example, a Handy bulk carrier vessel was considered to be a 25-30 dwt, but then, it was replaced by modern vessels of 32-35 dwt. This problem sometimes causes a discontinuity in the data. One solution to this problem could be the transformation of the prices from one size vessel into the other. However, there is no certain methodology or pattern to proceed with that kind of change. The easiest way would be to omit these observations and lower our sample, loosing sometimes a large period in our examination sample. We preferred to combine the prices of the old size of this type of vessel with the new size. The reasoning for this decision is that the old size vessels cease to exist, by some point, as a proxy and they are substituted by the new vessel size. The difference in prices would be insignificant, because, when the owner examines the market and valuates the vessel prices, he does not consider this minor change in dwt. We will further discuss our choice later on in our research.

The last step is to produce the descriptive statistics to check mean, median, variance, standard deviation, kurtosis and skewness and graph all the variables to check for any seasonality effect or any obsolete observation.

3.3. Stationarity Test

Dickey and Fuller test- Augmented Dickey and Fuller test- Phillips Perron-Kwiatkowski, Phillips, Schmidt and Shin test

Dickey Fuller test (DF)

The stationarity control is a very simple case. We consider an AR (1):

$$y_t = \varphi y_{t-1} + u_t \quad (7)$$

where as u_t= residuals normal independent with mean zero and variance σ^2, [u_t, N (0, σ^2]

The φ should be lower than one,| φ|<1 for the series to be stationary. If φ=1, then the time series is non-stationary and contains a unit root and if φ>1 the time series explodes. Dickey and Fuller (1979) proposed a simple method to examine for a unit root.

If we subtract for both sides y_{t-1}, then the equation is taking these form:

$$y_t - y_{t-1} = \varphi y_{t-1} - y_{t-1} + u_t \quad (8)$$

after a few alterations, the equation takes its final form:

$$\Delta y_{t-1} = \gamma y_{t-1} + u_t \quad (9)$$

now the only thing we have to do is to test the statistic significance of γ.

The test is set, as follows:

H_0:γ=0

H_1:γ<0.

Dickey and Fuller create a table including the critical values for testing the hypothesis. However, we use the critical values of MacKinnon (1991). If the t-statistic of the equation is larger in absolute value than the critical values, then the series is stationary and we reject H_0. Dickey and Fuller (1979) also introduced two other models with a constant (eq.10) and a model with definite trend and a constant(eq.11).

$$\Delta y_{t-1} = a + \gamma y_{t-1} + u_t, \quad (10)$$

$$\Delta y_{t-1} = a + \mu t + \gamma y_{t-1} + u_t\,, \quad (11)$$

If a time series has a constant and/or trend and is not included in the test, the results may not be robust. To avoid this case, it is better to use the general model with trend and constant, in order to lower the risk of not including a certain characteristic of the time series, than over-parameterized the model.

If time series is non-stationary and we transform it into first difference and the non-stationarity persists, we proceed again with the second difference, until it becomes stationary. This process should be used with caution, because, if we differentiate the data too many times, they might lose all the prolific characteristics that we want to examine.

The problem of this test is that the residuals were set a priori as a white noise, which is quite difficult. In addition, this unit root test could not determine higher order of unit root problem.

Augmented Dickey Fuller test (ADF)

As we have already mentioned, Dickey and Fuller suggest that the residuals have no autocorrelation. Financial time series are mostly trended and with a constant part. Autocorrelation in residuals is usual and the simple Dickey and Fuller test is not useful regarding the determination of the stationarity. Moreover, it is not adequate to examine for higher level of non-stationarity in the data.

In a later work of theirs, Dickey and Fuller (1981) tried to eliminate the correlation of the residuals by inserting lagged variables into the model. Residuals in this case altered from auto correlated to serial correlated and thus, avoiding a spurious model. This test is called “Augmented Dickey and Fuller test’’ and it is the same set of three equations augmented with the sum of differences of the lagged values. The three models are the plain (eq.12), with constant (eq.13) and with constant and variable (eq.14):

$$\Delta y_{t-1} = \gamma y_{t-1} + \delta_{p-1} \sum y_{t-p+1} + u_t \quad (12)$$

$$\Delta y_{t-1} = a + \gamma y_{t-1} + \delta_{p-1} \sum y_{t-p+1} + u_t \quad (13)$$

$$\Delta y_{t-1} = a + \mu t + \gamma y_{t-1} + \delta_{p-1} \sum y_{t-p+1} + u_t \quad (14)$$

The critical values of the test are the same as the ones in the Dickey Fuller test and they test the significance of γ. The Hypothesis of the test is, as follows: If the t-statistic of the equation is larger, in absolute value, than the critical values, then the series is stationary and we reject H0: γ=0 against H_1:γ<0. We use once again the critical values estimated by MacKinnon (1991).

One major problem arisen from this test is the number of lagged of observations to be included in the model. The use of too many lags can cause a multicollinearity problem in the model. On the other hand, less lagged values will not solve the problem of autocorrelation in data. The solution in this case is to use the Akaike Information Criterion (AIC) and the Schwartz Bayesian Criterion (SBC) regarding the determination of the best fit model. These tests will be described later in the methodology, as they are core criterions for further tests.

Phillips Perron test (PP)

The use of a single technique to test the series might or will suffer from biases caused by limitations of the test itself. Furthermore, a second examination will help us to ensure our outcomes.

Phillips-Perron (1998) overwhelmed the problem of autocorrelation by setting two criteria that are not affected by autocorrelation problem. The three models tested are the same as the ones in the Dickey Fuller test, which are the plain (eq.15), with constant (eq.16) and with constant and variable (eq.17):

$$\Delta y_{t-1} = \gamma y_{t-1} + u_t \quad (15)$$

$$\Delta y_{t-1} = a + \gamma y_{t-1} + u_t \quad (16)$$

$$\Delta y_{t-1} = a + \mu t + \gamma y_{t-1} + u_t \quad (17)$$

The t-statistic of the Phillips Perron test is given from the following equation:

$$Z_t = \left(\frac{\delta_0^{\frac{1}{2}} t_\gamma}{\omega}\right) - (\omega^2 - \delta_0) n s_\gamma / 2\omega s \quad (18)$$

Whereas, $\delta_j = \frac{1}{n}\sum_{t=j+1}^{n} u_t\, u_{t-1}$

Where ω, is a covariance estimator proposed by Newey-West (1994), which calculates heteroskedasticity and autocorrelation of unknown form in the data.

The test and the critical values used is the same as the ones in the Augmented Dickey Fuller,

H0: γ=0 against H_1:γ<0.

Because of the truncation lag (it is beyond the scope of our analysis to describe this equation) calculated for ω, the sample must be much too large to lead to good results.

Kwiatkowski, Phillips, Schmidt and Shin test (KPSS)

The KPSS test (1992) is listed in the new methodologies concerning the examintion for unit root in data. The main notion behind this methodology is that, in several cases, DF, ADF and PP failed to estimate that in several cases, a time series has a unit root test. However, the experience suggests that all financial data series are suffering from stationarity. Furthermore, the aforementioned methodologies firstly test the non-stationarity of the data against stationarity. KPSS alternates the test, using a stationarity as first hypothesis against the alternative, using a Lagrange multiplier methodology (LM) examining this hypothesis. For simplicity reasons, we consider the regression:

$$y_{t=} x_t \beta_t + z'_t + u_t \quad (20)$$

Whereas β_t, is a normal random walk process and u_t, the residuals normal independent with mean zero and variance σ^2, [u_t, N (0, σ^2].

Lagrange Multiplier test is, as follows:

$$LM = \sum_{t=1}^{T} S(t)^2 / \widehat{\sigma_u^2} \quad (21)$$

where as $S(t)=\sum_{t-1}^{t} u_t$, the partial sum process of the residuals.

The test is, as follows: Bartlett: H0: γ=1-|x|, if estimated LM< critical values estimated by Kwiatkowski et al., against H_1:γ=0.

Conclusion

In order to ensure that all data are correctly estimated for stationarity problems, we have examined three different methodologies, which overlap one another and reduce the risk to have biased results. The best-case scenario would be the entire set of tests to agree on the results. However, there will be cases that the outcome would be not easily derived from the results and then, we will have to decide about which result has to be accepted. A preferable treatment of these cases is to adopt the majority of methodologies, in order to accept the same result. Additionally, we cannot overwhelm our biasedness on non-stationarity of the data, because a large majority of works suggests that all financial series are keen to be non-stationary. Moreover, due to the fact that the data series of shipping industry suffer from tremendous fluctuations, the non-stationarity problem will be considered as a fact.

3.4. Model Selection Criteria

Before we continue with the co-integration theory methodology of time series, we will have a brief look in the selection of the model in several of our tests. As we have mentioned before, there are cases that we have to introduce in our model lagged values, so as the model to best fit in the data. However, the common R-square technique or R-square adjusted, which penalize the introduction of more variables in the model, might not be so helpful, because introducing more variables in our equation may increase the R-square; nevertheless, it has a consequence in degrees of freedom.

An additional solution in that case is to estimate the goodness of fit by using the residual sum of squares (RSS) with more penalties. The model selection is based on comparison of three key tests, which estimate the best model based on the model that minimizes the prices of these three tests. The three tests are analyzed below.

Akaike Information Criterion (AIC)

Akaike (1974) introduced a selection model with the following equation:

$$AIC = ({RSS}/{n})e^{2k/n} \tag{22}$$

whereas RSS=residual sum of squares, N=number of observations, k=number of parameters.

Eviews uses a modified version of this statistics, which is the following:

$$AIC = -{2L}/{n} + {2k}/{n} \tag{23}$$

whereas the L is a log likelihood estimation

Schwarz Bayesian Criterion (SBC)

Schwarz Bayesian Criterion (1978) accumulated the power of AIC, but with a more restrictive penalty.

$$SBC = ({RSS}/{n})e^{k/n} \tag{24}$$

Again Eviews uses a modified version

$$SBC = -{2L}/{n} + {k\log(n)}/{n} \tag{25}$$

whereas L is a log likelihood estimation.

Hannan and Quinn(HQ)

Hannan and Quinn (1979) introduced the following criterion:

$$HQ = ({RSS}/{n})(\ln n)^{2k/n} \tag{26}$$

and Eviews uses the following modified version:

$$HQ = -{2L}/{n} + {k\log(\log(n))}/{n} \tag{27}$$

whereas L is a log likelihood estimation.

Conclusion

In all cases, we can observe that the tests are composed of two times the negative log likelihood, plus a penalty. The log likelihood estimation in Eviews is given by a Gaussian estimation, i.e.:

$$L = -{}^{nM}/_{2}\,(1 + \log 2\pi) - {}^{n}/_{2}\log|\widehat{\Omega}| \quad (28)$$

whereas M is the number of equations and Ω :

$$|\widehat{\Omega}| = \det(\textstyle\sum_i \hat{e}\hat{e}'/n). \quad (29)$$

Since there are various tests, we expect to have different results in model fitting. Some tests will be rejecting the one model for the other and vice versa. Generally, the most common and widespread methodology in time series is the AIC information criterion. However, the selection of the criterion to be used depends on the researcher's choice. As an example, when we estimate the ADF test, we use the automatic selection with SBC criterion (automatically decide how many lags to insert into the model) provided by Eviews, because the model we choose is fully parameterized and the SBC information criterion penalizes more restrictively the insertion of more variables into the model. Also, it has to be stated that there will be cases, where all statistics will be reported.

3.5. Co-integration

From Engle Granger, to Johansen's co-integration technique.

Introduction

As we mentioned above, if two or more series are not stationary in their levels, the ordinary least square methodology is not appropriate, because, if the series have spectral forms, the results of the ordinary least squares are spurious (Granger and Newbold 1974). A linear combination of a time series that has seasonality with another one that does not have any would not have any logical explanation, since the first one has a spectral form with peaks, whereas the other one does not.

The economic theory has provided multiple researches with background based on relations between various macro-economic and micro-economic variables. These relations could not be examined with the traditional econometric tests, like the

Ordinary Least Squares and its variations, since the problem of autocorrelation was limiting the solutions and there was strong tendency to provide spurious regressions with abnormal results.

The simple correlation theory provided a solution in this case, but the dynamic of this procedure did not solve the stability problems, like autocorrelation. Furthermore, various researches, based on the correlation theory, provided results in many cases, which, at first glance, fulfilled the gap in the estimation theory, but in the end, the researchers denoted that these were not meaningful.

The co-integration theory fulfilled this gap in the research estimation theory with all the pros and cons it has. Various methodologies were applied, in order to determine co-integration relations. Granger (1981) pioneered in this area and then, other researches appeared in the field of co-integration theory, among whom Engle and Granger (1987) and then, Johansen (1988, 1991, 1995a) were the most exceptional.

Since we have analyzed before the problem of non-stationarity, we will describe in brief the first steps in co-integration theory and the logic sequence behind this methodology and then, we will end in the most advanced estimation procedure.

Engle Granger

Granger (1981) suggested that, if two series have the same rank of integration I (d), then there would be a long term relation that could explain the data, which might be interrelated.

Engle and Granger (1987) moved a step further by representing an Error correction model that described the changes in the equation to sustain the equilibrium in the long term.

We might consider two time series that are of the same level of integration:

$y \sim I(1)$ and $x \sim I(1)$ that have a simple linear relation:

$$y=a+bx+u_t \tag{30}$$

where as u_t the residuals of the Ordinary Least Squares.

If u_t~I(0) are stationary in their levels, then the two time series are co integrated. The estimated residuals are tested with ADF test without trend and constant for the integration level and we use the critical values estimated by MacKinnon (1991).

Then, if the hypothesis of non stationarity of the data is valid, we can apply an Error Correction Model:

$$\Delta y_t = b_1 \Delta x_t + \lambda(y_{t-1} - b_2 x_{t-1}) + u_t \qquad (31)$$

where u_t, the residuals of the Error Correction term.

The part $(y_{t-1} - b_2 x_{t-1})$ is called "error correction term". The coefficient b_1 is the short run relation between Δy_t and Δx_t and more specifically, the changes that occur. The λ term is called "adjustment coefficient", because it is a correction rate to sustain the long-term equilibrium. This equation is simply solved with ordinary least squares methodology, since both x and y are non-stationary in their levels, but stationary in the same difference and the residuals are stationary.

This methodology is very simple and can be applied for more than two variables and even with different integration level time series (Granger and Lee 1990). However, it suffers from certain drawbacks. Firstly, you have to decide which value will be set as dependent, and which independent, in an arbitrary manner. Secondly, if time series suffer from certain problems, like autocorrelation, the problem is carried on in the Error Correction model. Finally, it can only examine only one co-integration relation, but, when we have multiple variables, the co-integration equations might be multiple.

Johansen's Co-integration test

The Johansen (1988) estimation methodology overwhelms the disadvantage of the Engle and Granger theorem of estimating only one co-integration relation between the variables. Since there are more than two variables, maybe, more than one co-integration relations exist.

If we reproduce a simple system of equations with two variables, which are affected by the past values, we have:

$$y_t = -b_{12} x_t + z_{11} y_{t-1} + u_{yt} \qquad (32)$$

$$x_t = -b_{21}y_t + z_{21}x_{t-1} + u_{yt} \tag{33}$$

$$x_t = bx_{t-1} + u_{xt} \tag{34}$$

For simplicity reasons, we have neglected the existence of constant or trend. Also, we have included only one lag in our system. We can rewrite these relations in matrix form.

$$\begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix} \begin{bmatrix} y_t \\ x_t \end{bmatrix} = \begin{bmatrix} z_{11} \\ z_{21} \end{bmatrix} \begin{bmatrix} y_{t-1} \\ x_{t-1} \end{bmatrix} + \begin{bmatrix} u_{yt} \\ u_{xt} \end{bmatrix} \tag{35}$$

Or

$$BC_t = Z_1C_{t-1} + u_t \tag{36}$$

Whereas

$$B = \begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix} \tag{37}$$

$$C_t = \begin{bmatrix} y_t \\ x_t \end{bmatrix} \tag{38}$$

$$Z_1 = \begin{bmatrix} z_{11} \\ z_{21} \end{bmatrix}$$

$$C_{t-1} = \begin{bmatrix} y_{t-1} \\ x_{t-1} \end{bmatrix} \tag{39}$$

and

$$u_t = \begin{bmatrix} u_{yt} \\ u_{xt} \end{bmatrix} \tag{40}$$

if we multiply in both sides with B^{-1}, then we have:

$$C_t = A_1C_{t-1} + e_t \tag{41}$$

whereas $A_1 = B^{-1}Z_1$ and $e_t = B^{-1}u_t$, in this new form the residual is a composite of both residuals u_{yt} and u_{xt}.

This model is a Vector Autoregressive Model, where the residuals are white noise and the variables are stationary.

If the variables are non-stationary, then, we can estimate an error correction model

$$\Delta C_t = \Gamma_1 \Delta C_{t-1} + \Pi C_{t-1} + e_t \quad (42)$$

$$\begin{bmatrix} \Delta y_t \\ \Delta x_t \end{bmatrix} = \Gamma_1 \begin{bmatrix} \Delta y_{t-1} \\ \Delta x_{t-1} \end{bmatrix} + \Pi \begin{bmatrix} y_{t-1} \\ x_{t-1} \end{bmatrix} + e_t \quad (43)$$

Whereas $\Pi = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} b_{11} & b_{21} \\ b_{12} & b_{22} \end{bmatrix}$ (44)

We must define that, if series are non-stationary, Π will be either a set of zeros or, in case there is at least one co-integration vector, there should be any linear combination that is stationary, but with no long run relationship.

Johansen (1988) proposed that, if time series are non-stationary, there are three different cases concerning matrix Π:

1) When Π rank r=n dimension, then the variables are stationary and no co-integration relation exists.

2) When Π is zero, then, no co-integration relation exists.

3) In case Π rank r≤(n-1), then, there exists r co-integration relation, which can be described as a matrix, where Π= BD. Matrix B is called “co-integration matrix” and D “adjustment matrix”, both with rank r x n.

In order to test the hypothesis of co-integration, there are two tests proposed by Johansen (1988) and Johansen-Juselius (1990), namely maximum eigenvalue and trace statistic.

Provided that the formulation of both tests is very complex and beyond the scope of our research, we will provide the equation of both tests, which are estimated with log likelihood estimation and the determination of the characteristic roots of matrices.

Maximum eigenvalue statistic

$$\lambda_{max}(r,r+1) = -T\ln(1-\hat{\lambda}r+1) \quad (45)$$

where λ, are the characteristics roots of the matrix.

The test has the following form:

$H_0: r = 0$ against $H_1: r = 1$, if $\lambda_{max} > \lambda_{critical}$, we reject H_0 and check the next hypothesis

$H_0: r = 1$ against $H_1: r \leq 2$, if $\lambda_{max} > \lambda_{critical}$, we reject H_0 and check the next hypothesis.

The test stops, when we cannot reject the H_0 and this is the number of co-integration equation. The maximum hypothesis we can test is the rank r to be equivalent to be n-r, where n, the variables of the matrices.

Trace statistic

$$\lambda_{trace}(r) = -T \sum_{r+1}^{n} \ln(1 - \hat{\lambda}r+1) \quad (46)$$

The test has the following form:

$H_0: r = 0$ against $H_1: r \geq 1$, if $\lambda_{trace} > \lambda_{critical}$, we reject H_0 and check the next hypothesis

$H_0: r \leq 1$ against $H_1: r \geq 2$, if $\lambda_{trace} > \lambda_{critical}$, we reject H_0 and check the next hypothesis.

The test stops, when we cannot reject the H_0 and this is the number of co-integration equation. The maximum hypothesis we can test is the rank r to be equivalent to be n-r, where n, the variables of the matrices. The critical values in Eviews are provided by MacKinnon-Haug-Michelis (1999) for p-values and Osterwald-Lenum (1992) for λ(r).

The basic guidelines to estimate a Vector Error Correction Model can be found in Dickey et al. (1994), Johansen and Juselius (1990), Johansen (1992), Enders (1998) and Johansen (2007).

The methodology, which we are going to use, is significantly based on Dickey et al. (1994), but along with a modification in Vector Error Correction Model estimation, where we will apply the directions set by Johansen (1992). The significant problem relies on the best-fit model of the short term relationship and the long term relationship. There are five models concerning the VAR and VECM relationship, including no trend and/or intercept in VAR or VECM and vice versa. More specifically, the set of models is following:

If we consider the general form of a VECM, we have various possibilities for VAR and co-integration equation.

$$\Delta \mathrm{C_t} = \Gamma_1 \Delta \mathrm{C_{t-1}} + \mathrm{a}\begin{bmatrix} b \\ g_1 \\ d_1 \end{bmatrix}\begin{bmatrix} C_{t-1} & 1 & t \end{bmatrix}\mathrm{C_{t-1}} + g_2 + d_2\mathrm{t} + \mathrm{e_t} \tag{47}$$

Whereas g_i=constant and $d_i t$=trend (linear or quadratic). The identification process starts from a general form to a more restrictive one. The possibilities are to have no constant or trend in VAR, to have constant or a trend and to have both. Long term part has the same possibilities. We omit the cases having no trend and constant in both VAR and Co-integration equation, since in financial series the constant term and/or trend usually exists. Furthermore, we can also reject a hypothesis, where the trend is not linear, especially in cases, where we use the log formation of the time series. In addition, not linear trend in data is very difficult to be interpreted with this methodology and cannot be granted by economic theory. Therefore, we delimit our model estimation process in three models.

1) The data VAR has no trend or constant, but the co-integration equation has a constant term ($d_1 = g_2 = d_2$=0).
2) If both co-integration equation and VAR have a constant, but no trend ($d_1 = d_2$=0).
3) If both VAR and co-integration equation have intercept, but only co-integration equation has a linear trend. (d_2=0). The trend in co-integration suggests exogenous impact factors.

Johansen (1992) used the work of Pantula (1989) for unit root examination and proposed a similar guideline to examine all the possible models of VECM, jointly with the rank estimation. The estimation process starts from rank r=0 until r=n-r. Starting from the most restrictive model (I) and continuing with the least restrictive model. In each step, we test the estimated values against the critical values and if we reject H_o(as discussed above in hypothesis testing for trace statistic and maximum eigenvalue), we move on to the next model or to the next rank of co-integration. The identification process stops for the first time, when we cannot reject H_o, and we conclude that this is the model we are going to estimate and the number of co-integration ranks.

Since we have identified the co-integration model and the rank, we continue with the guideline we are going to use in our model.

The first step is to identify the time series for non stationarity with ADF test. The integration rank of the variables must be the same I (d), so as to proceed with co-integration. In case they found to be I (0), we stop the test and we use the simple ordinary least squares methodology to analyze the relation of the data.

The second step is the identification process of the VAR length we are going to test for co-integration. The variables are tested in their level form. The purpose of this process is to limit the values of the AIC information criterion, SBC information criterion and HQ criterion. The process starts from a large number of lags and downwards, until we reach lag zero. At the same time, each VAR lag length we choose shall be tested for Gaussian errors estimation (normal, no autocorrelation, no heteroskedasticity). In case we fail to find Gaussian errors, we will have to change the lags included in the test.

The third step is to examine the co-integration model specification with the Johansen methodology (1998). As we have already mentioned, the test stops, when first fail to reject H_0, and this is the model we are going to estimate. We check again the number of co-integration equations suggested for this model, this number of lags. Then, we estimate the co-integration equation or the equations.

The fourth step is to check again the residuals for non-normality, autocorrelation and heteroskedasticity.

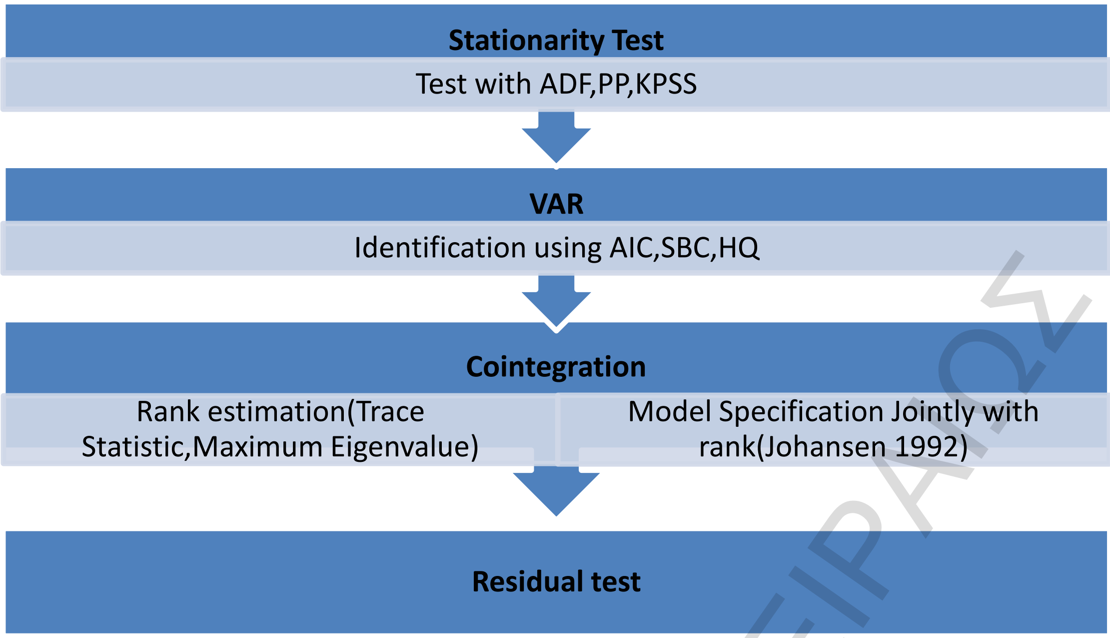


Table 1.: Vector Error Correction Model estimation procedure

Conclusion

The VAR estimation process is a complex procedure, because an underparameterisation or overparameterisation can affect the model specification. If we underestimate the model, there is high possibility the residuals to suffer from autocorrelation or non-normality. On the other hand, if we overestimate the model, there is high possibility to use variables that are not significant in the model and subsequently, the estimation procedure may be spurious. There is no strategy regarding the estimation of the lag order that is optimal (Lutkepohl 2011). The AIC information criterion is well behaved in small samples and limits the forecast estimation variance. Hence, in case we want to have a forecast model, the existence of non-significant terms does not fall within our interests. On the other hand, the SBC and HQ information criteria are penalizing the introduction of more lagged variables in the equation. In addition, they are behaving more efficiently in large samples.

Another consideration that we have to elaborate more is the maximum number of lags to be tested. Again, there is not quite clear maximum lag to be used in our downwards analysis. We might consider that the best scenario might be to start from three lags regarding quarterly data and six lags regarding six month data. In case we have monthly or annual data, the strategy to be followed is a little bit confusing.

Hence, we might face model fit problems if we overestimate or underestimate the model.

In this research, we conclude that the best methodology to follow is to estimate our model with regard to ten lags. Even if this lag number is enormous and might lead to an unconventional model, it has the advantage that we can start from over parameterized models, which can be reduced if the defined criteria are not optimal. Combining the results from information criteria and the residual analysis, we can reject some lags and move downwards in smaller models. We have to note again that different tests lead to different results and it is laid up to the researcher to decide which model to use. However, if the model estimated fulfills most of the residual test criteria, it will lead to the most appropriate model in our analysis. Surely, we want to be led to the model that combines good fit in our data and good forecast ability, if any.

Another diversification in our research is the acceptance of the residual tests. The residual tests we are going to use will be described later in our text. The proposal is that we estimate a VAR model with a number of lags and we check the residual that is consistency with Gaussian residuals. In our case, we will not proceed with the residual test from the VAR, but later, following our co-integration equation. If the residual suffer from autocorrelation, heteroskedasticity and non-normality from the VAR, then our co-integration equation will have the same deficiencies. Therefore, our strategy focuses on the co-integration equation and residual testing of the equation.

3.6. Residual Testing

Introduction

Following the estimation of the co-integration equation, we proceed with various diagnostic tests in the residuals and the variables. The basic guideline, which we will use, is totally based on Eviews features for model testing. There is a wide range of tools, which we are going to use aiming the best fitting of the model in the variables testing procedure. Provided that it is beyond the scope of this research, analytical imprinting of the diagnostic tests has been avoided.

Lag Structure

AR roots graph/table

Estimated roots should be inside the graph and should be less equal or close to unity. If the co-integration equations are r, then, the inverse roots estimated should k-r. In case there are roots outside the graph or more than one, the VECM is not stable.

Residual Test

Portmanteu Autocorrelation Test

The test is proposed by Box et al. (1970) and Ljung et al. (1978) and refers to the estimation of a multivariate Q estimator, with $x^2\left(hK^2 - K^2(p-1)\right) - Kr)$ distribution. hK^2The estimated parameters are subtracted (Lutkepohl 2011) from the number of autocovariances hK^2. The hypothesis tested is no serial correlation up to lag h against serial correlation. The test provides good results regarding small lags, because the estimated auxiliary model might not be feasible regarding larger lags, due to the small sample (Lutkepohl 2011).

Autocorrelation LM test

This test is based on running the estimated residuals up to lag h with original regressors in their difference formation. Then, we compute a Lagrange multiplier test on the equation that has an asymptotic x^2 distribution (Johansen 1995). The hypotheses tested are no serial correlation up to lag h against of correlation. Once again, the LM test is sufficient regarding the low order lag estimation or, as Lutkepohl (2011) proposes, up to lag 4.

Normality test

This test is based on Jarque-Bera (1980,1981,1987) Normality test. The factorization matrix of the residuals that we are going to use is based on Lutkepohl (1991) suggestion. In case the residuals are not multivariate normal, the forecastibility of the

VECM may suffer from bad parameterisation. However, this non-normality might be due to fat tail data or seasonality occurred in the tested sample. Therefore, we might reconsider the case of non-normality in the residuals.

However, many economic models suffer from non Gaussian residuals and Silvapulle and Podivinsky (2000) show that Johansen's (1995) procedure is robust for non-normal errors even in finite samples. Furthermore, the problem of skewness is no informative in such a small samples(Bai,Ng2001)

White Heteroskedasticity

This test uses White (1980) along with the extensions of Kelejian (1982) and Doornik (1995) (as reported by Eviews). In case there is heteroskedasticity, data are varying and the sample has to be regenerated either with more intense observation or with the omission of variables. The hypothesis tested is for jointly heteroskedasticity and individual heteroskedasticity, whereas the first hypothesis tested for no heteroskedasticity (homoscedasticity) or the existence of heteroskedasticity.

Graph Analysis

We check the graph of the inverse roots of the characteristic AR polynomial, which must lie inside the cycle and close to unity Lutkepohl (2011).

Granger Causality test

In addition to the co-integration theory, Granger (1969) manifested the concept of causality between the variables. When the estimation of a model is conducted, there must be a determination about which variable should be treated as endogenous or exogenous Engle (1983). The idea beyond this test is very simple; it is only a regression of the variables using several lags. In order to determine whether a variable y is Granger caused by x, we should test which lags of x are significant, in case we add more of them in the regression. If we find out that x granger cause y, we have a bidirectional relationship between the two variables. In case variables are integrated, we use the differenced values to test for Granger causality effects. The test concerns only the long term period, because we consider long term casual effects as more important within the valuation process. Finally, we must note that, in no way, Granger causality does not infer that y variable is the outcome of the change in x variable.

Impulse Response

By inserting impulse responses in the VECM model, we can determine how an exogenous shock in the independent variables affects the dependent variable from the coefficients of our model. The shock might affect the dependent variable from now and till the future or fade away. In our case, we would use one standard deviation impulse response. In case there is no causality between the variables, impulse response will be close to zero.

Multicollinearity Test

In order to test for multicollinearity the first step is to check the R-squared value and t-statistics estimations of the coefficients. A large number of insignificant t-statistics with on the other hand R-squared values very high will indicate a possible multicollinearity problem. Another test for multicollinearity is the correlation test and partial correlation test., but high correlation does not suggest in any case multicoolinearity. Finally, there is the solution of creating an auxiliary equation to test or to use the Variance Inflation factors.

The problem of multicollinearity has strong effect only in the estimated standard deviations of the coefficients and does not pose a problem for the biasdness of the estimators. In reality there is not perfect multicollinearity in data, but surely if the data are from the same industry or segment, there might be high possibilities that multicollinearity in data to exist. However, in co-integration theorem if any relation between the variables does not exist, there is no reason to test for a long term relation.

In this thesis, we insist that some short of relation must exist between the variables and the argument of multicollinearity is no sound, because Vector error correction models have always small R-squared outputs. Blanchard(1987) suggests that is reasonable to exist multicollinearity and it is not a problem of data or statistic techniques.

Conclusion

This set of diagnostic test control has significant impact in our model estimation. Each test has different impact factor in our analysis. Some diagnostics are important in our research, where others have a minor impact or the problem can be fixed with alterations in our model. However, we must be cautious for inconsistency in our results that might lead to unrelated assumptions, which might not have any logical sequence with the true nature of the market under examination.

Chapter 4

Market Analysis

4.1. Introduction

The shipping industry is characterized as one of the dominant types of goods transportation. The percentage of cargo carriage exceeds all the other means of transport, because of the cost efficiency in relation with the size of cargo carried and reaches the levels of a scale economy. The volume of shipments transported by sea is constantly rising (chart 1). The technological progress increased the speed of transportation means; there were several thoughts expressing that this will undermine the expansion of seaborne trade, because the speed rates of the vessels were still limited in contrast with airplane and railway transportation. On the contrary, the vessel capacity, always in connection with low transportation cost, could not be reached by the other means of transport. In any case, the expansion of seaborne trade was constantly following the growth rates of industrial production and even expanded its share in transportation market.

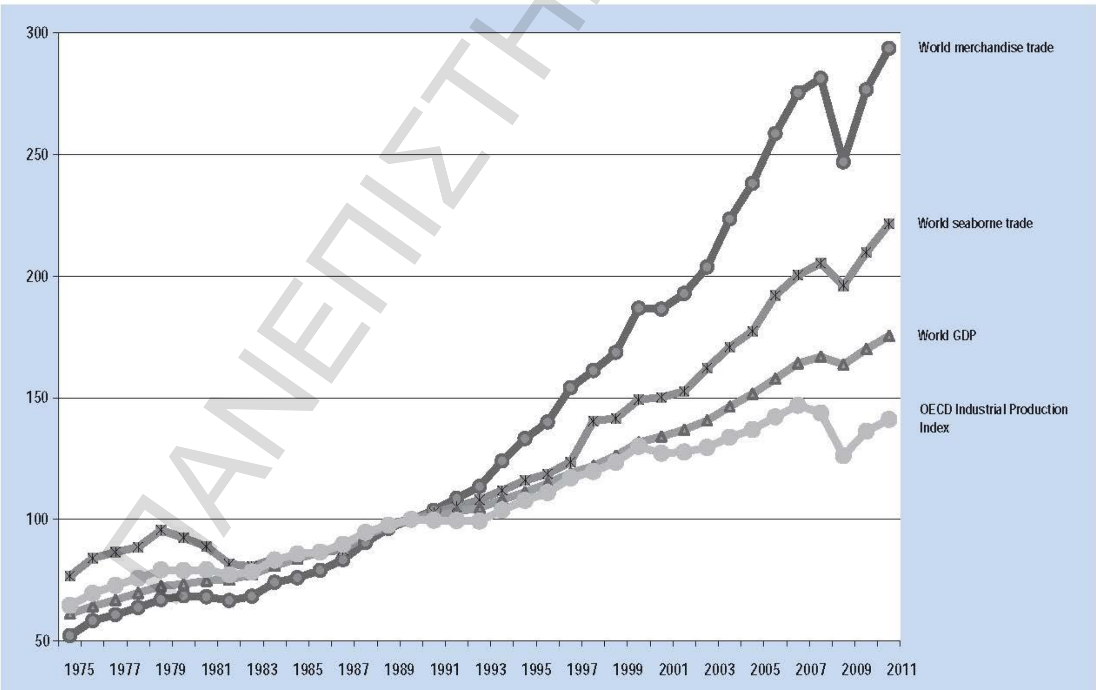


Chart 1.: Indices for world GDP, the OECD Industrial Production Index, world merchandise trade and world seaborne trade (1975–2011) (1990=100)

Source:Review of Maritime Transport 2011- UNCTAD

Vessels are subject to the legislation in force of the country, where the port is located and where the cargo is being loaded and discharged; nevertheless, when the vessels leave the port, they can float in international waters, where the provisions of international law are applied. The management of the shipping company is easily transferred from one country to the other. When the economic and legislative environment of the hosting country becomes hostile or unprofitable, the management company might decide to redomicile to another country. This mobility gives an advantage to shipping companies' management, because they can seek an increased role in a country's economy. This freedom of choice of the ship-owner imparts a unique advantage of this industry, which lasts for centuries. Every form of restriction that the international community has tried to force over shipping industry does not prevent this type of service from having the leading role in trade.

Another advantage of this industry is the production unit, the vessel. The profits maintained usually from the operation of the vessel. The operation of the vessel involves certain fixed costs and variable costs. Some costs are easily predicted, but there are several cases that miscalculations or nature forces create additional costs. Therefore, the ship-owner tries to operate the vessel within the limits of marginal cost. On the other hand, the income of the vessel, the freight rates, is rather volatile, since is constantly affected by several variables, which will be further described bellow. For that reason, the ship-owner must always monitor the market, in order to prevent his investment from loses, which sometimes might be severe. Nevertheless, if a good strategy of operation is applied the profits from the operation are well maintained.

In addition to the income resulting from the operation, there are another two sources of income, namely the sale and purchase of vessels and the scrap value of the vessel. A vessel can be purchased from the second hand market or ordered in a shipyard. A significant difference between these two markets is the time lag of the delivery of the vessel. A second hand vessel can be purchased at any time and be delivered to the new owner, when the contract terms define. The period of delivery to the new owner is very instant and it is not bound to any construction time limitations of a shipyard, like new building vessels. Therefore, the sale and purchase of a vessel in the second market have the advantage of instant transactions. Beenstock manifested the treatment of a vessel as a capital asset. The trade of this capital asset can generate profits, which might sometimes be significantly more than the ones resulting from a simple operation of the vessel. Prior to the decision of the ship-owner about an investment, he has two choices, namely a new building or a secondhand vessel. Each choice has advantages and disadvantages, as well as different types of risk.

The remaining value or the scrap value of a vessel has a crucial role, when the market is in downturn or the vessel has reached the limits of its operation and is not financially advantageous to maintain the vessel anymore. Typically, a vessel, if well maintained, can exceed the limit of the twenty-five years estimation of operation. Usually, the cost for the maintenance of an old vessel, which has to pass through the special survey, is not affordable or not economically advantageous. Nevertheless, if the freight market is heading upwards, the ship-owner might reconsider scrapping the vessel. A different case scenario is when the market is in recession and then, the ship-owner might consider scrapping the vessel in an early age. In anyway, the remaining value of vessel is also a capital, which can be liquidated instantly and it can be used as a safety net for a guaranteed amount.

To summarize all the aforementioned, the ship-owners usually estimate future expectations for these incomes, before they decide to buy a vessel from the second hand market or from a shipyard. Each income source has a crucial role in the acquiring decision policy, but in some cases ship-owners might consider to set aside one income factor if they consider that a drastically swift in the market is going to arise. As an example, there were several cases that the freight market rates were in their top peaks, the scrap value was very low and the ship values were soaring, but the ship-owner decided to sell the vessel, because he had a notion that the market would fall in long-term period. This decision, at that time, might not be considered to be wise, but the long-term results suggest the opposite. The ship-owners must always be well informed about the changes taking place in the global economy and wisely interpret any swift, because, if they are isolated from the market, then they can expose their shipping company in turmoil, with continuous loses or they might miss a very good opportunity.

Shipping companies' profile has changed during the last decade (2000–2010) in a vigorous manner. Shipping industry was trying to be adjusted to the new financial system. Since the shipping companies are a capital intense industry and there was a high stream of funds globally, they had to grab this opportunity to expand and modernize. Adjusting to the even more expanding need for seaborne trade, the shipping industry has drifted from the eudemonia of capital markets, witnessing higher levels of freight. Stock markets became one major source of funding. During a single decade, a large number of initial public offerings and spin off initiated, leading major and minor shipping companies listed in stock markets around the globe (see Appendices Chapter 4). United States, London and Oslo stock markets are the usual "harbors" for the listed companies. New York's stock market funding capacities were tremendous in that period and the ship-owners grabbed the chance to fund their investments with cheap liquidity.

Additionally, the traditional funds providers, i.e. the banks, have accumulated great sources of free cash flow and there were seeking opportunities to invest this liquidity. Low interest rates, in combination with the free cash flows, created a surplus of cheap cash, which was used to fund new acquisitions of vessels. Banks loosened their criteria to lend a company or could not foresee the "bubble" that was introduced in the shipping market. As a result of banks' sightedness, funding acquisition and expansion prospects were funded, as long as banks could find a way to invest this extra liquidity. Undoubtedly, financial institutions were only seeking the profit making, but the long term outcome of this decision was to suffer from bad loans or the loan agreement mortgage criteria were not covered from the vessel value. The results were massive orders for new vessels and a price bubble in the existing fleet.

The traditional funding process was the fund of a bank amounting to, at least, fifty percent of the face value of the vessel, or a little higher, always depending on the asset mortgaged and the credibility of the lender. This limit was a guarantee for the bank that will share the risk with the ship-owner. Only in a few cases, this limit was suspended, but this has happened under special circumstances, where customers were credible or there was a record of good business with other financial institutes.

However, in the last decade the funding limit was suspended in several cases and the funding percentage uplifted even to ninety percent of the face value of the vessel, whereas the bank had undertaken the whole risk of the vessel.

Commodities prices followed this euphoria of the finance markets. The investors closed deals for contracts regarding the supply of a commodity at a certain time, even if the supplier could not provide the agreed quantities by the end of the contract. All commodities were leading to a bubble, whereas the prices were soaring in unrealistic levels. A consequence of high commodity trading was the outrageous need for transportation means.

All these factors led to higher freights and the constant need for even more transportation capacity. The demand for transportation capacity consequently affected the prices of vessels. The prices of second hand vessels usually lagged the prices of new building vessels. This pattern was altered in this decade, as the seaborne trade need became immense. An example of this case is the price of new building 75-76 dwt Bulk carrier vessel, which has reached the price of a same capacity of a five year old second hand ship (chart 2).

