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INVESTIGATION OF THE POSSIBILITY THAT STOCK RETURNS OF SHIPPING LISTED CORPORATIONS PREDICT THE MOVEMENT OF THE BALTIC DRY INDEX

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Thesis

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Abstract

The shipping industry is the one of the main drivers of the world trade and world economy growth. It is responsible for the transportation of approximately 75% of world trade by volume (Lloyds Shipping Economist, 2011). Freight rates in the dry bulk shipping industry have been a core subject in the maritime studies for a long period of time. Most of the academic literature concentrates on examining the volatility of freight rates (Jing et al, 2008), seasonality (Kavussanos & Alizadeh, 2001), the dynamics of the freight rates (Xu et al, 2011, Tvedt, 2003) and forecasting approaches (Veenstra & Franses, 1997). The relationship between the freight rates and the dry bulk shipping companies' stock prices has been neglected in the academic literature. The lead lag relation between movements of stock prices and freight rates illustrates how fast one market reflects new information relative to the other and how well the two markets are linked together. The freight rates reflect the real market while the stock prices the financial market. Since we do not have any empirical data on the relation between the stock prices of shipping companies and the freight rates we will base our hypothesis on the academic literature that examines the relations between stock returns and the real market (represented by different variables). We develop an ECM and show that there is a lead lag relationship between freight rates and the stock prices of listed dry bulk companies.

The rational lies in the following. Since valuation models posit that stock prices are discounted future cash flows or earnings to be received by firms and firms' earnings are highly correlated to the gross domestic product, it follows that changes in stock prices might well reflect future directions of real activity.

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1. INTRODUCTION

The back bone of international trade is the dry bulk shipping market, which is an important feature in growth of the global economy and globalization, with dry bulk commodities representing around 40% of the sea borne trade. For the last two decades the dry bulk trade grew at an annual compound rate of 2,4% (1990-1999), 4,4% between 2000 and 2008. The prolonged period of buoyant markets, due to growing world trade and increasing international division of labor, ended in the late 2007. The only year the industry did not register growth was 2009, due to the effects of the global recession. The global seaborne dry bulk cargo trade is expected to grow at a rate of 4,6% during the period 2011 to 2013 (Chinnock & Hucker-Brown, A., 2011).

The main commodities that are transported in the dry bulk trade are iron, coal, and grain. Iron has the largest share in the dry bulk trade. It has registered constant growth in the last years and is expected to continue due to constant growth in demand and production on steel in big world economies as China and India. Coal is used as a source of energy and steel production. Its demand increased in 2010 due to growth in developing markets and is expected to continue to increase due to growing imports by China and Japan. Seaborne trade of grain also increased in 2010, after a decline in 2009, as a result of recovery of most world economies (IMO, 2011).

The growing increase in industrial production in emerging and developing countries like China and South East Asian countries constitute a major driving force for the demand of dry bulk commodities. Another growth source for the seaborne dry bulk trade is growing demand for energy and rising steel production. The growing world population and economic recovery will drive the demand and trade of grains. All these factors will contribute to the overall growth of global seaborne dry bulk trade. But the recent surge in global oil prices, prompted by spontaneous political unrest in the Middle East and disruption of Libyan oil supplies, poses a serious risk to the global recovery, as high oil prices weaken trade balances; add to inflation, while putting pressure on central banks to raise interest rates (Chinnock & Hucker-Brown, 2011). The European debt crisis and the critical situation of several European countries can constitute a threat to the trade routes between Asia and Europe.

Consequently, the market is characterized by high risk and volatility due to the uncertainty caused by factors as volume and pattern of world trade, global economy and government policy (Jing et al, 2008).

The dry bulk sector is highly fragmented, with no single owner accounting for clear majority share thus offering significant consolidation opportunities (Bornozis, 2006). It is also intensely competitive due to relatively low entry barriers and the companies operating in the industry compete mainly on fleet size, vessel capacity, and price.

The volatility of the dry bulk shipping market is reflected in the Baltic Dry Index. Since 2003 the international dry bulk shipping market freight rates have been in a prolonged peak period, with Dry Bulk Index reaching its maximum in the middle of 2008. The freight rates in the dry bulk shipping are driven by the forces of demand and supply. The demand side is affected by the global economic conditions and the factors mentioned above while supply side is affected by the availability and size of the global fleet. Shipping is a cyclical industry and it has been observed that imbalances between demand and supply have a direct impact on assets value, freight rates, and earnings. It is also influenced by seasonality and environmental conditions as hurricanes, monsoons and cold weather, which affect demand for dry bulk commodities.

We set out in the context of assisting the decision maker in shipping to investigate the lead lag relationship between freight rates and the stock prices of listed dry bulk companies.

The structure of the Thesis is the following: it started with a brief presentation of the dry bulk shipping sector, and continues with evidence from the academic literature about the freight rates, shipping stocks, and lead lag relationship between financial markets and real economy. The next section describes the data and the methodology used in the literature and in the present study. The econometric model is presented afterwards, together with the estimation results. The last section examines the forecasting performance of the models that have been developed.

2. LITERATURE REVIEW

The last two decades, the modern analysis of the bulk shipping industry was heavily influenced by the publication of Econometric Modeling of World Shipping by Beenstock and Vergottis (1993) and the revolution of econometric techniques generated by the development of co-integration analysis that changed the focus of researchers. Beenstock and Vergottis have developed a fully specified structural econometric model for the dry cargo freight market while the new econometric techniques include the use of reduced form and vector autoregressive (VAR) modeling, as an alternative to the structural models type used by Beenstock and Vergottis (Glen, 2006).

The freight risk and volatility are of a great interest because shipping markets have generated alternative investment opportunities attracting the interest of different investor groups in the last decade. Jing et al (2008) concentrate on the volatility of the freight rates in three sub markets of the dry bulk shipping industry, according to the vessel size (capsize, panamax and handysize). Using the daily returns of three different freight rates and integrating the data into an EGARCH model, the authors find that the changes in the dry bulk shipping market have a different influence on the volatility in different vessels types due to their distinct flexibility.

Dry bulk shipping is considered a seasonal sector, due to the nature and pattern of trade in transported commodities, and the seasonality is usually reflected in the dry bulk freight rates. An important work in this area has been published by Kavousanos & Alizadeh (2001). The authors examine the nature of seasonality in the dry bulk freight rates, measure it and compare it across freight rates of different vessel sizes, contract duration and market conditions. With the use of ARIMA and VAR models, the results show the presence significant deterministic seasonality (regular seasonal patterns). Freight rates increase during early spring (March) and drop sharply in June and July. There have also been identified asymmetric effects of seasonal fluctuations of freight rates under different market conditions. Seasonal fluctuations are sharper and more pronounced during market recovery as opposed to when market is deteriorating.

From the supply side the dry bulk freight rates are strongly influenced by the fleet size. A study that examines the relationship between the volatility of dry bulk freight rates and the fleet size is that of Xu et al (2011). Their a priori hypothesis that an increase in the change of the size of fleet trading in the market leads to an increase in freight rate volatility is supported by the estimation results. The relationship between the two variables is nonlinear and the study itself provides valuable insights into the current status of freight management.

The dynamics of the freight rates in the shipping industry is a widely examined subject. The consensus in the academic literature, strongly supported by evidence, is that freight rates are non-stationary. Veenstra & Frances (1997) using an augmented Dickey Fuller test conclude that all series are non-stationary at 1%, however, at 5% level the null hypothesis of non-stationarity is rejected only for two of the examined routes. The general result of the study is that freight rates follow random walks but are co-integrated. The same results are delivered by Kavoussanos (1996), Glen (1997), Hale & Vanags (1992) in Tvedt (2003). With few exceptions, the evidence in the modern literature seems very strong that freight rates in the dry bulk shipping markets follow random walks. One of the exceptions is the paper by Tvedt (2003). His study is based on the argument that demand for large dry bulk vessels is mainly generated by transport to Asia and Europe and that Japan is the major player in the dry bulk market form the demand for shipping services perspective as well as from a ship building perspective. The first tests, using US $ denominated freight rates, confirm the classical shipping models that indicate stationarity. By changing the denomination of the data from US $ to Japanese yen freight rates become stationary. This study indicates that the perception that international shipping is a US $ industry may be misleading, since yen denominated prices probably reflect better the fundamental changes in the industry and give more valuable information to market agents.