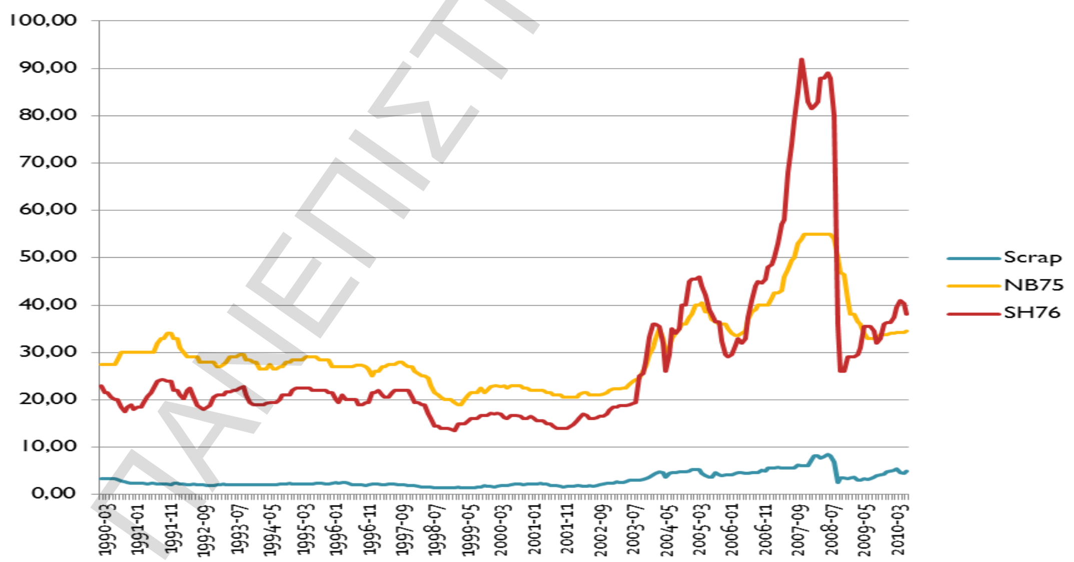


Chart 2.: New building Prices-Second hand Prices (75-76 dwt)(in million USD)

Data Source: Clarksons Research Services Ltd

There were several cases that a vessel managed to repay a great part of the investment in two to three voyages. Scraping of old vessels had been postponed for a certain period and the vessels that usually were non-operative in terms of cost efficiency, where chartered with extraordinary freights. The sale and purchase volume was tremendous. The ship-owners were attracted to the market conditions were willing to take further risk and invested in vessels acquisitions of all ages, without estimating any possible downturn of the market.

Stopford (2012) called this era as a shipping super circle, with high earnings (Chart 3). Giziakis et al. (2010) determine the era of the peak as a period, when all the demand for vessels has been exhausted and the shipping freights are adjusted at higher levels than the operating cost of the vessel. However, this time, the peak of the shipping lasted more than expected, if we consider the long term cycles theory of Stopford (1996), with an average of seven years from the one peak of the market to the other.

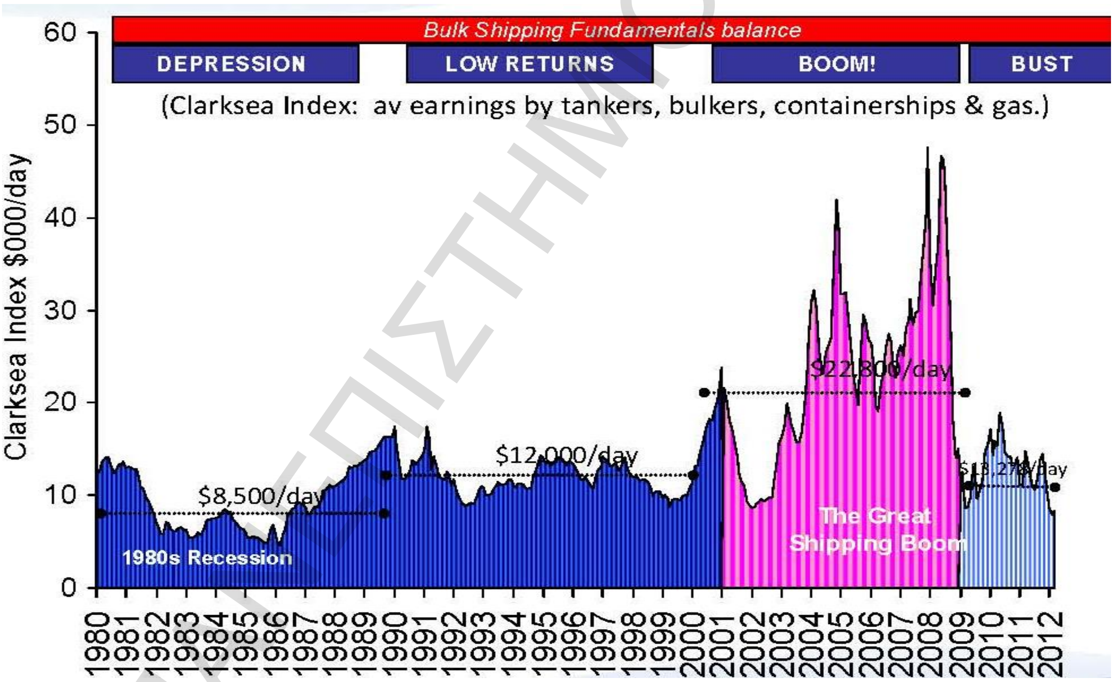


Chart 3.: Bulk Shipping Super-Cycle

Source:Dr. Martin Stopford-SMM advance press conference 2012

China and generally Far East contributed in the soaring of seaborne trade in the last decade. The growth rates of China and India contributed to a great dispatch of fleet from the Atlantic Basin to the Pacific Ocean. The demand for all sorts of cargo, with iron ore to be the main cargo contributed in the crowding of vessels in the ports of Asia. Steel production of the major three producer countries, namely China, India and Japan, thrived to cover the demand of the market (Chart 4).

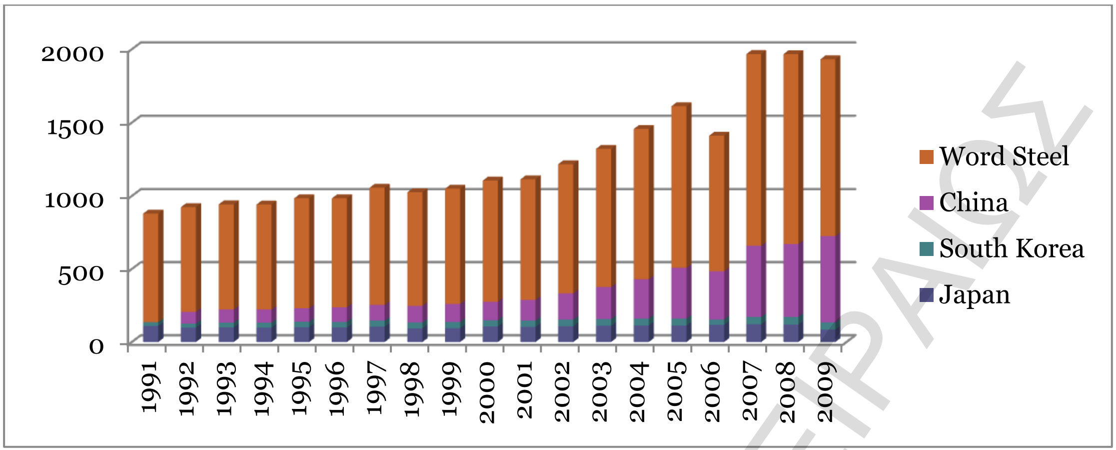


Chart 4.: Steel production (millions of tons)

Data Source: Clarksons Research Services Ltd

Another effect of the world economic boom and the change in prices between new building and second hand vessels was the construction or expansion of several shipyards in China. The Chinese government subsidized the shipyard industry. The cost of building a vessel in China was significantly lower than those of all the other shipyards, due to the low labor cost. The order book in these shipyards mounted to several new building vessels, which sometimes surpassed Japan and South Korea, which were used to be the leaders in shipping construction.

The results of this bubble were appeared early in twenty first century, by the end of 2008, when Lehman Brothers collapsed and the subprime crisis started to drag down the world economy. The freight rates dropped sharply and a significant number of vessels were laid up. The ship-owners started to cancel the orders in the shipyards, because the banks stopped the financial easing in the loans or were incapable to fund these loan agreements. Even if the vessel was delivered, the freight rates could not sustain the investment. Several shipyards in Far East, which were established in the economic boom, without having strong fundamentals, ceased operation. The unsustainability lasted for approximately two years and the shipping market has not managed yet to recover from these days in all the type of vessels.

In this chapter, we will describe in brief the shipping market and how interacts with global economy. We will give a brief description of the segmentation of the shipping industry by cargo and operation. Then, we will describe the main variables of a vessel operation. Finally, we will give a detailed description of the types of vessels and all the factors that are taken into account, when a vessel is purchased from the market. Our intention is to focus on the major variables affecting the shipping industry and more specifically, the decision policy of acquiring a new or a second hand vessel.

4.2. Ship Market Organization

Introduction

The shipping market industry can be classified in various ways, i.e. by the type of vessel, by the cargo carried, by the type of operation, by the trading area and by the duration of the chartering period. The reason of these multiple categorization ways is that shipping market is not a homogenous market, since each cargo might need a specially designed vessel to be loaded and transferred. Additionally, some cargoes are located in various or specific geographical areas, where only certain types of vessels can be utilized or all the types of vessels are adequate for this area of trading. Furthermore, large industrial companies have their own fleets, which can carry certain types of cargo at a frequent timetable. However, there are cases that the loading capacity of these industrial companies fleet cannot sustain the rate of production or demand for shipping service. In that case, extra loading capacity can be found in the open market from individual ship-owners. The loaded cargo might have a special route that the vessel will follow and the number of loading and discharging ports might vary constantly. Lastly, the hire of the vessel may concern from one trip to more or the duration might be a number of loading or discharging ports or the chartering period might last from some days to several years, depending on the agreement between the charterer and the ship-owner.

Each category has a special purpose, always depending on the aspect, from which way we want to analyze the market. In this research, we will focus only in two segments of the shipping industry, namely the type of the carried cargo and the operation. Cargo segmentation is only a stepping-stone that will give the potential power to highlight the operation of the vessel and why we focus only on a certain segment of the shipping industry. We consider that this specialization of our research is the most commonly used by the individual ship-owners operating in tramp industry with bulk carrier vessels and tanker vessels. The types of the vessels used in our research are the most common in the last decade.

Classification By cargo

Stopford (1996) introduced the term of parcel distribution function, along with the following description:

‘’For a particular commodity trade, the PSD function describes the range of parcel sizes, in which cargo is actually shipped by sea’’.

Under this term, the cargo is classified between general cargo and bulk cargo. In more detail, the small cargoes are usually shipped in liner shipping. If the size of the cargo is growing, it can be shipped in a bulk state, moving the operation from liner to bulk trade. However, a more simple classification of vessels is that the cargo is separated in:

1) General Cargo

2) Bulk Cargo

3) Passengers

4) Special Cargo

This classification includes all the possible types of cargo and passengers. We can consider a priori that general cargo is usually shipped by liner trade and bulk cargo by tramp shipping.

As general cargoes we define the items of high value that usually cannot fill a whole vessel and consequently, are stashed together with different cargo shipments. Additionally, these cargoes are usually expensive and needed to be transferred under certain conditions, so as to guarantee the integrity of the shipment. This type of cargoes might be liquids, parcels, mechanical equipment, foods or containerized cargo. Except for the liquids that can be loaded in tanks or drums and foods that need special refrigerators, nowadays, all the other types of cargo can be transferred in a container. The loading process is easier, when the shipment has a standard size and the stowage process is more accurate and faster.

The non-containerized cargoes are loaded in common vessels or in vessels, specially designed for this service. On the other hand, containerized cargo is transported in containership vessels, which are specially designed to carry only this type of shipment.

Bulk Cargoes are separated in two individual segments, i.e. the liquid bulk cargo and the dry bulk cargoes. Even further, liquid bulk cargoes are separated in crude oil and oil products, chemicals, and Liquefied Natural Gas or Liquefied petroleum gas.

Crude oil carriers are usually large vessels that have standard ports for loading and delivery and follow certain routes from the oil producing countries to the refineries. These types of vessels are not flexible because of their size and the specialty of their cargo. Crude oil is not refined and has a large concentration of sludge. When the shipment arrives in the final port for discharging, the ship-owner has to engage a cleaning operation for the tanks, in order to remove any sludge left. If the vessel is loaded without having removed the sludge, a part of the capacity of the vessel is left unused, contributing in the loss of transportation capacity. Moreover, the charterers expect the vessel to be clean, before the shipment is loaded, in order to avoid any deterioration of the shipment and gain the full capacity of the vessel.

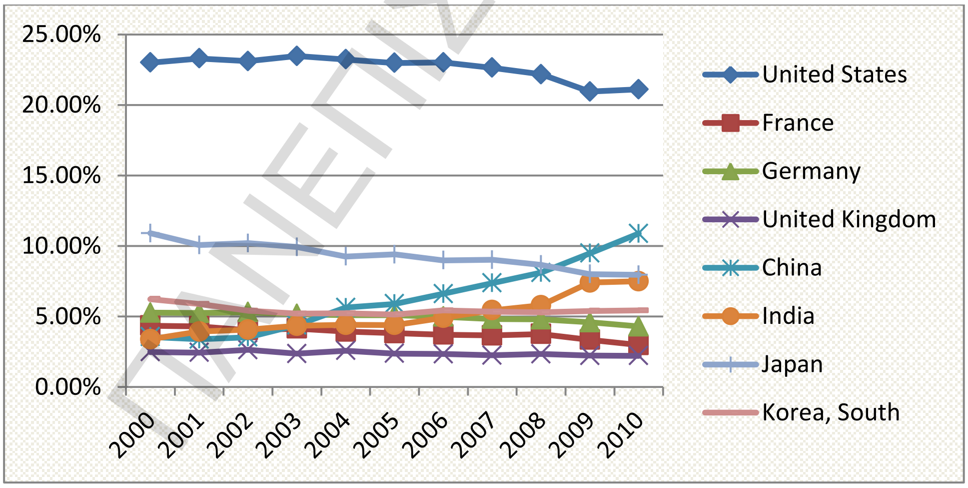


Chart 5.:Crude Oil Imports as percentage of world imports (Thousand Barrels)

Data source: US energy information administration

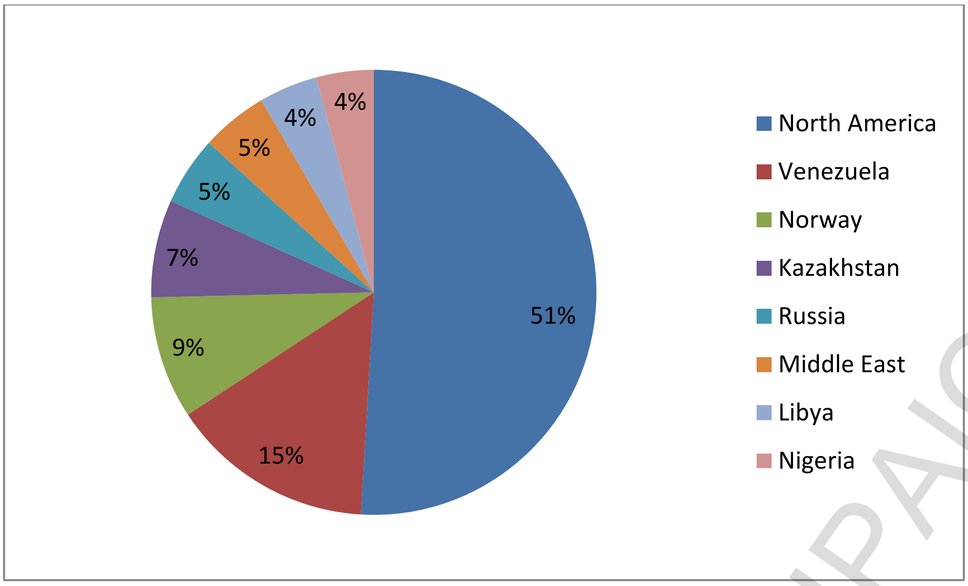


Chart 6.: Major Crude Oil Exports 2010 (Thousand Barrels)

Data source: US energy information administration

Oil products are refined products of crude oil, which are “clean”, which means that the vessel is ready to reload after it has discharged. However, in the refinement process there are certain products, usually the remnants of the refining process, which are called ”heavy refinements” or ”dirty”, because they contain large quantities of sludge. The dirty refinements can be transported in conventional crude carries, as well as in specially coated vessels. In case a vessel is dispatched from the clean oil products shipment to dirty products, the cost is zero, but the vice versa scenario is usually prohibitive for the owner. The transition from the one type of shipment to the other might not be so often, but it is not negligible if the ship-owner decides that the market conditions can cover the transition costs. Off course, this transition is always relying on the specifications of the vessel.

With regard to chemical shipments, there are specially designed tankers, which usually have small capacity, ranging up to forty thousand dead weight tones. The tanks of these vessels are specially coated. The coating of the tanks determines the shipments that they can load and transfer. There are cases that the cargo is flammable or acid and if the tanks are not designed for this case, the corrosion is inevitable. Moreover, some cargoes need special carrying conditions, like pressurized steam that has to be transferred into the cargo, in order to sustain certain heating condition. Apart for that, following the discharging, it is important to clean and ventilate the tanks, in order to avoid any purification problem to the next cargoes.

Lastly, LNG and LPG carriers are specially designed vessels that transfer gas in certain state. As the chemical tankers, these kinds of carriers transfer this cargo in special conditions, because the cargo is very flammable and it is easily affected by the environmental conditions. LNG transfers natural gas, whereas LPG transfers gas from oil fields or refinery process. In each case, the shipment must be transformed in a liquefied condition, in order to be transferred. The loading and discharging facilities have specially designed systems, in order to convert the gas in its prior state or liquefy it. These cargo shipments can be described as the future of the energy cargoes, having only one disadvantage, i.e. the fact that there is an ever expanding antagonism from offshore pipelines projects, which are planned to be constructed in the near future.

The bulk cargoes are transferred in massive quantities. The stowage of this cargo is easily adjusted and sometimes, there is no need for trimming. Anything that does not need special handling can be loaded in a bulk state. However, there are five major bulk cargoes (Giziakis et al.).

1) Coal

2) Iron ore

3) Bauxite/Alumina

4) Grains

5) Fertilizers

The first two cargoes are the main materials used to establish infrastructures of the modern world. For that reason, the shipment of these two cargoes covers the major percentage of bulk cargoes carriage.

The major iron ore producing countries are Brazil and Australia. The main importers of this cargo change from time to time, depending on which country of the world has the leadership in steel production. During the last years, China, Japan and South Korea have been the main importers of iron ore.

Japan and South Korea do not have physical resources and they import all quantities of iron ore. On the other hand, China has some resources, but not adequate enough to sustain the even growing needs. Furthermore, the mining companies in China are fragmented in a very large scale. The quality of the iron ore produced is very low, due to the physical resources and also, iron ore is expensive to be mined. At weaker prices several mines of China will have to close, in contrast with the soaring companies in Brazil and Australia.

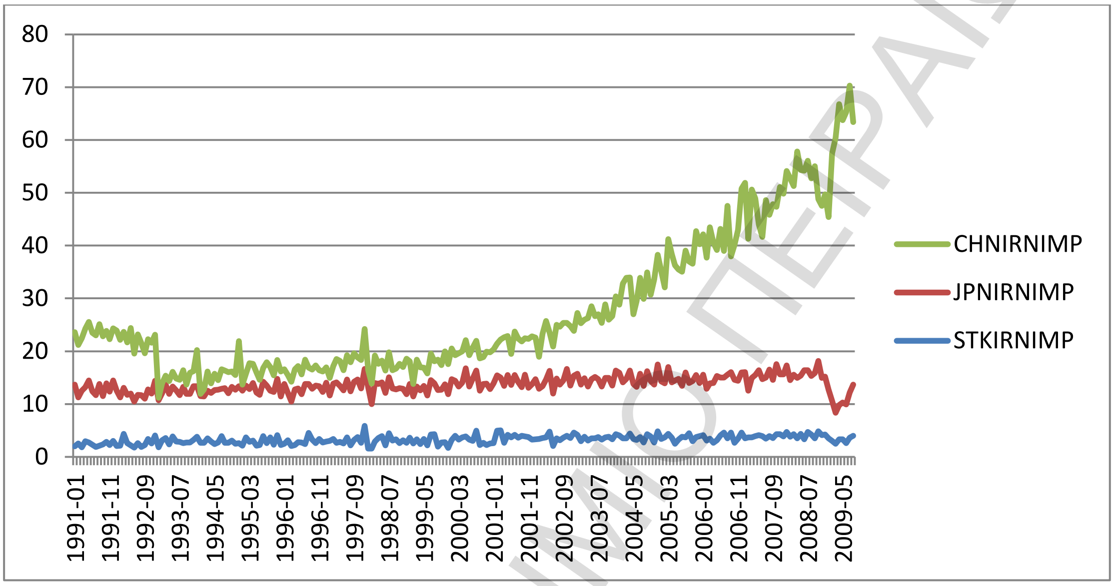


Chart 7.: Iron ore imports-all means of transport(millions of tons)

Data Source: Clarksons Research Services Ltd

The major iron ore producers are Australia, Brazil, China, India and Russia. Three companies are gathering the control of 70% to 80% of the sea-borne iron ore trade, namely Brazil's Vale SA and the Anglo-Australian companies, Rio Tinto Group and BHP Billiton Ltd. From the iron ore produced, 60% is consumed domestically or transported in short distance areas and the rest 40% is transported in large distances. International iron ore trade reached 882 Mt in 2008, up 7.8% and more specifically, in a period, where the subprime bubble started to collapse. Total iron ore exports have doubled since 1999.

Iron ore is the second most trade commodity after the oil. There is a continuous fight between the three companies, which try to gain one year contracts with the "Big Three" countries of iron ore import. The difference is lying on the cheapest transporting cost of the Australian Mines. However, the scene is dramatically altered after the subprime crisis, because the transportation costs fell sharply. Also, Rio Tinto, which suffered from the economic crisis, managed to start a joint venture with its Australian rival, BHP, enforcing their negotiating power regarding the prices of iron ore. Generally, all the three companies will seek cooperation with smaller mining companies, in order to reduce the cost and expand their business.

After the crisis, the usage of steel products fell by 7,9% in Asia and globally approximately by 36%. However, the steel companies of the "Big Three" are working less than their maximum capacity output. There is a tendency of cooperation and merge and acquisitions in steel producing companies. China enforces the industries to merge, forming larger groups. Japanese and South Korean companies are seeking with other companies to form joint ventures. Both sides are being prepared for a series of difficult negotiations concerning the purchase of iron ore of the highest quality, the best price and in large quantities.

	TOP STEEL PRODUCING COMPANIES 2008	
1	ArcelorMittal	EUROPE
2	Nippon Steel	JAPAN
3	Baosteel Group	CHINA
4	POSCO	SOUTH KOREA
5	Hebel Steel Group	CHINA
6	JFE	JAPAN
7	Wuhan Steel Group	CHINA
8	Tata Steel	INDIA
9	Jiangsu Shagang Group	CHINA
10	US Steel	USA

Table 2.:Top steel Producing Companies

Source:wordsteel

Coal cargo is the next major shipment in bulk carriers. It is mainly used in industrial production as a fuel or the production of iron ore. Iron ore does not need special trimming or stowage process. The vessels, which are used for the transportation of coal, are usually smaller than the iron ore transporters, because coal is flammable. There are several coal mines around the globe and the major ones of them are located in North America and Australia. The coal producing countries do not facilitate seaborne trade to supply their industries, because inland means of transport are appropriate for this case; subsequently, they are excluded from the import of coal, unless the quantities produced can sustain the need of their domestic industry. On the other hand, Europe and Japan have no domestic resources of coal.

Grain cargoes are a seasonal shipment, with non-constant routes. Loading and discharging process differentiates from the other aforementioned two types of cargoes. If the vessel is equipped with grabs, it can load and discharge in any port, which does not have specialized facilities. However, there are certain ports that are fully equipped and the vessel needs less time to end the loading and discharging process. Furthermore, large vessels have to reach several different ports, in order to be fully loaded. For that reason, there is tendency for grain cargo to be transferred in spot chartered market, due to this non canonical nature of this market. The grains shipments are sensitive to weather conditions.

Finally, bauxite and fertilizers constitute a minor percentage of shipments, in contrast with all the other grains. The bauxite has the same characteristics of the iron ore cargo. The vessels used for this cargo are usually of small capacity, unless the bauxite has been processed in its final form, i.e. alumina. The fertilizers cargo trading has the same characteristics as the ones of a shipment with grain transportation. The vessels used in these cases are of small capacity, since there might need to discharge in a farming area, which could not approached by larger size vessels.

Except for these five major shipments, there are several other shipments of the same importance as the ones of the five aforementioned cargoes, but not with the same volume of trade. These shipments are usually transferred in small size vessels.

In any case, the type of the vessel used is not set a priori and always depends on the shipment type. The capacity of the vessel that is going to be chartered depends on the size, the quantity and other characteristics of the cargo, which will not damage the purity of the cargo. In some cases, the vessels transfer two or three types of cargo, but always of the same category.

Passenger vessels are destined only for the transportation of passengers and minor quantity packed parcels along small or ocean going distances. Ferries are also listed in this category of vessels. The routes followed by this type of vessels are usually standard and only the small vessel follows more fluctuated routes.

The specialized cargoes are various shipments, which cannot be transferred in bulk or containerized form. The shipments vary from vehicles to refrigerated products. The vessels, which are qualified for these shipments, are specially designed to meet the standards of the cargo. In general, this type of cargo is transferred in both tramp and liner shipping.

Classification by operation

Maritime operation has four distinctive categories (Chrzanowski 1984):

1) Tramp (or irregular service)

2) Liner (or regular service)

3) Special (or industrial)shipping

4) Passenger shipping

The last two forms of vessel operation have the same characteristics as the ones of the special cargoes and passenger shipping. Chrzanowski (1984) suggests that, in special industrial shipping category, tankers are also included, as well as product tankers, chemical tankers, LNG and LPG. Definitely, a major percentage of the world fleet is owned by the oil producing companies, which can enlist these vessels in liner shipping. Nevertheless, if we considered that this categorization applies, we would argue that all trading regarding oil and oil products is regular and there is no room for individual ship-owners to enter this market. In reality, this special or industrial shipping is a mixture of liner and tramp services. Therefore, we can neglect this categorization. The same argument can be raised also for passenger shipping. There are scheduled regular routes, but there are also irregular services. For that reason, we can also neglect this categorization.

In liner trade, the operation of the vessel has a certain timetable, approaches reported ports and follows certain routes. In this case, the freight is already predefined with a special tariff unrelated with the volume of the shipment. Large industries and oil producers own vessels destined for transferring their production.

Vertical integration gives the opportunity to these companies to achieve economies of scale and lower their transportation costs. In addition to that, regular schedules of transportation contribute to effective distribution of cargo, which is tightly related with the needs of the company for optimal service. Another factor, which drives companies to be ship-owners, is the type of cargo or the carried quantities. If the quantities cannot fill the capacity of a vessel, it is not cost efficient to charter a vessel only for this size of cargo. Moreover, if a company has facilities in various places, it might need the vessel to load or discharge in various ports. Profoundly, the same considerations arise, when the shipment cannot be loaded in simple types of vessels.

One disadvantage of this type of operation is that, if the production volume of the company cannot be sustained by its own operating fleet at a time and there is a need for extra capacity. When this occurs for a short period, the company may outsource the transportation service to a third party ship-owner. However, if this happens for a longer period, the company may acquire new vessels or if it cannot afford this extra expenditure, it can address to the open market to hire a vessel. In any case, when there is lack of transportation capacity or the company does not want to involve in the transportation sector, there is an open market of transportation service.

Tramp shipping is an open market, where the ship-owner and the charter negotiate on a free basis the hire rate and the type of the chartering agreement. In tramp market, there are no certain routes or regular service that the vessel has to follow. Each voyage might be totally different from the previous one, as well as the cargo that is transferred.

Conclusion

In this research, we will combine the operation with the type of cargo shipment and the type of vessel, which is appropriate to be utilized for this transportation. (Stopford, 1997, Theotokas, 2011). In liner shipping, a vessel has to load one or more small parcels or cargoes, whereas in bulk shipping, larger quantities are transferred. Bulk shipping transfers all the bulk cargoes and liner shipping general cargoes and special cargoes.

4.3. Forces affecting the shipping market

The need for maritime service is affected by the laws of demand and supply. The four major markets that determine the demand and supply are the Freight market, the New building market, the Second hand market and the Scrap marker. These four markets are directly related to the shipping industry. However, we cannot neglect any submarket that has instant relation with the shipping market. Therefore, forces shaping the demand and supply in shipping and more specifically, the sale and purchase of vessels, will be expanded with two other markets, i.e. the financial markets and the world economy.

There is a distinction between the liner shipping and the bulk shipping in the case of freight market. In liner shipping, the freight is usually prearranged in the form of a tariff, without taking into consideration the duration of the trip, the shipment size and the number of ports, where the vessel has to do operation, as it happens in open market. Even though that we can consider the tariffs as a measurement of the demand for seaborne trade, we cannot neglect that the tariffs are usually fixed in conferences of liner shipping companies. In accordance with this procedure, the value of the transportation cost disconnects from the real market for the period, within which the tariff is fixed. Of course, there are outliers that can enter the market, but the impact is severely limited, because liner market is rather compact and does not leave enough room for price changes. Therefore, our analysis focus on bulk ships, where the market is open and the prices are constantly laid upon the forces of demand and supply for seaborne trade and they constantly change.

Freight Market

In the bulk shipping market, the ship-owner has to negotiate the freight rate with the customer, considering previous chartering rate fixtures or same day offers regarding this type of commodity and this type of operation. There are some main indexes like the Baltic Dry index for the dry bulk shipping and the World scale for the liquid bulks depending on various factors, like the capacity of the vessel. These indexes are used as guidance for a future agreement hire rate. In the negotiating procedure, the ship-owner and the customer evaluate the size of cargo, the operating procedure, the time period of the fixture, the number of ports that the vessel has to approach, the condition of the vessel, the type of the vessel and any equipment that it has on-board. After concentrating these parameters and the associated freight indexes, the customers determine the price of the transportation cost and the ship-owners reject or accept the deal. This procedure of evaluating the offer does not last too long and in some cases, it takes only a few minutes. The freight rate is the first part of the agreement and all the other parameters follow in a second stage, formatting a final charter party that is signed by both parties. There are three main types of chartering, which are amongst the most common types of contracts and highlights only the most important features of those agreements.

Voyage Charter

In this agreement the customer hires a vessel for a certain type of cargo and for a predefined voyage. The ship-owner is responsible for the operation of the vessel and the execution of the trip. The operating costs and the voyage costs are paid from the ship-owner. The hire includes all costs on a lump sum basis. The customer is responsible only for the extra costs that may arise regarding the cargo handling. This type of hire agreement is concluded regarding short run period strategies.

Time charter

The customer fixes a vessel for a certain time period and certain types of cargo, with a constant rate. The hire rate might be determined on a daily basis or a monthly basis. The charter party may refer to an extension of the hiring days. The ship-owner is still the operator of the vessel and the customer provides the voyage costs. Operating charges and financial charges of the vessel are paid by the ship-owner, whereas the customer is responsible for the bunkering costs, the stevedores, the agency fees and everything else that relating to the cargo handling. This type of chartering strategy is best for short term to long term strategies.

Bareboat Charter

In this type of agreement, the customer receives the vessel and he is fully responsible for the operation. Operation costs, voyage expenses and every cost that may occur are paid by the customer. The ship-owner is liable only for the financing of the vessel. This type of hire is for long-term period.

New building Market

A new building vessel has the advantage of lower operating cost, specialized construction features and the right for the ship-owner to select the type of vessel. There are several shipyards around the globe with different construction and quality standards. The optimal delivery and technological capacity of the shipyard is of high significance.

The most renowned shipyards are located in Japan and then, South Korea follows. The location of the shipyard has the crucial role of maintaining lower construction costs, because of the cheap labor market. China started, recently, to enter the pace of the new building vessels. Europe and America shipyards lost their dynamic, due to the expensive costs of construction.

The decision of the ship-owner to buy a new building vessel has the disadvantage of the time lag, which ranges from one year to three years, in general. In the last decade, lack of empty slots in shipyards was observed. For that reason, there was a tremendous rise in new shipyards of questionable quality. In addition, there were several cases, where the shipyard concluded agreements for the construction of more new building vessels that it could sustain. This problem was due to wrong calculation of the construction capacity. Moreover, the shipyard has to order in advance certain quantities of raw material, before the beginning of the construction of the vessel, which has to be financed with their own funding sources. Construction capacity limitations and lack of funding sources led to the cancellation of vessels or the bankruptcy of the shipyard.

On the other hand, the ship-owners might withdraw from the agreement, when the conditions in market change or they face an inability to finance the construction of the vessel. Undoubtedly, all the agreements include a penalty clause, but if this happens systematically, it might lead to systemic problems in shipyard industry.

Another thing that must be pointed out is the role of the new building construction agreement as an asset of trading. If the demand for new building vessels arises or the market faces another round of recovery, an agreement can be sold with a premium from the face value, resulting in profits. Off course, the outcome might be totally different in case the ship-owner is forced to withdraw the agreement due to financial problems. This is a rather rare case, because the ship-owner usually withdraws from the agreement with the shipyard and the shipyard is seaking to find a new buyer.

Second hand Market

Undoubtedly, second hand market is the classical paradigm of a free market. Demand and supply of second hand vessels shape the price of a vessel in real terms. The type of the vessel, the age, the construction features, the construction origins and the delivery option determine the price of the vessel. A vessel under sale can be traded, until it is delivered to the new owner.

Second hand vessel is a trading asset of instant liquidity, when the market conditions are favorable. Usually, the traditional ship-owners are seeking for bargains, when the recession in shipping market reaches the lowest levels. The profit resulting from a good deal is sometimes even more profitable than the simple operation of the vessel. Usually, in the second hand market, there are various vessel types with different cargo capacities.

What it might be considered as an advantage of the second hand market is the prompt delivery option and the lower price, though in recent years, there was non-normality in shipping market, where second hand vessels were drawn to higher levels from the new building prices.

Scrap market

A well maintained vessel has a long term life. However, there are some parameters that limit the operating years of a vessel to approximately twenty five years. The cost of operating a vessel under normal freight rates is the leading parameter to scrap a vessel. Due to the fact that the conditions in sea and ports are extremely difficult and the vessel suffers a lot of exhaustive circumstances, the maintenance cost of the vessel increases radically year after year. After a certain point, the operation of the vessel is non productive, leading to limited profit margins. At this point, the ship-owner has to take the decision to scrap it. In any way, there is no certain lifetime of a vessel.

Another parameter is the special survey costs. Approximately every five years, a vessel has to follow some certain technical services, which are significant for receiving a certification from the classification society. As the vessel is ageing, the classification society inspects more thoroughly certain parts of the vessel, using more strict standards. A special survey is costly and time consuming procedure, because the vessel has to enter in a shipyard for a long time period. Therefore, when the vessel reaches the age of twenty five years, the owner is not willing to pay the cost of this certain special survey, unless the shipping market is facing good years and the profit margins are increased. This is the main reason why an age limitation is set in the twenty fifth year of vessel.

On the other hand, if the market conditions are not ideal and the vessel operation is not profitable, a ship-owner might decide to scrap the vessel in younger age. The same decision can be taken, in case a vessel has a severe damage in hull or machinery and the cost to repair the damage is restrictive.

Finally, when the owner reaches the dilemma to scrap a vessel, he has also to consider the steel prices paid for scrap. The scrap value of the vessel is also an asset, because the steel used in the construction constitutes a significant quantity, which can be sold in the market for further use. Therefore, we might consider it as a trading asset.

Financial Markets

Shipping companies are capital intense companies. The liquidity needed to buy a vessel and operate can be funded by private resources or the financial markets. The financial markets, in this case, we might consider the stock market and the banks. Definitely, there are a lot of financial instruments to fund a vessel, like Special Purpose Vehicles, Joint Versions or specially designed funds. However, the banking system was the main resource of funds. As we have aforesaid, many shipping companies raised capital from the stock markets, but these funds might be used for various purposes, including financing a vessel. Therefore, we will focus on bank financing.

Banks usually undertake the financial risk to fund a vessel in a very large percentage. This percentage depends on the ship-owner needs and his credibility.

Some parameters were mentioned above. The initial scheme was to fund a vessel that is attached to secure revenues for a certain period. However, this scheme can change with analogous rise of cost charge from the lender to borrower. The loan agreements determine the loan facility, the duration of the loan, the repayment schedule, the interest charged and some liquidity ratios that reflect the good condition of the company. Banks request, as a prerequisite, the vessel to be fully insured for any matter, which might have an impact on the mortgaged vessel value.

World Economy

Seaborne trade is an important transportation mean for commodities, industrial production and passengers. The course of world economy does not leave the shipping sector intact, because the shipping business is relied on global economies. If the industrial production suffers, there is no need for commodities and there is no reason for companies to seek for transportation capacity. Subsequently, the hire rates become lower, the global fleet is decreased and the operational profits for the shipping companies are decreased and vice versa.

Ship-owners strongly observe the global growth and the economy of any major importing and exporting country. The course of these countries' economies are used as major parameters for ship-owners' future strategy. Their strategy is composed not only regarding future investments and de-investments, but also regarding dispatching their vessels in different parts of the world, where the need for transportation services is going to change in the future. In shipping history, there were several changes in the important trading areas, from Atlantic Ocean to Pacific Ocean and Indo-China area. Certainly, most of the world fleet is recently attracted by far east, because China, India and Australia employ the most of the transportation capacity. The growth rates of these countries are running in an extraordinary pace, in contrast to the rest of the globe.

Conclusion

Undoubtedly, the shipping market is actually more complex, but the markets described above give a very clear picture of the forces that seaborne trade is lying upon. When a strategy for a shipping company is being shaped, it is important to acquire this information, so as to have an integrated aspect. Modern technology and data bases provide a great portion of these information, which every modern economist in the shipping sector, can evaluate and shape an opinion about the course of the shipping market. The information is open and easily accessed by any researcher. For that reason, we would expect that volatility in shipping market would be avoided, because the market would operate under conditions of perfect competition and full information. The problem of this approach is that we restrain the human factor in analyzing the data and the thier decision importance. Every ship-owner is aware of all these parameters, but this does not guarantee that will act in the same way. We consider the ship-owners as trading investors, which invest on assets that will provide returns for the vessel operating period, always having the option to liquidate them. Therefore, any ship-owner investor has a certain investing profile, conservative or risky, which might change in due course.

Chapter 5

Model Specification and Data Selection

5.1. Introduction

In the previous chapter, the Market analysis provided a powerful insight of the shipping market structure. After decomposing the forces of the shipping market and penetrating into the core of the business, this analysis can provide fruitful outcomes about the operation of this industry and determine precisely the minor and major forces that have impact on the trend of this industry and especially, its fundamental assets. The previous research focused on the core variables of the shipping market and it precisely determined the role of each variable in this complex and multi-layer industry. The segmentation of the shipping sector into four distinct interacting markets helps to wisely isolate the forces that determine the trend of the market and provide more details about the role of exogenous factors, which are important in the operation of this market.

This research focuses on the construction of a valuation model for second hand vessels, which is a mixture of micro and macro variables. Literature review offers a palette of various factors and variables, which determine the price of a vessel. Each contribution of the literature review in shaping this valuation model must be evaluated from different aspects. The first step is to create a ranking from the uni-variate to multi-variable models. Then, each model is evaluated and any addition or subtraction of variables is performed until the optimal model is constructed. Undoubtedly, the target is to construct a simplistic model, eliminating micro variables that might have a crucial role in the market operation, but in the long term have no serious effect on the valuation process. Simulating in detail the shipping market is a trap, which can lead to spurious results. Unfortunately, several past researches did not avoid this loop and the result was the multi equation models, which were composed of no measurable variables. In addition, the solution of these kinds of models was extremely complex and forbidden for not initiated researchers.

Before we proceed with our model specification, it is important to depict the two most useful researches that were used as a pattern to our model. The analysis of these researches solves several important issues. Our model specification lays upon the valuation models of Beenstock and Vergotis (1985, 1989a, 1989b, 1993) and then, it was further evolved due to the contribution of Tsolakis et al. (2003). Therefore, it is important to quote the works of these researchers, as they describe properly this research's basic concept and how this concept has been processed step by step, so as to conclude about the final valuation model. Finally, the research of Liapis et al. (2014) defines the valuation of a fixed asset in a real property project, with the incorporation of life-cycle costs (LCC) and whole-life costing (WLC) method and the taxation environment.

5.2. Decomposing previous research

Beenstock and Vergottis (1985, 1989a, 1989b,1993) were the first that gathered all the past research in the modeling of shipping market. The structural models described in their publication describe in detail the aspects of the shipping market and try to gather all the variables shaping the operation of this distinctive market. After constructing a holistic model for each separate part of the shipping market, the researchers go one step further and try to solve this final system of equations by inserting anticipating and non-anticipating shocks into the system. As the shock is moving from each separate distinguished variable, the equilibrium of the shipping market is altering in a rapid rate. Still, the shock gradually fades away and the market is stabilizing at a different level.

The researchers treat the vessel as a capital asset, which is demand driven always in conjunction with the return on other assets. The first part of their analysis focuses on the micro foundation of the model. The next level is the macro foundation of the model and high it reaches long term equilibrium.

The researchers anticipate that there are four unique markets, namely the freight market, the second hand market, the shipbuilding market and the scraps market. The perfect competition feature of the shipping market is enclosed as an a priori condition regarding the functionality of the industry. In each step of the process, there are no bounds relating to the entry and the exit of new players in and out of the market and if any gap arises, it is instantly filled. The efficient market hypothesis is considered as a fundamental parameter in the analysis.

Reverting back again in Beenstock and Vergotis (1985, 1989a, 1989b, 1993) model, each market is working on an equilibrium basis. From the one side, there are the forces of demand and from the other side the forces of supply. Additionally, the researchers elaborate two separate models for the different segments of the market, i.e. dry cargo and tanker, because there is a need for additional real world phenomena, which have impact on those separate segments.

Beenstock and Vergottis (1985, 1989a, 1989b, 1993) consider that a state in the long term period is steady, meaning aither that all variables grow at a constant rate or that they are stable in some cases. The equations describing the stationary system are the following:

$$\Delta q = \Delta K \qquad (48)$$

Whereas Δq is the growth rate of the fleet and ΔK is the growth rate of demand

$$q = K + \gamma F - \gamma Pb \qquad (49)$$

Whereas K is carrying capacity in dwt of the ship, F is the freight rate in units of currency per ton-mile and Pb is the price of bunkers

$$\pi = (1 + \gamma)F - \gamma P_b \qquad (50)$$

whereas π is the profit

$$P = \pi - r \qquad (51)$$

Whereas P is the price of ship and r is the expected return on other investments

$$D = \mu 1 Pn - \mu 1 P1 \qquad (52)$$

Whereas D is the shipbuilding output, Pn is the price of new buildings and P1 is the shipbuilding cost

$$Pn = P \qquad (53)$$

Whereas price of new building is equivalent to price of vessel at any time in the long term period,

$$S = -\mu_2 P + \mu_2 P_s \qquad (54)$$

Whereas S is the deadweight of ships scraped Ps is the price of scrap

$$\Delta K = D - S \tag{55}$$

Whereas ΔK is the growth rate of demand, D is the shipbuilding output and S is the deadweight of ships scraped.

After a number of substitutions and solving for P, the researchers conclude to the long term equation for vessel price:

$$P = \left(\frac{1}{(\mu_1+\mu_2)}\right)\Delta q + \left(\frac{\mu_1}{(\mu_1+\mu_2)}\right)P_1 + \left(\frac{\mu_2}{(\mu_1+\mu_2)}\right)P_s \tag{56}$$

The long term equation suggests that the growth rate, the shipbuilding cost and scrap prices have positive effect on ship prices. This model lacks the equations of the market supply, the profit maximization and the investors' behavior, because the researchers suggest that these variables have no effect on the long term period.

The next step is the consideration of a micro variable model, which relates to the second hand values as far as the history of the exogenous variables, their past and the current expectations are concerned. The deriving model is more complex and has the advantage that it includes certain variables omitted in the long term equation. Notably, the researchers use this model specification to estimate a more complicated model, which includes several exogenous parameters that where ignored, in order to capture the fundamental operation of the vessel of prices. In accordance with this addition, they manage to estimate a more realistic model that is more close to the real market conditions. Off course, these changes apply in all shipping market segments, but in our case, we will only focus on the second hand market.

Beenstock and Vergotis (1985, 1989a, 1989b, 1993) presented the idea to treat a ship as a capital asset and the portfolio demand for ships is the following:

$$\left(P_t\, K_t^d / W_t\right) = f(E_t\pi_{t+1}/P_t\, , E_tP_{t+1}/P_t\, , \bar{r}_t) \tag{57}$$

whereas P_t is the price of the ship at time t, K_t^d is the stock demand for ships, W_t is the wealth, $E_t\pi_{t+1}$ is the expected profits, E_tP_{t+1} expected ship prices and $\bar{r}_t$ is the return on other investments. If we solve for P_t, the final equation is the following:

$$(P_t) = f\left(W_t/K_t^d, E_t\pi_{t+1}, E_tP_{t+1}, \bar{r}_t\right) \tag{58}$$

The expected profit of a vessel operation is the time charter contract minus the expected operating cost, which is given by the following equation:

$$E_t\pi_{t+1} = H_t - E_tOC_{t+1} \quad (59)$$

whereas H_t is the time charter rate and E_tOC_{t+1} is the expected operating cost. If we substitute the above equation in the ship prices equation, the final dynamic equation for the price of a vessel at time t will be the following:

$$(P_t) = f\left(W_t/K_t^d, H_t - E_tOC_{t+1}, E_tP_{t+1}, \bar{r}_t\right) \quad (60)$$

This model is the outcome of several substitutions omitting several parameters that researchers find difficult to observe. Furthermore, this is the equation for the dry sector and tanker sector.

The steady long term model and the dynamic short term model of Beenstock and Vergottis (1985, 1989a, 1989b, 1993) include major parameters, which can be used to estimate the ship prices. However, the robustness of this model can be easily questioned, since, on the one hand, some variables, like the operating cost, the expected ship prices and the return on other investments, which are difficult to be observed and on the other hand, the proposed solution of using dummy variables and substitute variables can lead to misleading results. Furthermore, someone can argue that the complexity and the extended calculations of the proposed model cause more trouble than explaining in a simple way the shipping market forces. Besides these short comings, all the variables used in this model create a certain guideline followed by the most of the researchers.

In the model specification procedure, the work of Veenstra (1999) sets out a new approach of the co-integration relation between the vessel prices. The researcher sets out two criteria for model specification, namely the speculation driving force and the replacement driving force. These are the two different approaches of the second hand market transactions. Replacement sales consist of new building prices, scrapping, time charter rate and second hand replacement prices (5 year old vessel). On the other hand, speculative sales consist of new building prices, scrapping prices, time charter rate and second hand speculation (10 year old vessels). Both model specifications are tested for any co-integration relation that will reveal any stochastic trend establishing the validity of the hypothesis of the two driving forces.

Undoubtedly, the work of Tsolakis et al. (2003) established an analytic, well designed methodology, in order to estimate the second hand prices. Tsolakis et al. (2003) followed the pattern of long term equilibrium, which was suggested by Beenstock and Vergottis. However, in this research the long term equilibrium is defined by the forces of demand and supply of second hand vessels.

In more detail, they gathered all the fundamental forces that shape the demand, which are the freight rates, the second hand vessel prices, the newbuilding prices, and the cost of capital, which is inserted in the model as the libor rate. The equation of second hand vessels demand is the following:

$$Q_{SH}^{D} = f(fr, sh, nb, libor) \quad (61)$$

On the other hand, the supply equation of the second hand vessels is formulated by a ratio of order book in shipyards to existing fleet and the second hand prices. The equation of second hand vessels supply is the following:

$$Q_{SH}^{S} = f(\frac{orderbook}{fleet}, sh) \quad (62)$$

In order to have an equilibrium, demand must be equal to supply and if we solve for second prices, the final equation is:

$$secondhand = f(fr, nb, \frac{orderbook}{fleet}, libor) \quad (63)$$

Whereas freight rates are the average time charter rate per day for the year and whereas order book is a percentage of the total fleet, which includes combined carriers. This simple model has the advantage that integrates the major variables describing the shipping market from the aspect of acquiring a second hand vessel.

The decision about the purchase of a second hand vessel is linked to the price of a new building vessel of the same size. The major difference between these two prices is the delivery date, as we have already aforementioned. However, the comparison of the price of two vessels of different age is taking place on the spot, considering that the second hand vessel will be delivered promptly. Therefore, the variables used to build these two scenarios are based on spot estimations and the delivery time is only considered in the revenue generation of each vessel by the time of delivery. In fact, this gap in revenue generation, which is different in case of second hand vessels, which are usually delivered to the new owners within one to six months and in case of a new building vessel, which are delivered within one to three months, is already enclosed in the sale price of the new building. To be more specific, except for the cost of constructing the vessel, the shipyard changes the price of the new building depending on demand. If a price of a new building vessel is not adjusted to the current prices of second hand vessels, the ship-owner does not have any potential reason to sign a shipbuilding contract.

The premium paid for a new-building vessel covers the gains from decreased fixed costs, newer technological features and finally, the ship type. The maintenance of a new building vessel is cheaper than the one regarding a second hand vessel. In addition to this, the technological features contribute is the lower operating costs, as wells as the more efficient cargo handling, eliminating any possible failures in the vessel equipment. As far as the ship type is concerned, the ship-owner has the option to build a vessel closer to his needs. Nevertheless, the owner attends the ship building and he is aware of the capabilities of the vessel and the construction quality.

On the other hand, the second hand market might have a large spectrum of ship designs and quantities to offer that can fulfil the needs of any potential buyer, at any time. For all these reasons, there is no need to construct a variable of expected prices, as Beenstock and Vergottis (1985, 1989a, 1989b,1993) did; instead, we just need to monitor the spot prices of new building and second hand vessels and include them in the valuation model.

Freight rates in form of time charter rate are the best ratio to estimate the returns of the investment on a ship. Freight rates are usually estimated on a lump-sum basis. Therefore, any fluctuations that may occur on the voyage costs (such as bunkers, agents, port expenses) are not included in real terms in the revenue from the vessel in question. So, the freight rate is a prior estimation of all possible costs that might occur during the transportation of the cargo. For that reason, when a charter party is agreed on a freight basis, the ship-owner usually calculates the equivalent in time charter ratio terms. This reevaluation of the revenue in time charter rates basis gives the financial hint to the ship-owner about if it is efficient to agree on a simple voyage or move to a long term or short term contract. Maybe, the time charter rate does not enclose all the constant fluctuations that might occur in freight rates periodically, but this can be neglected, when a company plans on a high capital intense investment. Definitely, there might be periods, during which the ship-owner will decide that a long term contract will not provide the optimal revenues and a short term strategy will be more appropriate for this time, until the market conditions change and there is enough space to move on with a long term contract.

Undoubtedly, there are ship-owners that prefer short term strategies based on freight rate agreements, but there is no accurate methodology to estimate the hypothetical returns of that strategy from the beginning, without having a significant decline from the actual returns, because you always have to calculate expected expenses and forecast the unexpected ones. If the charterer is in line with the market and has a good sense about the course of the market, the returns of a short term strategy (freight rate) might outbid the performance of a long term strategy. But we shall not underestimate the human factor and the decisions taken under various circumstances that might lead to bullish or bearish feeling about the course of the freight market and how a wrong decision might affect the outcome of this constant spot trading. Off course, every strategy has shortcomings, but the time charter rate might give the best results in terms of long term strategic planning. Moreover, this is the way, according to which the most of the ship-owners are estimating the results from trading a vessel.

The dominant currency in the most shipping transactions is the United States Dollar. The majority of loan agreements are expressed in United States Dollars and therefore, the Libor rate is the common rate used by the banks. Off course, there are loan agreements in other currencies and different interest rates, but it refer to a small portion of the capital loaned to shipping companies. Hedging strategies or interest exchanges from Libor to other rates are usually applied by using a financial instrument.

The loan agreement describes in detail the interest rate charged for all the duration of the loan. Off course, the interest rate can be floating or fixed. A loan agreement is a revolving financing facility and the length of the loan is a deterministic factor of the nature of the interest rate. Since the shipping companies want to adjust the break-even of the vessel with loans expenses included in feasible limits and always in conjunction with the revenues earned, they must calculate the loan period maximizing the net profits earned. After having taken these parameters into account, the loan agreements concerning a vessel usually last from seven to ten years. In this case, the interest rate applied in the loan facility must cover the bank expenses to facilitate the loan amount. The Libor rate is the primary reference rate for the interbank loan arrangements and a benchmark of the cost undertaken by the bank, in order to gather the funds needed for the loan agreement. Off course, the bank needs to cover these expenses and include the Libor interest in the total interest applied in the loan facility. The Libor interest charged depends on the repayment schedule of the loan. The remaining unpaid loan facility is charged with a Libor interest corresponding to the equivalent period, until the next payment date, plus the margin. For example, if the repayment schedule is monthly, the Libor interest charged is the monthly Libor interest announced by the British Bank Association on the date of the renewal of the unpaid loan amount, since the previous instalment due had been paid on the same date. In reality, the Libor that was used is one or two days before the renewal of the Loan, because the Libor interest is announced around noon by the British Banker Association.

Except for the Libor that is charged, there is a margin included in the loan interest, which is the largest portion of the interest expenses. The margin is predefined and fixed during the loan agreement period. Each financial institution charges different margins, which depend on the capabilities of the financial institution and the antagonism in the loan market. The characteristics of the margin will be described in more detail, later, in the model specification.

As far as the supply of second hand vessels is concerned, the ratio used for order book to existing fleet gives a glance about the condition of the shipping market at that time. The order book is the number of shipbuilding agreements existing, at that time, in the shipyards. If the order book is very large, it reflects the optimism of the ship-owners to acquire more tonnage and more specifically, either to renew their fleet or to extend their carrying capacity. Additionally, this is a binding contract, which enforces the owner to pay an amount concerning the construction of the vessel. The euphoria that might be reflected in a strong order book might be speculative. In the past, shipbuilding industry has faced cases, where the order book was soaring, but the client finally withdraws from the contract. Definitely, there is no reason to be led to generalize outcomes, when an order book reaches an unusual number of agreements, because there might be a widespread optimism regarding the course of the shipping markets in the next years, which might sustain the extra capacity that will reach the waters. In any way, the order book is good benchmarking of the existed ship building contracts at that time, but if we want to eliminate the possible risk of a speculative trend, it is useful to adjust the order book to the existed capacity at that time. Therefore, a ratio of order book to fleet is more eligible, as a variable in the valuation of a vessels price.

Concluding, the model proposed by Tsolakis et al. (2003) uses a simplistic way to imprint the shipping market and how the asset valuation process is determined by the various factors. Then, the model is estimated by using co-integration theory and constructs an error correction model. This approach is a step further in the valuation of vessel prices, but it can further evolve in the structure and the estimation methodology.

Vessels are fixed assets, which have about the same characteristics as real properties. Liapis et al (2011, 2014) introduces the Life Cycle Costs and Whole Life Cycle Cost as qualified methodology to estimate a real properties investment plan. In this seminal work it describe both methodologies and defines which is the most appropriate for valuation. Whole Life Cycle Cost has a broader meaning, because evaluates the project in whole life cycle of the fixed asset. This research is based in definitions provided by International Standards BS ISO 15686-5:2008

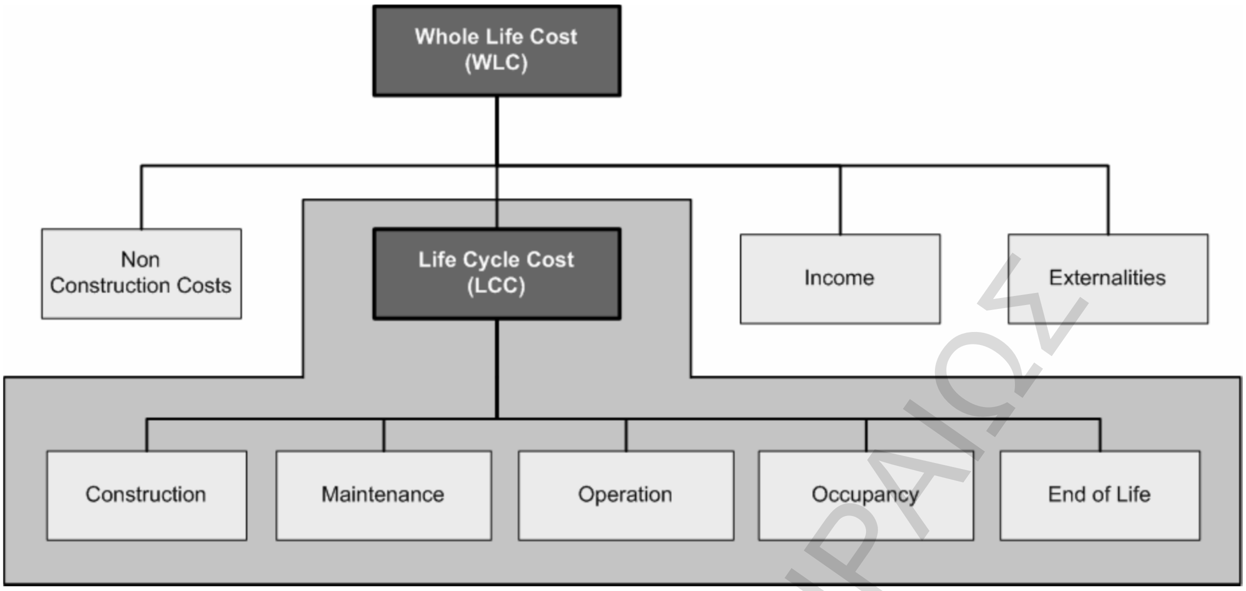


Table 3: WLC and LCC (from BS ISO 15686-5:2008)

Source:Liapis(2014)

Based on the International Standards a mathematical model is constructed, with unique points the insertion of key fundamental economic parameters and the taxation variable. This dynamic valuation process is very close to our research, though it is constructed for real property projects.

Previous attempts to combine financial data and search for any co integration relation where carried out by Thalassinos et al. (2009). Results of these researched suggest that co-integration theory is qualified for financial time series and economic variables like the oil prices and exchange differences.

5.3. Model Specification

The pattern initiated from the model structure of Beenstock and Vergottis (1985, 1989a, 1989b,1993), was enhanced due to the contribution of Tsolakis et al. (2003) and highlights the major variables affecting the shipping market and especially, the second hand market. This fruitful analysis determines the decision process of a ship-owner and the different parameters that have to be estimated, in order to minimize the potential risk of a misjudgement in the final acquisition decision. However, some limitations still exist in this process and there is still enough room for development.

If we set aside the operational and technical characteristics that a vessel should have and after determining in which segment the ship-owner intends to facilitate his invest, the key feature is the investment returns. Therefore, a cash flow analysis of the expected returns from the new investment is another important analytic tool in the decision making process. In order to construct a hypothetical cash flow analysis, we have to set some key parameters.

The first thing is to scan the second hand market for the available vessels on sale. As we have already mentioned, the age of the vessel is important regarding the fixed costs determination and the remaining operating days. We will focus only on the remaining operational days. Profoundly, a newer vessel has more available days of operation and consequently, a cash generation.

The second step is the price of the vessels. Off course, an older vessel is cheaper, but there might be slight differences depending on the ship type, the technical standards or the shipyard constructed. Ships constructed in well-established shipyards might have a premium in their price.

The third step is the loan facility. Loan facility characteristics are important in the cash flow analysis. Some aspects that have to be highlighted are the percentage of loan finance, the interest charge, the repayment schedule, the loan type, the financial costs and of course, the currency of the loan withdrawn.

The fourth step is the freight rates that will be earned by this vessel. The freight rate is determined after having taken into account the operational parameters, geographical parameters and types of cargo. All these parameters have already been analytically described above.

The final step is the calculation of the potential fixed costs of this vessel. Above all questions, an older vessel has more maintenance needs, which strongly affect the level of the operating costs. It is needless to say that dry docking and special surveys costs of older vessels are significantly high.

Finally, the last inflow from the investment on a ship depends on the remaining operational days of the asset. If the vessel is not operational and/or the maintenance cost is uneconomical, it could be sold for scrap. The scrap value is the last inflow from the investment. In case there are any remaining operating days, the last inflow of the investment is the selling price.

These are all the major parameters that an investor has to determine, in order to build a cash flow analysis. Off course, this analysis is very simple, because there are several other expenses that are not described, but it helps the investor to determine the major variables of a cash flow analysis.

The cash flow analysis is a micro model that reflects the potential or expected cash generation of an investment. If we decompose the cash flow analysis, we can easily derive a more macro-economic approach, in order to evaluate an investment in a second hand ship.

Starting again from the approach proposed by Tsolakis et al. (2003) regarding the description of the second hand market in terms of supply and demand, we have the existing demand equation

$$Q_{SH}^{D} = f(fr, secondhand, nb, libor) \quad (64)$$

The freight rate and in this case, the time charter rate, which will also facilitate our analysis, is a major parameter for an investment on a vessel; however, this is not appropriate, because, if the revenues are diminished from the fixed costs, the time charter rate will not provide any information in our decision process. Actually, it might be a misguiding parameter. Therefore, it would be more appropriate to use the operating profit of the vessel or the earnings before interest taxes amortization and depreciation. In order to estimate the operating profit, you have to subtract the operating and the voyage cost from the hire. The operating profit is given by the following equation:

$$OP_{sh,t} = \sum_t (TC_{sh} - Opex_{sh} - Voyex_{sh}) \quad (65)$$

where OP_{sh} , the operating profit of a second hand vessel for the period t, TC_{sh} , the time charter rate of a second hand vessel, $Opex_{sh}$, the operating expenses of a second hand vessel and $Voyex_{sh}$, the voyage cost of a second hand vessel. In every case, the operating profit is given by substracting the operating expenses for this period and the voyage costs from time charter rate.

In the case of time charter fixtures, the voyage costs are paid by the charterer; therefore, the value of the voyage costs is actually equal to zero. Definitely, there are some voyage expenses, when the ship-owner has the vessel in idle days or there is a cost that does not concern the cargo, but the operation of the vessel. We cannot calculate the frequency of these voyage costs paid by the owner, but, nevertheless, they constitute a very small portion of the total cost and for simplicity reasons, in all cases, they will be set to zero. The final form of the operating profit equation is the following:

$$OP_{sh,t} = \sum_t (TC_{sh} - Opex_{sh}) \quad (66)$$

An interest rate is a combination of the spread or margin charged by the bank and a Libor rate. If we delimit our calculations by using only the Libor interest, a large portion of the interest expense will be neglected by our model and consequently, a significant cost will not be taken into account in our valuation model. The interest rate is given by the following equation.

$$r_t = Libor_t + margin_t \quad (67)$$

Due to the fact that our intention is to have an insight in the dynamics of the spread expense, we will not combine the Libor with the Spread and we will not use them as separate variables in our model.

Scrap value is one important variable in the investment decision process, as it constitutes a strong inflow by the end of the investment. It is needless to say that the scrap value is one of the significant reasons that the vessels are usually financed with loans, having a balloon payment. The balloon payment reflects the trust of the lender, i.e. that he will have a guaranteed amount by the end of the investment, either as a resale price or as a scrap value. Therefore, it is mandatory to insert the scrap value variable in the valuation model and explore the dynamic of this value in the second hand prices.

The four distinctive markets, namely the freight market, the new building market, the second hand market and the scrap market are linked together and several researches provided analytic preview of the spillover effects of one on the other. Nevertheless, the shipping sector is an international service and all four markets are linked with exogenous forces that shape their course and volatility. In this case, a suitable exogenous parameter will enhance our valuation model to more macro dynamic relations and will determine this linkage of the shipping sector with the global economy.

This research focuses on the dry bulk sector and a combined exogenous variable will delimit our choices regarding the estimation of the forces shaping the second hand prices, because the two segments may have common characteristics, but these two markets operate in a different manner. If we go back to the analysis of the shipments carried by each separate segment, we will easily notice that the bulk sector includes the largest percentage of the shipments that are used in the industrial process. Having this into consideration, we can argue that if the industrial production faces changes, this will have a strong impact on the demand for more materials, which implies changes in the volume of the transported cargo. Concluding, the industrial production (IP) is the qualitative macro variable to use in the model, in order to enforce any exogenous dynamic inherited in the valuation model.

Following the addition of more variables, the final model for demand regarding second vessel is the following:

$$Q_{SH}^{D} = f(sh, nb, libor, margin, OP, Scrap, ip) \quad (68)$$

$$OP_{sh,t} = \sum_t (TC_{sh} - Opex_{sh}) \quad (69)$$

$$r_t = Libor_t + margin_t \quad (70)$$

Supply side is left intact, because the model proposed by Tsolakis et al. depicts well this part of the market.

$$Q_{SH}^{S} = f(orderbook/fleet\,, sh) \quad (71)$$

Following the analogous substitutions and solving for second had prices, the final model is the following one, with the expected sings above:

$$sh = f(\overset{+}{op}, \overset{+}{nb}, \overset{-}{libor}, \overset{-}{m\arg in}, \overset{+/-}{Orderbook/\,fleet}, \overset{+/-}{scrap}, \overset{+}{IP}) \quad (72)$$

This model will be estimated with Johansen's co-integration approach to estimate whether there is any long term relation and what effect has on second hand prices.

5.4. Data

Before we specify the data collection process, we should define the categories of vessels that we examine in our model.

First of all, this research focuses on dry bulk sector. The vessels employed in this segment are specialized only for dry cargo. Indeed, there are ship designs that could carry both types of cargoes, which are called Ore-bulk-oil (OBO) carriers or combination carriers. This type of vessel has declined dramatically and the order book of this vessels has not been opened since 2011(Clarksons). Consequently, the impact of this type of vessel is insignificant and it is not included in our research.

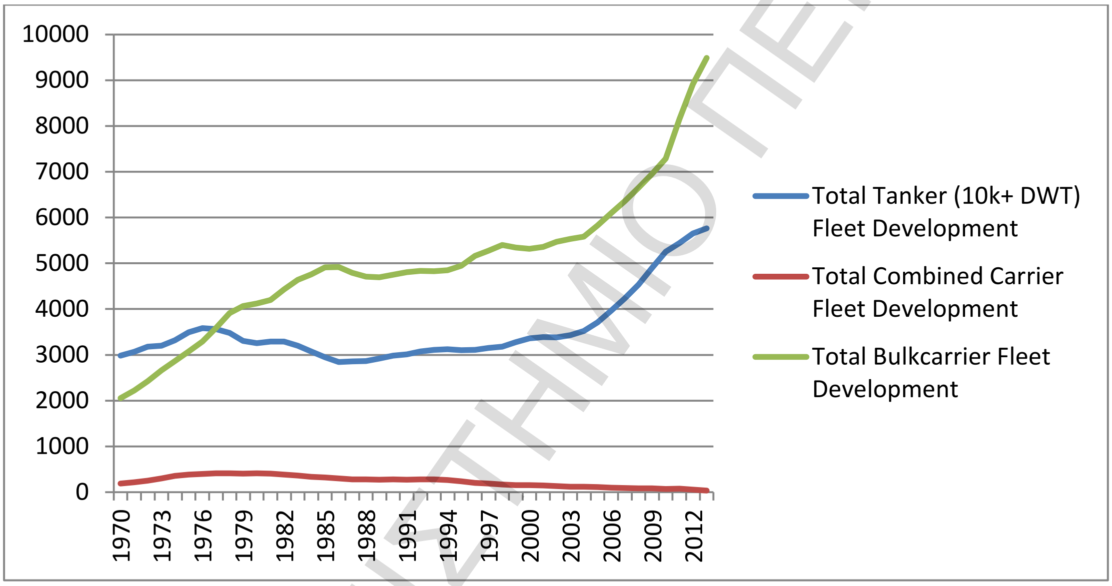


Chart 8.: Fleet development of Dry Bulk,Liquid Bulk and Combined Carriers

(Number of vessels)

Source:Clarksons Research

There are different categorizations of dry bulk carriers based on their capacity and their construction design (Double hull, Single Hull, Double Bottom and Single Bottom. etc.). Categorizations depend also on the surveyor that reports the data. In this research, we are interested only in the capacity of the vessel and not in the special characteristics of the ship design. As a general rule for capacity, the categorization is the following, which is reported in the Clarkson Research:

1. Handysize Bulkers: 10.000-39.999 DWT
2. Handymax Bulkers:40.000-59.999DWT
3. Panamax Bulker:60.000-99.999DWT
4. Capesize Bulker:100.000+DWT

These categories are also the most common in shipping industry operation, sale and purchase. Off course, these categories have been divided through the years. Handymax vessel was separated to Handymax and Supramax. Likewise, in Panamax category, Kamsarmax and Newcastlemax vessel ware appeared. This extra specification is needed, when a vessel is hired for a special quantity or to pass from a certain area or to reach a specific depth and longitude port. However, our data collected concern these "general" categories. The Clarkson Research provides an analytic table including all the changes in classifications that occurred through the years and the analogous adjustment in data collection.

Modern ship designs provide more capacity and the reclassification of the vessels will be inevitable in the near future.

5.4.1.Shipping Data

With regard to these certain categories of ships, we have collected monthly data concerning a period of ten years period, starting from January 2000 until December 2010, which includes about 132 observations. The main data sources are the following:

1. Drewry Shipping Consultants;
2. Clarkson Research;
3. Moore Stephens LLP;

These sources are the most reliable in the shipping industry and the data collections are based on certain strict criteria. Therefore, we consider the data collection methodology as optimal and there is no doubt about the integrity of the data. However, a brief description of each variable will further illuminate the model specification process.

New building prices are based on concluded contracts or the estimations of the shipbrokers about a hypothetical price on this date if there is no deal in that time period. Prices concern only first class competitive yards. The monthly data are based on end month data.

Second hand prices collection is the same as the one of new building prices. There are data concerning 5, 10 and 15 year old vessels. In our research, we use the five year old vessel prices, which might consider as more competitive to new building prices, because the vessel is still considered as “new’’. However, this is just a hypothesis and only a survey on the vessel will show the condition of the vessel and its actual value. Clarkson’s reports prices of vessels in average condition.

Time charter rates collection is the same as the previous variables. Clarkson provides a six month, a one year and a three years’ time charter rate. In our case, we consider the one year time charter as more appropriate, because it clearly inherits all the dynamic of the short term period time charter rates, as well as the expectations of the shipping individuals about the prospects of the shipping market. The six month time charter rate is rejected as a weak variable for long term investments on a vessel. On the other hand, the three year time charter rates can be considered as over conservative strategy for an industry that is characterized from strong volatility and the valuation of the vessel can change dramatically from time to time. Therefore, a short term strategy, like the one year time charter rate, can be considered as the most secure estimation variable in a valuation model.

Scrap prices collection derive from various scrapping locations. The prices are collected with the same procedure as new building and secondhand prices.

Fleet Development and Order book data are continuously updated. Figures describe in numbers the actual number of vessels on water and the actual orders in well-established shipyards.

Operating cost is provided by Drewry Shipping Consultants regarding various categories. The daily rate includes Crew Cost, Insurance, Repairs and Maintenance, Stores and Supplies and Administration and Management. Repairs and Maintenance include scheduled and not scheduled maintenance. Provided data reflect the daily operating expenses through the year. Due to the fact that we wanted to be more consisted with variations through the year, we interpolated the data, so as the sum of average of all the monthly observations to be the same as the daily operating cost reported by Drewry.

5.4.2.Macroeconomic Data

The main sources of the Macroeconomic indicators are the following:

1. British Banker Association;
2. Federal Reserve;
3. OECD

Libor interest rate is provided for several different time periods, starting from one month to three months and for more extended periods, too. The Libor interest is charged in the short term period to cover the losses from interbank loans and it is usually linked with the repayment schedule of the loan. The Libor interest is periodically renewed, as defined by the loan agreement. In our case, we prefer the three month libor, which is a short term variable. Data are provided by the British Banker Association.

Margin rates are difficult to be collected. Each Financial institution has its own margin charges, which are not the same for each loan. This information is disclosed and therefore, it is difficult to extract and collect it. Therefore, there was a need to consider a different variable that will have some short of relevance with the margin. If we consider the margin as the expected profits of the bank from the loan agreement, then it would be considered wise to use an opportunity cost of the bank, which will not bear any risk premium. The only solution in that case would be the 10 year T-bond yields. 10year T-bond yields provided by the Federal Reserve. Definitely, this rate is lower than the actual margin due to the risk premium.

Finally, Industrial production refers to OECD countries and it is an index, which measures the real output of all industrial production. The reference datum concerns the period specified and it constitutes a percentage change.

The dataset covers a period of ten years and more specifically, from January 2000 to December to 2010, implying 132 observations for each variable (Table x). The time series were transformed into their logarithmic, so as to inherit all the prolific characteristics of the variable and to bypass the problem of the different units measurement.

5.5. Conclusion

The decomposition of the past research models has contributed to the final establishment of a more simple valuation model. Additionally, the combination of the easily collected micro and macro data and this simple valuation model constitutes an easy adoptable methodology. If we consider that the range of parameters calculated by this model, in order to support the final decision of the ship-owner about the acquisition of a second hand vessel, this model can be described as the safest and as an integrated valuation approach.

Furthermore, the data used to estimate the functionality of the model cover a period of strong fluctuations and volatility in global economy and seaborne trade. Concluding, low frequency data, in combination with dynamic models can lead to results, which are closer to reality. The basic concept of all model specifications is to simulate the market, but in the process of reaching this target, a large portion of the simplicity needed for easy access results is lost. Therefore, this research enforced the quality of results, in contrast to the accurate simulation of real market.

Chapter 6

Empirical Results

Introduction

Dry Bulk sector characteristics are combined in a final model, which gathers the most indicative parts of the shipping market, without excluding the dominant effects of the exogenous variables. Though the complexity of the model might be a little bit difficult for non-specialists, but it does not abstains from the traditional models used for the valuation of a second hand ship. The significant enhancement of this model is the addition of specialized variables, which target certain characteristics of the valuation process and manage to inherit more dynamism and cover a larger portion of the conditions in shipping sector.

As far as it concerns the methodology used in this research, definitely is a key innovation in shipping economic analysis. The multidimensional characteristics of the matrices in relation to the ever growing co-integration researches, gives the advance to eliminate any possible misspecification or loss of any important outcome. The stability of the model specified is ensured with the various statistic tests, without leaving any doubt about the outcomes produce.

Before we start the analysis of the results, we must summarize the expected outcomes. Smaller size vessels will be more flexible in the freight market and have large integration with the fluctuations of this market. The prices of the new vessels with the second hand vessels will have common characteristics and actually will follow the same trend, without working in term of antagonism. Capital variables, will not have the same weight in the acquisition decision process, since the smaller size vessels are thought to be a conservative investment, in contrast to the larger size vessels. Leverage in this case will not be of the main interest. Finally, the correction of the equilibrium in the short term period might be more drastic, because of the instant adjustment of the ship prices to the changes of the market.

Moving on to medium to larger sized vessels, the expected outcomes are more perplexed. Since the expansion of the total fleet and as consequence the larger carrying capacity entering the market will have a major impact in the sale and purchase conditions. Therefore, new ships and second ship prices will have all the characteristics of antagonism. Alongside, freight market will have a crucial role but not the dominant. Larger size vessel means that the scrap value rises adequately from the smaller size vessel. Therefore, the value of the scrap will have a positive effect in vessel value. Capital expenditures and leverage in this size of vessels is crucial factor for investment. For that reason all the finance variables are expected to have significant impact in vessels values.

In all cases, the exogenous factor of the industrial production we are not sure what effect will have in ship prices. Surely, the significance of this parameter is unquestionable, but the outcomes might highlight different not expected results. In either way are notion is that industrial production has significant importance in vessel valuation in the long term period, but it will not surpass the endogenous variables effects.

Methodology is well described in Chapter 3. This research produce a large number of tests, which have to be evaluated and in the end lay only with the ones that are the most important.

The lag estimation procedure was carried on for all the various lags numbers, but we only introduce the optimal length specification based on various criteria. The same happens for all the tests followed for each of the different lag specifications. In the main body of this chapter, we have only the important parts of the methodology used to estimate the model. In appendices there is a more analytic procedure of our methodology, which also includes stability tests and statistics importance tests. Both coefficients and residuals are examined for statistic malfunctions that might cause the biasedness of the model.

Four categories of different size of vessels are estimated that cover total any range of dry bulk sector.

Dry Bulk Carriers

6.1. Handysize Vessel

6.1.1. Stationarity Test

			Level		First Difference	
Variables	**Test**	**Ho**	**Test Statistic**	**Critical Values (5%)**	**Test Statistic**	**Critical Values (5%)**
New Building	ADF	I(1)	-0.995	-3.445	-5.051	-3.445
	PP	I(1)	-0.815	-3.444	-8.289	-3.445
	KPSS	I(*)	0.216	0.146	0.162	0.146
Second Hand	ADF	I(1)	-1.767	-3.445	-8.104	-3.445
	PP	I(1)	-1.631	-3.444	-8.134	-3.445
	KPSS	I(1)	0.186	0.146	0.082	0.146
Operating Profit	ADF	I(1)	-2.438	-3.445	-7.063	-3.445
	PP	I(1)	-1.550	-3.444	-4.728	-3.445
	KPSS	I(1)	0.169	0.146	0.046	0.146
Scrap	ADF	I(1)	-2.343	-3.444	-12.207	-3.445
	PP	I(1)	-2.284	-3.444	-12.207	-3.445
	KPSS	I(1)	0.201	0.146	0.045	0.146
OrderBook/Fleet	ADF	I(1)	-1.527	-3.445	-8.407	-3.445
	PP	I(1)	-1.370	-3.444	-9.197	-3.445
	KPSS	I(*)	0.198	0.146	0.216	0.146

Table 4.: Unit Root Test for Handysize vessels.

***After first difference still stationary for 5% statistic significance**

All three unit root tests suggest that all variables except for the New Building prices and the Order Book to Fleet ratio are non-stationary at their levels and after differencing them once, they become stationary. With regard to the other two variables, the results are frustrating, because two tests denote the same results, while the third one reveals the opposite. The different results come from the KPSS. This is logical in some way, since we apply three different tests that apply different estimation methods and different approaches to the problem. Consequently, we have to accept the results from the two tests, which constitute the majority in this case.

6.1.2. Lag Length Criteria

Lag No.	AIC	SC	HQ
0	1.19	1.37	1.26
1	*-16.72	*-15.06	*-16.05
2	*-17.36	-14.24	*-16.09
3	*-17.44	-12.85	-15.58
4	*-17.45	-11.38	-14.98
5	-17.44	-9.90	-14.38
6	-17.25	-8.24	-13.59
7	-17.38	-6.90	-13.12
8	-17.48	-5.53	-12.62
9	-17.74	-4.32	-12.29
10	*-18.72	-3.83	-12.67

Table 5.: Lag Length Criteria Handysize Vessel
***Suggested lag length**

AIC suggests lag length of ten and then, from four lags to no lags. SC suggests only for lag one. Finally, HQ suggests for one or two lags. Lag length of five can be considered as the frontier, which helps us to avoid over-parameterization. The lag the lengths from five to none, are tested jointly for autocorrelation and heteroskedasticity. The results suggest that lag length of rank 2 is the best fitted for this model specification.

6.1.3. Model Selection and Co-integration rank

Included observations: 129 after adjustments												
	Model 2				Model 3				Model 4			
Trend assumption:	No deterministic trend (restricted				Linear deterministic trend				Linear deterministic trend (restricted)			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Values (5%)	Prob.**	Eigenvalue	Trace Statistic	Critical Values (5%)	Prob.**	Eigenvalue	Trace Statistic	Critical Values (5%)	Prob.**
r=0	0.406	240.986	169.599	0.000	0.390	229.067	159.530	0.000	0.460	262.891	187.470	0.000
r=1	0.343	173.737	134.678	0.000	0.335	165.201	125.615	0.000	0.356	183.411	150.559	0.000
r=2	0.257	119.612	103.847	0.003	0.246	112.554	95.754	0.002	0.261	126.565	117.708	0.012
r=3	0.202	81.304	76.973	0.023	0.199	76.069	69.819	0.015	**0.237**	**87.520**	**88.804**	**0.062**
r=4	0.169	52.231	54.079	0.072	0.164	47.482	47.856	0.054	0.164	52.652	63.876	0.304
r=5	0.108	28.341	35.193	0.226	0.103	24.357	29.797	0.186	0.104	29.525	42.915	0.531
r=6	0.071	13.547	20.262	0.322	0.066	10.342	15.495	0.255	0.070	15.412	25.872	0.540
r=7	0.031	4.080	9.165	0.400	0.011	1.481	3.841	0.224	0.046	6.097	12.518	0.448

Table 6.: Model Selection and Co-integration rank for a Handysize Vessel

Following the guideline of Johansen(1992), for no co-integration the null hypothesis is rejected at anytime. Moving on to one co-integration equation again the principle defines that there are more co-integration equations. The next step is to test for two co-integration equations, with the results again to propose more co-integration equations. In rank three and model number four, with linera deterministic trend and constant in the Long term equation and only constant in the short term part of the equation, is the first time that the Ho is rejected and this is the model that we are going to apply in the data. ****MacKinnon-Haug-Michelis (1999) p-values**

6.1.4. VECM model Long term Equation

	(SH)	(IP)	(LIBOR)	(NB)	(OB)	(SCRAP)	(OP)	(TY)	TREND(00 M01)
Lag	-1	-1	-1	-1	-1	-1	-1	-1	-1
Coef.	1	0	0	*-1.596042	-1.201084	-3.02487	2.603813	* 0.466033	0.024923
S.E.				(0.83748)	(0.36669)	(0.49432)	(0.30608)	(0.73583)	(0.00978)
t-stat.				[-1.90578]	[-3.27543]	[-6.11922]	[8.50705]	[0.63334]	[2.54852]

	C
Lag	0
Coef.	-24.17445
S.E.	
t-stat.	

Table 7: Vector Error Correction model with lag of order 2 for Handysize vessels-Long term equation Co-integration equation 1

***Rejected for a=0,5**

	(SH)	(IP)	(LIBOR)	(NB)	(OB)	(SCRAP)	(OP)	(TY)	TREND(00 M01)
Lag	-1	-1	-1	-1	-1	-1	-1	-1	-1
Coef.	1	1.573024	0	31.75554	0	-28.28654	5.789714	-10.60166	-0.073013
S.E.		(0.57600)		(5.16976)		(5.47457)	(2.31285)	(4.39319)	(0.03701)
t-stat.		[2.73094]		[6.14256]		[-5.16690]	[2.50329]	[-2.41320]	[-1.97295]

	C
Lag	0
Coef.	-111.1484
S.E.	
t-stat.	

Table 8: Vector Error Correction model with lag of order 2 for Handysize vessels-Long term equation Co-integration equation 2

***Rejected for a=0,5**

	(SH)	(IP)	(LIBOR)	(NB)	(OB)	(SCRAP)	(OP)	(TY)	TREND(00M01)
Lag	-1	-1	-1	-1	-1	-1	-1	-1	-1
Coef.	1	0	**-0.19054**	*-0.280991	**-0.305482**	**0**	*-0.010604	**0.533824**	*-0.001477
S.E.			**(0.02970)**	(0.22065)	**(0.07881)**		(0.05718)	**(0.16909)**	(0.00224)
t-stat.			**[-6.41445]**	[-1.27347]	**[-3.87595]**		[-0.18547]	**[3.15697]**	[-0.66035]

	C
Lag	0
Coef.	-3.282941
S.E.	
t-stat.	

Table 9: Vector Error Correction model with lag of order 2 for Handysize vessels-Long term equation Co-integration equation 3

In first co-integration equation Industrial production and Libor are constrained to zero. In the second co-integration equation Libor remains constrained and OrderBook/fleet takes the position of industrial production. Finally, in the third co-integration equation Industrial production and Scrap Value are constrained to zero. Second Values in all cases is constrained with coefficient one in order to be the depenant value in the three co-integration models. ***Rejected for a=0,5**

Co-integration equation 1 suggests that new building vessel prices in the long run are slightly significant and have negative impact on second prices by -1,59%. The order Book to fleet variable is also significant in the long run period and has negative relation with second hand prices by -1,2%. The scrap prices variable is also significant in the long run with negative effect of -3%. Finally, the operating profit variable is positive and has an impact of 2,6% on second hand prices. Treasury yields are non-significant in the long run. Trend is significant, which signifies that it is important in this model.

Considering the results, the new building prices are substitute of the second prices and this relation is strengthened by the results of order book to fleet coefficient. The scrap prices do not seem to have any explainable relationship with the second hand prices. We would consider that the scrap prices should have an additive effect on second vessel prices, which will constitute a reasonable fact. The second hand vessel that has been estimated is a five year old vessel and the option to scrap it or operate it is not considered as realistic. Lastly, the operating profit reflects the significance of the freight market conditions in the value of the vessel.

The second co-integration equation results reveal the positive impact of industrial production by 1,57% on second hand prices. Similarly, new building prices and operating profit have a positive impact of 31,75% and 5,78%. On the other hand, the scrap values adjust the second hand prices by -28,28% and the treasury yields affect the dependent variable by -10,60%. Trend is slightly significant.

Analysing the results, we conclude that new building prices are complementary to second hand price and are connected with a strong relation. Again, the freight market conditions have a major impact on second hand prices. Industrial production levels are considered as a significant parameter in the acquisition policy. In this model, we observe the negative and strong impact of treasury yields on second hand prices, which is considered as reasonable, since vessels constitute capital intense investments. Finally, scrap values coefficients do not provide any reliable outcome.

Co-integration equation 3 outcomes can be considered as non-important, because the major shipping variables are non-significant and the remained significant variables have mixed coefficient signs, which cannot be explained by theory.