On the other hand, the shipping companies' stock returns have been examined in the light of the macroeconomic factors that affect their performance (El-Masry et al, 2010, Drobetz et al, 2010). The literature that concentrates on the shipping stock in an asset pricing context is very limited. Most studies, conducted on US shipping stocks, have concluded that the beta of the shipping companies is below one (Kavussanos & Marcoulis, 1997a, Kavussanos & Marcoulis, 1997b) and that there is no significant difference between the average betas of the shipping industry and S&P index. Empirical findings suggest that shipping stocks exhibit lower risk (covariance) in terms of beta than the overall stock market (Drobetz et al, 2010). Related studies that examine the macro and micro economic factors to explain the transportation stock returns, have shown that there is some explanatory power of the changes in industrial production and the changes in the oil price for shipping stocks (Kavussanos & Marcoulis, 2000 in Drobetz et al, 2010). Grammenos & Arkoulis (2002) report that oil prices are negatively related to shipping stocks return, whereas a US $ depreciation results in a higher stock return. However, they did not find any significant relationship between shipping stock returns and industrial production and global measures of inflation. Using a multi pricing model Drobetz et al (2010) identify the world stock market index, currency fluctuations against US $, changes in industrial production and changes in oil price as long-run systematic factors that drive expected stock returns. El-Masry et al (2010) also examine the exposure of shipping stock returns to financial risks and oil prices. Their study analyzes the relationship between the stock return, the exchange rates fluctuations, interest rates, and oil prices. The results are contradictory to previous works and indicate that a higher proportion of shipping firms exhibit positive exposure coefficients of the exchange rates and oil prices. This means that they benefit from US $ appreciation and from an increase in oil prices.

The leading role of the stock prices changes has received a lot of attention in the academic literature Fama (1981), Fisher & Merton (1984), Barro (1990), Liu et Al (1993), Aylward & Glen (2000), Canova & De Nicolo (2000), Hassapis & Kalyvitis (2002), Panopoulu (2007), Ibrahim (2010). Most of these empirical papers concentrate on the US market and other advanced markets. Exceptions are Aylward & Glen (2000) and Ibrahim (2010), who extend their analysis to several emerging markets. In 1981 Fama, in his well-known article outline the famous "proxy hypothesis" which states that there is a negative relationship between real stock returns and expected inflation.

His proxy hypothesis consists of three empirically tested propositions:

- Current stock returns are positively related to anticipated real activity
- Monetary policy is countercyclical
- Expected increase in the money supply causes expected inflation to rise

The negative correlation between real stock return and inflation is a result of the negative correlation between inflation and real economic activity and the positive relation between real activity and stock returns. In Fama's (1981) analysis he uses post war US data and finds a positive relation between stock returns and GNP growth. Later on, Moore (1983) in Ibrahim (2010), Fisher & Merton (1984) and Barro (1990) document evidence of the leading role of stock prices for US business cycle for period 1873-1975, 1950-1982 and 1891-1971 respectively. By examining various financial variables as leading indicators Fisher & Merton (1984) conclude that stock returns are best predictor of future GNP growth. The same result is obtained by Barro (1990) who points out the significant predictive power of lagged stock returns for investment and GNP variations. Later on, Liu et al (1993) re-examined the propositions of the proxy hypothesis using monthly and quarterly data for the US, Canada, UK and Germany for the time period between July 1974 and June 1990. Using different models the authors conclude that there is an insignificant relation between real stock returns and anticipated real activity.

The analysis of the stock returns and real economic activity has been extended to other advanced markets. Canova & De Nicolo (2000) examine the interdependencies among assets returns, real activity and inflation from multicountry point of view. The countries analyzed are US, Germany, UK and Japan. Using VAR models, they estimate that informational content of innovations in nominal stock return for inflation and real activity is negligible in all countries, but innovations in US stock markets are rapidly incorporated in nominal foreign stock returns. Also, the link between financial markets and real activity is important for US and almost absent for other countries. A casual relation between output growth and real stock price changes has been examined by Hassapis & Kalyvitis (2002) for the G-7 countries. Using a VAR model they find a strong correlation between the two variables for each country. The results indicate that unanticipated changes in stock prices and output growth have a significant impact on future economic growth and market valuation of capital. Panopoulou (2007), confirms the relationship between the two variables using out of sample experiments and comparing various financial indicators.

From the above mentioned literature, only two studies extend the analysis to emerging markets. Aylward & Glen (2000) examine 15 emerging markets in addition to G7 and Australia. They show that there is evidence of the leading role of the stock price changes in some countries (data used: 1951-1993), but there is substantial variation the stock returns' explanatory power across countries. The estimations show that results for developed markets seem more encouraging than emerging markets. An important contribution on emergent markets is the paper of Ibrahim (2010), who examines the role of stock market returns as a predictor of real output for the fast-growing emerging market of Malaysia. Using quarterly data from 1978 to 2008 and employing a single-equation autoregressive linear model he concludes that there is significant evidence for the stock returns as indicator for output growth in Malaysia at short horizon (less than a year). Despite the high volatility, the Malaysian stock market has a predictive ability for real output growth, limited to the short term forecast.

3. METHODOLOGY

In lead lag relationships the main assumption is the co-integration of the series that are being examined. The cornerstone in the studies of co-integrated series that move together through time and the concept of error correction is provided by Engle and Granger (1987). The main idea is that a proportion of disequilibrium is corrected in the next period, given a movement away from long run equilibrium in one period (Harris et al, 1995). This procedure is appropriate for only two variables with one co-integrating vector. In the case of more variables, which is more practical, the co-integration test by Johansen is used, since it identifies the space spanned by co-integrating vector. As opposed to past studies, which discuss the cases where co-integrated residuals are integrated of order zero for an ECM, more recent studies have shown a more general case in which the co integrated residuals follow a fractionally integrated process. Rajaguru & Pattanayak (2007), when investigating the relationship between spot and future indices of the Hang Seng stock average, use all the model stated above. When comparing the forecast performance of the models, they show that, overall, ECM provides best performance in the short-term forecast but the FIECM forecasts are better than the other models in the long forecast horizon. This is due to the fact that ECM models allows only first order lag of the co-integration residual to affect the spot and the future prices. Kavoussanos et al (2008) examine the lead lag relationship in daily volatilities and returns between cash and stock index futures price series using a VECM-GARCH-X model and found that futures returns lead is much stronger than the cash index returns, as futures market responds more rapidly to economic events than stock prices. The volatility spillovers between cash and futures market are investigated and it is shown that futures market volatility spills information to the cash market volatility in both markets but not vice versa.

A newer approach to examining the lead lag relationship is the threshold regression model (TRM). The TRM gives the opportunity to capture lead lag relation under different scenarios or market conditions, which determine different linear regression regimes. The market conditions are proxied by threshold variables which segment the sample data into different pricewise linear regimes. Tse & Chan (2010) use this model in estimating the lead lag relation between the S&P500 spot and futures markets.

We will follow the co-integration approach, which is widely used in the modern academic literature (Veenstra & Franses, 1997; Tvedt, 2003) since our purpose in to determine if there is a lead lag relationship between the stock returns and the BDI in the dry bulk shipping industry. The null hypothesis will be that the stock returns lead the freight rates. We will test this hypothesis using a ECM and determine the correct form of the regression equation or system of equations.

4. DATA DESCRIPTION

The data used in the present study are monthly time series for the period January 2007 – September 2012. The variables that are employed in the model are:

- Baltic Dry Index (the freight rates for the dry bulk shipping)
- The size of the dry bulk fleet
- The world growth rate
- Stock returns index
- A dummy variable

Three different samples of dry bulk shipping companies are used in the analysis, according to the stock exchange the companies are listed in. The first sample contains 28 shipping companies listed at NYSE, NASDAQ and LSE (London Stock Exchange), the second one contains 14 European listed companies and the third one 27 Asia listed companies. Accordingly, three monthly stock indices for each market are created. The list of the analyzed companies is presented in Appendix. The stock index for each month is calculated using the market capitalization of each company and the monthly closing prices for their stocks. In order to be able to construct the indices, the closing stock prices for all companies are expressed in US $. The transformation from each national currency to US $ was done by using exchange rates for the last day of each month available at www.xe.com. Stock prices and the number of shares for each company were drawn from Reuters Database. The Baltic Dry Index is the index that tracks worldwide international shipping prices of various dry bulk cargoes. It contains the four different sizes of dry bulk transport vessels. Basically, it measures the demand for shipping capacity versus the supply of dry bulk carriers. Since the supply of cargo ships is generally inelastic and tight, a marginal increase in demand can push the index higher and vice versa. The fluctuations in demand for transportation services are strongly related to the world growth rate. Because dry bulk shipping transports primarily materials that function as raw material inputs to the intermediate and finished gods (concrete, electricity, steel, food), the index in seen as an efficient economic indicator because it predicts future economic activity. In order to have a larger sample size, in our analysis we use listed companies that activate in tankers and container shipping sectors. However, all companies have as a main activity dry bulk carriage. The monthly world growth rates have been collected from the Clarksonet database. A dummy variable is also included in the model. It takes a value of 0, except for the period June-December 2008, when it takes a value of 1. The specific period is the time frame when the BDI registered steep decline due to international economic recession.

Since the freight rates are determined by the forces of supply and demand, we will use the dry bulk fleet size as a variable that will stand for the supply side of the market. The size of the world dry bulk fleet on a monthly basis was found from the Clarksonet database. For the demand side of the market we create a new variable using both the world growth rate and the dry bulk fleet size.

This variable called **w1=wgr/100-D(log(bfl)**, is constructed this way as to eliminate the effect of the supply side on the freight rates and shows the pure effect of world growth rate on the freight rates.

In this study we analyze the data after taking natural logarithms. This overcomes comparability problems in the data, since the series originate from different sections of the dry bulk shipping industry and are expressed in different measure units. Taking logarithms helps in stabilizing the data and reduces the impact of heteroskedasticity. All series are plotted in Figure 1, 2, and 3 in the Appendix. Figure1 shows the plotted data for the fright rate (BDI). Figure 2, is a representation of the three stock indices, Figure 3 shows the plot of the fleet size. As we can see the freight rates as well as the stock indices follow the same pattern. There is an upward trend in 2007 and 2008, a steep fall in the middle of 2008 followed by a partial recovery in 2009 and 2010 and downward trend since the beginning of 2011. The US listed companies' stock index exhibits a downward trend much later (August 2011). There is a clear upward trend in the dry bulk fleet size, with the exception of the first two month of 2009, when there was no growth. The notation for each series is presented in Table 1.

Series Name	Variable
Stock index for the European Listed Shipping Companies	si1
Stock index for the Asian Listed Shipping Companies	si1
Stock index for the US Listed Shipping Companies	si3
World Growth Rate	wgr
Baltic Dry Index (Freight Rates)	bdi
Dummy Variable	dum
Size of the international dry bulk fleet	bfl
Variable that stands for the demand side of the market	w1 = wgr – D(log(bfl))

Table 1. Time series notation.

The standard procedure when dealing with univariate time series is testing for unit root. The existence of a unit root implies non-stationarity, which is why it is very important to test for it. Stationarity implies that the mean and variance of a time series process are constant over time and that the autocovarriances and autocorrelations only depend on the time difference between the observations involved. Testing for unit root enables direct inference on the degree of non-stationarity and indicates the degree of differencing that is needed to make the series stationary. There are several test available to test for unit root, we will be using the augmented Dickey-Fuller (ADF) and Philips Perron tests, since they are widely applied in time series analysis.

The null hypothesis of the ADF test that the time series is non-stationary (there is unit root). The ADF test is applied to all variables, except for bfl, where we apply the Philips-Perron test, to test for unit root. The results in the Table 2 show that all series, except for w1, are integrated of order one.

Series	**si1**	**si2**	**si3**	**bfl**	**w1**	**bdi**
t-statistic	-1,18	-1,22	-1,8	-3,23	-2,82	-2,34
Order of integration	1	1	1	1	0	1

Table 2. Unit root test results

Since all variables are integrated of the same order we can proceed with examining the co-integration assumption.

5. ECONOMETRIC MODEL

Co-integration implies that although two or more series are non-stationary, or integrated, a linear combination of these series can be stationary. To determine whether our variables are co-integrated we will use both, Engle Granger and Johansen approach. Engle Granger procedure implies running and OLS regression including all the variables. Since the evidence from the literature support that the financial markets lead the real economy, we will regress the freight rates on the stock return and all the other variables. The initial OLS regressions for the three stock returns will be:

$$\log(bdi) = \alpha 0+\alpha 1\log(si1)+\alpha 2w1+\alpha 3lbfl +ut \quad (1)$$

$$\log(bdi) = \beta 0+\beta 1\log(si2)+\beta 2w1+\beta 3lbfl+vt \quad (2)$$

$$\log(bdi) = \gamma 0+\gamma 1\log(si3)+\gamma 2w1+\gamma 3lbfl+rt \quad (3)$$

After running the three regressions and saving the residuals, a ADF test is performed on the residuals' series to determine if there is co-integration between the variables. For all stock indices the results show that the residuals are not integrated (no unit root), which means that the variables are co-integrated. This shows that the regression that has been estimated is a long run equilibrium relationship. In order to confirm this result, we will also run a Johansen test, which is more reliable in the case of more than two variables. The Johansen test examines the presence of a long-run relationship between the time series that are being examined. It permits the testing of hypothesis about the equilibrium relationships between the variables (Brooks, 2008). The Johansen technique is based on VECM (Vector Error Correction Model) and it allows testing a hypothesis for one or more coefficients in the co-integrating relationships. Johansen's test is based on the properties of the Π matrix. The elements of this matrix should be close to zero if the variables are not co-integrated. If a number of n co-integrating vectors are determined, only these linear combinations or linear transformations of them, or combinations of the co-integrating vectors, will be stationary. The number of co-integrating vectors is determined using the trace statistic and the max-eigen statistic. After analyzing the test results, the best co-integrating equation or set of equations is chosen, based on their validity and accordance with economic theory. The Johansen test results for the US listed companies group is presented in Table 3 below. As one can see the trace statistic and eigen value tasts indicate the presence of 2 co-integrating equations at 5% level of significance.

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.446511	64.15117	47.85613	0.0007
At most 1 *	0.326386	32.20941	29.79707	0.0259
At most 2	0.113242	10.87411	15.49471	0.2193
At most 3	0.077980	3.841466	4.384188	0.0363

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.446511	31.94176	27.58434	0.0129
At most 1 *	0.326386	21.33530	21.13162	0.0468
At most 2	0.113242	6.489917	14.26460	0.5512
At most 3	0.077980	3.841466	4.384188	0.0363

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 3. Johansen test results for US listed companies

The two co-integrating vectors give the following relationships between the variables:

$$LBDI=-8,98LBFL+16,94W1 \qquad (4)$$

$$LSI3=-2,15LBFL+15,49W1 \qquad (5)$$

Both relationships are reasonable according to economic theory. The freight rates are negatively related to the fleet size (an increase in fleet size leads to an increase in supply and consequently to a decrease in freight rates) and positively related to the variable W1, that stands for the net effect of the world growth rate on the freight rate. The second equation (5) indicates that the stock index return is negatively related to the fleet size and positively related to W1. Both relations stand economically so we can use them to create a system of two equations in order to test for the lead lad relationship between the freight rates and stock index. The Johansen test results for Europe listed companies are shown in Table 4. They show again the presence of 2 co-integrating vectors and lead us to the creation of a system of two equations.

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.582896	78.15123	47.85613	0.0000
At most 1 *	0.331762	30.93256	29.79707	0.0369
At most 2	0.125044	9.164597	15.49471	0.3504
At most 3	0.035488	1.951178	3.841466	0.1625

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.582896	47.21867	27.58434	0.0001
At most 1 *	0.331762	21.76796	21.13162	0.0407
At most 2	0.125044	7.213419	14.26460	0.4642
At most 3	0.035488	1.951178	3.841466	0.1625

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 4. Johansen test results for Europe listed companies

The two co-integrating equations generated by the Johansen test are:

$$LBDI=-12,2LBFL+17,26W1 \quad (6)$$

$$LSI1=-9,39+14,09W1 \quad (7)$$

The relationships presented by equations (6) and (7) are the same as in the case of the US listed companies and are in accordance with economic theory.