Concluding on the two long term equations, which have features explainable by theory and in conjunction with statistic stability, we move on to the short term equation.

6.1.5. VECM model Short term equation

	CointEq1	CointEq2	CointEq3
Coef.	0.046387	-0.004879	**-0.261598**
S.E.	(0.01896)	(0.00227)	**(0.10135)**
t-stat.	[2.44680]	[-2.15351]	**[-2.58112]**

Table 10: Vector Error Correction model with lag of order 2 for Handysize vessels- Error Correction Term

***Rejected for a=0,5**

	D(IP)	D(IP)	D(LIBOR)	D(LIBOR)	D(NB)	D(NB)	D(OB)	D(OB)	D(SCRAP)
Lag	**-1**	**-2**	**-1**	**-2**	**-1**	**-2**	**-1**	**-2**	**-1**
Coef.	*-0.004294	*-0.016463	**-0.145492**	* 0.004765	*-0.094434	* 0.127980	* 0.286950	*0.134052	*0.028052
S.E.	(0.00949)	(0.00954)	**(0.05839)**	(0.06213)	(0.30815)	(0.30639)	(0.16388)	(0.16670)	(0.10081)
t-stat.	[-0.45240]	[-1.72497]	**[-2.49163]**	[0.07670]	[-0.30645]	[0.41770]	[1.75102]	[0.80416]	[0.27826]

	D(SCRAP)	D(OP)	D(OP)	D(SH)	D(SH)	D(TY)	D(TY)	C
Lag	**-2**	**-1**	**-2**	**-1**	**-2**	**-1**	**-2**	**0**
Coef.	*0.075125	* 0.083870	*-0.101707	* 0.199862	*-0.02091	* 0.067711	**0.242616**	*-0.004134
S.E.	(0.08727)	(0.06075)	(0.05947)	(0.15504)	(0.15703)	(0.12249)	**(0.10589)**	(0.00725)
t-stat.	[0.86081]	[1.38057]	[-1.71022]	[1.28906]	[-0.13316]	[0.55277]	**[2.29120]**	[-0.56993]

Table 11: Vector Error Correction model with lag of order 2 for Handysize vessels- Short term equation

***Rejected for a=0,5**

R-squared	0.335122
Adj. R-squared	0.219226
Sum sq. resids	0.465725
S.E. equation	0.065366
F-statistic	2.891571
Log likelihood	179.7031
Akaike AIC	-2.47602
Schwarz SC	-2.03264
Mean dependent	0.005690
S.D. dependent	0.073976

Table 12: Vector Error Correction model with lag of order 2 for Handysize vessels- Statistics

***Rejected for a=0,5**

The error correction term should have negative sign, because it has a correction role in the model. Therefore, we consider the Error correction term 2 and 3 as reliable. If we consider that the Co-integration equation 3 was rejected in the previous analysis, the Co-integration 2 meets all the criteria, both economical and statistical. The second hand prices are adjusted by -0,48% per month, so as to have a long term equilibrium. Short term results suggest that most lagged values are non-significant and only the Libor variable one period back is significant with a negative effect(-0,15)..Regarding the data fitting into the model, R-squared is equal to 33,5%, which is a good percentage for a VECM, though this value is very small.

To sum up, handy size vessels seem to be market driven and the decision to acquire a second hand or a new building vessel is based upon the freight market conditions and the global economic status. Furthermore, the adjustments in the second hand prices in the long term can be considered as mild, suggesting decreased volatility in sale and purchase of vessels market. Therefore, Handy size vessels can be the best option for an investor, who wants to enter in the shipping market, or a conservative ship-owner, who wants to delimit the risk of the investment.

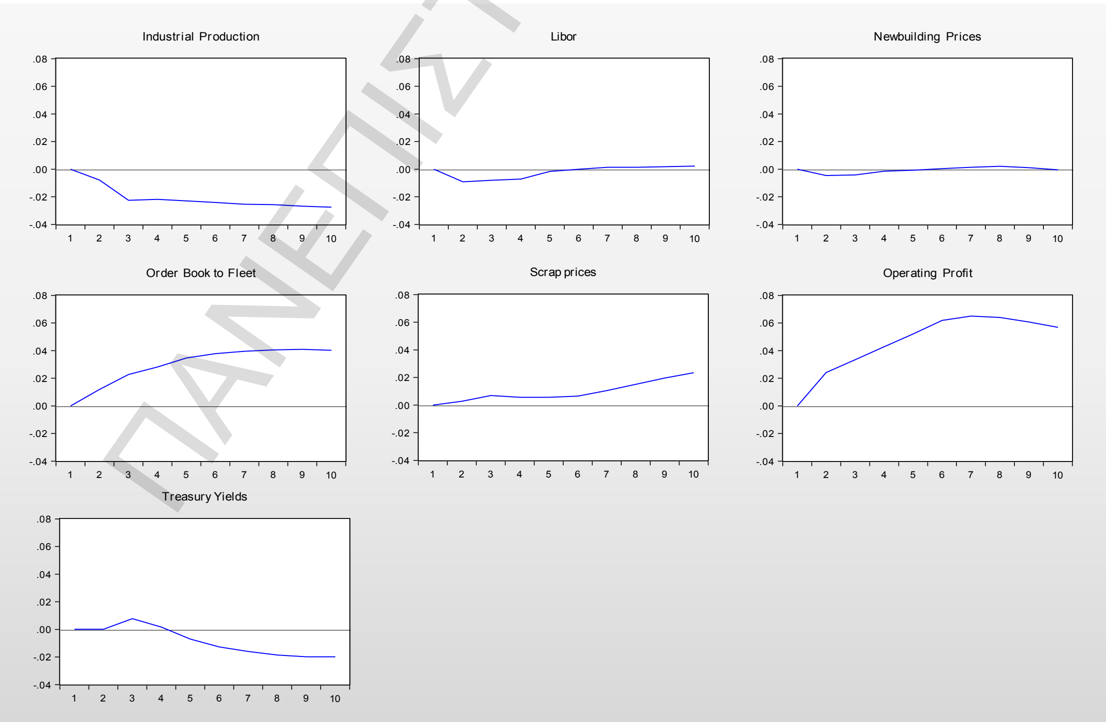
6.1.6. Granger Causality

Dependent variable: D(SHHNDSZ)			
Excluded	Chi-sq	df	Prob.
D(IP)	3.051430	2	0.2175
D(LIBOR)	6.254147	2	*0.0438
D(NBHNDSZ)	0.291026	2	0.8646
D(OB)	4.028233	2	0.1334
D(SCRAPHNDSZ)	0.763799	2	0.6826
D(OP)	5.110849	2	0.0777
D(TY)	5.472155	2	0.0648
All	26.06175	14	* 0.0254

Table 13:*Granger Causality/Block Exogeneity Tests*
***Not Rejected for a=0,5**

The Joint test suggests that the second hand prices are endogenous to the system and Granger causal to Second hand prices. Furthermore, in all cases, we reject the null hypothesis of excluding the variable from the system, except for the Libor variable. Treasury yields outcomes are on the edge to be considered as non-significant and excluded from the model.

6.1.7. Impulse Response



Graph 1. *Impulse response of one Standard Deviation on Second hand prices*

The Impulse response of one standard deviation suggests the diffusion of the shock initiated by operating profit has a sustainable and positive impact on second hand prices, which lasts throughout the period in question; we may be led to the same conclusion regarding the order book to fleet variable and the industrial production. New building prices, on the other hand, cannot create a major impact on second hand prices, as well as libor. The industrial production has a negative effect.

6.1.8. Model Robustness

Lag structure test (Appendices Table 80 and Graph 6) suggest that all the AR roots are inside the unit cirlce and the Model is stable. Lag exclusion criteria (Appendices Table 81) joint test provides strong results that for statistic significance of 5% all the lags are useful in the model and we reject the hypothesis that all lags are zero in all equations. Portmanteu Autocorrelation (Appendices Table 82) we reject the null hypothesis of autocorrelation up to lag order 10 in all cases for statistic significance of 5%. Autocorrelation LM test(Appendices Table 83) suggests that for lag order one exists serial correlation for significance 5%, but not for significance 1%. In all other lag autocorrelation existence is rejected. Normality test (Appendices Table 84) rejects in all cases the normality of the error term in all significance levels. The diagram of the residuals suggest the existence of a fat tail in the year 2008. Finally, White heteroskedasticity (Appendices Table 85) provides strong results that there is no existence of heteroskedasticity in data jointly, for statistic significance of 5%

6.2. Handymax Vessel

6.2.1. Stationarity Test

Variables	Test	Ho	Level: Test Statistic	Level: Critical Values (5%)	First Difference: Test Statistic	First Difference: Critical Values (5%)
New Building	ADF	I(1)	-0.978	-3.445	-7.088	-3.445
	PP	I(1)	-1.114	-3.444	-7.394	-3.445
	KPSS	I(1)	0.181	0.146	0.132	0.146
Second Hand	ADF	I(1)	-1.978	-3.445	-6.559	-3.445
	PP	I(1)	-1.597	-3.444	-6.178	-3.445
	KPSS	I(1)	0.173	0.146	0.099	0.146
Operating Profit	ADF	I(1)	-2.719	-2.884	-6.808	-2.884
	PP	I(1)	-1.437	-3.444	-5.316	-3.445
	KPSS	I(1)	0.170	0.146	0.051	0.146
Scrap	ADF	I(1)	-2.343	-3.444	-12.207	-3.445
	PP	I(1)	-2.284	-3.444	-12.207	-3.445
	KPSS	I(1)	0.201	0.146	0.045	0.146
OrderBook/Fleet	ADF	I(1)	-2.117	-3.445	-3.729	-3.445
	PP	I(1)	-1.532	-3.444	-8.093	-3.445
	KPSS	I(1)	0.181	0.146	0.135	0.146

Table 14: Unit Root Test for Handymax vessels.

***After first difference still stationary for 5% statistic significance**

Handymax variables are stationary in their first difference. The three tests jointly suggest that all variables are non-stationary at their levels, but after differencing them once, they become stationary.

6.2.2. Lag Length Criteria and model selection.

Lag No.	AIC	SC	HQ
0	1.26	1.45	1.34
1	-16.21	*-14.56	-15.54
2	*-16.90	-13.78	*-15.63
3	*-17.09	-12.49	-15.22
4	*-17.15	-11.08	-14.68
5	-16.89	-9.36	-13.83
6	-16.71	-7.70	-13.05
7	*-16.90	-6.42	-12.65
8	-17.34	-5.39	-12.49
9	-17.85	-4.43	-12.40
10	* -19.13	-4.24	-13.08

Table 15.: Lag Length Criteria Handymax Vessel
***Suggested lag length**

The AIC criterion indicates several lags as appropriate for VECM construction. On the other hand, SC and HQ criteria focus only on one lag length rank. SC criterion justifies the lag one length rank as the most appropriate construction and HQ justifies the lag length rank of two as the most appropriate for the VECM model. After several iterations, AIC provides the ideal solution of lag number 4, which does not lead to a complex model and it still, has all the prolific characteristics that will better map the Handymax sale and purchase market for second hand vessels.

After the lag selection criteria, Pantula principle suggests that the variables are best fitted in VECM model 2 and three co-integration equations with no deterministic trend.

6.2.3. Model Selection and Co-integration rank

Included observations: 127 after adjustments												
	Model 2				Model 3				Model 4			
Trend assumption:	No deterministic trend (restricted				Linear deterministic trend				Linear deterministic trend (restricted)			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Values (5%)	Prob.**	Eigenvalue	Trace Statistic	Critical Values (5%)	Prob.**	Eigenvalue	Trace Statistic	Critical Values (5%)	Prob.**
r=0	0.347	201.976	169.599	0.000	0.342	193.216	159.530	0.000	0.400	238.803	187.470	0.000
r=1	0.281	147.914	134.678	0.007	0.275	139.977	125.615	0.005	0.334	173.842	150.559	0.001
r=2	0.262	106.076	103.847	0.035	0.256	99.075	95.754	0.029	0.263	122.258	117.708	0.025
r=3	**0.192**	**67.526**	**76.973**	**0.211**	0.188	61.470	69.819	0.193	0.191	83.566	88.804	0.113
r=4	0.119	40.501	54.079	0.446	0.119	35.001	47.856	0.448	0.175	56.574	63.876	0.177
r=5	0.084	24.349	35.193	0.441	0.082	18.859	29.797	0.503	0.118	32.117	42.915	0.382
r=6	0.069	13.225	20.262	0.346	0.060	7.964	15.495	0.469	0.076	16.130	25.872	0.482
r=7	0.032	4.173	9.165	0.387	0.001	0.150	3.841	0.699	0.047	6.089	12.518	0.449

Table 16.: Model Selection and Co-integration rank for a Handymax Vessel

For no co-integration the null hypothesis is rejected at anytime. Moving on to one co-integration equation again the principle defines that there are more co-integration equations. The next step is to test for two co-integration equations, with the results again to propose more co-integration equations. In rank three and model number two, with constant in the Long term equation and no constant in the short term part of the equation, is the first time that the Ho is rejected and this is the model that we are going to apply in the data. ****MacKinnon-Haug-Michelis (1999) p-values**

6.2.4. VECM model Long term Equation

	(SH)	(IP)	(LIBOR)	(NB)	(OB)	(SCRAP)	(OP)	(TY)	C
Lag	-1	-1	-1	-1	-1	-1	-1	-1	0
Coef.	1	0	-0.416391	*-0.829659	0	-1.249168	0.615496	1.985380	-7.660058
S.E.			(0.05934)	(0.59712)		(0.53960)	(0.22724)	(0.28241)	(2.29103)
t-stat.			[-7.01676]	[-1.38944]		[-2.31499]	[2.70858]	[7.03010]	[-3.34350]

Table 17.: Vector Error Correction model with lag of order 4 for Handymax vessels-Long term equation Co-integration equation 1

***Rejected for a=0,5**

	(SH)	(IP)	(LIBOR)	(NB)	(OB)	(SCRAP)	(OP)	(TY)	C
Lag	-1	-1	-1	-1	-1	-1	-1	-1	0
Coef.	1	0	0	-0.947218	0.448618	-1.954815	0.523513	*-0.221995	*-2.335584
S.E.				(0.45955)	(0.08169)	(0.42771)	(0.17751)	(0.21774)	(1.68900)
t-stat.				[-2.06117]	[5.49157]	[-4.57039]	[2.94914]	[-1.01952]	[-1.38282]

Table 18.: Vector Error Correction model with lag of order 4 for Handymax vessels-Long term equation Co-integration equation 2

***Rejected for a=0,5**

	(SH)	(IP)	(LIBOR)	(NB)	(OB)	(SCRAP)	(OP)	(TY)	C
Lag	-1	-1	-1	-1	-1	-1	-1	-1	0
Coef.	1	0.090196	-0.060942	-1.082083	0	-1.216277	0.479205	0	-3.067725
S.E.		(0.01445)	(0.02975)	(0.34862)		(0.29804)	(0.12951)		(1.31042)
t-stat.		[6.24061]	[-2.04820]	[-3.10393]		[-4.08085]	[3.70012]		[-2.34103]

Table 19.: Vector Error Correction model with lag of order 4 for Handymax vessels-Long term equation Co-integration equation 3

In first co-integration equation Industrial production and OrderBook to Fleet are constrained to zero. In the second co-integration equation Libor remains constrained and industrial production. Finally, in the third co-integration equation OrderBool to Fleet and Treasury Yields are constrained to zero. Second Values in all cases is constrained with coefficient one in order to be the depenant value in the three co-integration models. ***Rejected for a=0,5**

The Industrial Production variable has been constrained to zero for the long term part. Only in the case of the co-integration 3 is tested for the significance in the valuation of a Handymax vessel. In co-integration 3, the industrial production variable is significant and has a positive effect on second hand Handymax prices. If Industrial production rises by 1% in the long term period, it causes the rise of second hand Handymax price by 0,09% .

The Libor variable is included in co-integration equations 1 and 3. The sign of the variable is negative in both cases and also significant. In more detail, a rise by 1% of the Libor interest rate will have a negative impact on second hand Handymax prices by -0,41% and -0,06%.

The order book to fleet variable is included only in co-integration equation number 2 and it is significant, with a positive sign. The effect of the order book to fleet variable on second hand prices is 0,44% for a rise of 1% in the order book to fleet ratio.

All three co-integration equation equations suggest that the new building prices have a negative relation with the second hand prices and the coefficients are close to 1. If we neglect the coefficient of the co-integration equation 1, which is non-significant, based on t-statistics, the coefficients of the other two co-integration relations have the same effect on second hand prices. In other words, a rise by 1% in new building prices will cause a drop of -0,94% and -1,08%.

The results for the Scrap price suggest that it causes a negative impact on Second hand Prices. The Scrap price coefficient is significant in the three co-integration equations. The price of the Scrap variable coefficients range from -1,21 to -1,95.

The Operating profit is positive in all cases and it is also significant. The price of the Operating profit suggest that a rise of 1% will have a positive impact on second hand prices by 0,61%, 0,52% and 0,47%. The results are surprisingly similar in all cases, suggesting the strong impact of the Operating profit on second hand prices.

Finally, the Treasury yield variable is constrained to zero in the third co-integration equation. For the rest of the two co-integration equations, the results are frustrating. In the first co-integration equation, Treasury yields rise by 1% and cause a positive impact of 1,98% on Second hand prices. On the other hand, in co-integration equation 2, a rise of the same level as the one concerning Treasury yields, will have a negative impact of -0,22%, but the significance of the Treasury yield coefficient is non-important and based on t-statistic test.

In conclusion, the three estimated co-integration equations have very similar outcomes. Except for Industrial production, Libor interest, Order book to fleet ratio and Treasury yields that are constrained variables and intentionally set to set zero in some cases, the other coefficients prices are very close.

The Industrial production is a significant parameter in the second hand prices level and aright, they cause the positive rise of second hand prices, when the need for seaborne trade is growing because of the rise in production. The two finance variables, namely Treasury Yields and Libor interest, have opposite results. The Libor interest rise will certainly cause a drop in second prices, because the relation is based on terms of supply and demand and an upward change in finance cost will surely diminish the demand for vessel acquisition, causing the drop of ship prices. Unlike, the Treasury yields have a positive effect on Second hand prices, which cannot be supported by the theory.

The Order book to fleet ratio has a positive impact on Second hand prices denoting that there is enough space for more vessels to enter the market.

Focusing on the maritime variables, Newbuilding prices compete against Second hand prices, with elasticity being close to one. Notably, the relation between Newbuilding prices and Second hand prices moves against, but at the same pace, suggesting that, if the demand for Newbuilding vessel rises, it will have an instant impact on second hand prices. If we consider that the dimensions and the capacity of this type of vessel is close to the ones of Handysize vessel, we can argue that only the small vessels sale and purchase market is open to more ship deliveries.

Additionally, Handymax vessel Order Book to fleet ratio denotes that the sale and purchase market is not congested for this type of vessels, which is something totally different from the conclusion raised from the relation between Newbuilding prices and Second Hand prices. A solution is to stand up on the argument raised from the New building and Second hand prices and consider the outcomes of the Order Book to fleet as non-important.

As revealed by the Order book to fleet ratio, the same can be concluded regarding the relation of Second hand Prices and Scrap prices. The expected outcome would be that a rise in Scrap prices will cause a subsequent rise in Second Hand vessels, since the valuation of the ship price includes the scrap price of the vessels.

Whereas two major maritime variables seem not to have a profound explanation based on the model estimated, the suitability of the model is not deteriorated. In particular, the Operating profit outcomes suggest that the Handymax prices, as the Handysize prices, are market driven. The Operating Profit suggests a stable pace of the linkage between vessel prices and the revenues. In terms of elasticity, the operating profit is inelastic against second hand prices.

Long term equation results provide an insight of the second hand market, providing strong assumptions that the Handymax vessels are merely laid upon the Shipping Market conditions and less in the Financial Market.

6.2.5. VECM model Short term equation

	CointEq1	CointEq2	CointEq3
Coef.	**0.129430**	**-0.207529**	*0.028425
S.E.	**(0.06029)**	**(0.07272)**	(0.13012)
t-stat.	**[2.14665]**	**[-2.85390]**	[0.21845]

Table 20: Vector Error Correction model with lag of order 4 for Handymax vessels- Error Correction Term

***Rejected for a=0,5**

	D(IP)	D(IP)	D(IP)	D(IP)	D(OB)	D(OB)	D(OB)	D(OB)
Lag	**-1**	**-2**	**-3**	**-4**	**-1**	**-2**	**-3**	**-4**
Coef.	*-0.010586	*-0.008755	* 0.003544	* 0.015791	* 0.256050	* 0.053256	* 0.076166	* 0.326132
S.E.	(0.01257)	(0.01199)	(0.01186)	(0.01078)	(0.19165)	(0.20098)	(0.20690)	(0.20946)
t-stat.	[-0.84204]	[-0.73019]	[0.29877]	[1.46424]	[1.33599]	[0.26499]	[0.36814]	[1.55698]

	D(SH)	D(SH)	D(SH)	D(SH)	D(OP)	D(OP)	D(OP)	D(OP)
Lag	**-1**	**-2**	**-3**	**-4**	**-1**	**-2**	**-3**	**-4**
Coef.	* 0.168702	*-0.059847	**-0.374119**	*-0.139808	**0.257894**	* 0.018465	**0.157251**	* 0.055615
S.E.	(0.18364)	(0.17397)	**(0.17575)**	(0.17416)	**(0.07674)**	(0.07402)	**(0.07156)**	(0.07140)
t-stat.	[0.91866]	[-0.34401]	**[-2.12872]**	[-0.80278]	**[3.36076]**	[0.24944]	**[2.19737]**	[0.77891]

	D(TY)	D(TY)	D(TY)	D(TY)	D(SCRAP)	D(SCRAP)	D(SCRAP)	D(SCRAP)
Lag	**-1**	**-2**	**-3**	**-4**	**-1**	**-2**	**-3**	**-4**
Coef.	*-0.149978	*-0.01623	*-0.045629	**-0.361731**	*-0.213635	**-0.197874**	*-0.143472	*-0.114919
S.E.	(0.16170)	(0.17695)	(0.15892)	**(0.14809)**	(0.11434)	**(0.10066)**	(0.09838)	(0.08840)
t-stat.	[-0.92751]	[-0.09172]	[-0.28712]	**[-2.44268]**	[-1.86848]	**[-1.96572]**	[-1.45832]	[-1.29997]

	D(NB)	D(NB)	D(NB)	D(NB)	D(LIBOR)	D(LIBOR)	D(LIBOR)	D(LIBOR)
Lag	**-1**	**-2**	**-3**	**-4**	**-1**	**-2**	**-3**	**-4**
Coef.	*-0.268988	*-0.416997	* 0.232811	* 0.029506	**-0.247406**	*-0.055049	*0.064529	*-0.07941
S.E.	(0.36064)	(0.33306)	(0.32038)	(0.28231)	**(0.06461)**	(0.06836)	(0.07126)	(0.07238)
t-stat.	[-0.74586]	[-1.25204]	[0.72668]	[0.10452]	**[-3.82948]**	[-0.80526]	[0.90551]	[-1.09715]

Table 21: Vector Error Correction model with lag of order 4 for Handymax vessels- Short term equation

***Rejected for a=0,5**

R-squared	0.551550
Adj. R-squared	0.385818
Sum sq. resids	0.399962
S.E. equation	0.065935
F-statistic	3.327972
Log likelihood	185.5912
Akaike AIC	-2.37152
Schwarz SC	-1.58768
Mean dependent	0.005191
S.D. dependent	0.084133

Table 22: Vector Error Correction model with lag of order 4 for Handymax vessels- Statistics

***Rejected for a=0,5**

Short term equation of the Handymax data reveals that in the short term period, most of the variables are non-significant. Second hand prices three lags back negatively affect the model by 0,374. The Operating profit of first and third lag has positive effect on second prices. Treasury yield of lag order four is significant and negative by -0,36 . The Libor of lag order one has a negative effect on second prices in the short term by -0,24 .

Concentrating all the previous results, we notice that all the signs of the variables are in line with the theory. Surprisingly, the Libor interest rate has a key role in the short term and the Treasury yield follows in the fourth lag. One reason might be that the variance of Treasury Yield is rather low, whereas Libor has a more rapid pace. Additionally, we cannot neglect the Operating profit, which is considered to be significant in two different time periods. Finally, past Second hand prices have a negative effect on spot prices.

The Error Correction term is significant for co-integration equation number 1 and 2. However, in co-integration equation number 1, the term has no adjusting role for having Long term equilibrium. Therefore, co-integration equation 1 is considered as non-explainable by theory and dropped from the analysis. The Error correction term of co-integration equation 2 is negative and lower than one, which is a limit of wellness. In the short term prices of second hand vessels, adjust by -20,7% monthly, so as to sustain the equilibrium.

In conclusion, Handymax Second hand vessel prices are considered to be driven by the market conditions and the expected operating profit. In addition, the decision to buy a second hand vessel is closely tied with the prices of New Building vessels, suggesting a congesting market. Furthermore, the correction of second hand prices has a quite significant rate, which might be related to volatility in this type of vessels.
Regarding the data fitting into the model, R-squared is 55%, which is a good percentage for a VECM.

6.2.6. Granger Causality

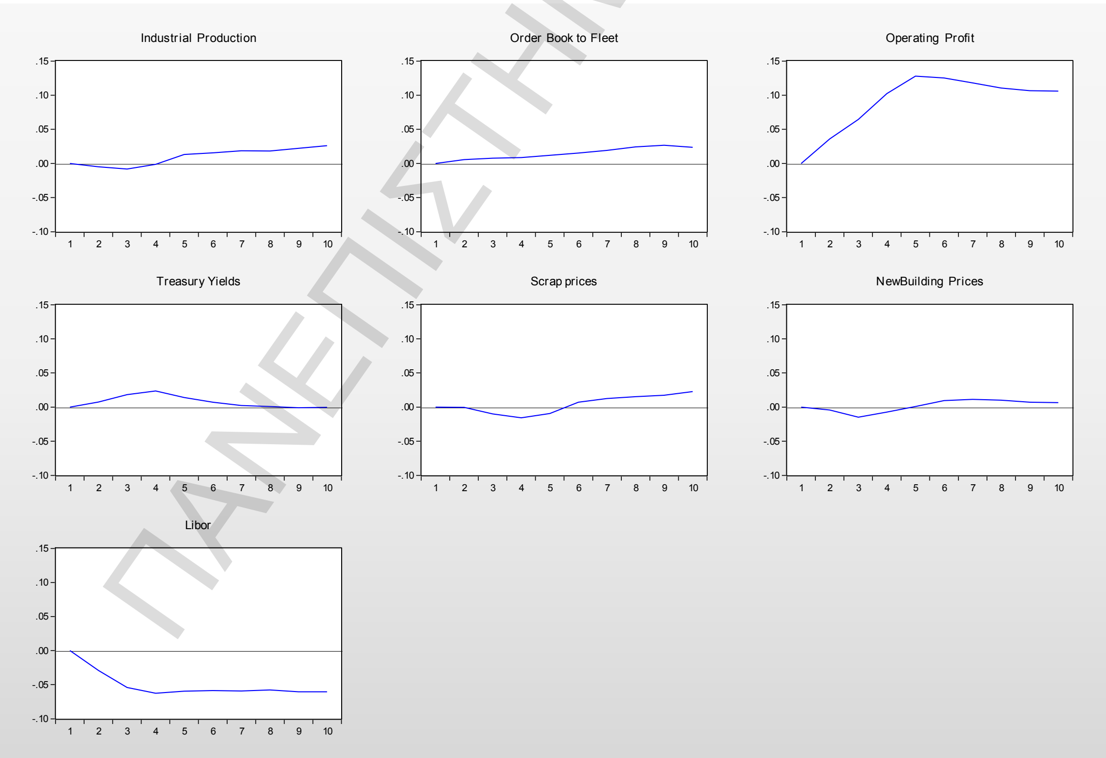
Dependent variable: D(SHHNDMX)			
Excluded	Chi-sq	df	Prob.
D(IP)	3.685987	4	0.4502
D(LIBOR)	17.30957	4	*0.0017
D(NBHND MX)	2.910332	4	0.5729
D(OB)	6.752970	4	0.1495
D(SCRAP HNDMX)	5.207094	4	0.2667
D(OP)	16.84923	4	*0.0021
D(TY)	7.183569	4	0.1265
All	53.76134	28	*0.0024

Table 23: Granger Causality/Block Exogeneity Tests

***Not Rejected for a=0,5**

Granger cause results suggest that only the Libor interest rate and the Operating profit Granger cause Second hand prices. However, the Joint test of Error Correction Term suggest that all variables Granger cause Second Hand prices.

6.2.7. Impulse Response



Graph 2. : Impulse response of one Standard Deviation on Second hand prices

The Impulse response of one standard deviation of Industrial Production causes no serious fluctuations in second hand prices in the short term. After the fourth lag, there is an upward trend in Second Hand prices. Order Book to fleet has the same results, as the ones in the long term equation. The Operating profit has a major impact on Second hand prices. From the first period, the Operating profit causes a positive boost in Second Hand prices, which resists till the end. Treasury Yields, Scrap prices and New building prices do not cause a major impact on Second Hand prices. Especially, Treasury yields force is eliminated after the seventh period. Scrap prices and New building prices alternate their impact on Second hand prices. The force of these two standard deviation impulses start from a negative course, but in the middle of the time period, the price course changes to positive and remains positive. Finally, the Libor impulse response causes a major negative impact on Second hand prices.

Co-integration equation, Granger causality and impulse response end up to the same result, i.e. that the Second hand prices of a Handymax vessels are more dependent on changes in the freight market and how this affects the Operating profit of the vessel; we can be led to the same conclusion regarding the Libor interest.

6.2.8. Model Robustness

Lag structure test (Appendices Table 119 and Graph 8) suggest that all the AR roots are inside the unit cirlce and the Model is stable. Lag exclusion criteria (Appendices Table 120) joint test provides strong results that for statistic significance of 5% all the lags are useful in the model and we reject the hypothesis that all lags are zero in all equations, but in the case of the fourth lag where null hypothesis of joint test, that all coefficients are zero is rejected for statistic significance 10%. Portmanteu Autocorrelation (Appendices Table 121) we reject the null hypothesis of autocorrelation up to lag order 8 in all cases for statistic significance of 5%, while in the last two lags only for 10% significance we reject the null hypothesis. Autocorrelation LM test(Appendices Table 122) suggests that for lag up to order 8 and lag order10 does not exists serial correlation for significance 5%, while in the lag 9, autocorrelation is rejected for 1% statistic significance. Normality test (Appendices Table 123) rejects in all cases the normality of the error term in all significance levels. The diagram of the residuals suggests the existence of a fat tail in the year 2008. Finally, White heteroskedasticity (Appendices Table 124) provides strong results that there is no existence of heteroskedasticity in data jointly, for statistic significance of 5%

6.3.Panamax Vessel

6.3.1.Stationarity Test

			Level		First Difference	
Variables	Test	Ho	Test Statistic	Critical Values (5%)	Test Statistic	Critical Values (5%)
New Building	ADF	I(1)	-1.041	-3.445	-6.735	-3.445
	PP	I(1)	-1.116	-3.444	-6.929	-3.445
	KPSS	I(1)	0.193	0.146	0.122	0.146
Second Hand	ADF	I(1)	-2.156	-3.445	-7.267	-3.445
	PP	I(1)	-1.796	-3.444	-7.166	-3.445
	KPSS	I(1)	0.180	0.146	0.069	0.146
Operating Profit	ADF	I(1)	2.628	-3.445	-7.019	-3.445
	PP	I(1)	-2.001	-3.444	-6.288	-3.445
	KPSS	I(1)	0.181	0.146	0.044	0.146
Scrap	ADF	I(1)	-2.361	-3.444	-12.197	-3.445
	PP	I(1)	-2.315	-3.444	-12.197	-3.445
	KPSS	I(1)	0.196	0.146	0.046	0.146
OrderBook/Fleet	ADF	I(0)	-4.858	-3.445	*	-3.445
	PP	I(1)	-2.417	-3.444	-8.026	-3.445
	KPSS	I(0)	0.110	0.146	*	0.146

Table 24.:Unit Root Test for Panamax vessels.

***After first difference still stationary for 5% statistic significance**

Based on the results from the stationarity test, most of the time series are non-stationary in their levels, except for the Order Book to Fleet ratio, which is defined by ADF and KPSS test as stationary in levels, but not PP. In this case, we will consider the Order Book to Fleet ratio as stationary in levels. For the rest of the variables, if we difference them once, they become stationary.

Although the Order Book to Fleet ratio is not in line with other variables, we do not reject it and we use it as an exogenous variable in the short term of the VECM, because we want to test the impact of this variable on the Second Hand prices.

6.3.2. Lag Length Criteria and model selection.

Lag No.	AIC	SC	HQ
0	0.24	0.56	0.37
1	*-11.76	*-10.32	-11.18
2	*-12.38	-9.81	* -11.34
3	-12.37	-8.67	-10.86
4	*-12.38	-7.55	-10.42
5	-11.98	-6.03	-9.56
6	-11.80	-4.72	-8.92
7	-11.63	-3.42	-8.29
8	*-12.05	-2.71	-8.26
9	-12.10	-1.64	-7.85
10	*-12.53	-0.94	-7.82

Table 25: Lag Length Criteria Panamax Vessel
***Suggested lag length**

The three lag criteria propose several lags, as the optimal for this set of data. More specifically, AIC suggests lag of order 10, 8, 4, 2 and 1. Lags more than 5 create complex models, which are not easily handled. Therefore, we ignore these lags as inappropriate. Moving on to SC criterion, the only suggested lag in this criterion is 1. Next, HQ criterion follows, which suggests lag of order 2. Based on the stability test and the hypothesis testing, lag of order 4 has the most resilient and stable results.

The next step in our model estimation procedure is to define the co-integration equations, as well as the suitable long term and short term equation of the VECM model. Pantula principle suggests model number 3 and 3 co-integration equations. The Critical Values used in this case are different, because, in the model selection, we have selected a variable that is stationary.

6.3.3. Model Selection and Co-integration rank

Included observations: 127 after adjustments												
	Model 2				Model 3				Model 4			
Trend assumption:	No deterministic trend (restricted constant)				Linear deterministic trend				Linear deterministic trend (restricted)			
Hypothesized		Trace	0.05			Trace	0.05			Trace	0.05	
No. of CE(s)	Eigenvalu	Statistic	C.V.**	Prob.	Eigenvalu	Statistic	C.V.**	Prob.	Eigenvalu	Statistic	C.V.**	Prob.
r=0	0.34	164.77	12.34		0.34	159.15	11.42		0.39	197.74	15.46	
r=1	0.28	112.35	25.64		0.28	106.79	23.62		0.33	134.39	31.05	
r=2	0.22	70.48	42.70		0.22	65.08	39.56		0.22	84.42	50.25	
r=3	**0.17**	**38.74**	**63.66**		0.17	33.68	59.42		0.18	52.23	73.31	

Table 26: Model Selection and Co-integration rank for a Panamax Vessel

For no co-integration the null hypothesis is rejected at anytime. Moving on to one co-integration equation again the principle defines that there are more co-integration equations. The next step is to test for two co-integration equations, with the results again to propose more co-integration equations. In rank three and model number two, with constant in the Long term equation and no constant in the short term part of the equation, is the first time that the Ho is rejected and this is the model that we are going to apply in the data. ****MacKinnon-Haug-Michelis (1999) p-values**

6.3.4. VECM model Long term equation

	(SH)	(IP)	(LIBOR)	(NB)	(SCRAP)	(OP)	(TY)	C
Lag	-1	-1	-1	-1	-1	-1	-1	0
Coef.	1	0	0	-0.85956	-0.67814	*-0.061655	*-0.061655	1.206515
S.E.				-0.1968	-0.1338	-0.06968	-0.06968	-0.52468
t-stat.				[-4.36777]	[-5.06837]	[-0.88484]	[-0.88484]	[2.29954]

Table 27: Vector Error Correction model with lag of order 4 for Panamax vessels-Long term equation Co-integration equation 1

***Rejected for a=0,5**

	(SH)	(IP)	(LIBOR)	(NB)	(SCRAP)	(OP)	(TY)	C
Lag	-1	-1	-1	-1	-1	-1	-1	0
Coef.	1	0.104431	0	-2.34567	0	0.375288	0.482608	*0.208839
S.E.		-0.01608		-0.21643		-0.0915	-0.16281	-0.56955
t-stat.		[6.49346]		[-10.8380]		[4.10146]	[2.96427]	[0.36668]

Table 28: Vector Error Correction model with lag of order 4 for Panamax vessels-Long term equation Co-integration equation 2

***Rejected for a=0,5**

	(SH)	(IP)	(LIBOR)	(NB)	(SCRAP)	(OP)	(TY)	C
Lag	-1	-1	-1	-1	-1	-1	-1	0
Coef.	1	0	-0.145159	-1.889357	0	0.246418	1.242814	*-0.934223
S.E.			-0.025	-0.23133		-0.09224	-0.20743	-0.68864
t-stat.			[-5.80653]	[-8.16725]		[2.67150]	[5.99161]	[-1.35661]

Table 29: Vector Error Correction model with lag of order 4 for Panamax vessels-Long term equation Co-integration equation 3

In first co-integration equation Industrial production and Libor are constrained to zero. In the second co-integration equation Libor remains constrained and Scrap value. Finally, in the third co-integration equation Industrial production and Scrap are constrained to zero. Second Values in all cases is constrained with coefficient one in order to be the depenant value in the three co-integration models. ***Rejected for a=**

In co-integration 1, the Industrial production and the Libor are constrained to zero. Newbuilding prices coefficient is negative and statistically significant. A rise by 1% in New building prices of a Panamax vessel will cause the drop of the price of a Second hand Panamax vessel by -0,85%.

The Scrap prices have a negative effect on Second Hand prices and they are significant. A rise by 1% in Scrap prices will lead to a drop in Second Hand prices by -0,67%.
The Operating profit has a negative impact on Second Hand prices. However, the statistic significance of this variable is rejected.

Treasury yields have a positive effect on Second hand prices, but they are also non-significant.

On the next co-integration equation, the Libor interest and the Scrap prices are constrained to zero. In this case, the Industrial production has a positive and statistically significant effect on Second Hand Prices. A rise of 1% in Industrial Production leads to a mild rise in Second hand prices by 0,10%.

On the other hand, New Building prices have the same impact on Second Hand prices, as the one in co-integration 1. In this case, the negative effect on Second Hand prices reaches -2,34%, if there is a drop in New Building prices by 1%.
The Operating profit is statistically significant in this co-integration equation. A rise by 1% in Operating profit will cause the similar rise in Second Hand prices by 0,37%.

Treasury yields results do not change from co-integration, but in this case, they are statistically significant. In other words, a rise in Treasury yields by 1% will cause the analogous rise of 0,48% in Second Hand prices.

The constant term in this co-integration equation is non-significant, based on t-statistics.

Finally, in co-integration equation 3, the Industrial production variable and Libor interest have been constrained. Libor, in this case, is statistically significant and negative. Actually, a rise of 1% in Libor will cause an analogous drop in Second Hand prices by -0,14%.

New Building prices also have a negative impact on this co-integration equation. New Building prices are statistically significant with a price of -1,88, meaning that a rise of New Building prices by 1% will cause the drop of Second Hand prices by -1,88%.

Conversely to New Building prices, Operating Profit has a positive effect on Second Hand prices. The Operating Profit coefficient is statistically significant. Particularly, a rise by 1% in Operating Profit will cause the rise in Second Hand prices by 0,24%.

Similarly, Treasury yields have positive effect on Second Hand prices and statistic significance. A rise by 1% in Treasury yields has a statistically significant effect of 1,24%.The constant term in this co-integration equation is non-significant, based on t-statistics.

In summary, New Building prices seem to have negative effect on Second Hand prices in all three co-integration equations. Thus, New building Panamax vessels are competitive to Second Hand vessels. On the other hand, the Operating Profit is not considered as significant in co-integration 1. In this case, we can easily derive the outcome that Second Hand prices are directly connected with the conditions in Sale and Purchase of Panamax vessels and the freight market does not have any substantial role in shaping the Second Hand prices. Conversely, if the other two co-integration equations are valid, Second Hand prices are also market driven. The Industrial production has a small impact on the decision to acquire a Second Hand Panamax vessel, but it is positive. Libor's negative role in Second Hand prices is in line with our assumptions. Finally, Treasury yields and Scrap prices do not provide any meaningful outcome.

The Short term equation will further highlight the dynamic of variables.

6.3.5 VECM model Short term equation

	CointEq1	CointEq2	CointEq3
Coef.	**-0.232658**	* 0.012918	*0.025428
S.E.	**-0.11229**	-0.15688	-0.15238
t-stat.	**[-2.07185]**	[0.08234]	[0.16687]

Table 30: Vector Error Correction model with lag of order 2 for Panamax vessels- Error Correction Term

***Rejected for a=0,5**

	D(IP)	D(IP)	D(IP)	D(IP)	D(LIBOR)	D(LIBOR)	D(LIBOR)	D(LIBOR)
Lag	**-1**	**-2**	**-3**	**-4**	**-1**	**-2**	**-3**	**-4**
Coef.	*-0.010506	*-0.014628	*-0.003426	*-0.006032	**-0.311759**	* 0.041124	* 0.106947	*-0.086854
S.E.	-0.0163	-0.0157	-0.0151	-0.01343	**-0.07839**	-0.08115	-0.08312	-0.08397
t-stat.	[-0.64464]	[-0.93176]	[-0.22690]	[-0.44908]	**[-3.97694]**	[0.50678]	[1.28665]	[-1.03430]

	D(NB)	D(NB)	D(NB)	D(NB)	D(SCRAP)	D(SCRAP)	D(SCRAP)	D(SCRAP)
Lag	**-1**	**-2**	**-3**	**-4**	**-1**	**-2**	**-3**	**-4**
Coef.	*0.197969	*-0.410927	**0.782402**	*-0.069262	*-0.047607	*-0.107289	*-0.073381	*-0.062873
S.E.	-0.4306	-0.3872	**-0.37027**	-0.35671	-0.12048	-0.11327	-0.11479	-0.10355
t-stat.	[0.45975]	[-1.06128]	**[2.11304]**	[-0.19417]	[-0.39515]	[-0.94723]	[-0.63924]	[-0.60718]

	D(SH)	D(SH)	D(SH)	D(SH)	D(OP)	D(OP)	D(OP)	D(OP)
Lag	**-1**	**-2**	**-3**	**-4**	**-1**	**-2**	**-3**	**-4**
Coef.	*0.20419	*-0.000967	*-0.180762	*-0.082216	**0.220168**	*-0.016918	*0.080407	* -0.00492
S.E.	-0.1746	-0.18336	-0.17228	-0.17446	**-0.06295**	-0.06631	-0.06669	-0.06772
t-stat.	[1.16951]	[-0.00527]	[-1.04926]	[-0.47125]	**[3.49736]**	[-0.25512]	[1.20563]	[-0.07265]

	D(TY)	D(TY)	D(TY)	D(TY)	OB
Lag	-1	-2	-3	-4	-1
Coef.	*-0.11745	*0.206148	*0.219945	*-0.274956	*-0.033442
S.E.	-0.18195	-0.18634	-0.17151	-0.16022	-0.01775
t-stat.	[-0.64550]	[1.10632]	[1.28238]	[-1.71609]	[-1.88436]

Table 31: Vector Error Correction model with lag of order 2 for Panamax vessels- Short term equation

***Rejected for a=0,5**

R-squared	0.496822
Adj. R-squared	0.332628
Sum sq. resids	0.617929
S.E. equation	0.080651
F-statistic	3.025811
Log likelihood	157.9684
Akaike AIC	-1.98375
Schwarz SC	-1.26711
Mean dependent	0.006263
S.D. dependent	0.098724

Table 32: Vector Error Correction model with lag of order 2 for Panamax vessels- Statistics

***Rejected for a=0,5**

The results of the short term equation suggest that only the Error Correction Term of co-integration 1 is significant. Furthermore, the negative sign shows the adjusting role of Error correction term, so as to sustain the long term equilibrium. More specifically, second hand prices are monthly adjusted by 23,26% to fix the disequilibrium.