In the case of Asia, the Johansen test indicates the presence of three co-integrating equations as shown in Table 5.

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.479527	80.26971	47.85613	0.0000
At most 1 *	0.380281	45.00680	29.79707	0.0004
At most 2 *	0.263163	19.16843	15.49471	0.0133
At most 3	0.048374	2.677473	3.841466	0.1018

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.479527	35.26290	27.58434	0.0043
At most 1 *	0.380281	25.83837	21.13162	0.0101
At most 2 *	0.263163	16.49096	14.26460	0.0219
At most 3	0.048374	2.677473	3.841466	0.1018

Max-eigenvalue test indicates 3 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 5. Johansen test results for Asia listed companies

Since the methodology for the case of Asia is more time consuming and complicated we will not proceed with analyzing the return of this stock index in relation to the freight rates in the framework of this study.

Before proceeding with the construction of the ECM, the residuals from the two initial equations (1), (2) are saved (after being tested for unit root) and introduced in the final systems of equations we create for US and Europe.

The estimated long run equation is used in the ECM as the imposed long run solution of the short run model. We have to estimate a ECM consisting of a system of two equations in order to be able to determine the lead lad relationship and interpret the results. The following Vector Error Correction model is estimated:

$$\Delta R_t = \sum_{i=1}^{n-1} a_{R,i}\Delta R_{t-i} + \sum_{i=1}^{n-1} b_{R,i}\Delta SI_{t-i} + a_R(R_{t-1} - \beta_1 - \beta_2 SI_{t-1}) + dum + \varepsilon_{R,t} \quad (8a)$$

$$\Delta SI_t = \sum_{i=1}^{n-1} a_{SI,i}\Delta R_{t-i} + \sum_{i=1}^{n-1} b_{SI,i}\Delta SI_{t-i} + a_{SI}(R_{t-1} - \beta_1 - \beta_2 SI_{t-1}) + dum + \varepsilon_{SI,t} \quad (8b)$$

Where $\mathbf{SI_t}$ and $\mathbf{R_t}$ are the logarithmic prices for the stock index for each region and the freight rate (Baltic Dry Index) and $Z_{t-1}=R_{t-1} - \beta_1 - \beta_2 SI_{t-1}$ is the lagged Error Correction Term. Coefficients $\boldsymbol{\alpha_{R,i}}$, $\boldsymbol{\alpha_{SI,i}}$, $\mathbf{b_{R,i}}$, $\mathbf{b_{SI,i}}$ are the short run coefficients, while $\mathbf{a_R}$ and $\mathbf{a_{SI}}$ measure the long run impact of the lagged ECT on ΔR_t and ΔSI_t. If the freight rates and stock returns are co-integrated, then there has to be causality in at least one direction. Unidirectional causality (from stock index return to the freight rate) requires that:

(i) Some of the $\mathbf{b_{R,i}}$ coefficients are different from zero

(ii) $\mathbf{a_R}$, the Error Correction Term from equation (8a) is significant

Unidirectional causality (from freight rate to stock index return) requires:

(i) Some of the $\mathbf{a_{SI,i}}$ coefficients are different from zero

(ii) $\mathbf{a_{SI}}$, the Error Correction Term from equation (8b) is significant

If both variables cause each other, it is said that there is a two way feedback relationship between ΔR_t and ΔSI_t (Kavoussanos et al, 2008).

6. ESTIMATION RESULTS

6.1 US listed companies

The coefficient of the lagged Error term measures the adjustment to long term equilibrium. If the coefficient is close to zero the adjustment is slow, while if it is one the adjustment to equilibrium is quick. The results of estimating the short run parameters, the coefficients of the ECT and the t statistics of the coefficients are shown in below.

Using a general to specific methodology and trying different combinations of variables and lagged variables we estimate a final ECM system of two equations for the US listed companies:

$$D(lbdi)=0{,}014+1{,}22D(lsi3)-0{,}26dum-\mathbf{0{,}41ECT}-0{,}16D(lbdi(-8))-0{,}96D(lsi3(-3))-0{,}46D(lsi3(-7))+u_t \quad (9a)$$

(0,45) (4,56) (-2,81) (-3,65) (-1,38) (-4,36) (-1,68)

$$D(lsi3)=0{,}031-0{,}19dum+\mathbf{0{,}21ECT}-0{,}36D(lsi3(-12))-0{,}2D(lsi3(-2))-0{,}08D(lbdi(-7))+v_t \quad (9b)$$

(2,1) (-4,7) (3,94) (-3,2) (-1,82) (-1,96)

The coefficients of the Error Correction Terms a_R=-0,413 and a_{SI}=0,21 provide information about the adjustment process of the freight rates and stock index return to equilibrium. Both coefficients are statistically significant, the coefficient in the freight rate equation is negative, while the one in the stock index equation is positive. This means that both, freight rates and stock index prices respond to correct a shock in the system in order to reach long run equilibrium. For example, in response to a positive deviation from equilibrium relationship in period t-1, freight rates in the next period decrease in value, thus eliminating any disequilibrium. On the other hand, the second equation shows that in response to positive deviation from equilibrium in period t-1, stock index returns in the next period increase in value to reach equilibrium. Equation 9a is a expression of the freight rates in relation to the stock index return, its lagged values and the lagged values of the freight rates. We can see a strong positive relation between the freight rates and the stock index return. A unit change in the stock index return will lead to 1,222 units change in the dry bulk freight rates. It can be observed that freight rates are negatively related to the stock index return in period t-3 (3 month ago), a unit change in stock returns in period t-3 will lead to a decrease in freight rates by 0,96 units. The coefficients for the lagged values of freight rates are insignificant. This shows a strong lead role of the stock index return on the freight rates. Equation 9b is a representation of the stock index return in relation to the freight rates. The coefficients of the level and lagged values of the freight rates are insignificant, while the lagged values of the stock return in previous period influence the present prices. This statement comes to confirm the fact that the relationship between stock index return and freight rates is unidirectional and that, for the case of US listed dry bulk shipping companies, the stock index return leads.

Residual tests performed on the system give the following results:

1) Normality (Cholesky of covariance): the Joint Jarque Berra shows that the residuals of the system are normally distributed
2) Correlograms: the graphs of the autocorrelations show that the errors are within the two standard errors boundaries, which indicates the correct specification of the system (no heteroskedasticity and autocorrelation)

The explanatory power of the model is good, since R^2 and adjusted R^2 for both equations is above 54%.

Series	**Equation 9a**	**Equation 9b**
R^2	0,63	0,59
Adjusted R^2	0,58	0,54

Table 6. Model explanatory power (US)

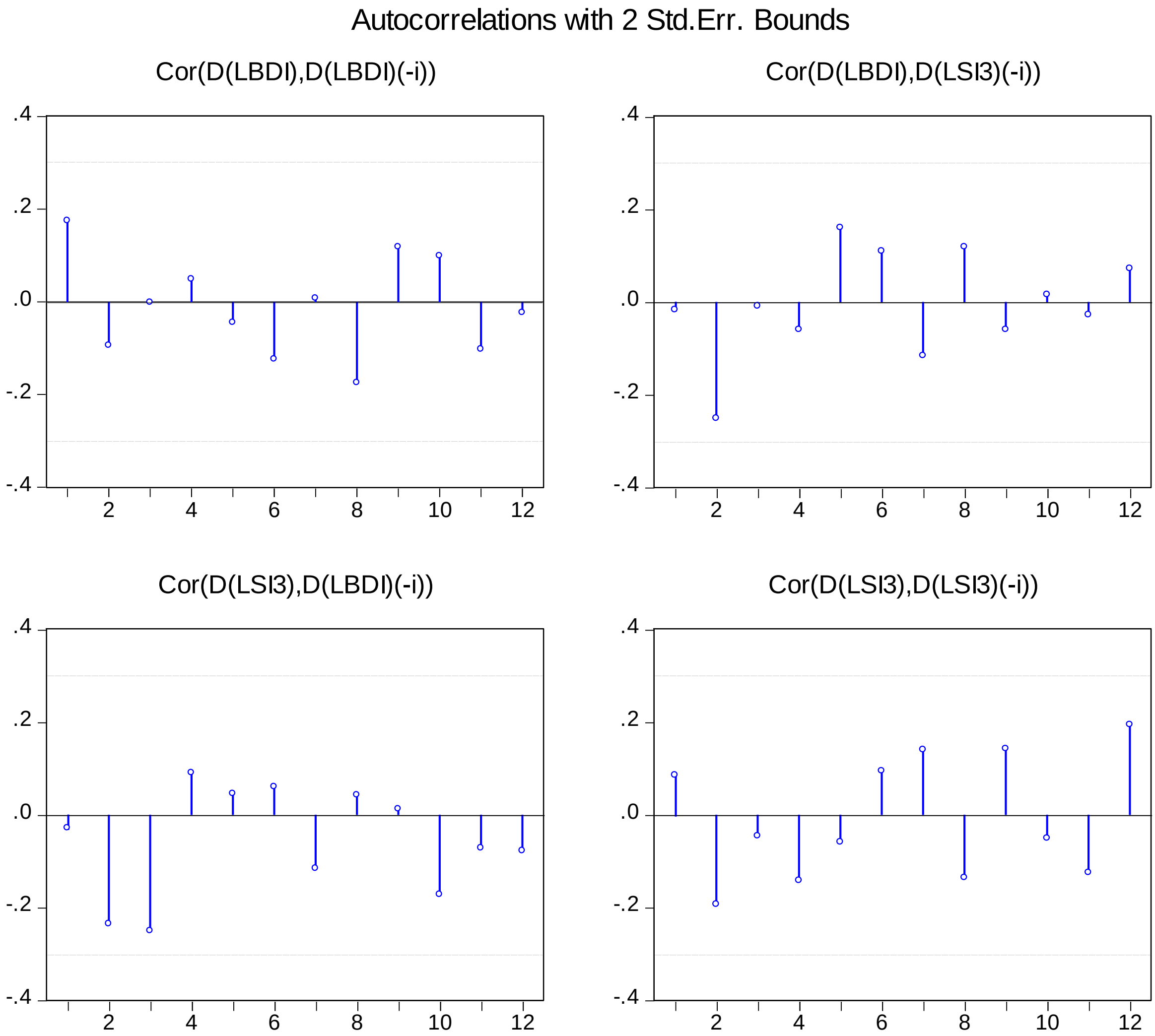


Table 7. Correlograms for US listed companies ECM system

6.2 Europe Listed Companies

For the Europe listed companies the estimated ECM system has the following equations:

$$D(lbdi)=0{,}014+1{,}34D(lsi1)-0{,}34dum-0{,}37ECT-0{,}17D(lbdi(-8))-0{,}65D(lsi1(-3))+u_t \quad (10a)$$

(0,47) (4,59) (-3,54) (-3,21) (-1,67) (-2,53)

$$D(lsi1)=0{,}2ECT+0{,}2D(lbdi)-0{,}15D(lsi1(-2))-0{,}07D(lbdi(-5))+v_t \quad (10b)$$

(5,22) (5,25) (-1,37) (1,86)

The t statistics of the coefficients are presented in the parenthesis below the equations. The coefficients of the Error Correction Terms a_R=-0,37 and a_{SI}=0,2 provide information about the adjustment process of the freight rates and stock index return to equilibrium. Both coefficients are statistically significant, the coefficient in the freight rate equation is negative, while the one in the stock index equation is positive. This means that both, freight rates and stock index prices respond to correct a shock in the system in order to reach long run equilibrium. The opposite signs of the coefficients indicate a clear lead lag relationship between the freight rates and the stock index returns in the European listed dry bulk shipping companies. Equation (10a) is a representation of the relationship between freight rates and stock index. The freight rates are positively related to the stock index returns, which mean that a unit increase in the stock index in period t will lead to a 1,34 units increase in the freight rates in the same period. The equation also indicates that the freight rates depend on lagged values of the stock index, which means that the present value of the freight rate changes are also influenced by past changes in the values of the stock index. The coefficients for the lagged values of freight rates are insignificant. This shows a strong lead role of the stock index return on the freight rates. The second equation of the system (10b) is an expression of the stock index dependence on the freight rates and its lagged values, the ECT and the lagged values of the stock index. As opposed to the US listed companies system of equations, in the case of Europe we observe, except for the lead lag relationship, a bi-directional Granger causality. The stock index is positively related to the level value of the freight rate changes (LBDI). The coefficients for the lagged stock index values and lagged values of LBDI are insignificant. These results show that in the case of Europe, in the short run, the there is a bi-directional (positive) relationship between changes in the stock index returns and changes in the freight rates for the dry bulk shipping companies. This means that, in the short run, not only financial market influences (leads) the real economy (freight rates), but also the real economy has an impact on the financial markets (significantly smaller effect since the coefficient of the freight rate change in the second equation is 0,2 as compared to the coefficient of the stock index change in the first equation of 1,34). However, in the long run, the adjustment to equilibrium (shown by the ECTs) is being done by the financial markets.

Residual tests performed on the system give the following results:

1) Normality (Cholesky of covariance): the Joint Jarque Berra shows that the residuals of the system are not normally distributed. There seems to be a problem with the residuals distribution of the second equation, specifically with its kurtosis, it seems to be significantly greater than 3.
2) Correlograms: the graphs of the autocorrelations show that the errors are within the two standard errors boundaries, which indicated the correct specification of the system (no heteroskedasticity and autocorrelation)

The explanatory power of the model is good, since R2 and adjusted R2 for both equations are above 55%.

Series	**Equation 9a**	**Equation 9b**
R^2	0,61	0,6
Adjusted R^2	0,56	0,58

Table 8. Model explanatory power (Europe)

7. FORECASTING

Forecasting is crucial in every industry, but even more important in the shipping industry. In shipping market changes frequently and the events take place very quickly. That is why forecasting of BDI is a common need in shipping.

Many studies in the academic literature have found that ECMs outperform other models (VAR) in their forecasting accuracy over long horizon, since the equilibrium relationship in the ECM is expected to hold only in the long run (Rajaguru & Pattanayak, 2007). In this section we will evaluate the forecasting performance of the models presented in the previous section.