As far as the short run effect of variables in Second Hand prices is concerned, most of the variables are non-significant. Only Newbuilding prices have a positive relation with Second Hand prices in the third lag. Surprisingly, the Operating Profit has significant and positive impact on Second Hand prices in the first lag by 0,22. Finally, the Order Book to fleet ratio results are poor, with no important role in Second Hand prices.Regarding the data fitting into the model, R-squared is 49%, which is a good percentage for a VECM.

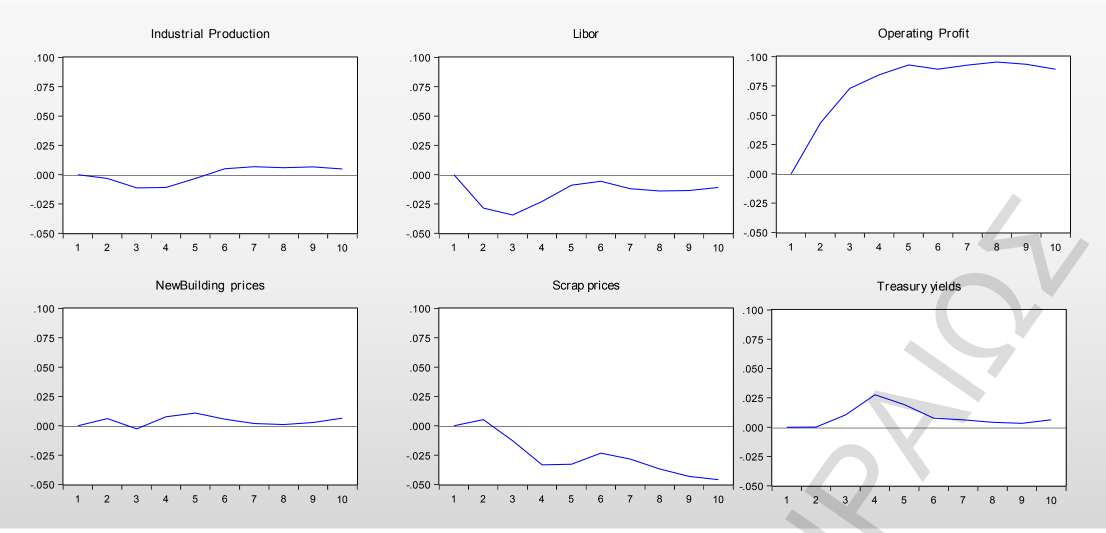
6.3.6 Granger Causality

Dependent variable: D(SHPNMX)			
Excluded	Chi-sq	df	Prob.
D(IP)	1.172720	4	0.8826
D(LIBOR)	16.03543	4	* 0.0030
D(NBPNMXZ)	5.566823	4	0.2339
D(SCRAPPNMX)	1.222746	4	0.8743
D(OP)	12.43535	4	*0.0144
D(TY)	9.775813	4	*0.0444
All	49.05605	24	*0.0019

Table 33: Granger Causality/Block Exogeneity Tests
***Not Rejected for a=0,5**

Granger cause results suggest that only Libor interest rate, Operating profit and Treasury Yields Granger cause Second hand prices. However, the Joint test of Error Correction Term suggests that all variables Granger cause Second Hand prices.

6.3.7. Impulse Response



Graph 3: Impulse response of one Standard Deviation on Second hand prices

The Industrial Production causes a negative effect on Second Hand prices, which changes after the fifth period into positive. This reason enforces our decision to constrain the Industrial production variable in the co-integration model, because this outcome does not materialize any realistic event. Libor impulse response causes the negative impact on Second Hand prices, which is constant and dynamic. The Operating profit has a significant and radical effect on Second Hand prices, which does not cease till the end of the period tested. Newbuilding prices impulse response further denotes the mild effect on Second Hand prices. Scrap prices and Treasury yields results do not provide any realistic outcome, which is something in line with the co-integration equation.

6.3.8. Model Robustness

Lag structure test (Appendices Table 156 and Graph 10) suggest that all the AR roots are inside the unit circle and the Model is stable. Lag exclusion criteria (Appendices Table 120) joint test provides strong results that for statistic significance of 5% all the lags are useful in the model and we reject the hypothesis that all lags are zero in all equations, but in the case of the fourth lag where null hypothesis of joint test, that all coefficients are zero is rejected for statistic significance 10%. Portmanteu Autocorrelation (Appendices Table 158) we reject the null hypothesis of autocorrelation up to lag order 8 in all cases for statistic significance of 5%, while in the last two lags only for 10% significance we reject the null hypothesis. Autocorrelation LM test(Appendices Table 159) suggests that for lag up tp order 7 and lag order 9 and 10 does not exists serial correlation for significance 5%, while in the lag 8, autocorrelation is rejected for 1% statistic significance. Normality test (Appendices Table 160) rejects in all cases the normality of the error term in all significance levels. The diagram of the residuals suggests the existence of a fat tail in the year 2008. Finally, White heteroskedasticity (Appendices Table 161) provides strong results that there is no existence of heteroskedasticity in data jointly, for statistic significance of 5%

6.4.Capesize Vessel

6.4.1.Stationarity Test

Variables	Test	Ho	Level Test Statistic	Level Critical Values (5%)	First Difference Test Statistic	First Difference Critical Values (5%)
New Building	ADF	I(1)	-0.951	-3.445	-4.820	-3.445
	PP	I(1)	-0.891	-3.444	-8.420	-3.445
	KPSS	I(1)	0.183	0.146	0.124	0.146
Second Hand	ADF	I(1)	-1.908	-3.445	-6.556	-3.445
	PP	I(1)	-1.509	-3.444	-6.487	-3.445
	KPSS	I(1)	0.184	0.146	0.076	0.146
Operating Profit	ADF	I(1)	-2.359	-3.445	-7.802	-3.445
	PP	I(1)	-1.828	-3.444	-6.963	-3.445
	KPSS	I(1)	0.204	0.146	0.051	0.146
Scrap	ADF	I(1)	-2.359	-3.444	-12.177	-3.445
	PP	I(1)	-2.314	-3.444	-12.177	-3.445
	KPSS	I(1)	0.195	0.146	0.046	0.146
OrderBook/Fleet	ADF	I(*)	-2.426	-3.445	-2.259	-3.445
	PP	I(1)	-1.810	-3.444	-11.050	-3.445
	KPSS	I(*)	0.122	0.146	0.177	0.146

Variables	Test	Ho	First Difference Test Statistic	First Difference Critical Values (5%)	Second Difference Test Statistic	Second Difference Critical Values (5%)
OrderBook/Fleet	ADF	I(2)	-2.259	-3.445	-13.139	-3.445
	KPSS	I(2)	0.177	0.146	0.048	0.146

Table 34: Unit Root Test for Capesize vessels.

***After first difference still stationary for 5% statistic significance**

The three stationarity tests suggest that all variables are non-stationary in their levels, but they become stationary after differencing them once. Likewise, the Order Book to Fleet ratio is suggested as non-stationary, but after converting it into first difference, only the PP test defines it as stationary. The Order Book to Fleet ratio becomes stationary after differencing the variable for second time.

6.4.2.Lag Length Criteria

Lag No.	AIC	SC	HQ
0	-0.52	-0.33	-0.44
1	-14.62	*-12.95	-13.94
2	*-15.23	-12.09	*-13.96
3	-15.03	-10.41	-13.16
4	*-15.18	-9.08	-12.70
5	-14.97	-7.39	-11.89
6	-14.85	-5.80	-11.17
7	*-15.04	-4.50	-10.76
8	*-15.29	-3.27	-10.41
9	*-15.68	-2.19	-10.20
10	*-16.44	-1.47	-10.36

Table 35: Lag Length Criteria Capesize Vessel
***Suggested lag length**

AIC criterion proposes several lag lengths as optimal for a VECM lag formation. However, we reject any lag larger than five, because these number of lags create an over parameterized model, which is not easily manipulated and solved. For that reason, we consider only the fourth and second lag length as optimal. SC and HQ criteria continue to highlight the opinion, that less lags than the ones proposed by AIC criterion are optimal. SC lag proposal of number 1 is the smallest, with HQ criterion to follow with optimal lag length of 2. Lag length of order 4 is suggested as the optimal, based on several statistic results.

6.4.3. Model Selection and Co-integration rank

Included observations: 129 after adjustments												
	Model 2				Model 3				Model 4			
Trend assumption:	No deterministic trend (restricted				Linear deterministic trend				Linear deterministic trend			
Hypothesized		Trace	0.05			Trace	0.05			Trace	0.05	
No, of CE(s)	Eigenvalue	Statistic	C.V.	Prob.**	Eigenvalu	Statistic	C.V.	Prob.**	Eigenvalue	Statistic	C.V.	Prob.**
r=0	0.356	213.849	169.599	0.000	0.356	205.991	159.530	0.000	0.385	237.691	187.470	0.000
r=1	0.315	158.369	134.678	0.001	0.313	150.548	125.615	0.001	0.332	176.401	150.559	0.001
r=2	0.262	110.777	103.847	0.016	0.257	103.155	95.754	0.014	0.292	125.515	117.708	0.015
r=3	**0.223**	**72.541**	**76.973**	**0.104**	0.209	65.808	69.819	0.100	0.218	82.040	88.804	0.139
r=4	0.150	40.822	54.079	0.430	0.149	36.250	47.856	0.384	0.153	51.000	63.876	0.371
r=5	0.081	20.419	35.193	0.700	0.079	15.987	29.797	0.713	0.132	30.138	42.915	0.494
r=6	0.045	9.829	20.262	0.657	0.038	5.624	15.495	0.739	0.067	12.333	25.872	0.789
r=7	0.031	3.982	9.165	0.415	0.006	0.793	3.841	0.373	0.028	3.621	12.518	0.796

Table 36: Model Selection and Co-integration rank for a Capesize Vessel

For no co-integration the null hypothesis is rejected at anytime. Moving on to one co-integration equation again the principle defines that there are more co-integration equations. The next step is to test for two co-integration equations, with the results again to propose more co-integration equations. In rank three and model number two, with constant in the Long term equation and no constant in the short term part of the equation, is the first time that the Ho is rejected and this is the model that we are going to apply in the data. ****MacKinnon-Haug-Michelis (1999) p-values**

6.4.4. VECM model Long term Equation

	(SH)	(IP)	(LIBOR)	(NB)	D(OB)	(SCRAP)	(OP)	(TY)	C
Lag	-1	-1	-1	-1	-1	-1	-1	-1	0
Coef.	1	0	0	-0.47296	-2.661522	-0.895245	* 0.001962	-0.645214	* 0.440018
S.E.				(0.19485)	(0.56928)	(0.14825)	(0.06522)	(0.12218)	(0.48276)
t-stat.				[-2.42727]	[-4.67527]	[-6.03884]	[0.03009]	[-5.28104]	[0.91145]

Table 37: Vector Error Correction model with lag of order 4 for Capesize vessels-Long term equation Co-integration equation 1

***Rejected for a=0,5**

	(SH)	(IP)	(LIBOR)	(NB)	D(OB)	(SCRAP)	(OP)	(TY)	C
Lag	-1	-1	-1	-1	-1	-1	-1	-1	0
Coef.	1	0.200793	0	-3.905693	0	* 0.364512	0.789626	* 0.289515	2.437742
S.E.		(0.03396)		(0.44514)		(0.21961)	(0.15234)	(0.26609)	(0.85497)
t-stat.		[5.91199]		[-8.77404]		[1.65984]	[5.18325]	[1.08802]	[2.85125]

Table 38: Vector Error Correction model with lag of order 4 for Capesize vessels-Long term equation Co-integration equation 2

***Rejected for a=0,5**

	(SH)	(IP)	(LIBOR)	(NB)	D(OB)	(SCRAP)	(OP)	(TY)	C
Lag	-1	-1	-1	-1	-1	-1	-1	-1	0
Coef.	1	0	-0.30066	-1.971835	*-1.38634	0	0.387451	1.706581	-2.199221
S.E.			(0.04557)	(0.35841)	(0.85063)		(0.14654)	(0.34336)	(0.96040)
t-stat.			[-6.59821]	[-5.50166]	[-1.62977]		[2.64392]	[4.97019]	[-2.28991]

Table 39: Vector Error Correction model with lag of order 4 for Capesize vessels-Long term equation Co-integration equation 3

In first co-integration equation Industrial production and Libor are constrained to zero. In the second co-integration equation Libor remains constrained and Order Book to fleet value. Finally, in the third co-integration equation Industrial production and Scrap are constrained to zero. Second Values in all cases is constrained with coefficient one in order to be the depenant value in the three co-integration models. ***Rejected for a=**

In co-integration 1, the Industrial production and the Libor are constrained to zero. Newbuilding prices have negative impact on Second Hand prices. Thus, New Building prices coefficient is significant and has a negative relation with Second Hand prices by -0,47% on a mild change of New Building prices by 1%. Likewise, the second difference of the Order Book to Fleet ratio is statistically significant, with a negative relation with Second Hand prices by -2,66. In other words, a change of 1% in Order Book to Fleet ratio causes the lowering of Second Hand prices by -2,66%. Similarly, Scrap prices have negative impact on Second Hand prices, changing Second Hand prices by -0,89% on a mild change of 1% on Scrap prices. The Operating profit is suggested to be non-significant, denoting that the Second Hand prices have no long term relation with the freight market. For the first time, in Dry Bulk sector analysis, we notice a negative and statistically significant coefficient of Treasury yields. Treasury yields cause a negative effect on Second Hand prices by -0,64%. Finally, the constant term is not statistically significant.

Moving on to co-integration 2, Libor and Order Book to Fleet ratio variables are constrained to zero. New Building prices are again negative and statistically significant, but this time the effect on Second Hand prices is higher, approaching the -4%, if New Building prices rise by 1% in the long term. In contrast, the Operating profit has positive and significant impact on Second Hand prices. The statistically significant coefficient of the Operating profit suggests that if the Operating profit rises by 1%, it will cause a smooth rise of Second Hand prices by 0,36%. Finally, Treasury yields and Order Book to Fleet ratio are statistically non-significant and the constant term is significant and positive.

The last co-integration equation has the Industrial production and Scrap values constrained to zero. Libor interest has a negative and significant relation with Second Hand prices. If Libor interest rates rise by 1%, they will cause an analogous smooth drop of -0,30%. In the same way, as far as the negative relation with Second Hand prices is concerned, New Building prices will cause a sharp drop of -3,9% in Second Hand prices. The Order Book to Fleet ratio is neglected as non-significant from a statistic point of view. Operating profit and Treasury yields have positive and significant impact on Second Hand prices. More specifically, if the Operating profit rises by 1%, it will cause a rise of Second Hand prices by 0,38%. If there is a same rise in Treasury yields, it will cause a rise of 1,7%. Constant term is significant, with a negative sign.

Summarizing all the above, Newbuilding prices and Second Hand prices are competitive, starting from -0,5% until -3,9%. The Order Book to Fleet ratio has a negative effect on Second Hand prices, which might leads to the conclusion that this market is congested and if the Order Book to Fleet ratio is inclining, consequently, there will be a drop in Second hand prices. Another interesting point is that in the co-integration 1, where the Order Book to Fleet ratio is negative and statistically significant, the Operating profit is non-statistically significant. All the three previous outcomes together suggest that the Capesize market is only affected by the number of vessels in the water and the orders and not by the freight conditions. Off course, this will only take place if the co-integration 1 is appropriate for this model. The Order Book to Fleet ratio for co-integration 2 and 3 is constrained and non-significant. Scrap value has no logical result. Similarly, with regard to Treasury yields, we cannot extract any valuable result.Short term equation will further highlight the dynamic of variables.

6.4.5. VECM model Short term equation

	CointEq1	CointEq2	CointEq3
Coef.	**-0.288301**	*-0.032978	0.083432
S.E.	**(0.07842)**	(0.05418)	(0.06007)
t-stat.	**[-3.67634]**	[-0.60873]	[*1.38889]

Table 40: Vector Error Correction model with lag of order 4 for Capesize vessels- Error Correction Term

***Rejected for a=0,5**

	D(IP)	D(IP)	D(IP)	D(IP)	D(LIBOR)	D(LIBOR)	D(LIBOR)	D(LIBOR)
Lag	**-1**	**-2**	**-3**	**-4**	**-1**	**-2**	**-3**	**-4**
Coef.	* -0.004804	* -0.010458	* 0.011860	*-0.004335	**-0.200323**	* -0.067114	* 0.116890	-0.132564
S.E.	(0.01237)	(0.01194)	(0.01162)	(0.01074)	**(0.06333)**	(0.06441)	(0.06769)	(0.06870)
t-stat.	[-0.38842]	[-0.87572]	[1.02053]	[-0.40357]	**[-3.16313]**	[-1.04199]	[1.72685]	[-1.92967]

	D(OB)	D(OB)	D(OB)	D(OB)	D(NB)	D(NB)	D(NB)	D(NB)
Lag	**-1**	**-2**	**-3**	**-4**	**-1**	**-2**	**-3**	**-4**
Coef.	**-0.773453**	**-0.621448**	* -0.308248	* -0.150545	* -0.085956	*-0.094153	*-0.070051	*-0.258999
S.E.	**(0.21994)**	**(0.22103)**	(0.20316)	(0.14507)	(0.29142)	(0.27765)	(0.28574)	(0.28089)
t-stat.	**[-3.51669]**	**[-2.81157]**	[-1.51726]	[-1.03772]	[-0.29496]	[-0.33910]	[-0.24516]	[-0.92206]

	D(OP)	D(OP)	D(OP)	D(OP)	D(SCRAP)	D(SCRAP)	D(SCRAP)	D(SCRAP)
Lag	**-1**	**-2**	**-3**	**-4**	**-1**	**-2**	**-3**	**-4**
Coef.	**0.230833**	* -0.010903	* 0.058341	* 0.053131	*-0.122624	*-0.064155	* 0.171443	* -0.167581
S.E.	**(0.05309)**	(0.05432)	(0.04965)	(0.05127)	(0.10691)	(0.14310)	(0.14908)	(0.13859)
t-stat.	**[4.34782]**	[-0.20071]	[1.17516]	[1.03635]	[-1.14699]	[-0.44833]	[1.15000]	[-1.20919]

	D(TY)	D(TY)	D(TY)	D(TY)
Lag	-1	-2	-3	-4
Coef.	* -0.221767	* 0.017114	* 0.025223	**-0.340595**
S.E.	(0.15150)	(0.16146)	(0.14444)	**(0.13070)**
t-stat.	[-1.46381]	[0.10599]	[0.17463]	**[-2.60598]**

Table 41: Vector Error Correction model with lag of order 4 for Capesize vessels- Statistics

***Rejected for a=0,5**

R-squared	0.608573
Adj. R-squared	0.462326
Sum sq. resids	0.386041
S.E. equation	0.065132
F-statistic	4.161263
Log likelihood	185.8637
Akaike AIC	-2.39466
Schwarz SC	-1.60681
Mean dependent	0.004439
S.D. dependent	0.088825

Table 42: Vector Error Correction model with lag of order 4 for Capesize vessels- Statistics

***Rejected for a=0,5**

Only the Error Correction term of co-integration 1 is statistically significant. The negative sign establishes the adjusting purpose for a long term equilibrium. Every month, the Second Hand prices are adjusted by 28%, so as to sustain the long run equilibrium.

In the short term period, Libor one month back has negative impact on second hand prices by -0,2% for a rise by 1% in the interest rate. The same happens for Libor four months back, where the ratio is -0,13%. The Order Book to Fleet ratio has again negative relation with the Second Hand prices. A change of the Order Book to Fleet ratio one and two months back causes the drop of Second Hand prices by -0,77% and -0,62%, accordingly. In the short term part of the co-integration equation, we find Operating profit to be positive one month back and with an impact of 0,23%.Regarding the data fitting into the model, R-squared is 61%, which is a good percentage for a VECM.

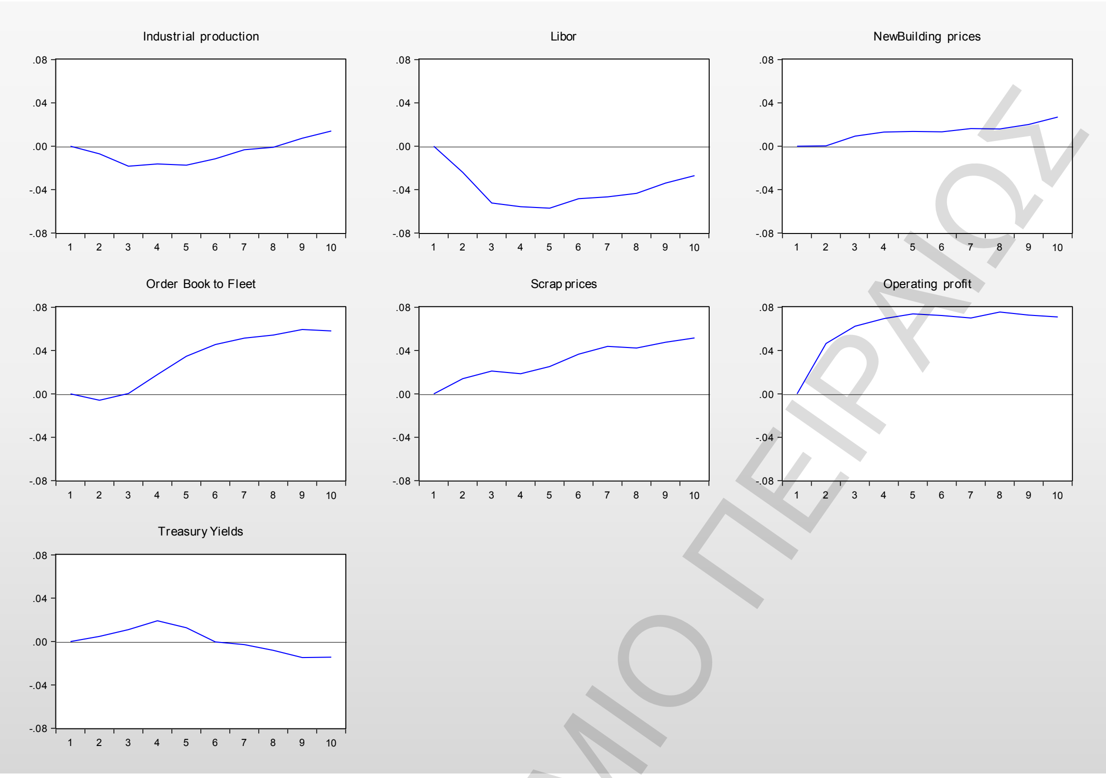
6.4.6. Granger Causality

Dependent variable: D(SHCAPSZ)			
Excluded	Chi-sq	df	Prob.
D(IP)	4.225881	4	0.3763
D(LIBOR)	15.04142	4	* 0.0046
D(NBCAP SZ)	1.113702	4	0.8921
D(OB,2)	13.11668	4	* 0.0107
D(SCRAP CAPSZ)	3.922422	4	0.4166
D(OP)	20.25277	4	* 0.0004
D(TY)	9.965372	4	* 0.0410
All	70.19292	28	*0.0000

Table 43: Granger Causality/Block Exogeneity Tests
***Not Rejected for a=0,5**

Granger cause results suggest that only Libor interest rate, Order Book to Fleet ratio, Operating profit and Treasury Yields Granger cause Second hand prices. However, the Joint test of Error Correction Term suggests that all variables Granger cause Second Hand prices.

6.4.7. Impulse Response



Graph 4.: Impulse response of one Standard Deviation on Second hand prices

The Industrial production impulse response on Second Hand prices does not have any logical explanation. On the other hand, Libor has a dynamic negative effect on Second Hand prices. New Building prices start having effects after the second period and then, they start being positive on prices. The Order Book to Fleet ratio starts with zero effect and then, turns for a short while into negative. Then, Second Hand prices start to incline at high pace. Scrap prices have positive and strong effect. Likewise, the Operating profit has strong and positive effect on Second Hand prices. Finally, Treasury yields do not seem to have any logical sequence on Second Hand prices.

6.4.8. Model Robustness

Lag structure test (Appendices Table 197 and Graph 12) suggest that all the AR roots are inside the unit circle and the Model is stable. Lag exclusion criteria (Appendices Table 199) joint test provides strong results that for statistic significance of 5% all the lags are useful in the model and we reject the hypothesis that all lags are zero in all equations. Portmanteu Autocorrelation (Appendices Table 200) we reject the null hypothesis of autocorrelation for lag orders of 6,8,9 and 10 for statistic significance of 5%, while for the lags of 5 and 7 and 10% significance we reject the null hypothesis. Autocorrelation LM test (Appendices Table 201) suggests that for lag up tp order 6 and lag order 8, 9 and 10 does not exists serial correlation for significance 5%, while in the lag 7, autocorrelation is rejected for 1% statistic significance. Normality test (Appendices Table 202) rejects in all cases the normality of the error term in all significance levels. The diagram of the residuals suggest the existence of a fat tail in the year 2008. Finally, White heteroskedasticity (Appendices Table 162) provides strong results that there is no existence of heteroskedasticity in data Jointly, for statistic significance of 1%

Conclusion

The results did not deviate from our expectations. Small vessels have special characteristics, which are different from those associated with vessels of other sizes. New-building and secondhand vessels prices in the handysize segment are having a positive relation. Furthermore, if there is an upward trend in demand for new building vessels, the prices of secondhand vessels will drastically increase. This is a signal that this segment is not concentrated at these levels and that there is enough space for more cargo capacity to enter the market. Tsolakis, et al. (2003) found that the new-building prices have no effect on secondhand prices in both short-term and long-term periods. However, Tsolakis, et al.'s (2003) empirical results suggest that freight rates have a positive impact of 8%, if the freight rates increase by 10% for yearly observations. Our estimations suggest that, for similar time charter rates, there will be an increase of 57%, but this relates to monthly observations.

The prices of new-building and secondhand medium- to larger-sized vessels are moving in the opposite direction. Concentration in this market exists, but not at very high levels. There is a minor negative percentage change in the medium- to larger-sized vessel prices. Nevertheless, there is room for more capacity, but there is a restraining point that should not be neglected. According to Tsolakis, et al. (2003), new-building prices have a positive effect on secondhand prices for medium- to large-sized vessels, but only in the short run.

The freight market is another major variable in determining secondhand prices. The expectations were that secondhand prices of vessels of all sizes would be affected by the changes in freight markets, as Tsolakis, et al. (2003) results suggest, for the short-term period. However, the results highlighted interesting differences between small- to middle-sized vessels, with larger vessels having no relation with operating profit.

Handysize and Handymax vessels have strong correlations to conditions in the freight market. More specifically, these types of carriers are valuated closely with the market conditions. Handysize vessels have the highest level of dependency on freight market conditions. A change in freight rates or in operating costs will have an important effect on secondhand prices, whereas Handymax prices change in a more moderate way. Small carriers are market-driven. The same results were derived from the work of Tsolakis, et al. (2003) for small- to medium-sized vessels, with Panamax having the strongest relation to freight rates; in contrast with our results were handysize vessels, which related more to changes in freight rates.

It is interesting to note that larger vessels have no relation to the operating profit. If we consider that the valuation process includes the future earnings, and capitalize them according to the value of the vessel, then we might argue that these results are spurious. However, if we consider that these types of vessels handle certain types of cargoes, and that their flexibility is insufficient to allow them to be hired for different or random bulk cargoes, then the results are reasonable. The independency of secondhand prices from operating profits might be a result of the active sale, the purchase market, and the profit earned from these transactions, which might overwhelm the linkage of secondhand prices with the freight market. Nevertheless, the profits from sale and purchase are significantly higher than the operation of the vessel in the long run. A ship owner is interested in acquiring large cargo carriers during the shipping market bottom, and selling them when the market reaches the upper limits. Therefore, the long-term nonsignificant relation between operating profit and secondhand prices actually exists in the long-term period, since the ship owner is expecting a profit from the difference between the purchase price and the resale price. The vessel, in this case, is actually working as an asset.

Results in financial cost expenditures are rather ambiguous. Except for the Capesize vessel, for which only the Treasury yield has a negative effective on secondhand prices, both Libor and Treasury yields for vessels of other sizes are restricted to zero, or they are not significant. Capesize vessels are the more expensive vessels to acquire. The leverage for these vessels is highest in all categories. Only the large shipping companies have the financial resources to acquire these types of vessels and manage the associated financial costs, resulting in a major impact on break-even rates. Shipping cycles suggest that Capesize vessels potentially provide good returns in good freight market conditions, but when the shipping cycle reaches recession lows, these types of vessels are usually laid up, sold in the secondhand market, or scrapped. The financial risk is inevitably elevated in contrast to vessels of other sizes. These results are in constraint with the findings of Tsolakis, et al. (2003), in which all types of vessels Libor was significant, with a negative impact on secondhand prices.

On the other hand, small- to medium-sized vessels have a different financial profile. The acquisition of these types of vessels is affordable from a wide range of shipping companies. The financial risk attached to these ship values is arguably smaller, and a ship owner has the option to maintain the ownership of the vessel even in bad freight conditions.

For these reasons, the significant Treasury yields in the long-term period (only for the Capesize vessels) are absolutely realistic in the shipping market. We would expect the same with respect to the Panamax vessels, but there is a significant difference: A vessel of this size is considered to be the “workhorse” of the shipping industry. Both Capesize and Panamax vessels operate in the same cargo markets, whereas the Panamax ships are more adaptable to different freight conditions. Therefore, in the acquisition decision-making process, the financial cost has a relatively higher weight than that of Capesize vessels.

Finally, scrap price results do not provide any meaningful result in cargoes of all sizes, although in all cases they are significant. The problem arises in the negative effect of scrap prices on secondhand values, which denotes the reduction of secondhand prices, when a rise in scrap prices occurs. In the asset valuation, scrap value is the last outflow that provides a significant return, and if we consider that most of the shipping loans are based on a balloon repayment schedule in which the balloon payment reflects the resale price or the scrap of the vessel, a negative effect has the opposite effect in the ship valuation process. Even if we consider that the scrap price plays a role in the alternative option to scrap the vessel rather than to buy it, the sample that we have used for the secondhand vessels refers to a five-year-old secondhand ship, which has another 20 years of operation potential, and for which the scrap option is considered unrealistic. Based on our results, the noninsertion of scrap values in the Tsolakis, et al. (2003) model might be an optimal decision.

The error correction term provides significant insight into the adjusting process of secondhand vessels in the short term, so as to maintain the long-term equilibrium. A high rate of error correction term reflects a risky market with significant changes in the conditions. Medium- to larger-sized vessels have error correction terms ranging from 20% to 30%, with the Capsize having the highest right of adjustment. On the other hand, the error correction term for handysize vessels is lower than -0.5%. The results clearly state the market conditions, where the small vessels are concentrating the lowest risk, and their ship values are not suffering from tremendous changes in the short- and long-term periods. Provided that vessel prices remain stable, they are surely a safe investment with moderate risk…but with moderate returns, as well.

Conversely, the change in ship size from medium to large adds additional risk, which is reflected in the ship values. However, the higher risk contributes to higher operating profits in good markets. In addition, if we apply the results to the shipping cycle theory, an investment in medium- to large-sized vessels during a market bottom will undoubtedly provide higher returns if the vessel is sold during market peaks.

A causality test confirmed the previous results: In vessels of all sizes, all the variables used are instrumental in causing the ship prices. The causality test applies only to the long- term period, and, definitely, an analogous test for the short term could provide more detailed results with respect to the causality of the variables inserted in this model on secondhand prices. Finally, the impulse response proves not to produce substantial results, except in minor cases. In reality, this is meaningful, since the model is more complex than the impulse response test.

	Handysize	Handymax	Panamax	Capesize
Second Hand prices	1	1	1	1
New building Prices	31.75	-0.94	-0.85	-0.47
Operating profit	5.78	0.52	*-0.06	*0.01
Scrap prices	-28.28	-1.95	-0.67	-0.89
Order book /Fleet	0	0.44	-	-2.66
Libor	0	0	0	0
U.S. T-Bond yields	-10.6	*-0.22	*0.01	-0.64
Industrial Production	1.57	0	0	0
Error Correction Term	-0.01	-0.2	-0.23	-0.28
R-sq	0.33	0.55	0.66	0.6

Table 44: Summary of long term equation results

***Non-significant**

Table 44 provides the summary of long term equation results. New building prices have a negative relation with the second hand prices for Handymax, Panamax and Capesize vessels. In terms of elasticity, Handymax and Panamax new building prices are close to unit elasticity with the second hand prices. Capesize vessels new building prices have a negative elasticity with second hand prices 47%. More specific, a new building prices increase leads to a decrease on second hand prices by half in the long term period. Handymax and Panamax vessels second hand prices are more sensitive to changes in new building prices. Handysize second hand prices are more sensitive in new building prices, in such levels that we might consider that the results suffer from biasedness. Maybe, the error correction model applied in Handysize data, did not adjust in any outlier. However, the positive relation of new building and second hand prices is a fact and provides information about the market conditions in Handysize vessels.

This extraordinary sensitivity of Handysize vessel equation is a visible fact in most variables. As we have already describe above, Handysize vessels or small to medium size vessels are closer to trade conditions and are more adoptable in changes. An evident fact of this close relation with trade conditions of Handysize vessels is the relation of Industrial production and second hand prices, which is significant and positive. Additionally operating profit coefficient has a strong positive impact on second hand prices of Handysize vessel. The rest types of vessel do not have any relation with industrial production. If we link the long term sensitivity with the small error correction term we might consider that second hand prices and new building prices of second hand vessels are a conservative investment, with only long term fluctuations. The estimated models for the rest of the vessels are sensitive in the short period, where the error correction term causes drastic fluctuations in prices in order to have a long term equilibrium.

Apparently the estimated models suffer in terms of predictability. R-square levels start from 33% for Handysize vessels and elevates to 66% for Capesize vessels. Therefore, any forecasting scenario might not provide the best results. Apparently, the model behavior would be different if we have added more lagged variables in the model in the lag length test. As we have already discussed, we had to consider the option to omit forecastability of the model over the good diagnostic of the data. For that reason, we avoided an overparameterized model and we focus more on an empirical diagnostic model. Any comparison of this VECM model predictability with a model more sensitive to volatility will surely reflect this intentional drawback.

Chapter 7

7.1. Conclusion

The intention of this research was to construct a valuation model based on various endogenous and exogenous variables from the shipping market, the economy, and the finance market. A unique characteristic of this research is the econometric methodology that was used, which is ultimately a turnover in valuation models of vessels. The co-integration methodology of higher rank has never before been used in shipping valuations. Though multiparametric models can easily lead to spurious results, the outcomes of this valuation model managed to re-establish the co-integration of various shipping factors, as previous researches describe (Veenstra, 1999; Tsolakis, et al., 2003; Jane Jing Xu, et al., 2011).

For the first time, a multiparametric model has been constructed that includes the operating profit and the margin of loans. The addition of these two variables gives a characteristic linkage between finance and the valuation process. The operating profit is calculated after deducting the operating cost of the vessel from the time charter rate. On the other hand, margin data are difficult to be maintained, since they constitute disclosed information of the financial institutes. For that reason, we prefer the inclusion of a free risk rate, which is the yield of 10-year T-bond bills, as the bank margin.

From the outcomes of the model, we can derive that it might not be the optimum choice to include the 10-year T-bond as a margin, but that it is closer to the cost of the bank to maintain a loan facility, instead of investing its money in an alternative free risk rate. As mentioned earlier, the results from the introduction of the 10-year T-bond treasury yields in the valuation process were rather poor. If the same result did not occur for the Libor interest, some would suggest that this variable is not significant in the model. However, both Libor and 10-year T-bonds, in most in cases, have no significant relation to secondhand prices. One important aspect of this outcome might be that, when the valuation includes market terms, the vessel price is not related, in any case, to the finance needs of the ship owner. The finance part of the acquisition of the vessel is maintained in a stage different from that of determining the optimal price of a secondhand vessel.

During the period investigated, the financial sector was facing strong liquidity. There was a continuous reduction of U.S. government interest rates, which were dragging the interbank rates down. Following the government interest rates, interbank interest rates were reaching the lowest prices in years. More specifically, the three-month Libor reached a low of 0.2491% in this period. Similarly, Treasury bond yields were moving downward throughout the entire period, to reach 2.42%.

The financial sector had excessive liquidity, which wanted to invest it in order to generate profits. The shipping sector was an industry that started to provide tremendous profits, and the return in investments in shipping followed the general prosperity in trading and finance. Therefore, financial institutions, providing easy and fast liquidity, experienced a drastic entrance into the shipping sector. Several banks started to create shipping loan portfolios, though they did not have any past business with the shipping sector. With this move of banks into ship finance, they started to implement competitive loan criteria, providing loan facilities with very small marginal costs. At this time, the impact of marginal costs in ship valuation was insignificant. Ship owners were more interested in the profit expected to result from the operation of the vessel, which, at times, was sufficient to repay the loan facility within a very short period. In several cases, there were prospective ship owners who had no experience with the shipping culture or any significant profile in the bank sector, but who nevertheless managed to obtain large amounts for shipping loans, without the banks reducing their risk by inserting high marginal costs.The above discussion might be a good explanation as to why, in this research, the finance cost is rather insignificant in most cases, whereas in similar works, such as Tsolakis, et al. (2003), Libor interest is important in valuation with negative effect on ship prices.

Market analysis, along with the past literature review, provides significant results about the major factors of the shipping industry. Several diversified vessels, freight rates, and economic variables have been used in the previous research. The result was the definition of the positive and negative effects of all these variables, as well as the isolation of only the most important models concerning the valuation. Another conclusion derived from the literature review is the plethora of statistic and econometric methodologies and different results provided by univariate and multivariate models. We managed to locate the gap in the multiparametric models, as far as co-integration is concerned. Though co-integration has appeared in several previous researches, VECMs for higher rank of co-integration are absent. Furthermore, the multiparametric models, which were abandoned for a significant period of time, in conjunction with vector error correction methodology, as also suggested by Pruyn, et al. (2011), was not included in discussions of further research in the literature.

The next step of this research was to focus on the econometric methodology that was applied in the model and to the data. The unit root effect on data is something that is neglected in a major part of the literature review. This effect is common in time series, especially in volatile markets, which is characteristic of the shipping market. Therefore, if the time series suffered from the unit root problem, there was a core problem concerning the estimation using simple linear models. This was a reason for considering many researches that attempted to identify the volatility and create models based on this characteristic. For security reasons, time series were tested with three different models having different characteristics, restrictions, and advantages. The next step was the construction of a vector autoregressive model to identify the optimum lag. The optimum lag is always subject to the researcher, the characteristics he wants to include, and the purpose of the model. After several iterations and the use of the Pantula (1989) methodology, which is designed for unit root tests, but which is also helpful for identification of the best VECM and the number of ranks, a final model was constructed. The VECM also had to be tested for residual and stability problems. In addition to this methodology, two complementary methodologies were applied to the data to determine the causation relation of the variables. The model specification is robust for the four types of vessels, which further strengthens the assumption of co-integration of the major shipping factors.

The outcomes of the results suggest that the decomposition of the operation of the market and the specialization of certain finance tools, such as the incorporation of the operating profit instead of the gross charter rate, can enhance the valuation process. The operating profit was significant in most cases, with different weights in the secondhand prices for vessels of different sizes. Market-driven vessel sizes are the best solution for the period, when the market is fruitful and the operation of large carriers is likely to provide significant income to the company. The larger-sized vessels are a risky investment for the ship owner, but the earnings are significantly higher when the market is going well. Furthermore, the resale value of the vessel during a market peak provides excessive profits in the cases of larger-sized vessels, while, in the case of small-sized vessels, the profit is always conservative.

Scrap value is not considered to be a key factor in vessel valuation, because the secondhand size vessels prices used in this model are only for five-year-old vessels, which still have about 20 years of operation potential. Considering the long period of time prior to the disposal of the vessel, the ship owner valuates the vessel based only on the resale price of the asset. When the market starts to reach a peak, or if market conditions worsen, there is still a resale value that is surely larger than scrap value. Only in those periods in which the market is in deep recession and the cost of lay-up of the vessel is considered unaffordable does the ship owner have to reevaluate the decision to maintain the vessel at any cost and sell for scrap. The number of cases in which this has occurred for a five-year-old vessel is limited.

To easily identify the core variables, which define the valuation of a vessel, it is important to describe the structure of the shipping market. The shipping sector can be separated into four distinctive interconnected and interrelated markets. Each market has special characteristics and different parameters, which change the trend and conditions. Classification can be based on operation, cargo, types of vessels, and even on the chartering policy. Aside from classification, it is useful to describe the conditions in these markets with respect to the last decade and how they shaped the face of the shipping sector. The outcome of this analysis is a classification arrived at by combining the operation, the type of shipment and the type of vessel, and the gathering of all the major variables of our evaluation model. Iron ore and coal carried by large-sized vessels are commodities that are used in the construction. Therefore, economic growth cannot be sustained with the use of iron ore and, generally, steel production. Small- to medium-sized vessels can be described as the carriers of goods that are intended for the daily use of an economy. Our results provide substantial indications for the different types of cargoes carried by vessels of different size.

Additionally, small-sized vessels provide the safest harbor for an investment because, in this category, the fluctuations in market conditions are smoother

(Kavussanos, 1996). Conversely, this lack of volatility combined with the lesser risk of this investment has reduced earnings during market peaks, but it most definitely pays off during market lows (Glen, et al. 1998). Additionally, the complementary relation of new-building and secondhand vessel prices results in a major decision dilemma for the ship owner. The prices of both new-building and secondhand vessels are connected to freight market conditions. This outcome is very close to the real conditions of the shipping market (Strandeness, 1984).

The risk associated with an expensive investment provides radically more returns if the market conditions are good. As expected, the prices of new-building and secondhand vessels work in an antagonistic manner. Freight markets do not prove to have significant effects on secondhand markets, and this is more intensive as far as the large-sized vessels are concerned. Capital expenditures based on the results of this model are insignificant in most cases, except for those relating to the larger-sized vessels, e.g., Capesize.

7.2. Managerial implications

Ship owners are rather conservative in their valuations methodologies. The methodologies used do not slip from traditional linear models and discounted cash flows. The changes in the shipping sector are not included in their valuation models; actually, they do not leave any room for the insertion of externalities in their valuation procedures…they do it in a later stage, without the use of any financial methodology. They maintain these "feelings'' concerning the market by being continuously informed about the vessel fixtures, the prices in sale, and the purchase of secondhand and new- building vessels. Every ship owner has an opinion for each different segment of shipping, but a few maintain a fleet for both dry and liquid bulk vessels. The diversification of a fleet is difficult, and it is usually achieved only by experienced ship owners.

Additionally, the ship owners usually purchase valuations from professional valuators and brokering houses. This convenience provided by the professional valuators is expensive, because a ship owner usually inspects more than several vessels before deciding in which vessel to invest. Furthermore, no valuator or ship broking firm has ever provided the valuation model and the accuracy of the methods used. If we add discrepancies in valuation prices of different ship broking firms for the same vessel, then it is easy to derive the cautious stance of ship owner to the professional ship-broking valuation results.

This valuation model provides adequate information for future acquisition of a vessel. It can provide the ship owner with useful information about the long-term conditions in the shipping market. In addition, it can be used for the estimation of a future change in shipping market conditions, which is a powerful tool in the decision process. Moreover, the risk calculated for each size of vessel can give systematic information about which size of vessel is a better investment, depending on the shipping market conditions.

The estimation of this model might be difficult to be applied by the leaders of a shipping company. However, it can be a basis for the future construction of software that will provide easier, cheaper, and more transparent valuations. This can be an alternative tool to use against the prices provided by valuators.

Finally, the market results suggest that the experience of the ship owner is an effective qualification in the investment decision process. Ship owners, surely, have a more accurate opinion than any valuation methodology about the price of a vessel, because they manage to focus on certain criteria that cannot be compiled in any valuation model. However, additional information provided by our valuation might be a better combination for effective investment planning.

7.3. Limitations

The data existing in the shipping market are very few, considering the heritage of this industry. In most cases, existing data are of high frequency, with major gaps in certain periods. Furthermore, the data bases in electronic form start to provide more detailed data beginning with the year 2000, and on. Another flaw in data is the continuous modernization of the vessels, which has, as an effect, vessels of different capacities. For that reason, it is very difficult to have data for a certain capacity vessel for continuous years. In this case, you have to maintain an average value for an average-capacity vessel or to combine the data series of vessels with similar capacity sizes.

The use of dummy variables can provide significant results for externalities in data. However, it might cause serious problems in various statistics properties. For that reason, this research did not incorporate any dummy variables in data, though some believe that an externality existed in the year 2008, which was linked with the subprime crisis and the financial instability of this period.

VECMs can provide meaningful results for the relations between the variables. However, there are atheoretical models, which have limitations, that describe and predict the behavior of a situation. Though many researchers apply this methodology, the results are too often ambiguous and must be treated carefully when they are used to explain any theory.

The variables used in this model describe the long-term part of the operation of the vessel. There are several micro variables, such as bunkers, port expenses, and trading routes that could prove to be meaningful in the valuation of a secondhand vessel. If we add all these parameters, the usage of a VECM would not be possible, because it would create an overparameterized model that is difficult to handle.

The statistic packages have limitations in the estimation process and the later stability test of the model. VECM are rather new in economic analysis, and the software packages have not yet managed to incorporate all the prolific characteristics of this methodology.

Moreover, if there were available financial data for the marginal cost of loan facilities from various financial institutions or maybe an average marginal cost, this information would significantly help in the valuation of different types of vessels and companies.

7.4. Recommendations for further work

This model concentrated only on one part of the shipping sector, the dry bulk carriers. Following some additions and modifications, it can be easily applied in additional sectors. Definitely, the liquid bulk sector would be a perfect candidate for future research; LNG carriers would also be good candidates, but not containerships, which have a different type of operation.

The number of data providers has expanded in the last decade, and the data collections are significantly larger than those from previous years. The application of this model to future data will provide more elements concerning this valuation model's suitability in the dry bulk sector. Furthermore, the ship-size categories used in this model are only the major ones. There are several ship-size categories, but there were not enough data to apply this valuation model. Currently, the data sets are full and cover various ship-size categories.

Since more shipping companies are seeking liquidity in stock markets through public offerings or corporate bonds, a parameter of this variable in a future valuation model might provide qualifying results. The use of such a variable might solve the dilemma of a ship owner decision to use liquidity from financial institutions versus the markets.

Finally, volatility in data is a major problem that can be addressed with different statistic models rather than with VECMs: vector error correction models with structural points, like SVECM.

Appendices

Chapter 1

Dry Bulk	Ticker	Stock Market	Listing Date
Baltic Trading Ltd	BALT	NYSE	2010
Diana Shipping Inc	DSX	NYSE	2005
DryShips Inc	DRYS	NASDAQ	2005
Eagle Bulk Shipping Inc	EGLE	NASDAQ	2005
Excel Maritime Carriers	EXM	NYSE	2007
FreeSeas Inc	FREE	NASDAQ	2005
Hellenic Carriers LTD	HCL	AIM	2007
Genco Shipping	GNK	NASDAQ	2005
Globus Maritime	GLBS	AIM*	2007
Navios Maritime Hldgs	NM	NYSE	2008
Navios Maritime Ptns	NMM	NYSE	2007
OceanFreight Inc	OCNF	NASDAQ	2007
Paragon Shipping Inc	PRGN	NASDAQ*	2007
Safe Bulkers Inc	SB	NYSE	2008
Seanergy Maritime Hldg	SHIP	NASDAQ	2007
Star Bulk Carriers Corp	SBLK	NASDAQ	2005
TBS International PLC	TBSI	NASDAQ	2005
Tankers	**Ticker**	**Stock Market**	**Listing Date**
Aegean Marine Petrol	ANW	NYSE	2006
Capital Product Ptns	CPLP	NASDAQ	2007
Crude Carriers Corp	CRU	NYSE	2010
DHT Holdings Inc	DHT	NYSE	2005
Frontline Ltd	FRO	NYSE/OSLO**	2001
General Maritime Corp	GMR	NYSE	2001
Navios Maritime Acq.	NNA	NYSE	2008
Nordic American Tanker	NAT	NYSE	Prior to 2000
Omega Navigation Ent.	ONAV	NASDAQ	2006
Overseas Shipholding	OSG	NYSE	2007
Scorpio Tankers Inc	STNG	NYSE	2010
Teekay Corp	TK	NYSE	2007
Teekay Offshore Ptns	TOO	NYSE	2006
Teekay Tankers Ltd	TNK	NYSE	2007
Torm A/S	TRMD	NASDAQ	2004
Tsakos Energy Nav.	TNP	NYSE/OSLO**	2002
Containers Ticker Current	**Ticker**	**Stock Market**	**Listing Date**
Alexander & Baldwin	ALEX	NYSE	Prior to 2000
Costamare Inc	CMRE	NYSE	2010
Danaos Corp	DAC	NYSE	2006
Diana Containerships	DCIX	NASDAQ	2010
Global Ship Lease Inc	GSL	NYSE	2008
Horizon Lines Inc	HRZ	NYSE	2005
Seaspan Corp	SSW	NYSE	2005
LNG/LPG Ticker Current	**Ticker**	**Stock Market**	**Listing Date**
Golar LNG Ltd	GLNG	NASDAQ	2005
Golar LNG Partners LP	GMLP	NASDAQ	2005
StealthGas Inc	GASS	NASDAQ	2005
Teekay LNG Partners	TGP	NYSE	2005
Mixed Fleet Ticker Current	**Ticker**	**Stock Market**	**Listing Date**
B+H Ocean Carriers Ltd	BHO	AMEX/OSLO**	Prior to 2000
Euroseas Ltd	ESEA	NASDAQ	2006
Goldenport Holdings	GPRT	LSE	2005
Knightsbridge Tankers	VLCCF	NASDAQ	Prior to 2000
NewLead Holdings Ltd	NEWL	NASDAQ	2005
Ship Finance Intl	SFL	NYSE	2004
Top Ships Inc	TOPS	NASDAQ	2004

Table 45: Listed shipping Companies in USA and UK

***Listed to another market**
****Dual Listed**
Data Source: www.nasdaq.com/www.investopedia.com/www.sec.gov/www.londonstockexchange.com

Chapter 5

Table 46: Dry Bulk Data

	Handysize Vessel	**Units**	**Obs.**	**Period**	**No.Obs.**	**Source**
1	Newbuilding	Millions	Monthly	01/2000-12/2010	132	Clarksons
2	Second Hand Vessel	Millions	Monthly	01/2000-12/2010	132	Clarksons
3	1 year Time Charter Rate	Thousand	Monthly	01/2000-12/2010	132	Clarksons
4	Scrap Value	Millions	Monthly	01/2000-12/2010	132	Clarksons
5	Operating Cost	Thousand	Yearly/day	2000-2010	10	Drewry
6	Fleet Development	Number	Monthly	01/2000-12/2010	132	Clarksons
7	Order Book	Number	Monthly	01/2000-12/2010	132	Clarksons
	Handymax Vessel	**Units**	**Obs.**	**Period**	**No.Obs.**	**Source**
1	Newbuilding	Millions	Monthly	01/2000-12/2010	132	Clarksons
2	Second Hand Vessel	Millions	Monthly	01/2000-12/2010	132	Clarksons
3	1 year Time Charter Rate	Thousand	Monthly	01/2000-12/2010	132	Clarksons
4	Scrap Value	Millions	Monthly	01/2000-12/2010	132	Clarksons
5	Operating Cost	Thousand	Yearly/day	2000-2010	10	Drewry
6	Fleet Development	Number	Monthly	01/2000-12/2010	132	Clarksons
7	Order Book	Number	Monthly	01/2000-12/2010	132	Clarksons
	Panamax Vessel	**Units**	**Obs.**	**Period**	**No.Obs.**	**Source**
1	Newbuilding	Millions	Monthly	01/2000-12/2010	132	Clarksons
2	Second Hand Vessel	Millions	Monthly	01/2000-12/2010	132	Clarksons
3	1 year Time Charter Rate	Thousand	Monthly	01/2000-12/2010	132	Clarksons
4	Scrap Value	Millions	Monthly	01/2000-12/2010	132	Clarksons
5	Operating Cost	Thousand	Yearly/day	2000-2010	10	Drewry
6	Fleet Development	Number	Monthly	01/2000-12/2010	132	Clarksons
7	Order Book	Number	Monthly	01/2000-12/2010	132	Clarksons
	Capesize Vessel	**Units**	**Obs.**	**Period**	**No.Obs.**	**Source**
1	Newbuilding	Millions	Monthly	01/2000-12/2010	132	Clarksons
2	Second Hand Vessel	Millions	Monthly	01/2000-12/2010	132	Clarksons
3	1 year Time Charter Rate	Thousand	Monthly	01/2000-12/2010	132	Clarksons
4	Scrap Value	Millions	Monthly	01/2000-12/2010	132	Clarksons
5	Operating Cost	Thousand	Yearly/day	2000-2010	10	Drewry
6	Fleet Development	Number	Monthly	01/2000-12/2010	132	Clarksons
7	Order Book	Number	Monthly	01/2000-12/2010	132	Clarksons

Table 47: Macroeconomic Data

		Units	**Obs.**	**Period**	**No.Obs.**	**Source**
1	IP	Rate	Monthly	10/2001-12/2010	132	Clarksons
2	3 Month Libor	Rate	Monthly	01/2001-12/2010	132	BBA
3	10 year Treasury Yields	Rate	Monthly	01/2000-12/2010	132	FED

Chapter 6

Stationarity Test Handysize Vessels

ADF outcomes

Table 48:Levels New Building Prices

Null Hypothesis: New Building Prices has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.994661	0.9403
Test critical values:	1% level	-4.030729	
	5% level	-3.445030	
	10% level	-3.147382	

Non stationary for statistic significance a=0,05

Table 49:First Difference New Building Prices

Null Hypothesis: D(New Building Prices) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.051273	0.0003
Test critical values:	1% level	-4.030729	
	5% level	-3.445030	
	10% level	-3.147382	

Stationary for statistic significance a=0,05

Table 50:Levels Second Hand Prices

Null Hypothesis: Second Hand Prices has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.766611	0.7153
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Non stationary for statistic significance a=0,05

Table 51:First Difference Second Hand Prices

Null Hypothesis: : Second Hand Prices has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.104364	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 52:Levels Operating Profit

Null Hypothesis: Operating Profit has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.438331	0.3583
Test critical values:	1% level	-4.030729	
	5% level	-3.445030	
	10% level	-3.147382	

Non stationary for statistic significance a=0,05

Table 53:First Difference Operating Profit

Null Hypothesis: D(Operating Profit) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.062930	0.0000
Test critical values:	1% level	-4.030729	
	5% level	-3.445030	
	10% level	-3.147382	

Stationary for statistic significance a=0,05

Table 54:Levels Scrap Value

Null Hypothesis: Scrap Value has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.343229	0.4076
Test critical values:	1% level	-4.029595	
	5% level	-3.444487	
	10% level	-3.147063	

Non stationary for statistic significance a=0,05

Table 55:First Difference Scrap Value

Null Hypothesis: D(Scrap Value) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.20670	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 56:Levels Order Book/Fleet

Null Hypothesis: Order Book/ Fleet has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.527267	0.8152
Test critical values:	1% level	-4.031309	
	5% level	-3.445308	
	10% level	-3.147545	

Non stationary for statistic significance a=0,05

Table 57:First Difference Order Book/Fleet

Null Hypothesis: D(Order Book/ Fleet) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.407348	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

PP outcomes

Table 58:Levels New Building Prices

Null Hypothesis: New Building Prices has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.814552	0.9609
Test critical values:	1% level	-4.029595	
	5% level	-3.444487	
	10% level	-3.147063	

Non stationary for statistic significance a=0,05

Table 59:First Difference New Building Prices

Null Hypothesis: D(New Building Prices) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-8.288971	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 60:Levels Second Hand Prices

Null Hypothesis: Second Hand Prices has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.631038	0.7755
Test critical values:	1% level	-4.029595	
	5% level	-3.444487	
	10% level	-3.147063	

Non stationary for statistic significance a=0,05

Table 61:First Difference Second Hand Prices

Null Hypothesis: D(Second Hand Prices) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-8.133932	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 62:Levels Operating Profit

Null Hypothesis: Operating Profit has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.549649	0.8072
Test critical values:	1% level	-4.029595	
	5% level	-3.444487	
	10% level	-3.147063	

Non stationary for statistic significance a=0,05

Table 63:First Difference Operating Profit

Null Hypothesis: D(Operating Profit) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 23 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.727509	0.0010
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 64:Levels Scrap Value

Null Hypothesis: Scrap Value has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.284013	0.4393
Test critical values:	1% level	-4.029595	
	5% level	-3.444487	
	10% level	-3.147063	

Non stationary for statistic significance a=0,05

Table 65:First Difference Scrap Value

Null Hypothesis: D(Scrap Value) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-12.20661	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 66:Levels Order Book/Fleet

Null Hypothesis: Order Book /Fleet has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.370084	0.8653
Test critical values:	1% level	-4.029595	
	5% level	-3.444487	
	10% level	-3.147063	

Non stationary for statistic significance a=0,05

Table 67:First Difference Order Book/Fleet

Null Hypothesis: D(Order Book /Fleet) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-9.196517	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

KPSS outcomes

Table 68:Levels New Building Prices

Null Hypothesis: New Building Prices is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.216170
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Non stationary for statistic significance a=0,05

Table 69:First Difference New Building Prices

Null Hypothesis: D(New Building Prices) is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.161839
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Stationary for statistic significance a=0,05

Table 70:Levels Second Hand Prices

Null Hypothesis: Second Hand Prices is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.186428
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Non stationary for statistic significance a=0,05

Table 71:First Difference Second Hand Prices

Null Hypothesis: D(Second Hand Prices) is stationary		
Exogenous: Constant, Linear Trend		
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel		
		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.081711
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Stationary for statistic significance a=0,05

Table 72:Levels Operating Profit

Null Hypothesis: Operating Profit is stationary		
Exogenous: Constant, Linear Trend		
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel		
		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.168876
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Non stationary for statistic significance a=0,05

Table 73:First Difference Operating Profit

Null Hypothesis: D(Operating Profit) is stationary		
Exogenous: Constant, Linear Trend		
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel		
		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.045848
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Stationary for statistic significance a=0,05

Table 74:Levels Scrap Value

Null Hypothesis: Scrap Value is stationary		
Exogenous: Constant, Linear Trend		
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel		
		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.201288
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Non stationary for statistic significance a=0,05

Table 75:First Difference Scrap Value

Null Hypothesis: D(Scrap Value) is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.044581
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Stationary for statistic significance a=0,05

Table 76:Levels Order Book/Fleet

Null Hypothesis: Order Book /Fleet is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.198107
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Non stationary for statistic significance a=0,05

Table 77:First Difference Order Book/Fleet

Null Hypothesis: D(Order Book /Fleet) is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.215728
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Stationary for statistic significance a=0,05

VECM Model estimation process

Table 78:Lag Length Criteria

Lag No.	AIC	SC	HQ
0	1.19	1.37	1.26
1	*-16.72	*-15.06	*-16.05
2	*-17.36	-14.24	*-16.09
3	*-17.44	-12.85	-15.58
4	*-17.45	-11.38	-14.98
5	-17.44	-9.90	-14.38
6	-17.25	-8.24	-13.59
7	-17.38	-6.90	-13.12
8	-17.48	-5.53	-12.62
9	-17.74	-4.32	-12.29
10	*-18.72	-3.83	-12.67

Lag Length Criteria Handysize Vessel
***Suggested lag length**

Table 79:VECM model Long term Equation

	(SH)	(IP)	(LIBOR)	(NB)	(OB)	(SCRAP)	(OP)	(TY)	TREND(00 M01)
Lag	-1	-1	-1	-1	-1	-1	-1	-1	-1
Coef.	1	0	0	*-1.596042	-1.201084	-3.02487	2.603813	* 0.466033	0.024923
S.E.				(0.83748)	(0.36669)	(0.49432)	(0.30608)	(0.73583)	(0.00978)
t-stat.				[-1.90578]	[-3.27543]	[-6.11922]	[8.50705]	[0.63334]	[2.54852]

	C
Lag	0
Coef.	-24.17445
S.E.	
t-stat.	

Vector Error Correction model with lag of order 2 for Handysize vessels-Long term equation Co-integration equation 1
*Rejected for a=0,5

	(SH)	(IP)	(LIBOR)	(NB)	(OB)	(SCRAP)	(OP)	(TY)	TREND(00 M01)
Lag	-1	-1	-1	-1	-1	-1	-1	-1	-1
Coef.	1	1.573024	0	31.75554	0	-28.28654	5.789714	-10.60166	-0.073013
S.E.		(0.57600)		(5.16976)		(5.47457)	(2.31285)	(4.39319)	(0.03701)
t-stat.		[2.73094]		[6.14256]		[-5.16690]	[2.50329]	[-2.41320]	[-1.97295]

	C
Lag	0
Coef.	-111.1484
S.E.	
t-stat.	

Vector Error Correction model with lag of order 2 for Handysize vessels-Long term equation Co-integration equation 2
*Rejected for a=0,5

	(SH)	(IP)	(LIBOR)	(NB)	(OB)	(SCRAP)	(OP)	(TY)	TREND(00 M01)
Lag	-1	-1	-1	-1	-1	-1	-1	-1	-1
Coef.	1	0	-0.19054	*-0.280991	-0.305482	0	*-0.010604	0.533824	*-0.001477
S.E.			(0.02970)	(0.22065)	(0.07881)		(0.05718)	(0.16909)	(0.00224)
t-stat.			[-6.41445]	[-1.27347]	[-3.87595]		[-0.18547]	[3.15697]	[-0.66035]

	C
Lag	0
Coef.	-3.282941
S.E.	
t-stat.	

Vector Error Correction model with lag of order 2 for Handysize vessels-Long term equation Co-integration equation 3
*Rejected for a=0,5

Table 80:VECM model Short term equation

	CointEq1	CointEq2	CointEq2
Coef.	0.046387	-0.004879	-0.261598
S.E.	(0.01896)	(0.00227)	(0.10135)
t-stat.	[2.44680]	[-2.15351]	[-2.58112]

Vector Error Correction model with lag of order 2 for Handysize vessels- Error Correction Term
*Rejected for a=0,5

	D(IP)	D(IP)	D(LIBOR)	D(LIBOR)	D(NB)	D(NB)	D(OB)	D(OB)	D(SCRAP)
Lag	**-1**	**-2**	**-1**	**-2**	**-1**	**-2**	**-1**	**-2**	**-1**
Coef.	*-0.004294	*-0.016463	**-0.145492**	* 0.004765	*-0.094434	* 0.127980	* 0.286950	*0.134052	*0.028052
S.E.	(0.00949)	(0.00954)	**(0.05839)**	(0.06213)	(0.30815)	(0.30639)	(0.16388)	(0.16670)	(0.10081)
t-stat.	[-0.45240]	[-1.72497]	**[-2.49163]**	[0.07670]	[-0.30645]	[0.41770]	[1.75102]	[0.80416]	[0.27826]

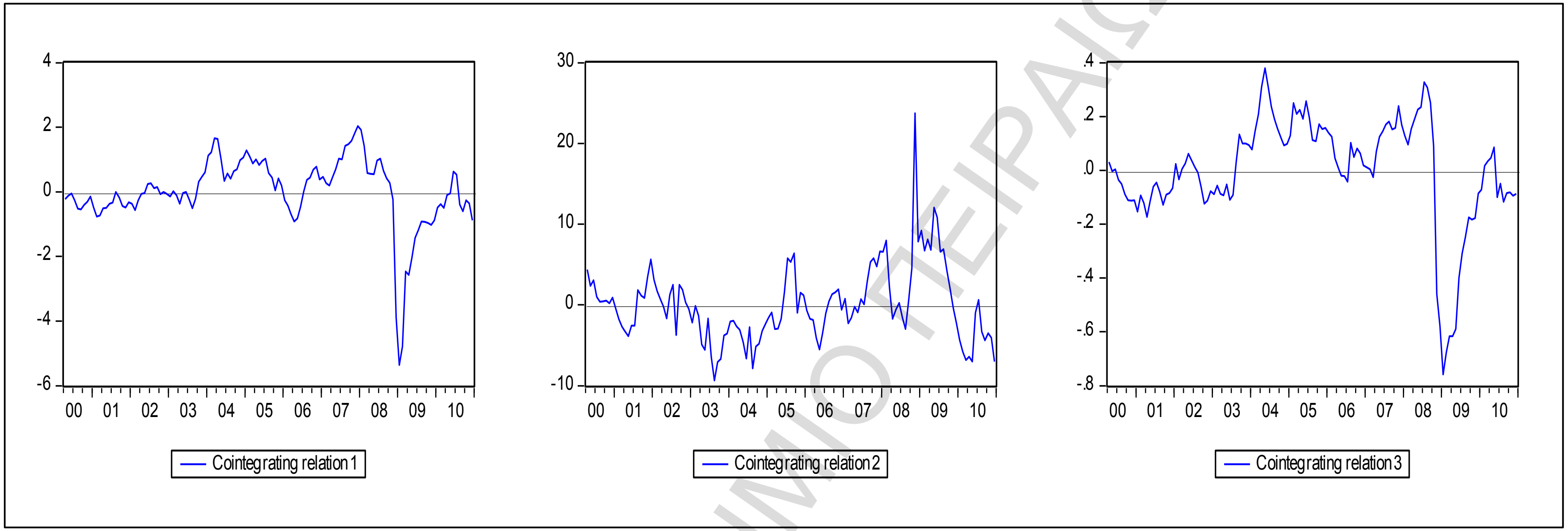
	D(SCRAP)	D(OP)	D(OP)	D(SH)	D(SH)	D(TY)	D(TY)	C
Lag	**-1**	**-2**	**-1**	**-2**	**-1**	**-2**	**-1**	**-2**
Coef.	*0.075125	* 0.083870	*-0.101707	* 0.199862	*-0.02091	* 0.067711	**0.242616**	*-0.004134
S.E.	(0.08727)	(0.06075)	(0.05947)	(0.15504)	(0.15703)	(0.12249)	**(0.10589)**	(0.00725)
t-stat.	[0.86081]	[1.38057]	[-1.71022]	[1.28906]	[-0.13316]	[0.55277]	**[2.29120]**	[-0.56993]

Vector Error Correction model with lag of order 2 for Handysize vessels- Short term equation

*Rejected for a=0,5

R-squared	0.335122
Adj. R-squared	0.219226
Sum sq. resids	0.465725
S.E. equation	0.065366
F-statistic	2.891571
Log likelihood	179.7031
Akaike AIC	-2.47602
Schwarz SC	-2.03264
Mean dependent	0.005690
S.D. dependent	0.073976

Graph 5:Co-integration Equation Graph VECM for lag 2 and 5% statistical Significance



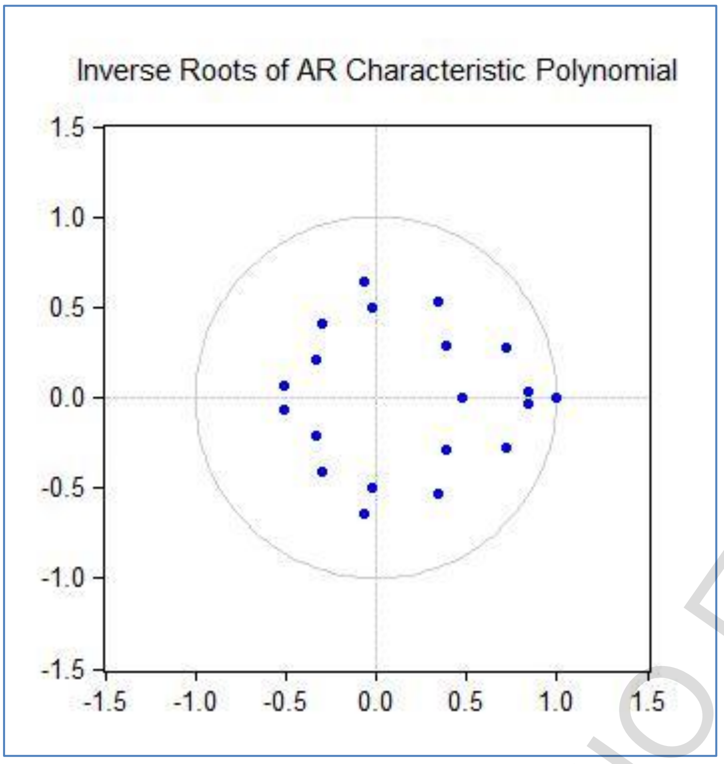
Lag Structure Test

Table 81:AR Roots table- VECM for lag 2 and 5% statistical Significance

Roots of Characteristic Polynomial	
Endogenous variables: IP LIBOR NBHNDSZ OB SCRAPHNDSZ TCHNDSZ SHHNDSZ TY	
Exogenous variables:	None
Lag specification: 1 2	
Root	**Modulus**
1	1
1	1
1	1
1.000000 - 2.21e-15i	1
1.000000 + 2.21e-15i	1
0.845308 - 0.031353i	0.84589
0.845308 + 0.031353i	0.84589
0.715542 - 0.278876i	0.767967
0.715542 + 0.278876i	0.767967
-0.067876 + 0.636936i	0.640542
-0.067876 - 0.636936i	0.640542
0.342362 + 0.534179i	0.634475
0.342362 - 0.534179i	0.634475
-0.513234 - 0.067020i	0.517591
-0.513234 + 0.067020i	0.517591
-0.296897 - 0.405498i	0.50257
-0.296897 + 0.405498i	0.50257
-0.017532 - 0.494559i	0.494869
-0.017532 + 0.494559i	0.494869
0.481259	0.481259
0.384691 - 0.282655i	0.477368
0.384691 + 0.282655i	0.477368
-0.333562 - 0.215380i	0.397055
-0.333562 + 0.215380i	0.397055

No unit roots

Graph 6:AR roots Graph- VECM for lag 2 and 5% statistical Significance



No unit roots

Table 82:Lag Exclusion Tests- VECM for lag 2 and 5% statistical Significance

VEC Lag Exclusion Wald Tests

Sample: 2000M01 2010M12

Included observations: 129

Chi-squared test statistics for lag exclusion:

Numbers in [ ] are p-values

	D(IP)	D(LIBOR)	D(NBHNDSZ)	D(OB)	D(SCRAPHNDSZ)	D(OP)	D(SHHNDSZ)	D(TY)	Joint
DLag 1	26.70021	17.19672	14.35318	9.576361	23.35589	76.94774	24.14792	8.734557	211.9762
	[0.000796]	[0.028125]	[0.073012]	[0.296027]	[0.002936]	[2.01e-13]	[0.002164]	0.365181]	[0.000000]
DLag 2	6.765723	7.455955	18.06043	5.225312	10.49708	13.72471	10.27244	31.52311	146.109
	[0.562108]	[0.488329]	[0.020778]	[0.733245]	[0.231854]	[0.089229]	[0.246423]	0.000113]	[2.31e-08]
df	8	8	8	8	8	8	8	8	64

Joint test suggest that no lag should be excluded from the VEC for statistic 5%

Residual Tests

Table 83:Portmanteu Autocorrelation Test

Portmanteau Tests for Autocorrelations					
Null Hypothesis: no residual autocorrelations up to lag h					
Sample: 2000M01 2010M12					
Included observations: 129					
Lags	**Q-Stat**	**Prob.**	**Adj Q-Stat**	**Prob.**	**df**
1	14.45297	NA*	14.56588	NA*	NA*
2	31.82301	NA*	32.20947	NA*	NA*
3	93.21710	0.7669	95.06532	0.7229	104
4	156.0588	0.7360	159.9180	0.6597	168
5	212.0071	0.8225	218.1222	0.7345	232
6	262.5391	0.9197	271.1192	0.8474	296
7	328.8988	0.8788	341.2864	0.7533	360
8	382.1683	0.9283	398.0779	0.8122	424
9	444.9572	0.9191	465.5759	0.7604	488
10	488.8435	0.9749	513.1501	0.8805	552

We do not reject Ho for statistic 5%

Table 84:Autocorrelation LM Test

Residual Serial Correlation LM Tests		
Null Hypothesis: no serial correlation at lag order h		
Sample: 2000M01 2010M12		
Included observations: 129		
Lags	**LM-Stat**	**Prob**
1	92.99793	0.0104
2	72.33655	0.2220
3	72.34984	0.2217
4	72.19410	0.2255
5	59.28565	0.6436
6	54.53257	0.7946
7	70.53577	0.2684
8	62.34492	0.5352
9	73.40203	0.1972
10	48.88349	0.9190

We do not reject Ho for statistic 1%, but we reject Ho for statistic 5%

Table 85:Normality Test

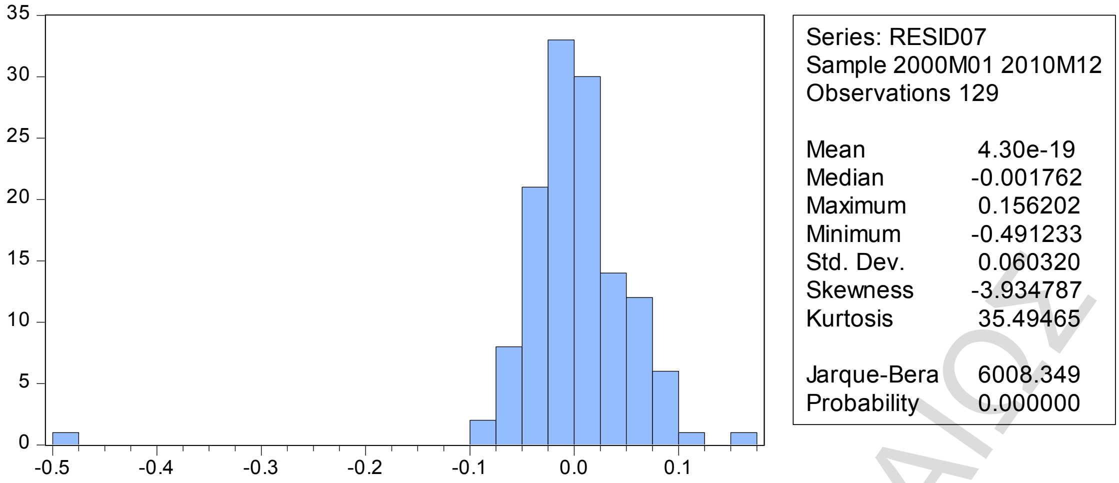
VEC Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: residuals are multivariate normal
Sample: 2000M01 2010M12
Included observations: 129

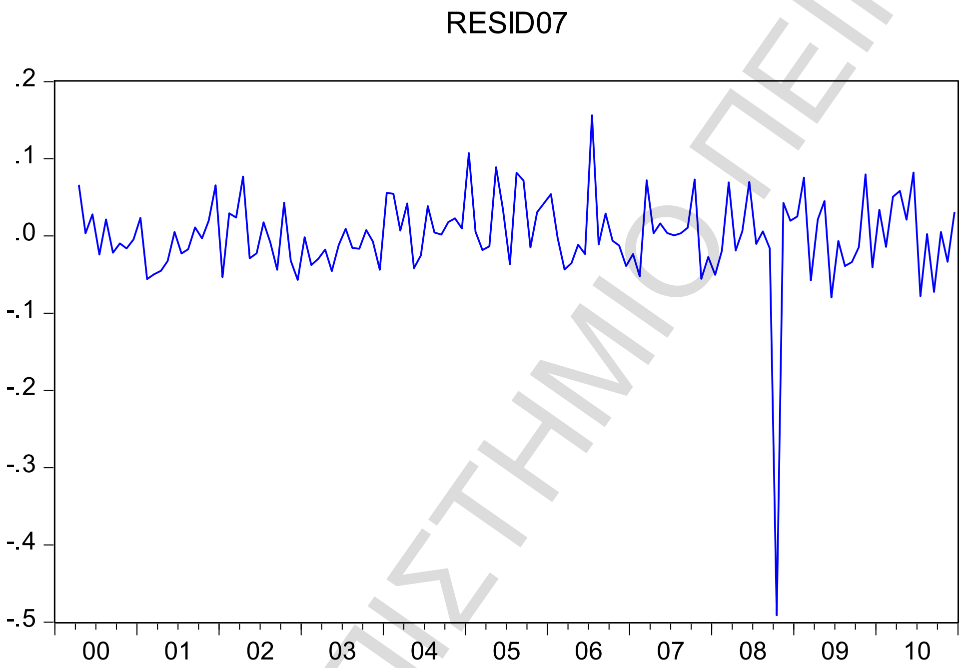
Component	Skewness	Chi-sq	df	Prob.
1	-1.219705	31.98514	1	0.0000
2	0.855667	15.74157	1	0.0001
3	0.060205	0.077930	1	0.7801
4	0.674906	9.793196	1	0.0018
5	-2.291214	112.8677	1	0.0000
6	-0.217016	1.012559	1	0.3143
7	0.805409	13.94670	1	0.0002
8	0.152336	0.498937	1	0.4800
Joint		185.9238	8	0.0000

Component	Kurtosis	Chi-sq	df	Prob.
1	8.758354	178.2277	1	0.0000
2	12.37995	472.9107	1	0.0000
3	4.202987	7.778587	1	0.0053
4	4.604952	13.84531	1	0.0002
5	17.62676	1149.939	1	0.0000
6	3.911341	4.464164	1	0.0346
7	5.448993	32.23692	1	0.0000
8	3.614254	2.028029	1	0.1544
Joint		1861.431	8	0.0000

Component	Jarque-Bera	df	Prob.
1	210.2128	2	0.0000
2	488.6522	2	0.0000
3	7.856516	2	0.0197
4	23.63851	2	0.0000
5	1262.807	2	0.0000
6	5.476723	2	0.0647
7	46.18362	2	0.0000
8	2.526966	2	0.2827
Joint	2047.354	16	0.0000

We reject Ho for statistic 5%





We reject normality for any statistic significance

Table 86:White Heteroskedasticity

Heteroskedasticity Tests: No Cross Terms (only levels and squares)

Sample: 2000M01 2010M12
Included observations: 129

Joint test:

Chi-sq	df	Prob.
1454.631	1368	0.0510

Individual components:

Dependent	R-squared	F(38,90)	Prob.	Chi-sq(38)	Prob.
res1*res1	0.174466	0.500535	0.9907	22.50611	0.9783
res2*res2	0.230850	0.710849	0.8799	29.77964	0.8272
res3*res3	0.327722	1.154556	0.2860	42.27609	0.2915
res4*res4	0.205714	0.613404	0.9534	26.53714	0.9189
res5*res5	0.380601	1.455320	0.0757	49.09754	0.1072
res6*res6	0.379852	1.450700	0.0774	49.00089	0.1089
res7*res7	0.361712	1.342164	0.1296	46.66087	0.1582
res8*res8	0.465999	2.066819	0.0027	60.11392	0.0126
res2*res1	0.271222	0.881433	0.6621	34.98767	0.6095
res3*res1	0.281149	0.926308	0.5948	36.26816	0.5497
res3*res2	0.317108	1.099802	0.3499	40.90695	0.3441
res4*res1	0.224958	0.687440	0.9015	29.01956	0.8523
res4*res2	0.273944	0.893616	0.6440	35.33879	0.5932
res4*res3	0.147327	0.409223	0.9986	19.00524	0.9957
res5*res1	0.342973	1.236334	0.2061	44.24352	0.2249
res5*res2	0.291915	0.976404	0.5198	37.65702	0.4852
res5*res3	0.331273	1.173265	0.2661	42.73421	0.2750
res5*res4	0.197559	0.583098	0.9677	25.48506	0.9399
res6*res1	0.334410	1.189958	0.2491	43.13890	0.2609
res6*res2	0.366712	1.371459	0.1132	47.30586	0.1432
res6*res3	0.272562	0.887418	0.6532	35.16050	0.6015
res6*res4	0.270540	0.878395	0.6666	34.89971	0.6136
res6*res5	0.377440	1.435904	0.0832	48.68975	0.1147
res7*res1	0.333543	1.185327	0.2537	43.02702	0.2647
res7*res2	0.348633	1.267655	0.1805	44.97363	0.2030
res7*res3	0.306938	1.048907	0.4163	39.59498	0.3987
res7*res4	0.245562	0.770897	0.8139	31.67750	0.7556
res7*res5	0.366884	1.372474	0.1127	47.32801	0.1427
res7*res6	0.363863	1.354709	0.1224	46.93832	0.1516
res8*res1	0.302485	1.027092	0.4465	39.02057	0.4237
res8*res2	0.246387	0.774334	0.8097	31.78393	0.7513
res8*res3	0.417529	1.697738	0.0215	53.86120	0.0457
res8*res4	0.252396	0.799596	0.7776	32.55913	0.7188
res8*res5	0.327666	1.154266	0.2863	42.26897	0.2917
res8*res6	0.422070	1.729688	0.0180	54.44701	0.0408
res8*res7	0.322586	1.127846	0.3161	41.61356	0.3163

We do not reject Ho: no Heteroskedasticity for statistic significance 5%

Stationarity Test Handymax Vessels

ADF outcomes

Table 87:Levels New Building Prices

Null Hypothesis: New Building Prices has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.978184	0.9425
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Non stationary for statistic significance a=0,05

Table 88:First Difference New Building Prices

Null Hypothesis: D(New Building Prices) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.088261	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 89:Levels Second Hand Prices

Null Hypothesis: Second Hand Prices has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.978451	0.6072
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Non stationary for statistic significance a=5

Table 90:First Difference Second Hand Prices

Null Hypothesis: D(Second Hand Prices) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.559451	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 91:Levels Operating Profit

Null Hypothesis: Operating Profit has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.718964	0.0735
Test critical values:	1% level	-3.481217	
	5% level	-2.883753	
	10% level	-2.578694	

Non stationary for statistic significance a=0,05

Table 92:First Difference Operating Profit

Null Hypothesis: D(Operating Profit) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.807755	0.0000
Test critical values:	1% level	-3.481623	
	5% level	-2.883930	
	10% level	-2.578788	

Stationary for statistic significance a=0,05

Table 93:Levels Scrap Value

Null Hypothesis: Scrap Value has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.343229	0.4076
Test critical values:	1% level	-4.029595	
	5% level	-3.444487	
	10% level	-3.147063	

Non stationary for statistic significance a=0,05

Table 94:First Difference Scrap Value

Null Hypothesis: D(Scrap Value) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.20670	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 95:Levels Order Book/Fleet

Null Hypothesis: Order Book/ Fleet has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.116713	0.5313
Test critical values:	1% level	-4.031309	
	5% level	-3.445308	
	10% level	-3.147545	

Non stationary for statistic significance a=0,05

Table 96:First Difference Order Book/Fleet

Null Hypothesis: D(Order Book/ Fleet) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.729364	0.0238
Test critical values:	1% level	-4.031309	
	5% level	-3.445308	
	10% level	-3.147545	

Stationary for statistic significance a=0,05

PP outcomes

Table 97:Levels New Building Prices

Null Hypothesis: New Building Prices has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.113757	0.9221
Test critical values:	1% level	-4.029595	
	5% level	-3.444487	
	10% level	-3.147063	

Non stationary for statistic significance a=0,05

Table 98:First Difference New Building Prices

Null Hypothesis: D(New Building Prices) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 6 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.394061	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 99:Levels Second Hand Prices

Null Hypothesis: Second Hand Prices has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.597316	0.7890
Test critical values:	1% level	-4.029595	
	5% level	-3.444487	
	10% level	-3.147063	

Non stationary for statistic significance a=0,05

Table 100:First Difference Second Hand Prices

Null Hypothesis: D(Second Hand Prices) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.177748	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 101:Levels Operating Profit

Null Hypothesis: Operating Profit has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.436951	0.8456
Test critical values:	1% level	-4.029595	
	5% level	-3.444487	
	10% level	-3.147063	

Non stationary for statistic significance a=0,05

Table 102:First Difference Operating Profit

Null Hypothesis: D(Operating Profit) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 22 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.315886	0.0001
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 103:Levels Scrap Value

Null Hypothesis: SCRAPHNDMX has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.284013	0.4393
Test critical values:	1% level	-4.029595	
	5% level	-3.444487	
	10% level	-3.147063	

Non stationary for statistic significance a=0,05

Table 104:First Difference Scrap Value

Null Hypothesis: D(Scrap Value) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-12.20661	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 105:Levels Order Book/Fleet

Null Hypothesis: Order Book /Fleet has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.531958	0.8137
Test critical values:	1% level	-4.029595	
	5% level	-3.444487	
	10% level	-3.147063	