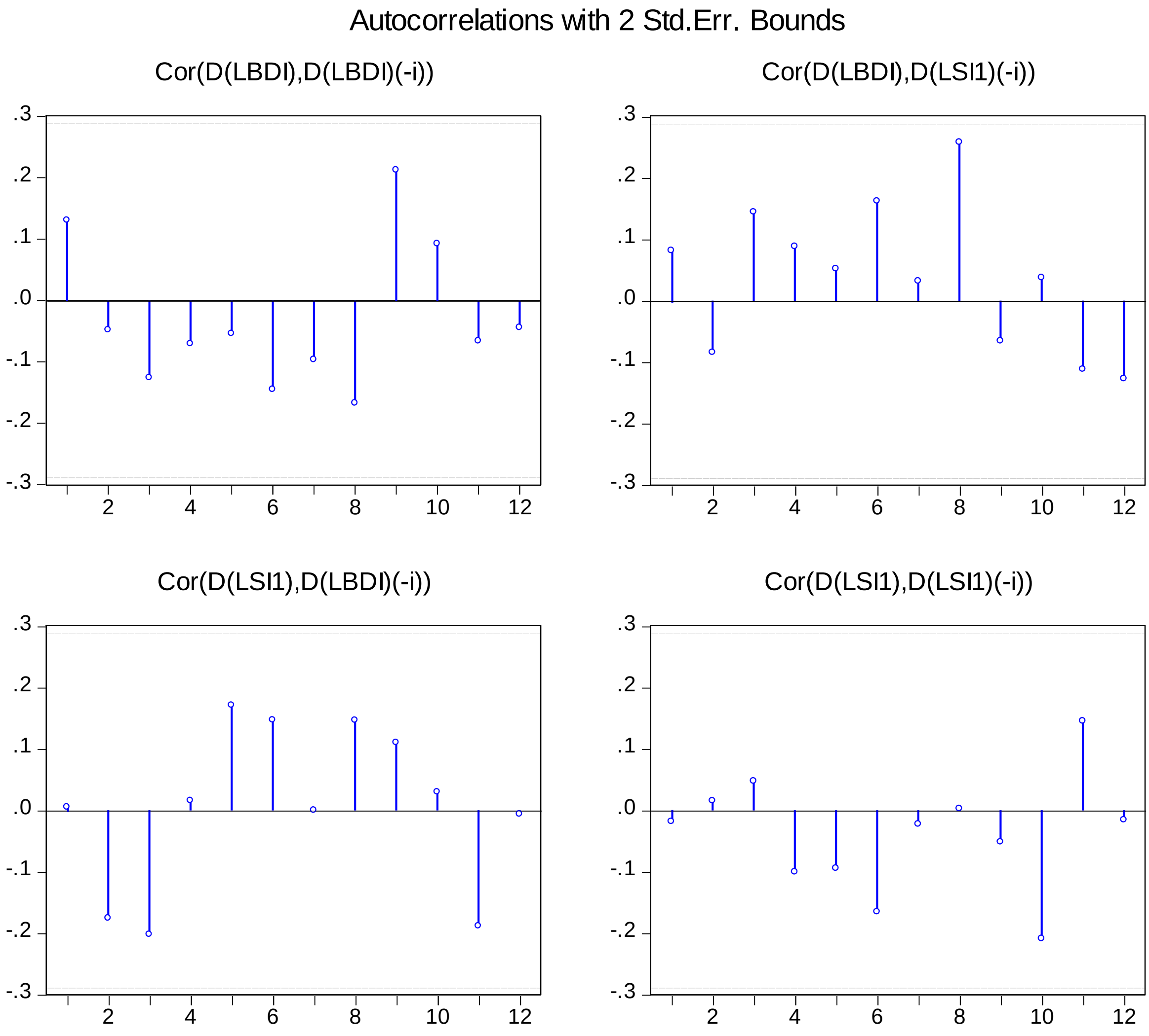
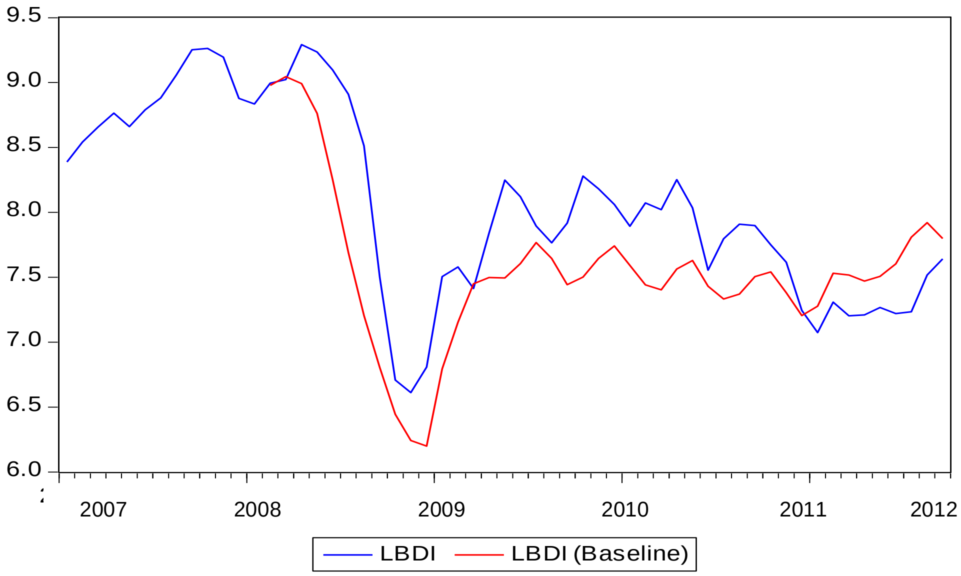


Table 9. Correlograms for European listed companies ECM system

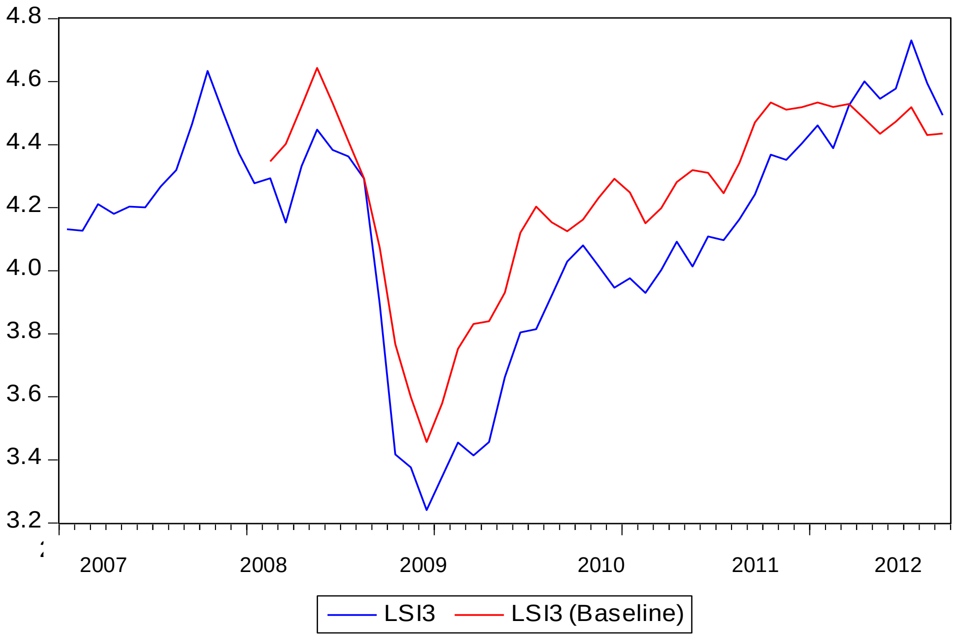
Graph 1 and Graph 2 below are visual representations of the actual versus model based forecast of the freight rates and the stock index (US listed companies). In the case freight rate forecasting, one can observe that our model under predicts the value of the freight rate for the period 2008-2010 and over predicts the value of the rates in 2011. The forecasting performance is not very good, but it is expected since the ECM estimated in this study uses as variables only the freight rates, the stock index returns and their lagged values. Significant variables that can explain the variation in the freight rate, can improve the forecasting performance of the model.

Graph 1. Forecasting performance of the freight rate model (US)



Theil's inequality coefficient = 0,35

Graph 2. Forecasting performance of the stock index model (US)

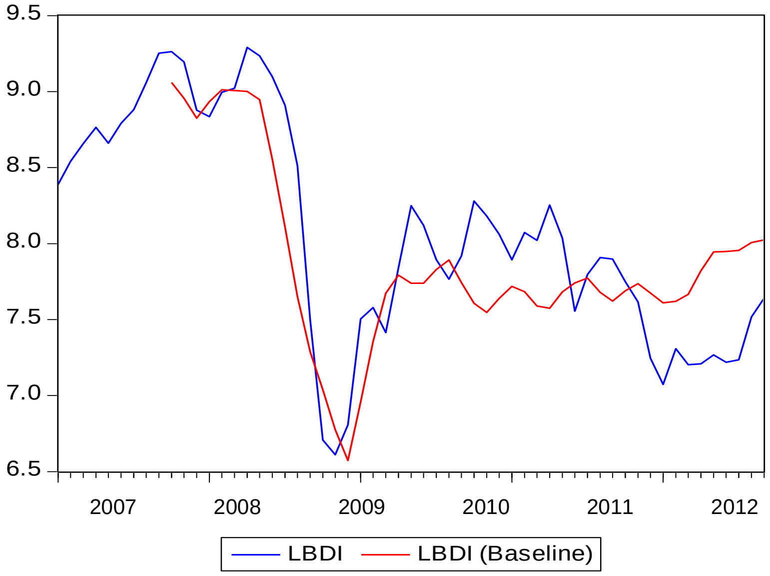


Theil's inequality coefficient = 0,42

For the stock index return the predictive performance of the model remains mediocre, since it over predicts the stock index returns for the period 2008-2010 and under predicts them for 2011. In order to improve the forecasting performance of the model we have to introduce new variables that will explain the phenomena in the market. The beginning of 2011 seems to have been a crucial point since in both graphs we can observe a shift in the prediction model as compared to the real performance of the two variables.