Non stationary for statistic significance a=0,05

Table 106:First Difference Order Book/Fleet

Null Hypothesis: D(Order Book /Fleet) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 6 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-8.093020	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

KPSS outcomes

Table 107:Levels New Building Prices

Null Hypothesis: New Building Prices is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.180576
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Non stationary for statistic significance a=0,05

Table 108:First Difference New Building Prices

Null Hypothesis: D(New Building Prices) is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.131671
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Stationary for statistic significance a=0,05

Table 109:Levels Second Hand Prices

Null Hypothesis: Second Hand Prices is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.172952
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Non stationary for statistic significance a=0,05

Table 110:First Difference Second Hand Prices

Null Hypothesis: D(Second Hand Prices) is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.098846
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Stationary for statistic significance a=0,05

Table 111:Levels Operating Profit

Null Hypothesis: Operating Profit is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.169700
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Non stationary for statistic significance a=0,05

Table 112:First Difference Operating Profit

Null Hypothesis: D(Operating Profit) is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.051071
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Stationary for statistic significance a=0,05

Table 113:Levels Scrap Value

Null Hypothesis: Scrap Value is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.201288
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Non stationary for statistic significance a=0,05

Table 114:First Difference Scrap Value

Null Hypothesis: D(Scrap Value) is stationary Exogenous: Constant, Linear Trend Bandwidth: 2 (Newey-West automatic) using Bartlett kernel		
		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.044581
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Stationary for statistic significance a=0,05

Table 115:Levels Order Book/Fleet

Null Hypothesis: Order Book /Fleet is stationary Exogenous: Constant, Linear Trend Bandwidth: 9 (Newey-West automatic) using Bartlett kernel		
		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.180982
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Non stationary for statistic significance a=0,05

Table 116:First Difference Order Book/Fleet

Null Hypothesis: D(Order Book /Fleet) is stationary Exogenous: Constant, Linear Trend Bandwidth: 8 (Newey-West automatic) using Bartlett kernel		
		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.134937
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Stationary for statistic significance a=0,05

VECM Model estimation process

Table 117:Lag Length Criteria

Lag No.	AIC	SC	HQ
0	1.26	1.45	1.34
1	-16.21	*-14.56	-15.54
2	*-16.90	-13.78	*-15.63
3	*-17.09	-12.49	-15.22
4	*-17.15	-11.08	-14.68
5	-16.89	-9.36	-13.83
6	-16.71	-7.70	-13.05
7	*-16.90	-6.42	-12.65
8	-17.34	-5.39	-12.49
9	-17.85	-4.43	-12.40
10	* -19.13	-4.24	-13.08

Table 118:VECM model Long term Equation

	(SH)	(IP)	(LIBOR)	(NB)	(OB)	(SCRAP)	(OP)	(TY)	C
Lag	-1	-1	-1	-1	-1	-1	-1	-1	0
Coef.	1	0	-0.416391	*-0.829659	0	-1.249168	0.615496	1.985380	-7.660058
S.E.			(0.05934)	(0.59712)		(0.53960)	(0.22724)	(0.28241)	(2.29103)
t-stat.			[-7.01676]	[-1.38944]		[-2.31499]	[2.70858]	[7.03010]	[-3.34350]

Vector Error Correction model with lag of order 4 for Handymax vessels-Long term equation Co-integration equation 1
*Rejected for a=0,5

	(SH)	(IP)	(LIBOR)	(NB)	(OB)	(SCRAP)	(OP)	(TY)	C
Lag	-1	-1	-1	-1	-1	-1	-1	-1	0
Coef.	1	0	0	-0.947218	0.448618	-1.954815	0.523513	*-0.221995	*-2.335584
S.E.				(0.45955)	(0.08169)	(0.42771)	(0.17751)	(0.21774)	(1.68900)
t-stat.				[-2.06117]	[5.49157]	[-4.57039]	[2.94914]	[-1.01952]	[-1.38282]

Vector Error Correction model with lag of order 4 for Handymax vessels-Long term equation Co-integration equation 2
*Rejected for a=0,5

	(SH)	(IP)	(LIBOR)	(NB)	(SCRAP)	(OP)	(TY)	C
Lag	-1	-1	-1	-1	-1	-1	-1	0
Coef.	1	0	-0.145159	-1.889357	0	0.246418	1.242814	*-0.934223
S.E.			-0.025	-0.23133		-0.09224	-0.20743	-0.68864
t-stat.			[-5.80653]	[-8.16725]		[2.67150]	[5.99161]	[-1.35661]

Vector Error Correction model with lag of order 4 for Handymax vessels-Long term equation Co-integration equation 3
*Rejected for a=0,5

Table 119:VECM model Short term equation

	CointEq1	CointEq2	CointEq3
Coef.	**0.129430**	**-0.207529**	*0.028425
S.E.	**(0.06029)**	**(0.07272)**	(0.13012)
t-stat.	**[2.14665]**	**[-2.85390]**	[0.21845]

Vector Error Correction model with lag of order 2 Handymax vessels- Error Correction Term

*Rejected for a=0,5

	D(IP)	D(IP)	D(IP)	D(IP)	D(OB)	D(OB)	D(OB)	D(OB)
Lag	-1	-2	-3	-4	-1	-2	-3	-4
Coef.	*-0.010586	*-0.008755	* 0.003544	* 0.015791	* 0.256050	* 0.053256	* 0.076166	* 0.326132
S.E.	(0.01257)	(0.01199)	(0.01186)	(0.01078)	(0.19165)	(0.20098)	(0.20690)	(0.20946)
t-stat.	[-0.84204]	[-0.73019]	[0.29877]	[1.46424]	[1.33599]	[0.26499]	[0.36814]	[1.55698]

	D(SH)	D(SH)	D(SH)	D(SH)	D(OP)	D(OP)	D(OP)	D(OP)
Lag	-1	-2	-3	-4	-1	-2	-3	-4
Coef.	* 0.168702	*-0.059847	**-0.374119**	*-0.139808	**0.257894**	* 0.018465	**0.157251**	* 0.055615
S.E.	(0.18364)	(0.17397)	**(0.17575)**	(0.17416)	**(0.07674)**	(0.07402)	**(0.07156)**	(0.07140)
t-stat.	[0.91866]	[-0.34401]	**[-2.12872]**	[-0.80278]	**[3.36076]**	[0.24944]	**[2.19737]**	[0.77891]

	D(TY)	D(TY)	D(TY)	D(TY)	D(SCRAP)	D(SCRAP)	D(SCRAP)	D(SCRAP)
Lag	-1	-2	-3	-4	-1	-2	-3	-4
Coef.	*-0.149978	*-0.01623	*-0.045629	**-0.361731**	*-0.213635	**-0.197874**	*-0.143472	*-0.114919
S.E.	(0.16170)	(0.17695)	(0.15892)	**(0.14809)**	(0.11434)	**(0.10066)**	(0.09838)	(0.08840)
t-stat.	[-0.92751]	[-0.09172]	[-0.28712]	**[-2.44268]**	[-1.86848]	**[-1.96572]**	[-1.45832]	[-1.29997]

	D(NB)	D(NB)	D(NB)	D(NB)	D(LIBOR)	D(LIBOR)	D(LIBOR)	D(LIBOR)
Lag	**-1**	**-2**	**-3**	**-4**	**-1**	**-2**	**-3**	**-4**
Coef.	*-0.268988	*-0.416997	* 0.232811	* 0.029506	**-0.247406**	*-0.055049	*0.064529	*-0.07941
S.E.	(0.36064)	(0.33306)	(0.32038)	(0.28231)	**(0.06461)**	(0.06836)	(0.07126)	(0.07238)
t-stat.	[-0.74586]	[-1.25204]	[0.72668]	[0.10452]	**[-3.82948]**	[-0.80526]	[0.90551]	[-1.09715]

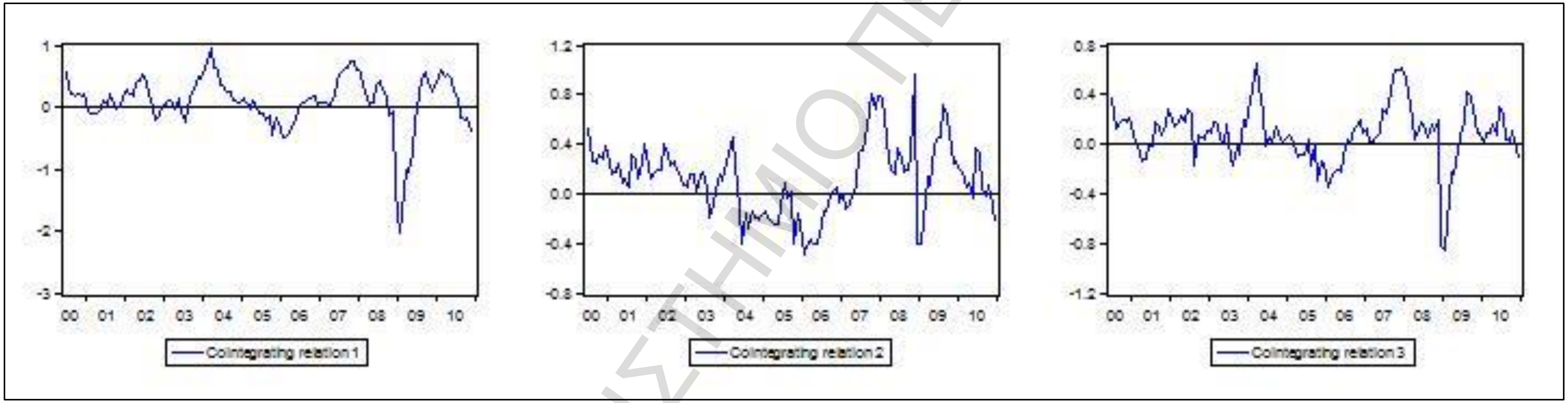
Vector Error Correction model with lag of order 2 for Handymax vessels- Short term equation
*Rejected for a=0,5

R-squared	0.551550
Adj. R-squared	0.385818
Sum sq. resids	0.399962
S.E. equation	0.065935
F-statistic	3.327972
Log likelihood	185.5912
Akaike AIC	-2.37152
Schwarz SC	-1.58768
Mean dependent	0.005191
S.D. dependent	0.084133

Vector Error Correction model with lag of order 2 for Handymax vessels- Statistics
*Rejected for a=0,5

Graph 7:Co-integration Equation Graph VECM for lag 4 and 5% statistical Significance

Co-integration Equation Graph VECM for lag 4 and 5% statistical Significance



Lag Structure Test

Table 120:AR Roots table- VECM for lag 4 and 5% statistical Significance

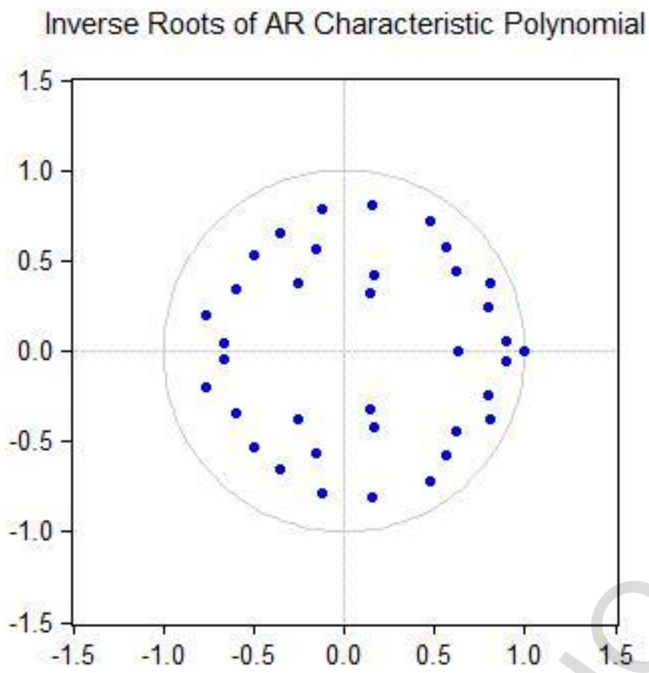
Roots of Characteristic Polynomial
Endogenous variables: SHHNDMX INDUSTRIAL_PRODUCTION_OE ORDER_BOOK TCHNDMX TREUSURY_YIELDS SCRAPHNDMX NBHNDMX LIBOR
Exogenous variables:
Lag specification: 1 4
Date: 06/16/13 Time: 20:50

Root	Modulus
1.000000 - 4.48e-16i	1.000000
1.000000 + 4.48e-16i	1.000000
1.000000 - 2.31e-15i	1.000000
1.000000 + 2.31e-15i	1.000000
1.000000	1.000000
0.898985 - 0.051185i	0.900441
0.898985 + 0.051185i	0.900441
0.807752 + 0.377142i	0.891459
0.807752 - 0.377142i	0.891459
0.472047 + 0.717663i	0.858992
0.472047 - 0.717663i	0.858992
0.793485 - 0.244305i	0.830243
0.793485 + 0.244305i	0.830243
0.158016 + 0.810954i	0.826206
0.158016 - 0.810954i	0.826206
0.566392 - 0.573507i	0.806046
0.566392 + 0.573507i	0.806046
-0.119968 + 0.790253i	0.799308
-0.119968 - 0.790253i	0.799308
-0.762004 - 0.204679i	0.789014
-0.762004 + 0.204679i	0.789014
0.619063 - 0.443089i	0.761293
0.619063 + 0.443089i	0.761293
-0.355827 + 0.653493i	0.744087
-0.355827 - 0.653493i	0.744087
-0.498789 - 0.529014i	0.727080
-0.498789 + 0.529014i	0.727080
-0.601497 - 0.346889i	0.694356
-0.601497 + 0.346889i	0.694356
-0.665195 + 0.039462i	0.666364
-0.665195 - 0.039462i	0.666364
0.627223	0.627223
-0.153354 + 0.564059i	0.584534
-0.153354 - 0.564059i	0.584534
-0.251687 + 0.381681i	0.457195
-0.251687 - 0.381681i	0.457195
0.165967 - 0.425350i	0.456583
0.165967 + 0.425350i	0.456583
0.141196 + 0.316993i	0.347017
0.141196 - 0.316993i	0.347017

VEC specification imposes 5 unit root(s).

No unit roots

Graph 8:AR roots Graph- VECM for lag 2 and 5% statistical Significance



No unit roots

Table 121:Lag Exclusion Tests- VECM for lag 2 and 5% statistical Significance

VEC Lag Exclusion Wald Tests

Sample: 2000M01 2010M12
Included observations: 127

Chi-squared test statistics for lag exclusion:
Numbers in [ ] are p-values

	D(SHHNDMX)	D(INDUSTRIAL _PRODUCTION _OE)	D(ORDER_BO OK)	D(TCHNDMX)	D(TREUSURY_ YIELDS)	D(SCRAPHND MX)	D(NBHNDMX)	D(LIBOR)	Joint
DLag 1	40.87992 [2.20e-06]	2.999201 [0.934408]	13.86252 [0.085420]	58.22159 [1.04e-09]	17.87133 [0.022212]	31.05309 [0.000137]	34.74745 [2.97e-05]	5.681310 [0.682880]	208.6814 [0.000000]
DLag 2	7.561497 [0.477431]	17.89765 [0.022007]	14.05594 [0.080319]	6.279533 [0.615952]	25.33279 [0.001365]	14.80318 [0.063087]	15.19258 [0.055507]	9.549885 [0.298049]	136.5557 [3.54e-07]
DLag 3	9.751336 [0.282915]	12.48323 [0.130911]	8.693881 [0.368774]	10.91670 [0.206464]	11.00144 [0.201618]	6.960660 [0.540883]	18.95996 [0.015075]	15.82607 [0.044938]	108.9926 [0.000389]
DLag 4	11.41976 [0.179030]	5.077951 [0.749213]	9.619541 [0.292751]	10.09781 [0.258228]	12.83351 [0.117708]	7.492067 [0.484588]	6.891088 [0.548428]	7.812399 [0.452007]	81.01628 [0.074089]
df	8	8	8	8	8	8	8	8	64

Joint test suggest that no lag should be excluded from the VEC for statistic 5%

Residual Tests

Table 122:Portmanteu Autocorrelation Test

VEC Residual Portmanteau Tests for Autocorrelations
Null Hypothesis: no residual autocorrelations up to lag h

Sample: 2000M01 2010M12
Included observations: 127

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	8.807920	NA*	8.877824	NA*	NA*
2	27.85765	NA*	28.23235	NA*	NA*
3	49.28270	NA*	50.17575	NA*	NA*
4	70.38139	NA*	71.96058	NA*	NA*
5	115.8194	0.2015	119.2608	0.1455	104
6	185.5657	0.1678	192.4656	0.0950	168
7	250.5489	0.1922	261.2394	0.0910	232
8	320.0505	0.1611	335.4135	0.0570	296
9	390.2782	0.1307	410.9975	0.0327	360
10	454.7771	0.1457	481.0091	0.0288	424

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution

We do not reject Ho for statistic 5%

Table 123:Autocorrelation LM Test

VEC Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h

Sample: 2000M01 2010M12
Included observations: 127

Lags	LM-Stat	Prob
1	59.24077	0.6451
2	83.09262	0.0546
3	69.27823	0.3040
4	57.30629	0.7103
5	49.72782	0.9048
6	78.46208	0.1055
7	73.49103	0.1952
8	80.57720	0.0789
9	89.13669	0.0206
10	80.17258	0.0835

Probs from chi-square with 64 df.

We do not reject Ho for statistic 1%, but we reject Ho for statistic 5%

Table 124:Normality Test

VEC Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: residuals are multivariate normal

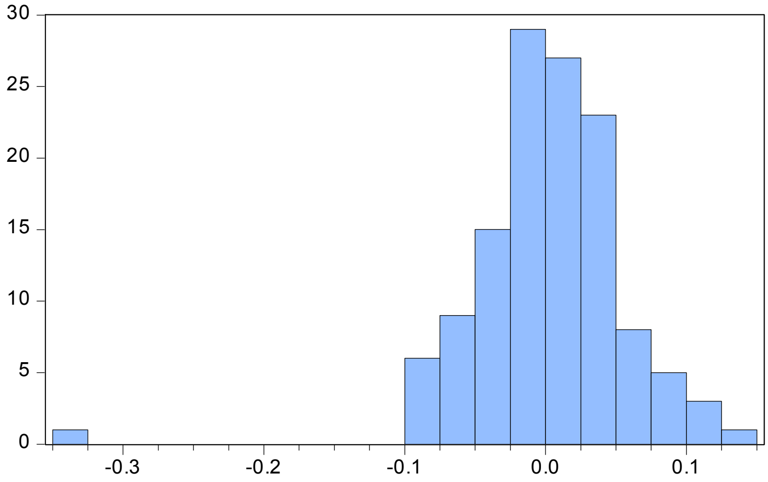
Sample: 2000M01 2010M12
Included observations: 127

Component	Skewness	Chi-sq	df	Prob.
1	-1.608608	54.77126	1	0.0000
2	-1.535702	49.91906	1	0.0000
3	0.631805	8.449252	1	0.0037
4	0.070173	0.104229	1	0.7468
5	0.104200	0.229819	1	0.6317
6	-0.446321	4.216442	1	0.0400
7	-0.000930	1.83E-05	1	0.9966
8	1.013136	21.72639	1	0.0000
Joint		139.4165	8	0.0000

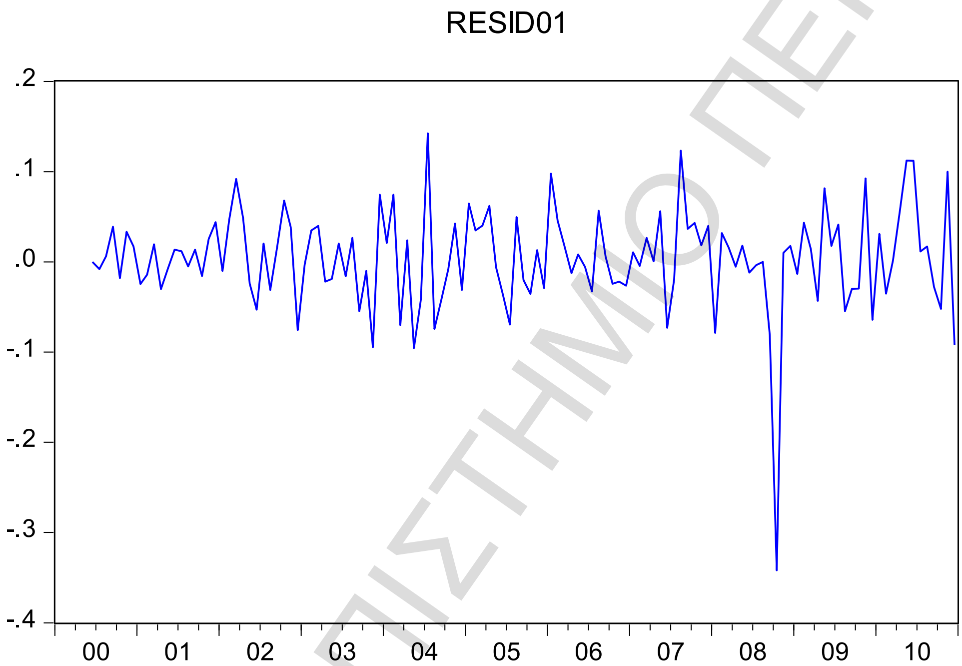
Component	Kurtosis	Chi-sq	df	Prob.
1	12.98355	527.4275	1	0.0000
2	9.788039	243.8267	1	0.0000
3	3.870333	4.008326	1	0.0453
4	3.169603	0.152216	1	0.6964
5	3.608361	1.958461	1	0.1617
6	4.505143	11.98803	1	0.0005
7	4.556357	12.81773	1	0.0003
8	9.404399	217.0447	1	0.0000
Joint		1019.224	8	0.0000

Component	Jarque-Bera	df	Prob.
1	582.1988	2	0.0000
2	293.7457	2	0.0000
3	12.45758	2	0.0020
4	0.256445	2	0.8797
5	2.188280	2	0.3348
6	16.20447	2	0.0003
7	12.81775	2	0.0016
8	238.7711	2	0.0000
Joint	1158.640	16	0.0000

We reject Ho for statistic 5%



Series: RESID01	
Sample 2000M01 2010M12	
Observations 127	
Mean	0.003514
Median	0.006051
Maximum	0.142396
Minimum	-0.341967
Std. Dev.	0.056230
Skewness	-1.608608
Kurtosis	12.98355
Jarque-Bera	582.1988
Probability	0.000000



We reject normality for any statistic significance

Table 125:White Heteroskedasticity

VEC Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)

Sample: 2000M01 2010M12
Included observations: 127

Joint test:

Chi-sq	df	Prob.
2591.678	2520	0.1563

Individual components:

Dependent	R-squared	F(70,56)	Prob.	Chi-sq(70)	Prob.
res1*res1	0.620741	1.309379	0.1485	78.83416	0.2197
res2*res2	0.463582	0.691374	0.9286	58.87492	0.8259
res3*res3	0.495697	0.786348	0.8306	62.95352	0.7122
res4*res4	0.633035	1.380042	0.1064	80.39538	0.1856
res5*res5	0.478389	0.733709	0.8907	60.75536	0.7769
res6*res6	0.607441	1.237908	0.2047	77.14496	0.2610
res7*res7	0.672543	1.643070	0.0278	85.41298	0.1015
res8*res8	0.463459	0.691034	0.9288	58.85935	0.8263
res2*res1	0.573894	1.077467	0.3885	72.88452	0.3833
res3*res1	0.573643	1.076363	0.3900	72.85271	0.3843
res3*res2	0.429030	0.601124	0.9781	54.48681	0.9139
res4*res1	0.628925	1.355901	0.1195	79.87353	0.1966
res4*res2	0.528648	0.897246	0.6686	67.13833	0.5748
res4*res3	0.483220	0.748048	0.8757	61.36898	0.7595
res5*res1	0.587606	1.139891	0.3073	74.62593	0.3304
res5*res2	0.554677	0.996450	0.5093	70.44401	0.4626
res5*res3	0.525090	0.884529	0.6888	66.68642	0.5902
res5*res4	0.549908	0.977414	0.5395	69.83830	0.4830
res6*res1	0.629728	1.360571	0.1168	79.97540	0.1944
res6*res2	0.564052	1.035081	0.4499	71.63458	0.4233
res6*res3	0.478409	0.733770	0.8907	60.75798	0.7768
res6*res4	0.612521	1.264627	0.1820	77.79013	0.2447
res6*res5	0.614083	1.272986	0.1753	77.98857	0.2398
res7*res1	0.750736	2.409454	0.0004	95.34353	0.0237
res7*res2	0.597752	1.188822	0.2522	75.91447	0.2938
res7*res3	0.604389	1.222190	0.2191	76.75743	0.2710
res7*res4	0.807701	3.360182	0.0000	102.5780	0.0068
res7*res5	0.640899	1.427787	0.0843	81.39421	0.1658
res7*res6	0.757887	2.504244	0.0003	96.25167	0.0205
res8*res1	0.469344	0.707568	0.9152	59.60670	0.8076
res8*res2	0.662505	1.570409	0.0408	84.13819	0.1193
res8*res3	0.457422	0.674443	0.9410	58.09264	0.8444
res8*res4	0.525158	0.884770	0.6884	66.69502	0.5899
res8*res5	0.474490	0.722330	0.9018	60.26020	0.7904
res8*res6	0.541469	0.944702	0.5922	68.76655	0.5193
res8*res7	0.621012	1.310884	0.1475	78.86850	0.2189

We do not reject Ho: no Heteroskedasticity for statistic significance 5%

Stationarity Test Panamax Vessels

ADF outcomes

Table 126:Levels New Building Prices

Null Hypothesis: New Building Prices has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.041040	0.9337
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Non stationary for statistic significance a=0,05

Table 127:First Difference New Building Prices

Null Hypothesis:D(New Building Prices) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.735001	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 128:Levels Second Hand Prices

Null Hypothesis: Second Hand Prices has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.155976	0.5096
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Non stationary for statistic significance a=0,05

Table 129:First Difference Second Hand Prices

Null Hypothesis: D(Second Hand Prices) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.267106	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 130:Levels Operating Profit

Null Hypothesis: Operating Profit has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.628215	0.2687
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Non stationary for statistic significance a=0,05

Table 131:First Difference Operating Profit

Null Hypothesis: D(Operating Profit) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.018891	0.0000
Test critical values:	1% level	-4.030729	
	5% level	-3.445030	
	10% level	-3.147382	

Stationary for statistic significance a=0,05

Table 132:Levels Scrap Value

Null Hypothesis: Scrap Value has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.360801	0.3983
Test critical values:	1% level	-4.029595	
	5% level	-3.444487	
	10% level	-3.147063	

Non stationary for statistic significance a=0,05

Table 133:First Difference Scrap Value

Null Hypothesis: D(Scrap Value) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.19727	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 134:Levels Order Book/Fleet

Null Hypothesis: Order Book/ Fleet has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 5 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.857590	0.0006
Test critical values:	1% level	-4.032498	
	5% level	-3.445877	
	10% level	-3.147878	

Stationary for statistic significance a=0,05

PP outcomes

Table 135:Levels New Building Prices

Null Hypothesis: New Building Prices has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.116134	0.9217
Test critical values:	1% level	-4.029595	
	5% level	-3.444487	
	10% level	-3.147063	

Non stationary for statistic significance a=0,05

Table 136:First Difference New Building Prices

Null Hypothesis: D(NBPNMX) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 5 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.928677	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 137:Levels Second Hand Prices

Null Hypothesis: Second Hand Prices has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.796449	0.7011
Test critical values:	1% level	-4.029595	
	5% level	-3.444487	
	10% level	-3.147063	

Non stationary for statistic significance a=0,05

Table 138:First Difference Second Hand Prices

Null Hypothesis: D(Second Hand Prices) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.165627	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 139:Levels Operating Profit

Null Hypothesis: Operating Profit has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.000560	0.5953
Test critical values:	1% level	-4.029595	
	5% level	-3.444487	
	10% level	-3.147063	

Non stationary for statistic significance a=0,05

Table 140:First Difference Operating Profit

Null Hypothesis: D(Operating Profit) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.287731	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 141:Levels Scrap Value

Null Hypothesis: Scrap Value has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.315144	0.4225
Test critical values:	1% level	-4.029595	
	5% level	-3.444487	
	10% level	-3.147063	

Non stationary for statistic significance a=0,05

Table 142:First Difference Scrap Value

Null Hypothesis: D(Scrap Value) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-12.20661	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 143:Levels Order Book/Fleet

Null Hypothesis: Order Book /Fleet has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.417175	0.3690
Test critical values:	1% level	-4.029595	
	5% level	-3.444487	
	10% level	-3.147063	

Non stationary for statistic significance a=0,05

Table 144:First Difference Order Book/Fleet

Null Hypothesis: D(Order Book /Fleet) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-8.025979	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

KPSS outcomes

Table 145:Levels New Building Prices

Null Hypothesis: New Building Prices is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.193184
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Non stationary for statistic significance a=0,05

Table 146:First Difference New Building Prices

Null Hypothesis: D(New Building Prices) is stationary Exogenous: Constant, Linear Trend Bandwidth: 7 (Newey-West automatic) using Bartlett kernel		
		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.121707
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Stationary for statistic significance a=0,05

Table 147:Levels Second Hand Prices

Null Hypothesis: Second Hand Prices is stationary Exogenous: Constant, Linear Trend Bandwidth: 9 (Newey-West automatic) using Bartlett kernel		
		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.179649
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Non stationary for statistic significance a=0,05

Table 148:First Difference Second Hand Prices

Null Hypothesis: D(Second Hand Prices) is stationary Exogenous: Constant, Linear Trend Bandwidth: 3 (Newey-West automatic) using Bartlett kernel		
		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.068596
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Stationary for statistic significance a=0,05

Table 149:Levels Operating Profit

Null Hypothesis: Operating Profit is stationary Exogenous: Constant, Linear Trend Bandwidth: 9 (Newey-West automatic) using Bartlett kernel		
		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.181346
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Non stationary for statistic significance a=0,05

Table 150:First Difference Operating Profit

Null Hypothesis: D(Operating Profit) is stationary		
Exogenous: Constant, Linear Trend		
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel		
		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.044261
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Stationary for statistic significance a=0,05

Table 151:Levels Scrap Value

Null Hypothesis: Scrap Value is stationary		
Exogenous: Constant, Linear Trend		
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel		
		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.195574
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Non stationary for statistic significance a=0,05

Table 152:First Difference Scrap Value

Null Hypothesis: D(Scrap Value) is stationary		
Exogenous: Constant, Linear Trend		
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel		
		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.045720
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Stationary for statistic significance a=0,05

Table 153:Levels Order Book/Fleet

Null Hypothesis: Order Book /Fleet is stationary		
Exogenous: Constant, Linear Trend		
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel		
		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.109682
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Stationary for statistic significance a=0,05

VECM Model estimation process

Table 154:Lag Length Criteria

Lag Length Criteria			
No	AIC	SC	HQ
0	0.24	0.56	0.37
1	*-11.76	*-10.32	-11.16
2	*-12.39	-9.81	* -11.34
3	-12.37	-8.67	-10.86
4	*-12.38	-7.55	-10.42
5	-11.98	-6.03	-9.56
6	-11.8	-4.72	-8.92
7	-11.63	-3.42	-8.29
8	*-12.05	-2.71	-8.26
9	-12.1	-1.64	-7.85
10	*-12.53	-0.94	-7.82

Table 6.3.2.: Lag Length Criteria Panamax Vessel
*Suggested lag length

Table 155:VECM model Long term Equation

	(SH)	(IP)	(LIBOR)	(NB)	(SCRAP)	(OP)	(TY)	C
Lag	-1	-1	-1	-1	-1	-1	-1	0
Coef.	1	0	0	-0.85956	-0.67814	*-0.061655	*0.005704	1.206515
S.E.				-0.1968	-0.1338	-0.06968	-0.13113	-0.52468
t-stat.				[-4.36777]	[-5.06837]	[-0.88484]	[0.04350]	[2.29954]

Vector Error Correction model with lag of order 4 for Panamax vessels-Long term equation Co-integration equation 1

*Rejected for a=0,5

	(SH)	(IP)	(LIBOR)	(NB)	(SCRAP)	(OP)	(TY)	C
Lag	-1	-1	-1	-1	-1	-1	-1	0
Coef.	1	0.104431	0	-2.34567	0	0.375288	0.482608	*0.208839
S.E.		-0.01608		-0.21643		-0.0915	-0.16281	-0.56955
t-stat.		[6.49346]		[-10.8380]		[4.10146]	[2.96427]	[0.36668]

Vector Error Correction model with lag of order 4 for Panamax vessels-Long term equation Co-integration equation 2

*Rejected for a=0,5

	(SH)	(IP)	(LIBOR)	(NB)	(SCRAP)	(OP)	(TY)	C
Lag	-1	-1	-1	-1	-1	-1	-1	0
Coef.	1	0	-0.145159	-1.889357	0	0.246418	0	*-0.934223
S.E.			-0.025	-0.23133		-0.09224		-0.68864
t-stat.			[-5.80653]	[-8.16725]		[2.67150]		[-1.35661]

Vector Error Correction model with lag of order 4 for Panamax vessels-Long term equation Co-integration equation 3

*Rejected for a=0,5

Table 156:VECM model Short term equation

	CointEq1	CointEq2	CointEq3
Coef.	**-0.232658**	* 0.012918	*0.025428
S.E.	**-0.11229**	-0.15688	-0.15238
t-stat.	**[-2.07185]**	[0.08234]	[0.16687]

Table 6.3.5.1.: Vector Error Correction model with lag of order 2 for Panamax vessels- Error Correction Term

*Rejected for a=0,5

	D(IP)	D(IP)	D(IP)	D(IP)	D(LIBOR)	D(LIBOR)	D(LIBOR)	D(LIBOR)
Lag	-1	-2	-3	-4	-1	-2	-3	-4
Coef.	*-0.010506	*-0.014628	*-0.003426	*-0.006032	**-0.311759**	* 0.041124	* 0.106947	*-0.086854
S.E.	-0.0163	-0.0157	-0.0151	-0.01343	**-0.07839**	-0.08115	-0.08312	-0.08397
t-stat.	[-0.64464]	[-0.93176]	[-0.22690]	[-0.44908]	**[-3.97694]**	[0.50678]	[1.28665]	[-1.03430]

	D(NB)	D(NB)	D(NB)	D(NB)	D(SCRAP)	D(SCRAP)	D(SCRAP)	D(SCRAP)
Lag	-1	-2	-3	-4	-1	-2	-3	-4
Coef.	*0.197969	*-0.410927	**0.782402**	*-0.069262	*-0.047607	*-0.107289	*-0.073381	*-0.062873
S.E.	-0.4306	-0.3872	**-0.37027**	-0.35671	-0.12048	-0.11327	-0.11479	-0.10355
t-stat.	[0.45975]	[-1.06128]	**[2.11304]**	[-0.19417]	[-0.39515]	[-0.94723]	[-0.63924]	[-0.60718]

	D(SH)	D(SH)	D(SH)	D(SH)	D(OP)	D(OP)	D(OP)	D(OP)
Lag	-1	-2	-3	-4	-1	-2	-3	-4
Coef.	*0.20419	*-0.000967	*-0.180762	*-0.082216	**0.220168**	*-0.016918	*0.080407	* -0.00492
S.E.	-0.1746	-0.18336	-0.17228	-0.17446	**-0.06295**	-0.06631	-0.06669	-0.06772
t-stat.	[1.16951]	[-0.00527]	[-1.04926]	[-0.47125]	**[3.49736]**	[-0.25512]	[1.20563]	[-0.07265]

	D(TY)	D(TY)	D(TY)	D(TY)	OB
Lag	-1	-2	-3	-4	-1
Coef.	*-0.11745	*0.206148	*0.219945	*-0.274956	*-0.033442
S.E.	-0.18195	-0.18634	-0.17151	-0.16022	-0.01775
t-stat.	[-0.64550]	[1.10632]	[1.28238]	[-1.71609]	[-1.88436]

Table 6.3.5.2.: Vector Error Correction model with lag of order 2 for Panamax vessels- Short term equation

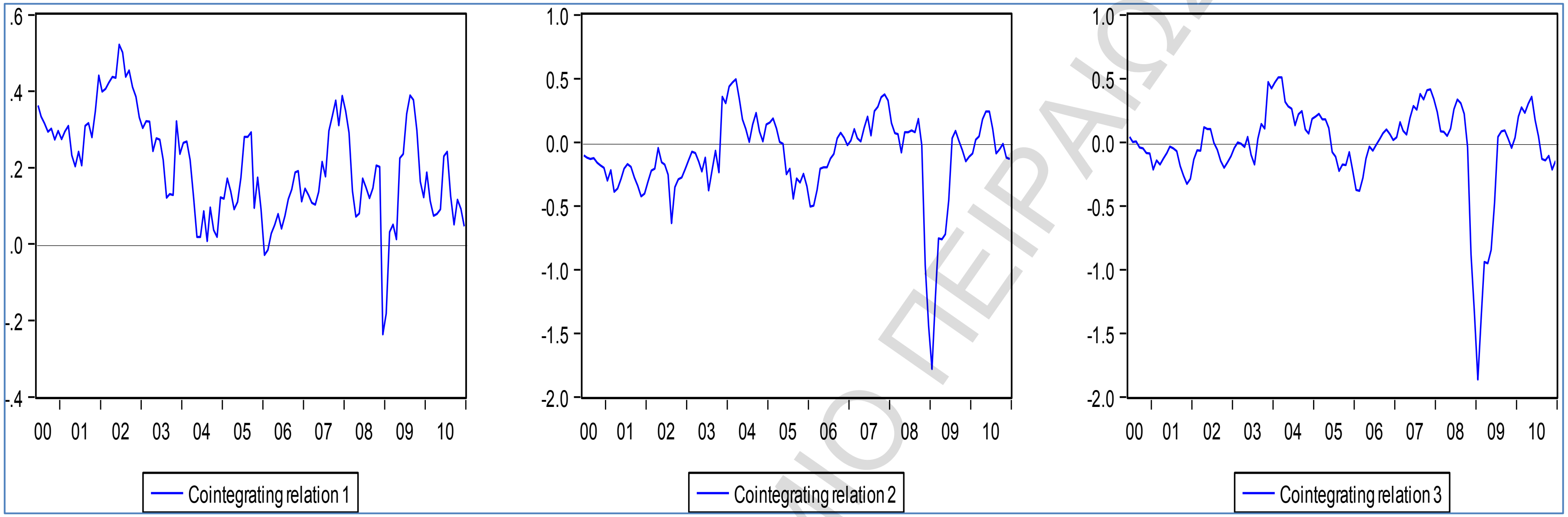
*Rejected for a=0,5

R-squared	0.608573
Adj. R-squared	0.462326
Sum sq. resids	0.386041
S.E. equation	0.065132
F-statistic	4.161263
Log likelihood	185.8637
Akaike AIC	-2.394661
Schwarz SC	-1.606805
Mean dependent	0.004439
S.D. dependent	0.088825

Table 6.2.5.3.: Vector Error Correction model with lag of order 2 for Panamax vessels- Statistics

Graph 9:Co-integration Equation Graph VECM for lag 4 and 5% statistical Significance

Co-integration Equation Graph VECM for lag 4 and 5% statistical Significance

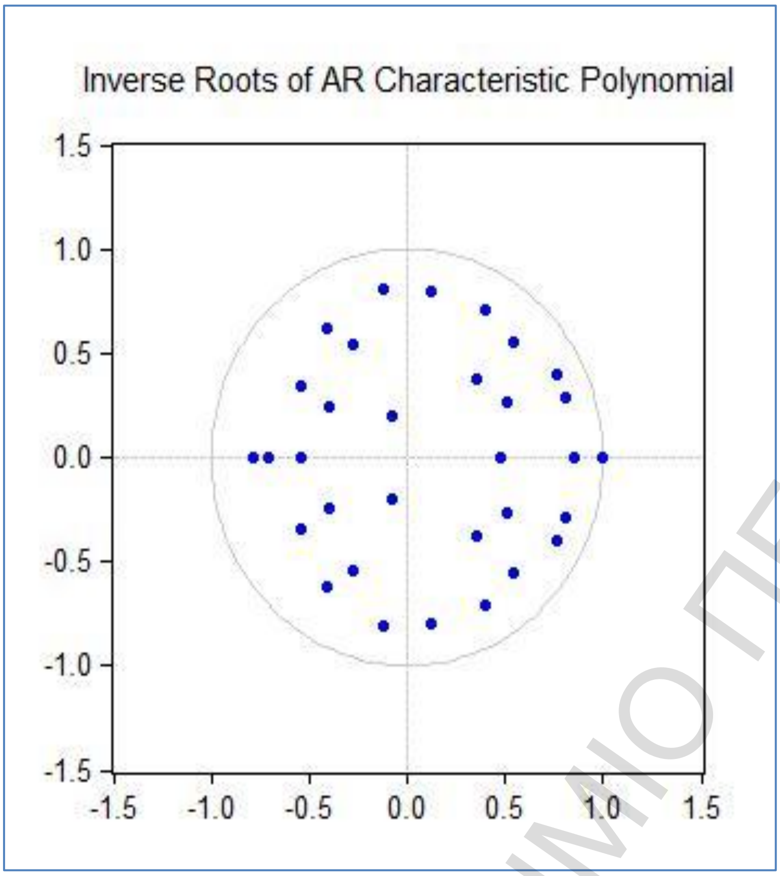

.6
.4
.2
.0
-.2
-.4
00 01 02 03 04 05 06 07 08 09 10
Cointegrating relation 1
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
00 01 02 03 04 05 06 07 08 09 10
Cointegrating relation 2
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
00 01 02 03 04 05 06 07 08 09 10
Cointegrating relation 3

Lag Structure Test

Table 157:AR Roots table- VECM for lag 4 and 5% statistical Significance

Roots of Characteristic Polynomial	
Endogenous variables: IP LIBOR NBPNMX SCRAPPNMX SHPNMX OP TY	
Exogenous variables:	OB
Lag specification: 1 4	
Root	**Modulus**
1.000000	1.000000
1.000000	1.000000
1.000000 - 1.91e-15i	1.000000
1.000000 + 1.91e-15i	1.000000
0.766676 - 0.393716i	0.861861
0.766676 + 0.393716i	0.861861
0.810175 - 0.285599i	0.859040
0.810175 + 0.285599i	0.859040
0.853339	0.853339
-0.121229 + 0.804788i	0.813868
-0.121229 - 0.804788i	0.813868
0.396779 + 0.706997i	0.810727
0.396779 - 0.706997i	0.810727
0.122988 - 0.798922i	0.808334
0.122988 + 0.798922i	0.808334
-0.781276	0.781276
0.542202 + 0.552040i	0.773778
0.542202 - 0.552040i	0.773778
-0.412650 + 0.620436i	0.745132
-0.412650 - 0.620436i	0.745132
-0.707537	0.707537
-0.547728 + 0.348260i	0.649070
-0.547728 - 0.348260i	0.649070
-0.274558 + 0.547503i	0.612488
-0.274558 - 0.547503i	0.612488
0.510917 + 0.270845i	0.578268
0.510917 - 0.270845i	0.578268
-0.541656	0.541656
0.350257 - 0.381264i	0.517728
0.350257 + 0.381264i	0.517728
0.478455	0.478455
-0.403145 + 0.241974i	0.470188
-0.403145 - 0.241974i	0.470188
-0.076761 + 0.198596i	0.212914
-0.076761 - 0.198596i	0.212914

Graph 10:AR roots Graph- VECM for lag 4 and 5% statistical Significance



No unit roots

Table 158:Lag Exclusion Tests- VECM for lag 4 and 5% statistical Significance

VEC Lag Exclusion Wald Tests
Sample: 2000M01 2010M12
Included observations: 127
Chi-squared test statistics for lag exclusion:
Numbers in [ ] are p-values

	D(IP)	D(LIBOR)	D(NBPNMX)	D(SCRAPHNDSZ)	D(OP)	D(SHHNDSZ)	D(TY)	Joint
DLag 1	5.151748	10.74526	23.02510	28.84276	53.63473	42.67603	16.44283	163.5638
	[0.641451]	[0.150123]	[0.000000]	[0.000000]	[0.000000]	[0.000000]	[0.021365]	[0.000000]
DLag 2	10.08864	12.04379	10.10700	4.760589	5.987778	7.211487	26.03467	97.86219
	[0.183606]	[0.099128]	[0.182591]	[0.689153]	[0.541177]	[0.407197]	[0.000000]	[0.000000]
DLag 3	12.70245	10.10304	8.759761	8.712026	9.312682	7.368286	10.76867	76.70705
	[0.079699]	[0.182809]	[0.270368]	[0.273998]	[0.230979]	[0.391567]	[0.149033]	[0.000000]
DLag 4	4.035305	0.283163	4.259371	5.357017	6.677917	2.300673	9.388744	36.01079
	[0.775702]	[0.999918]	[0.749465]	[0.616482]	[0.463167]	[0.941345]	[0.225937]	[0.916376]
df	7	7	7	7	7	7	7	49

Joint test suggest that lag 4 should be excluded from the VEC for statistic 5%

Residual Tests

Table 159:Portmanteu Autocorrelation Test

Portmanteau Tests for Autocorrelations					
Null Hypothesis: no residual autocorrelations up to lag h					
Sample: 2000M01 2010M12					
Included observations: 127					
Lags	**Q-Stat**	**Prob.**	**Adj Q-Stat**	**Prob.**	**df**
1	3.894257	NA*	3.925164	NA*	NA*
2	14.43914	NA*	14.63877	NA*	NA*
3	24.90883	NA*	25.36176	NA*	NA*
4	45.11590	NA*	46.22596	NA*	NA*
5	92.80342	0.1059	95.86789	0.0716	77
6	131.5178	0.3503	136.5020	0.2464	126
7	182.9697	0.3245	190.9553	0.1939	175
8	245.5346	0.1544	257.7262	0.0605	224
9	298.0358	0.1426	314.2317	0.0435	273
10	353.1189	0.1122	374.0228	0.0241	322

We do not reject Ho for statistic 5%

Table 160:Autocorrelation LM Test

Residual Serial Correlation LM Tests		
Null Hypothesis: no serial correlation at lag order h		
Sample: 2000M01 2010M12		
Included observations: 127		
Lags	**LM-Stat**	**Prob**
1	46.55342	0.5729
2	51.78650	0.3656
3	47.72821	0.5247
4	55.89112	0.2319
5	59.19341	0.1510
6	41.35451	0.7728
7	58.91084	0.1570
8	72.84376	0.0151
9	63.02367	0.0859
10	65.96003	0.0533

We do not reject Ho for statistic 1%

Table 161:Normality Test

VEC Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: residuals are multivariate normal

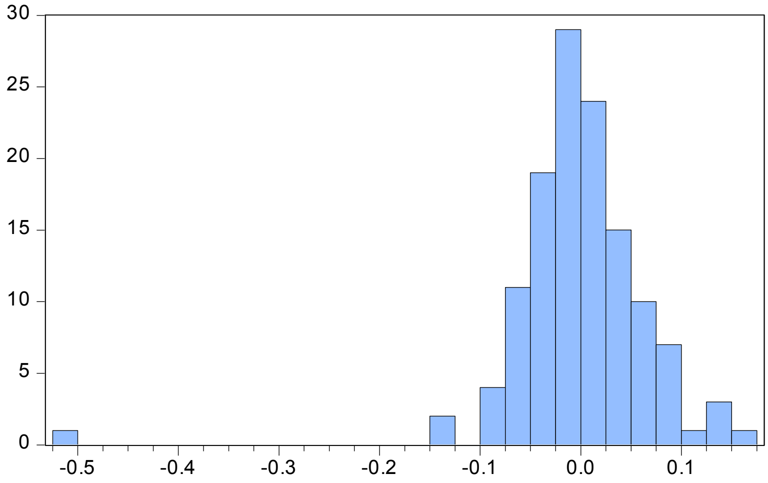
Sample: 2000M01 2010M12
Included observations: 127

Component	Skewness	Chi-sq	df	Prob.
1	-2.138219	96.77355	1	0.0000
2	0.840253	14.94419	1	0.0001
3	-0.150709	0.480763	1	0.4881
4	-1.880123	74.82129	1	0.0000
5	-0.208682	0.921767	1	0.3370
6	0.594855	7.489887	1	0.0062
7	0.042940	0.039029	1	0.8434
Joint		195.4705	7	0.0000

Component	Kurtosis	Chi-sq	df	Prob.
1	13.11488	541.3951	1	0.0000
2	9.914489	252.9954	1	0.0000
3	4.254389	8.326390	1	0.0039
4	14.09058	650.8796	1	0.0000
5	3.233038	0.287373	1	0.5919
6	4.401006	10.38658	1	0.0013
7	3.295180	0.461069	1	0.4971
Joint		1464.732	7	0.0000

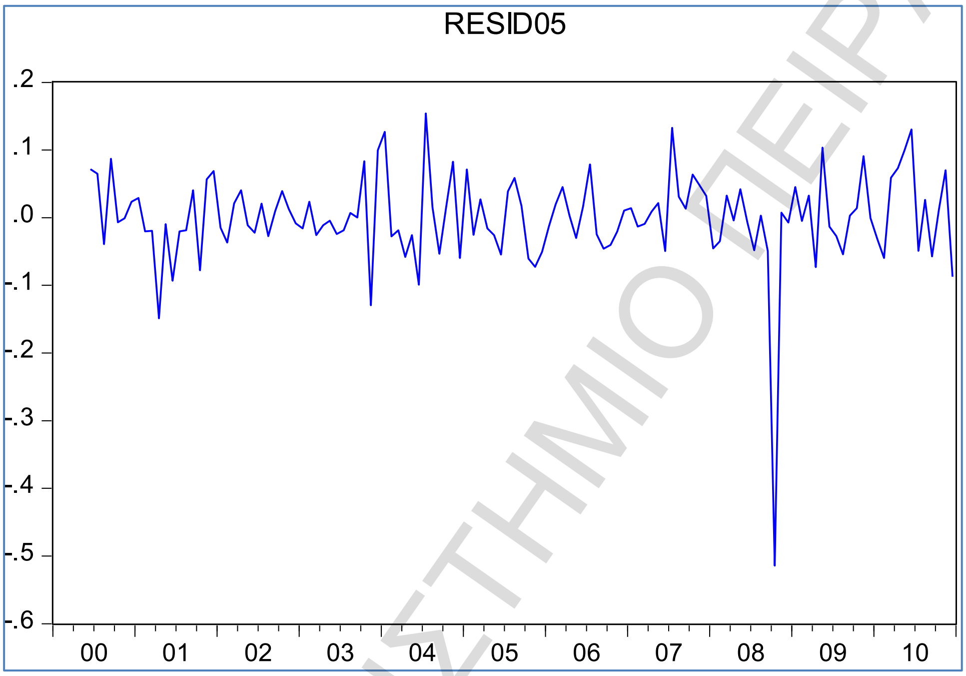
Component	Jarque-Bera	df	Prob.
1	638.1686	2	0.0000
2	267.9396	2	0.0000
3	8.807153	2	0.0122
4	725.7009	2	0.0000
5	1.209140	2	0.5463
6	17.87647	2	0.0001
7	0.500098	2	0.7788
Joint	1660.202	14	0.0000

We reject Ho for statistic 5%



Series: RESID05
Sample 2000M01 2010M12
Observations 127

Mean	-0.000531
Median	-0.004054
Maximum	0.153938
Minimum	-0.514053
Std. Dev.	0.070028
Skewness	-2.936465
Kurtosis	24.28813
Jarque-Bera	2580.618
Probability	0.000000



We do not reject Ho for statistic 1%, but we reject Ho for statistic 5%

Table 162:White Heteroskedasticity

Heteroskedasticity Tests: No Cross Terms (only levels and squares)

Sample: 2000M01 2010M12

Included observations: 127

Joint test:

Chi-sq	df	Prob.
1844.912	1792	0.1877

Individual components:

Dependent	R-squared	F(64,62)	Prob.	Chi-sq(64)	Prob.
res1*res1	0.374672	0.580436	0.9839	47.58331	0.9379
res2*res2	0.452376	0.800256	0.8110	57.45174	0.7055
res3*res3	0.689645	2.152677	0.0014	87.58494	0.0268
res4*res4	0.611213	1.522974	0.0491	77.62404	0.1178
res5*res5	0.616734	1.558865	0.0406	78.32517	0.1074
res6*res6	0.587824	1.381581	0.1016	74.65364	0.1705
res7*res7	0.390953	0.621850	0.9694	49.65107	0.9062
res2*res1	0.610982	1.521492	0.0495	77.59466	0.1183
res3*res1	0.576619	1.319380	0.1375	73.23065	0.2010
res3*res2	0.465710	0.844405	0.7485	59.14521	0.6484
res4*res1	0.545988	1.165006	0.2737	69.34053	0.3022
res4*res2	0.506115	0.992738	0.5120	64.27658	0.4668
res4*res3	0.693675	2.193741	0.0011	88.09673	0.0246
res5*res1	0.596331	1.431110	0.0792	75.73399	0.1497
res5*res2	0.553407	1.200451	0.2358	70.28269	0.2754
res5*res3	0.670340	1.969886	0.0040	85.13322	0.0399
res5*res4	0.617388	1.563187	0.0396	78.40825	0.1062
res6*res1	0.404103	0.656949	0.9513	51.32103	0.8738
res6*res2	0.516684	1.035631	0.4455	65.61882	0.4204
res6*res3	0.715741	2.439237	0.0003	90.89915	0.0152
res6*res4	0.627963	1.635155	0.0268	79.75126	0.0885
res6*res5	0.625179	1.615815	0.0298	79.39769	0.0929
res7*res1	0.445637	0.778751	0.8387	56.59587	0.7330
res7*res2	0.432019	0.736852	0.8863	54.86636	0.7851
res7*res3	0.468984	0.855583	0.7316	59.56096	0.6340
res7*res4	0.486724	0.918637	0.6319	61.81398	0.5542
res7*res5	0.542149	1.147115	0.2943	68.85297	0.3166
res7*res6	0.566974	1.268412	0.1745	72.00565	0.2301

We do not reject Ho for statistic 1%, but we reject Ho for statistic 5%

Stationarity Test Capesize Vessels

ADF outcomes

Table 163:Levels New Building Prices

Null Hypothesis: New Building Prices has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.950998	0.9460
Test critical values:	1% level	-4.030729	
	5% level	-3.445030	
	10% level	-3.147382	

Non stationary for statistic significance a=0,05

Table 164:First Difference New Building Prices

Null Hypothesis: D(: New Building Prices) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.820058	0.0007
Test critical values:	1% level	-4.030729	
	5% level	-3.445030	
	10% level	-3.147382	

Stationary for statistic significance a=0,05

Table 165:Levels Second Hand Prices

Null Hypothesis: Second Hand Prices has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.907664	0.6449
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Non stationary for statistic significance a=0,05

Table 166:First Difference Second Hand Prices

Null Hypothesis: D(Second Hand Prices) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.556379	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 167:Levels Operating Profit

Null Hypothesis: Operating Profit has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.358914	0.3993
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Non stationary for statistic significance a=0,05

Table 168:First Difference Operating Profit

Null Hypothesis: D(Operating Profit) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.801523	0.0000
Test critical values:	1% level	-4.030729	
	5% level	-3.445030	
	10% level	-3.147382	

Stationary for statistic significance a=0,05

Table 169:Levels Scrap Value

Null Hypothesis: Scrap Value has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.358657	0.3994
Test critical values:	1% level	-4.029595	
	5% level	-3.444487	
	10% level	-3.147063	

Non stationary for statistic significance a=0,05

Table 170:First Difference Scrap Value

Null Hypothesis: D(Scrap Value) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.17715	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 171:Levels Order Book/Fleet

Null Hypothesis: Order Book/ Fleet has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.425537	0.3647
Test critical values:	1% level	-4.031899	
	5% level	-3.445590	
	10% level	-3.147710	

Non stationary for statistic significance a=0,05

Table 172:First Difference Order Book/Fleet

Null Hypothesis: D(Order Book/ Fleet) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.259476	0.4525
Test critical values:	1% level	-4.031899	
	5% level	-3.445590	
	10% level	-3.147710	

Non stationary for statistic significance a=0,05

Table 173:Second Difference Order Book/Fleet

Null Hypothesis: D(Order Book/ Fleet,2) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-13.13881	0.0000
Test critical values:	1% level	-4.031899	
	5% level	-3.445590	
	10% level	-3.147710	

Stationary for statistic significance a=0,05

PP outcomes

Table 174:Levels New Building Prices

Null Hypothesis: New Building Prices has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.891397	0.9531
Test critical values:	1% level	-4.029595	
	5% level	-3.444487	
	10% level	-3.147063	

Non stationary for statistic significance a=0,05

Table 175:First Difference New Building Prices

Null Hypothesis: D(New Building Prices) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-8.419579	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 176:Levels Second Hand Prices

Null Hypothesis: Second Hand Prices has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.509330	0.8217
Test critical values:	1% level	-4.029595	
	5% level	-3.444487	
	10% level	-3.147063	

Non stationary for statistic significance a=0,05

Table 177:First Difference Second Hand Prices

Null Hypothesis: D(Second Hand Prices) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.487031	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 178:Levels Operating Profit

Null Hypothesis: Operating Profit has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.827524	0.6858
Test critical values:	1% level	-4.029595	
	5% level	-3.444487	
	10% level	-3.147063	

Non stationary for statistic significance a=0,05

Table 179:First Difference Operating Profit

Null Hypothesis: D(Operating Profit) has a unit root

Exogenous: Constant, Linear Trend
Bandwidth: 13 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.962633	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 180:Levels Scrap Value

Null Hypothesis: Scrap Value has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.314413	0.4229
Test critical values:	1% level	-4.029595	
	5% level	-3.444487	
	10% level	-3.147063	

Non stationary for statistic significance a=0,05

Table 181:First Difference Scrap Value

Null Hypothesis: D(Scrap Value) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-12.17715	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

Stationary for statistic significance a=0,05

Table 182:Levels Order Book/Fleet

Null Hypothesis: Order Book /Fleet has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.809630	0.6946
Test critical values:	1% level	-4.029595	
	5% level	-3.444487	
	10% level	-3.147063	

*MacKinnon (1996) one-sided p-values.

Non stationary for statistic significance a=0,05

Table 183:First Difference Order Book/Fleet

Null Hypothesis: D(Order Book /Fleet) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-11.04962	0.0000
Test critical values:	1% level	-4.030157	
	5% level	-3.444756	
	10% level	-3.147221	

*MacKinnon (1996) one-sided p-values.

Stationary for statistic significance a=0,05

KPSS outcomes

Table 184:Levels New Building Prices

Null Hypothesis: New Building Prices is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.182704
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Non stationary for statistic significance a=0,05

Table 185:First Difference New Building Prices

Null Hypothesis: D(New Building Prices) is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.123881
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Stationary for statistic significance a=1%

Table 186:Levels Second Hand Prices

Null Hypothesis: Second Hand Prices is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.183910
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Non stationary for statistic significance a=0,05

Table 187:First Difference Second Hand Prices

Null Hypothesis: D(Second Hand Prices) is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.076221
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Stationary for statistic significance a=1%

Table 188:Levels Operating Profit

Null Hypothesis: Operatong Profit is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.203972
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Non stationary for statistic significance a=0,05

Table 189:First Difference Operating Profit

Null Hypothesis: D(Operatong Profit) is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.050507
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Stationary for statistic significance a=1%

Table 190:Levels Scrap Value

Null Hypothesis: Scrap Value is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.195466
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Non stationary for statistic significance a=0,05

Table 191:First Difference Scrap Value

Null Hypothesis: D(Scrap Value) is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.045834
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Stationary for statistic significance a=1%

Table 192:Levels Order Book/Fleet

Null Hypothesis: Order Book /Fleet is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.121723
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Non stationary for statistic significance a=10%

Table 193:First Difference Order Book/Fleet

Null Hypothesis: D(Order Book /Fleet) is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.176661
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Non stationary for statistic significance a=0,05

Table 194:Second Difference Order Book/Fleet

Null Hypothesis: D(Order Book /Fleet,2) is stationary
Exogenous: Constant, Linear Trend

Bandwidth: 8 (Newey-West automatic) using Bartlett kernel		
		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.048096
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000
*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)		

Stationary for statistic significance a=1%

VECM Model estimation process

Table 195:Lag Length Criteria

Lag Length Criteria			
No	AIC	SC	HQ
0	-0.52	-0.33	-0.44
1	-14.62	*-12,95	-13.94
2	*-15,23	-12.09	*-13,96
3	-15.03	-10.41	-13.16
4	*-15,18	-9.08	-12.70
5	-14.97	-7.39	-11.89
6	-14.85	-5.80	-11.17
7	*-15,04	-4.50	-10.76
8	*-15,29	-3.27	-10.41
9	*-15,68	-2.19	-10.20
10	*-16,44	-1.47	-10.36

Lag Length Criteria Capesize Vessel
*Suggested lag length

Table 196:VECM model Long term Equation

	(SH)	(IP)	(LIBOR)	(NB)	D(OB)	(SCRAP)	(OP)	(TY)	C
Lag	-1	-1	-1	-1	-1	-1	-1	-1	0
Coef.	1	0	0	-0.47296	-2.661522	-0.895245	* 0.001962	-0.645214	* 0.440018
S.E.				(0.19485)	(0.56928)	(0.14825)	(0.06522)	(0.12218)	(0.48276)
t-stat.				[-2.42727]	[-4.67527]	[-6.03884]	[0.03009]	[-5.28104]	[0.91145]

Vector Error Correction model with lag of order 4 for Capesize vessels-Long term equation Co-integration equation 1
*Rejected for a=0,5

	(SH)	(IP)	(LIBOR)	(NB)	D(OB)	(SCRAP)	(OP)	(TY)	C
Lag	-1	-1	-1	-1	-1	-1	-1	-1	0
Coef.	1	0.200793	0	-3.905693	0	* 0.364512	0.789626	* 0.289515	2.437742
S.E.		(0.03396)		(0.44514)		(0.21961)	(0.15234)	(0.26609)	(0.85497)
t-stat.		[5.91199]		[-8.77404]		[1.65984]	[5.18325]	[1.08802]	[2.85125]

Vector Error Correction model with lag of order 4 for Capesize vessels-Long term equation Co-integration equation 2
*Rejected for a=0,5

	(SH)	(IP)	(LIBOR)	(NB)	D(OB)	(SCRAP)	(OP)	(TY)	C
Lag	-1	-1	-1	-1	-1	-1	-1	-1	0
Coef.	1	0	-0.30066	-1.971835	*-1.38634	0	0.387451	1.706581	-2.199221
S.E.			(0.04557)	(0.35841)	(0.85063)		(0.14654)	(0.34336)	(0.96040)
t-stat.			[-6.59821]	[-5.50166]	[-1.62977]		[2.64392]	[4.97019]	[-2.28991]

Vector Error Correction model with lag of order 4 for Capesize vessels-Long term equation Co-integration equation 3
*Rejected for a=0,5

Table 197:VECM model Short term Equation

	CointEq1	CointEq2	CointEq3
Coef.	**-0.288301**	*-0.032978	0.083432
S.E.	**(0.07842)**	(0.05418)	(0.06007)
t-stat.	**[-3.67634]**	[-0.60873]	[*1.38889]

Table 6.4.5.1.: Vector Error Correction model with lag of order 4 for Capesize vessels- Error Correction Term

*Rejected for a=0,5

	D(IP)	D(IP)	D(IP)	D(IP)	D(LIBOR)	D(LIBOR)	D(LIBOR)	D(LIBOR)
Lag	**-1**	**-2**	**-3**	**-4**	**-1**	**-2**	**-3**	**-4**
Coef.	* -0.004804	* -0.010458	* 0.011860	*-0.004335	**-0.200323**	* -0.067114	* 0.116890	-0.132564
S.E.	(0.01237)	(0.01194)	(0.01162)	(0.01074)	**(0.06333)**	(0.06441)	(0.06769)	(0.06870)
t-stat.	[-0.38842]	[-0.87572]	[1.02053]	[-0.40357]	**[-3.16313]**	[-1.04199]	[1.72685]	[-1.92967]

	D(OB)	D(OB)	D(OB)	D(OB)	D(NB)	D(NB)	D(NB)	D(NB)
Lag	**-1**	**-2**	**-3**	**-4**	**-1**	**-2**	**-3**	**-4**
Coef.	**-0.773453**	**-0.621448**	* -0.308248	* -0.150545	* -0.085956	*-0.094153	*-0.070051	*-0.258999
S.E.	**(0.21994)**	**(0.22103)**	(0.20316)	(0.14507)	(0.29142)	(0.27765)	(0.28574)	(0.28089)
t-stat.	**[-3.51669]**	**[-2.81157]**	[-1.51726]	[-1.03772]	[-0.29496]	[-0.33910]	[-0.24516]	[-0.92206]

	D(OP)	D(OP)	D(OP)	D(OP)	D(SCRAP)	D(SCRAP)	D(SCRAP)	D(SCRAP)
Lag	**-1**	**-2**	**-3**	**-4**	**-1**	**-2**	**-3**	**-4**
Coef.	**0.230833**	* -0.010903	* 0.058341	* 0.053131	*-0.122624	*-0.064155	* 0.171443	* -0.167581

S.E.	**(0.05309)**	(0.05432)	(0.04965)	(0.05127)	(0.10691)	(0.14310)	(0.14908)	(0.13859)
t-stat.	**[4.34782]**	[-0.20071]	[1.17516]	[1.03635]	[-1.14699]	[-0.44833]	[1.15000]	[-1.20919]

	D(TY)	**D(TY)**	**D(TY)**	**D(TY)**
Lag	**-1**	**-2**	**-3**	**-4**
Coef.	* -0.221767	* 0.017114	* 0.025223	**-0.340595**
S.E.	(0.15150)	(0.16146)	(0.14444)	**(0.13070)**
t-stat.	[-1.46381]	[0.10599]	[0.17463]	**[-2.60598]**

Table 6.4.5.2.: Vector Error Correction model with lag of order 4 for Capesize vessels- Statistics

*Rejected for a=0,5

R-squared	0.608573
Adj. R-squared	0.462326
Sum sq. resids	0.386041
S.E. equation	0.065132

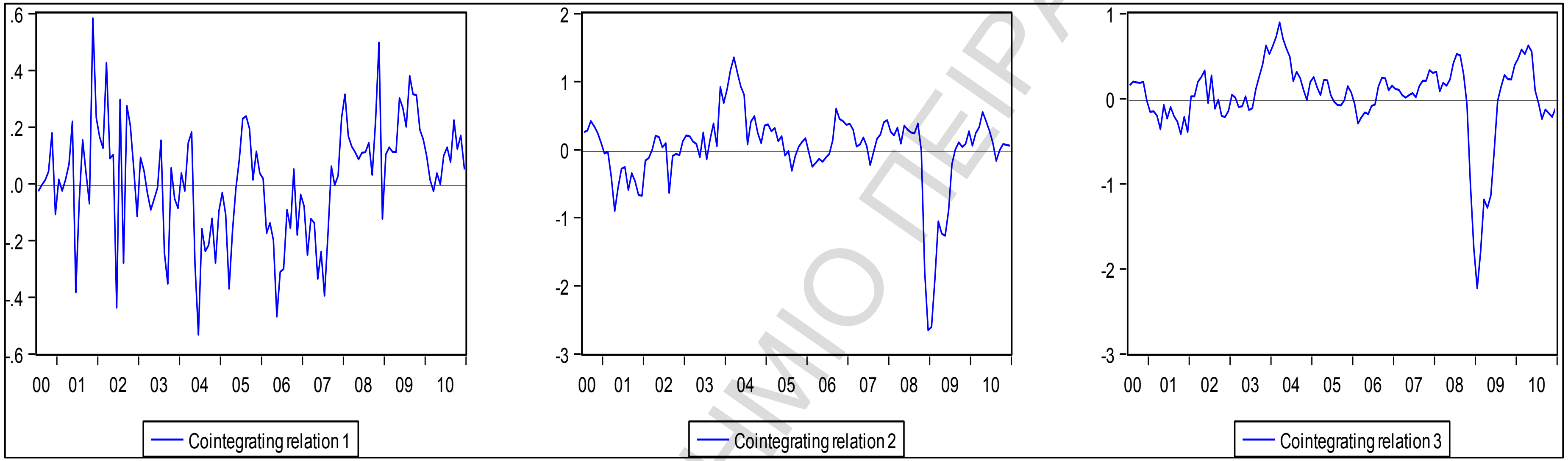
F-statistic	4.161263
Log likelihood	185.8637
Akaike AIC	-2.394661
Schwarz SC	-1.606805
Mean dependent	0.004439
S.D. dependent	0.088825

Table 6.2.5.3.: Vector Error Correction model with lag of order 4 for Capesize vessels- Statistics

*Rejected for a=0,

Graph 11:Co-integration Equation Graph VECM for lag 4 and 5% statistical Significance

Co-integration Equation Graph VECM for lag 4 and 5% statistical Significance

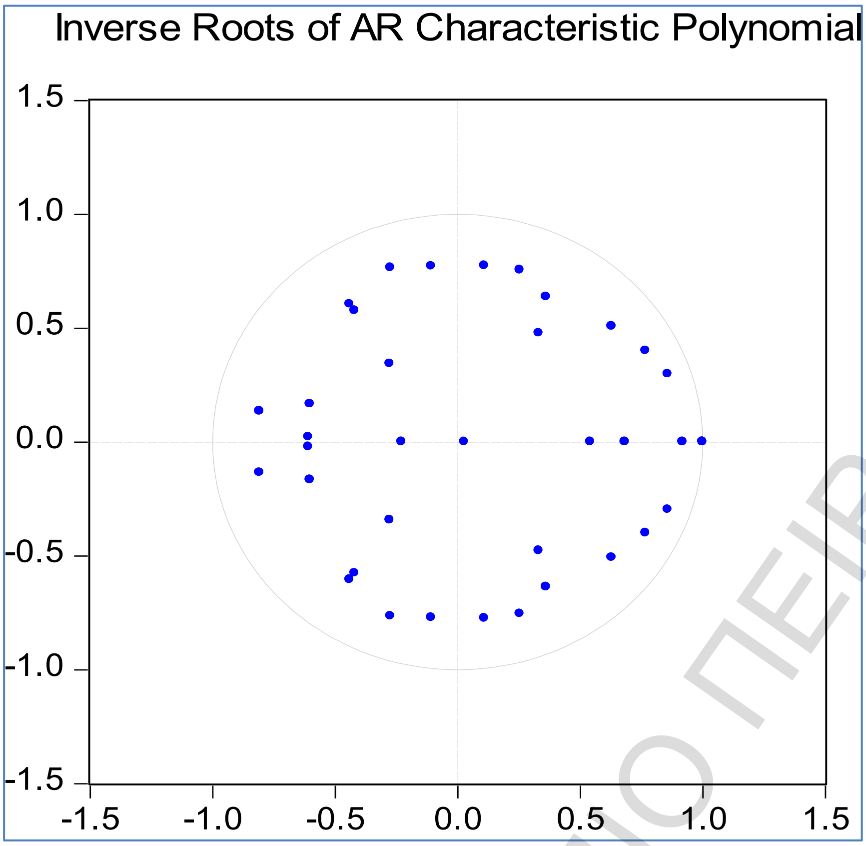


Lag Structure Test

Table 198:AR Roots table- VECM for lag 4 and 5% statistical Significance

Roots of Characteristic Polynomial	
Endogenous variables: IP LIBOR NBCAPSZ D(OB) SCRAPCAPSZ SHCAPSZ OP TY	
Exogenous variables:	None
Lag specification: 1 4	
Root	**Modulus**
□1.000000	□1.000000
□1.000000	□1.000000
□1.000000□□1.26e-15i	□1.000000
□1.000000□+□1.26e-15i	□1.000000
□1.000000	□1.000000
□0.919215	□0.919215
□0.858595□+□0.298130i	□0.908882
□0.858595□□0.298130i	□0.908882
□0.768488□+□0.399318i	□0.866042
□0.768488□□0.399318i	□0.866042
-0.808069□□0.134900i	□0.819251
-0.808069□+□0.134900i	□0.819251
-0.272041□+□0.764921i	□0.811856
-0.272041□□0.764921i	□0.811856
□0.629231□+□0.507887i	□0.808629
□0.629231□□0.507887i	□0.808629
□0.255515□+□0.754925i	□0.796994
□0.255515□□0.754925i	□0.796994
□0.110094□+□0.773496i	□0.781292
□0.110094□□0.773496i	□0.781292
-0.105914□+□0.770948i	□0.778189
-0.105914□□0.770948i	□0.778189
-0.438892□□0.604818i	□0.747282
-0.438892□+□0.604818i	□0.747282
□0.361350□+□0.637177i	□0.732508
□0.361350□□0.637177i	□0.732508
-0.418486□+□0.577109i	□0.712871
-0.418486□□0.577109i	□0.712871
□0.683345	□0.683345
-0.601728□+□0.165350i	□0.624033
-0.601728□□0.165350i	□0.624033
-0.607899□+□0.021664i	□0.608285
-0.607899□□0.021664i	□0.608285
□0.333022□□0.477563i	□0.582211
□0.333022□+□0.477563i	□0.582211
□0.543537	□0.543537
-0.275087□□0.343134i	□0.439788
-0.275087□+□0.343134i	□0.439788
-0.227894	□0.227894
□0.028899	□0.028899

Graph 12:AR roots Graph- VECM for lag 4 and 5% statistical Significance



No unit roots

Table 199:Granger Causality- VECM for lag 4 and 5% statistical Significance

VEC Granger Causality/Block Exogeneity Wald Tests							
Sample: 2000M01 2010M12							
Included observations: 126							
Dependent variable: D(SHCAPSZ)				Excluded variable: D(SHPNMX)			
Excluded	Chi-sq	df	Prob.	Dependent	Chi-sq	df	Prob.
D(IP)	4.225881	4	0.3763	D(IP)	0.646788	4	0.9577
D(LIBOR)	15.04142	4	0.0046	D(LIBOR)	4.261161	4	0.3718
D(NBCAPSZ)	1.113702	4	0.8921	D(NBCAPSZ)	6.673097	4	0.1542
D(OB,2)	13.11668	4	0.0107	D(OB,2)	6.544909	4	0.1620
D(SCRAPCAPSZ)	3.922422	4	0.4166	D(SCRAPCAPSZ)	1.938259	4	0.7471
D(OP)	20.25277	4	0.0004	D(OP)	3.513369	4	0.4758
D(TY)	9.965372	4	0.0410	D(TY)	10.61693	4	0.0312
All	70.19292	28	0.0000				

Table 200:Lag Exclusion Tests- VECM for lag 4 and 5% statistical Significance

VEC Lag Exclusion Wald Tests
Sample: 2000M01 2010M12
Included observations: 126
Chi-squared test statistics for lag exclusion:
Numbers in [ ] are p-values

	D(IP)	D(LIBOR)	D(NBCAPSZ)	D(OB,2)	D(SCRAPCAPSZ)	D(SHCAPSZ)	D(OP)	D(TY)	Joint
DLag 1	11.28312	9.480945	8.248690	55.72571	29.16857	78.64889	39.44838	35.35295	307.9861
	[0.186168]	[0.303361]	0.409562]	[0.000000]	[0.000000]	[0.000000]	[0.000000]	[0.000000]	[0.000000]
DLag 2	13.89594	5.448754	5.489143	39.90582	8.408052	10.55500	7.901282	22.18423	124.0019
	[0.084518]	[0.708711]	0.704243]	[0.000000]	[0.394658]	[0.228210]	[0.443172]	[0.004586]	[0.000000]
DLag 3	13.44689	14.08824	5.680040	12.37925	5.140103	12.69317	3.253872	14.75717	108.7966
	[0.097371]	[0.079494]	0.683022]	[0.135068]	[0.742502]	[0.122852]	[0.917430]	[0.064043]	[0.000000]
DLag 4	6.536203	6.101940	7.743313	2.996443	8.418566	15.41292	8.858253	19.37766	92.01456
	[0.587395]	[0.635814]	0.458937]	[0.934581]	[0.393687]	[0.051597]	[0.354394]	[0.012965]	[0.012447]
df	8	8	8	8	8	8	8	8	64

Joint test suggest that no lag should be excluded from the VEC for statistic 5%

Residual Tests

Table 201:Portmanteu Autocorrelation Test

Portmanteau Tests for Autocorrelations
Null Hypothesis: no residual autocorrelations up to lag h
Sample: 2000M01 2010M12
Included observations: 126

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	12.50641	NA*	12.60646	NA*	NA*
2	32.32583	NA*	32.74555	NA*	NA*
3	52.54826	NA*	53.46121	NA*	NA*
4	81.93782	NA*	83.81437	NA*	NA*
5	126.0808	0.0695	129.7814	0.0442	104
6	183.6886	0.1931	190.2696	0.1149	168
7	258.9396	0.1082	269.9472	0.0442	232
8	317.9141	0.1823	332.9199	0.0687	296
9	380.9228	0.2148	400.7755	0.0681	360
10	431.6707	0.3879	455.8982	0.1375	424

We do not reject Ho for statistic 5%

Table 202:Autocorrelation LM Test

Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Sample: 2000M01 2010M12
Included observations: 126

Lags	LM-Stat	Prob
1	63.39686	0.4978
2	69.29696	0.3035
3	63.16469	0.5060
4	70.75836	0.2624
5	61.63677	0.5605
6	62.39096	0.5336
7	89.18719	0.0205
8	67.24033	0.3668
9	76.12670	0.1426
10	58.61076	0.6668

We do not reject Ho for statistic 1%

Table 203:Normality Test

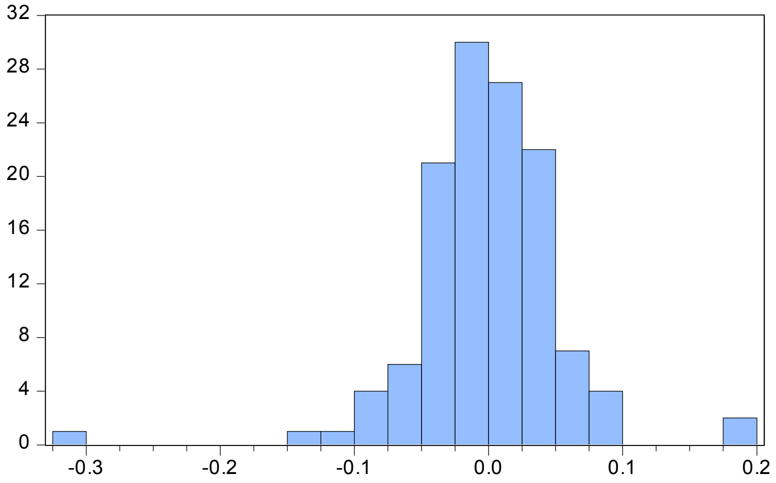
VEC Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: residuals are multivariate normal
Date: 09/01/13 Time: 17:23
Sample: 2000M01 2010M12
Included observations: 126

Component	Skewness	Chi-sq	df	Prob.
1	-0.740245	11.50722	1	0.0007
2	0.822833	14.21812	1	0.0002
3	-0.690148	10.00240	1	0.0016
4	1.596654	53.53537	1	0.0000
5	-2.516901	133.0306	1	0.0000
6	0.722005	10.94712	1	0.0009
7	0.551307	6.382721	1	0.0115
8	-0.017307	0.006290	1	0.9368
Joint		239.6298	8	0.0000

Component	Kurtosis	Chi-sq	df	Prob.
1	4.982016	20.62403	1	0.0000
2	8.433976	155.0225	1	0.0000
3	6.322288	57.94737	1	0.0000
4	9.604249	228.9845	1	0.0000
5	18.65153	1286.094	1	0.0000
6	4.791397	16.84778	1	0.0000
7	3.406589	0.867902	1	0.3515
8	3.483228	1.225923	1	0.2682
Joint		1767.614	8	0.0000

Component	Jarque-Bera	df	Prob.
1	32.13126	2	0.0000
2	169.2406	2	0.0000
3	67.94977	2	0.0000
4	282.5199	2	0.0000
5	1419.125	2	0.0000
6	27.79490	2	0.0000
7	7.250623	2	0.0266
8	1.232213	2	0.5400
Joint	2007.244	16	0.0000

We reject Ho for statistic 5%



Series: RESID06
Sample 2000M01 2010M12
Observations 126

Mean	0.000102
Median	-0.000487
Maximum	0.195156
Minimum	-0.324015
Std. Dev.	0.055573
Skewness	-1.046819
Kurtosis	12.66627
Jarque-Bera	513.5554
Probability	0.000000

RESID06

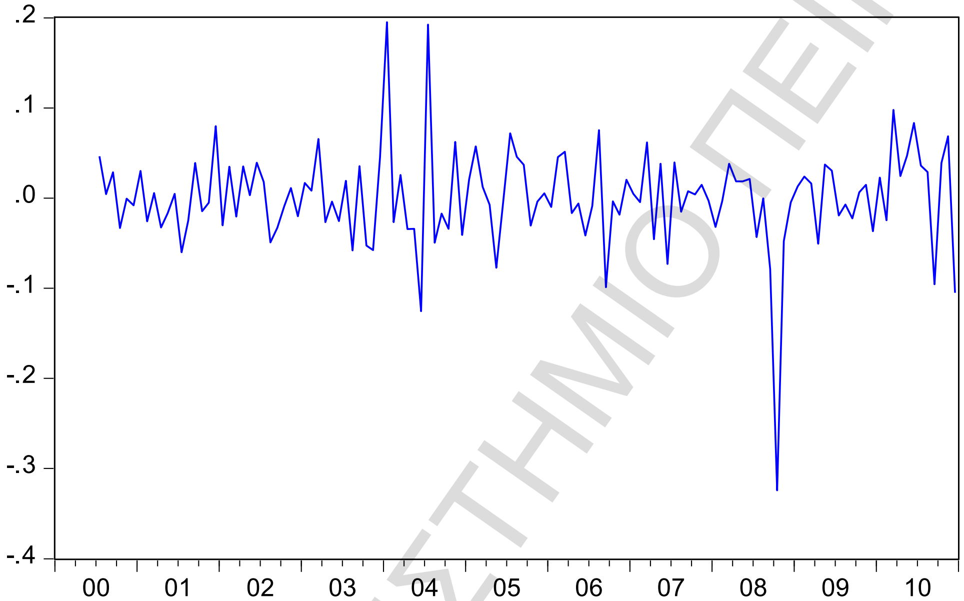


Table 204:White Heteroskedasticity

Heteroskedasticity Tests: No Cross Terms (only levels and squares)

Sample: 2000M01 2010M12

Included observations: 126

Joint test:

Chi-sq	df	Prob.
2641.708	2520	0.0449

Individual components:

Dependent	R-squared	F(70,55)	Prob.	Chi-sq(70)	Prob.
res1*res1	0.630317	1.339656	0.1305	79.41989	0.2065
res2*res2	0.501806	0.791411	0.8233	63.22754	0.7037
res3*res3	0.612827	1.243650	0.2011	77.21626	0.2591
res4*res4	0.286254	0.315117	1.0000	36.06796	0.9997
res5*res5	0.610074	1.229318	0.2140	76.86928	0.2681
res6*res6	0.669457	1.591328	0.0374	84.35161	0.1162
res7*res7	0.664265	1.554566	0.0453	83.69737	0.1261
res8*res8	0.596218	1.160171	0.2849	75.12341	0.3160
res2*res1	0.619918	1.281511	0.1702	78.10972	0.2369
res3*res1	0.569740	1.040423	0.4425	71.78721	0.4184
res3*res2	0.611130	1.234792	0.2090	77.00238	0.2646
res4*res1	0.602508	1.190967	0.2514	75.91604	0.2937
res4*res2	0.578957	1.080398	0.3853	72.94852	0.3813
res4*res3	0.487162	0.746375	0.8766	61.38237	0.7592
res5*res1	0.558500	0.993934	0.5136	70.37103	0.4651
res5*res2	0.578558	1.078633	0.3878	72.89829	0.3829
res5*res3	0.618474	1.273687	0.1763	77.92778	0.2413
res5*res4	0.540145	0.922897	0.6271	68.05821	0.5435
res6*res1	0.675079	1.632459	0.0302	85.06000	0.1062
res6*res2	0.615673	1.258675	0.1884	77.57479	0.2500
res6*res3	0.696038	1.799192	0.0124	87.70074	0.0748
res6*res4	0.536047	0.907805	0.6513	67.54186	0.5611
res6*res5	0.629179	1.333135	0.1345	79.27652	0.2097
res7*res1	0.687857	1.731447	0.0179	86.66998	0.0860
res7*res2	0.678981	1.661847	0.0259	85.55157	0.0997
res7*res3	0.582124	1.094542	0.3661	73.34761	0.3689
res7*res4	0.533396	0.898184	0.6667	67.20785	0.5725
res7*res5	0.613950	1.249552	0.1960	77.35771	0.2555
res7*res6	0.650942	1.465242	0.0711	82.01869	0.1542
res8*res1	0.506558	0.806600	0.8032	63.82633	0.6848
res8*res2	0.558411	0.993574	0.5141	70.35977	0.4655
res8*res3	0.642767	1.413734	0.0917	80.98870	0.1737
res8*res4	0.534199	0.901087	0.6620	67.30903	0.5690
res8*res5	0.508830	0.813963	0.7931	64.11252	0.6756
res8*res6	0.508497	0.812881	0.7946	64.07063	0.6770
res8*res7	0.584067	1.103326	0.3545	73.59242	0.3614

We do not reject Ho for statistic 1%, but we reject Ho for statistic

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