Graphs 3 and 4 present the comparison between the actual and the forecasted values for the examined variables for the model of the European listed companies. The same pattern, as in the case of the US companies, is observed in the forecasting performance of the freight rates by the model. It under performs in the period 2008-2010 and over performs in 2011-2012. No significant differences with the previous model are observed. The forecasting performance seems again to be quite low.

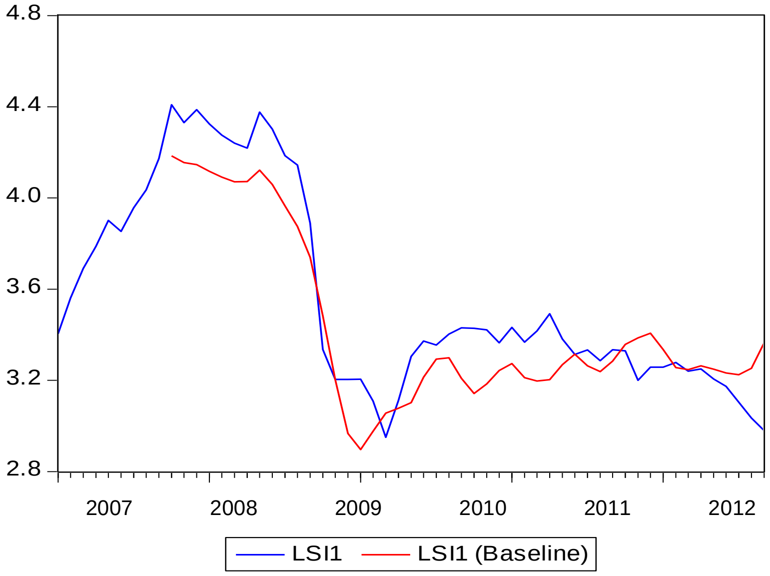
Graph 3. Forecasting performance of the freight rate model (Europe)



Theil's inequality coefficient = 0,45

However, in the case of the forecasting performance of the stock index prediction equation, differences with the previous case are observed. In period January 2008-October 2010, the model under predicts the value of the stock index in the European dry bulk shipping market and after October 2010 it over predicts it. There are points when the model predicts exactly (or very close) the actual values of the stock index (August 2008-October 2008 and January-March 2011). It seems that, for Europe, the model developed in the present study has a better forecasting performance when it comes to predicting the stock index return of the dry bulk shipping companies.

Graph 4. Forecasting performance of the stock index model (Europe)



Theil's inequality coefficient = 0,38

8. CONCLUSIONS

The present study established a very important relationship for the dry bulk shipping industry, the lead lag relation between the freight rates and the stock prices of the dry bulk companies. More specifically, the clear lead role of the stock index return was established for dry bulk shipping companies listed in the US and Europe. The ECMs developed show the existence of a long-run (positive) lead relationship of the stock index, but in the case of European companies, we observed a bi-directional causality between the two variables. This means that in the short run, freight rates also influence (positively) the dry bulk European stock index performance. Further, we examined the forecast performance of the ECMs that were estimated and concluded that they can be improved by adding more variables that explain the volatility of the freight rates and the stock prices of the shipping companies. Overall, the predicting ability of the model developed for Europe seems to be slightly better. The estimated results, also, come to confirm the leading role of the stock prices changes (financial markets' lead) in relation to the real economy.

9. APPENDICES

9.1 Time series graphs

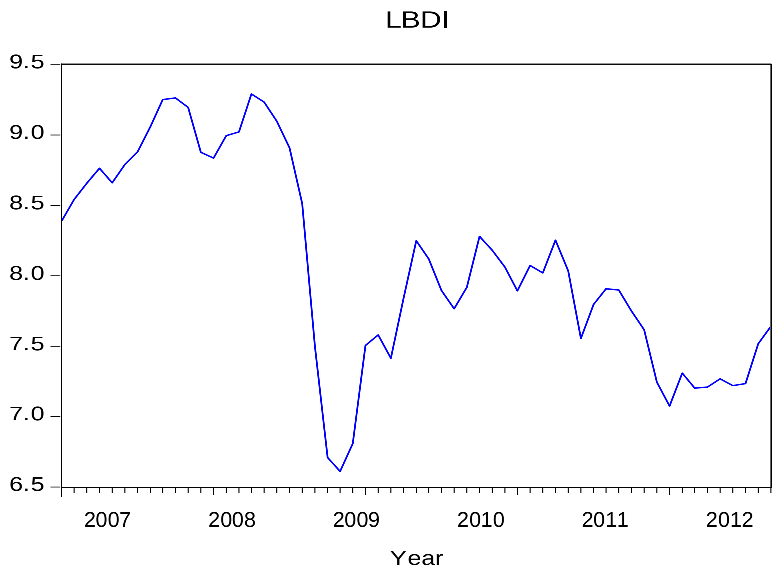


Figure 1. Freight rates

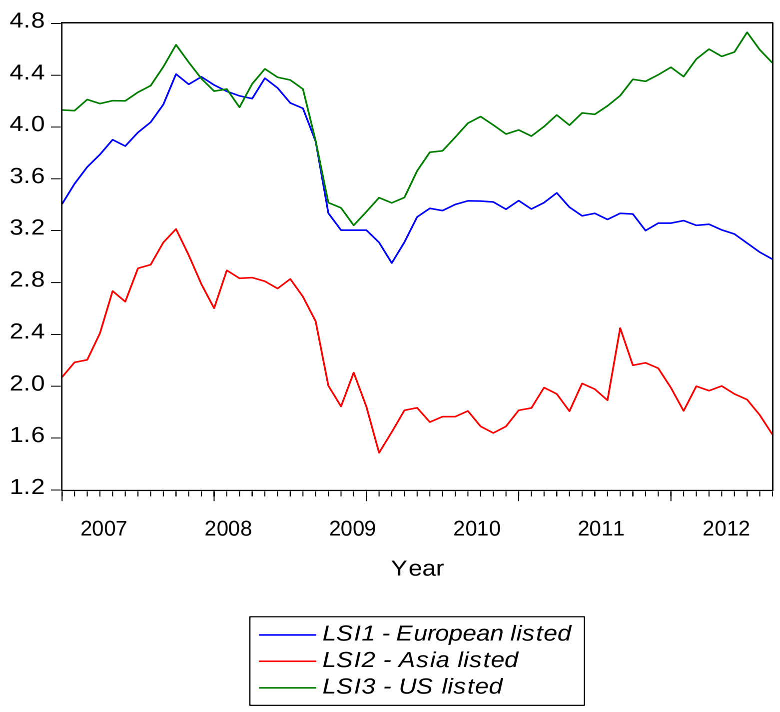


Figure 2. Stock indices

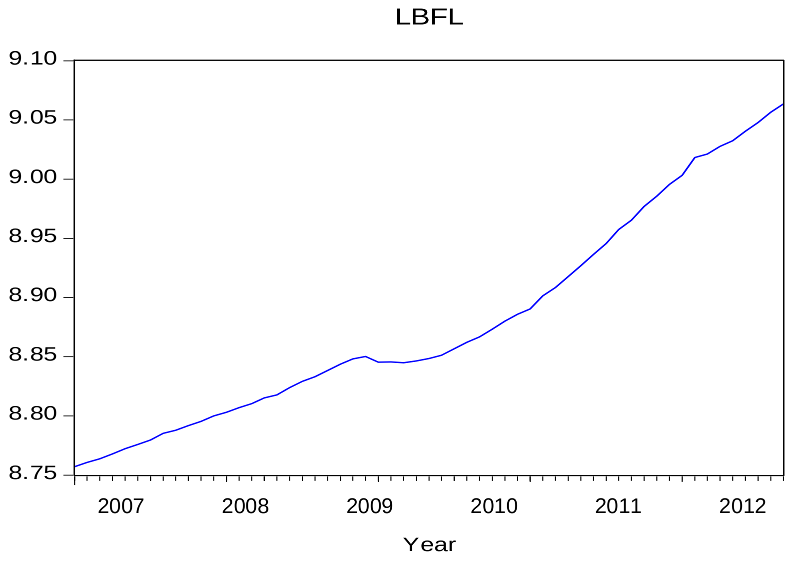


Figure 3. Dry bulk fleet size

9.2 Dry bulk shipping companies

SHIPPING COMPANIES LISTED AT EUROPEAN STOCK EXCHANGES		
	NAME	TIME PERIOD
1.	ATLANTSKA PLOVIDBA DD	JANUARY 2007 – SEPTEMBER 2012
2.	BELSHIPS ASA	JANUARY 2007 – SEPTEMBER 2012
3.	BORGESTAD	JANUARY 2007 – SEPTEMBER 2012
4.	COMPAGNIE MERITIME BELGE NV	JANUARY 2007 – SEPTEMBER 2012
5.	D/S NORDEN	JANUARY 2007 – SEPTEMBER 2012
6.	GOLDEN OCEAN GROUP	JANUARY 2007 – SEPTEMBER 2012
7.	GREEN REFERS ASA	JANUARY 2007 – SEPTEMBER 2012
8.	JINHUI SHIPPING & TRANSPORTATION LTD	JANUARY 2007 – SEPTEMBER 2012
9.	LATVIAN SHIPPING CO	JANUARY 2007 – SEPTEMBER 2012
10.	LIETUVOS JURU LAIVININKYSTE AB	JANUARY 2007 – SEPTEMBER 2012
11.	PREMUDA SpA	JANUARY 2007 – SEPTEMBER 2012
12.	RICHFIELD INTERNATIONAL LTD	JANUARY 2007 – SEPTEMBER 2012
13.	TORM A/S	JANUARY 2007 – SEPTEMBER 2012
14.	FRONTLINE LTD	JANUARY 2007 – SEPTEMBER 2012

SHIPPING COMPANIES LISTED AT ASIAN STOCK EXCHANGES		
	NAME	TIME PERIOD
1.	CHANG JIANG SHIPPING GROUP PHOENIX CO. LTD	JANUARY 2007 – SEPTEMBER 2012
2.	COURAGE MARINE GROUP LTD	JANUARY 2007 – SEPTEMBER 2012
3.	MITSUI O.S.K. LINES LTD	JANUARY 2007 – SEPTEMBER 2012
4.	KAWASAKI KISEN KAISHA LTD	JANUARY 2007 – SEPTEMBER 2012
5.	NS UNITED KAIUN KAISHA LTD	JANUARY 2007 – SEPTEMBER 2012
6.	INUI STEAMSHIP CO. LTD	JANUARY 2007 – SEPTEMBER 2012
7.	MEIJI SHIPPING CO. LTD	JANUARY 2007 – SEPTEMBER 2012
8.	IINO KAIUN KAISHA LTD	JANUARY 2007 – SEPTEMBER 2012
9.	DAIICHI CHUO KISHEN KAISHA	JANUARY 2007 – SEPTEMBER 2012
10.	KURIBAYASHI STEAMSHIP CO. LTD	JANUARY 2007 – SEPTEMBER 2012
11.	KAWASAKI KINKAI KISEN KAISHALTD	JANUARY 2007 – SEPTEMBER 2012
12.	U MING MARINE TRANSPORT CORP	JANUARY 2007 – SEPTEMBER 2012
13.	FIRST STEAMSHIP CO LTD	JANUARY 2007 – SEPTEMBER 2012
14.	SINCERE NAVIGATION CORPORATION	JANUARY 2007 – SEPTEMBER 2012
15.	TAIWAN NAVIGATION CO. LTD	JANUARY 2007 – SEPTEMBER 2012
16.	CHINA SHIPPING DEVELOPMENT COMPANY LTD	JANUARY 2007 – SEPTEMBER 2012
17.	CHINA SHIPPING HAISHENG CO LTD	JANUARY 2007 – SEPTEMBER 2012
18.	CHINESE MARITIME TRANSPORT LTD	JANUARY 2007 – SEPTEMBER 2012
19.	CHOWGULE STEAMSHIPS LTD	JANUARY 2007 – SEPTEMBER 2012

20.	HYUNDAI MERCHANT MARINE CO LTD	JANUARY 2007 – SEPTEMBER 2012
21.	GREAT EASTERN SHIPPING CO LTD	JANUARY 2007 – SEPTEMBER 2012
22.	KOREA LINE CORP	JANUARY 2007 – SEPTEMBER 2012
23.	SHIPPING CORP OF INDIA LTD	JANUARY 2007 – SEPTEMBER 2012
24.	TAMAI STEAMSHIP CO LTD	JANUARY 2007 – SEPTEMBER 2012
25.	VARUM SHIPPING CO LTD	JANUARY 2007 – SEPTEMBER 2012
26.	EVERGREEN MARINE CORP (TAIWAN)	JANUARY 2007 – SEPTEMBER 2012
27.	PACIFIC BASIN SHIPPING LTD	JANUARY 2007 – SEPTEMBER 2012

SHIPPING COMPANIES LISTED AT NYSE, NASDAQ, LSE		
	NAME	TIME PERIOD
1.	ACM SHIPPING GROUP PLC	JANUARY 2007 – SEPTEMBER 2012
2.	AEGEAN MARINE PETROLEUM NETWORK INC.	JANUARY 2007 – SEPTEMBER 2012
3.	ALEXANDER & BALDWIN INC	JANUARY 2007 – SEPTEMBER 2012
4.	ALGOMA CENTRAL CORP.	JANUARY 2007 – SEPTEMBER 2012
5.	B&H OCEAN	JANUARY 2007 – SEPTEMBER 2012
6.	BRAEMAR SHIPPING SERVICES PLC	JANUARY 2007 – SEPTEMBER 2012
7.	CLARKSON	JANUARY 2007 – SEPTEMBER 2012
8.	DANAOS CORPORATION	JANUARY 2007 – SEPTEMBER 2012
9.	DIANA SHIPPING INC	JANUARY 2007 – SEPTEMBER 2012
10.	DRYSHIPS INC	JANUARY 2007 – SEPTEMBER 2012
11.	EAGLE BULK SHIPPING INC	JANUARY 2007 – SEPTEMBER 2012
12.	EUROSEAS LTD	JANUARY 2007 – SEPTEMBER 2012
13.	EXCEL MARITIME CARRIERS LTD	JANUARY 2007 – SEPTEMBER 2012
14.	FREESEAS INC	JANUARY 2007 – SEPTEMBER 2012
15.	GENCO SHIPPING & TRADING LTD	JANUARY 2007 – SEPTEMBER 2012
16.	GOLDENPORT HOLDINGS	JANUARY 2007 – SEPTEMBER 2012
17.	HORIZON LINES INC	JANUARY 2007 – SEPTEMBER 2012
18.	INTERNATIONAL SHIPHOLDING CORPORATION	JANUARY 2007 – SEPTEMBER 2012
19.	KIRBY CORPORATION	JANUARY 2007 – SEPTEMBER 2012
20.	NAVIOS MARITIME HOLDINGS	JANUARY 2007 – SEPTEMBER 2012

21.	NEWLEAD HOLDINGS LTD	JANUARY 2007 – SEPTEMBER 2012
22.	SEACOR HOLDINGS INC	JANUARY 2007 – SEPTEMBER 2012
23.	SEASPAN CORPORATION	JANUARY 2007 – SEPTEMBER 2012
24.	SHIP FINANCE INTERNATIONAL LIMITED	JANUARY 2007 – SEPTEMBER 2012
25.	STARBULK CARRIERS CORP	JANUARY 2007 – SEPTEMBER 2012
26.	TBS INTERNATIONAL PLC	JANUARY 2007 – SEPTEMBER 2012
27.	TOPSHIPS INC	JANUARY 2007 – SEPTEMBER 2012
28.	ULTRAPETROL LIMITED	JANUARY 2007 – SEPTEMBER 2012

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