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Supply-Demand Interaction in the Formation of Freight Rates: China's Trade Volume as Demand Side in the Dry Bulk Market

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ABSTRACT

Freight revenues are a fundamental objective of the maritime industry, and provide a baseline for stakeholders to plan their current strategies and future investments. Reduction of uncertainty-induced risk is therefore essential for predicting market prospects and for achieving sustainable growth for sector participants. This can be achieved by conceiving the formation of freight rates as well as the macro variables that have the greatest impact on rates. This study aims to contribute to the existing freight rate formation literature by empirically testing the supply–demand balance of China, one of the world's largest economies. The Baltic Dry Index (BDI) has been selected as a measure of freight rates, trade volume of China has been selected as a demand-side indicator and the dry bulk fleet has been selected as a supply-side indicator in the model. It has been hypothesized that a larger trade volume has the effect of increasing freight rates, while an increasing fleet capacity has the effect of reducing freight rates. Correlation and regression analyses have been applied to test the econometric relationships between variables. The results of the study have confirmed the hypotheses, and it has been found that freight rates reacted more vigorously to changes in the dry bulk fleet, which forms the supply side.

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1 Introduction

The borders are disappearing in a globalized world, and countries are pursuing their own welfare-enhancing policies. Since each country cannot be superior in every area, the need for trade among countries arises. This in turn leads to the need for trade logistics, for which the most economical method, in terms of cost per unit, is shipment by sea. Maritime transport facilitates world trade. For instance, the strong economic growth experienced by China after the integration into the world trade could not have been achieved without efficient maritime transport [16]. However, sea transport has an economic structure in itself. This economic structure is affected by global trade, and also affects global trade. This interaction originates from the position of the supply–demand balance.

Stopford [15] has explained the supply and demand sides in shipping by separating each of them into five factors. Variables affecting the demand side are world economy, seaborne commodity trades, average haul, random shocks and transport costs. On the other hand, supply side variables are world fleet, fleet productivity, shipbuilding production, scrapping and losses, and freight revenue. The interaction between these variables determines freight rates, and these rates are at the heart of the shipping market.

Freight rates are fundamentally dependent on economic activity and fluctuations in the economy are felt strongly in the maritime market [16]. Thus, understanding the dynamics and trends in freight rates is very beneficial in terms of risk management and resource allocation [21]. In this respect, the impact of the Chinese economy, which accounted for about 12% of world trade volume in recent years, on the maritime market is certain. In order to present econometric explanations of this effect, this study has designed a simple model inspired by the variables of [15].

This study seeks to contribute to the existing maritime economics literature by empirically testing the supply–demand balance based of China, one of the world's largest economies. The fact that freight rates are mainly formed by the intersection of supply and demand is common in the literature, however, an empirically tested study has not been spotted. It is also considered that determining whether the supply side or the demand side are more determinant in the formation of freight rates is important for developing sustainable maritime strategies. Thus, both transport companies and transportation customers may contribute to the welfare-increasing impact of world trade by allocating resources in a sustainable manner. The results have shown that an increase in demand leads to a higher level of price equilibrium, while an increase in supply leads to lower price equilibrium. It has also been found that the freight rates are more affected by changes in the supply side of maritime transport.

The rest of this paper has been organized as follows. In section 2, the formation of the supply–demand balance and freight rates in the maritime market has been explained. In section 3, China's place in world trade has been briefly discussed. In section 4, the methodology of the research has been introduced. Section 5 has presented the model of the research and lastly, in section 6, findings have been presented and results discussed.

2 The Supply and Demand Mechanism in Maritime Transport

Sea transport is composed of different segments according to diverse cargo types. Demand for these segments also varies according to world economic activity and trade. These sections are interlinked to each other, but also have different characteristic features [16]. Whether dry, wet, or container markets, all maritime markets are comprised of five variables: demand for sea transport, net fleet volume, freight rates, new construction prices, and second-hand prices. Each variable is shaped in one or more markets, but all the markets are interacting with each other [10].

Dry bulk trade, which is the area of interest in this study, supported by maritime transport, is a key element in the supply chain for metallurgical producers, steel plants, aluminum industries, and agro-food businesses. It seems that the role of bulk transport in the global economic process will never diminish [6].

Bulk cargo transport consists of four different structures. First, some plants carry their cargo with their own vessels, while others carry out transportation activities through time charter, where the shipowner has control over the ship, but the route is determined by the charterer. The third structure is a contract of affreightment or a trip charter. The shipowner agrees to deliver the determined cargo of the charterer between the specified dates. The fourth structure is a bareboat charter and, in this structure, the charterer has a long-term lease for the chartered ship [6].

Bulk trade operations, whether dry or wet, are generally carried out on board relatively simple and standardized vessels. Bulk operations also do not require large and complex organizational structures. Moreover, commercial, technical, and managerial issues can be provided by third parties. This facilitates entry into and exit from the market, but service providers are unable to differentiate their services. It can be said that the market is showing almost perfect competitive features [16].

As for all maritime, markets, the dry bulk market is divided into four sub-markets: the freight market where transport transactions are made; the sale and purchase market where second-hand vessels are bought and sold; the new construction market where new ships are built; and the demolition market where old ships are scrapped [15]. The freight market is also defined as a market where shipowners earn revenues from their operations in the maritime industry [16]. However, understanding and absorbing how freight rates are shaped in the existing market conditions have vital prospects for achieving sustainable revenues for maritime companies.

As the economy expands, maritime transport also increases and freight rates are directly affected by this situation. However, the growth of the economy is the first requirement for freight rates to be influenced in a positive direction [13]. The dependence of shipping on the developments in world trade causes fluctuations in the demand for maritime transport [16]. In other words, bulk cargo transport is a derived demand; the level of transportation supply in the transportation chain is therefore unpredictable [6]. The variations of demand for maritime transport follow the cycles in the world economic activity and in global trade. Therefore, it can be said that the changes in demand can have a significant effect even in the short run, considering that the response of the supply side is relatively slow [16].

In the traditional model, the freight rates are a function of shipping demand and supply [10]. The demand side of the market is represented by the need for freight transport, while the supply side of the market consists of ships delivering commodities [12]. Freight rates are determined by the demand for maritime transport by charterers and the supply of maritime transport by shipowners. The amount of cargo transported is affected by this interaction [10]. The change in these rates is a result of the supply–demand balance. However, the freight rates are not only related to the demand for transport; the supply side is also directly influential in the formation of these rates. This shift in favour of freight may be due to several events on the supply side: slow growth of the fleet, rapid increase in international trade, port congestion, weather conditions, and strikes [5]. Because of all these reasons, freight rates are very volatile and can fluctuate greatly in a very short time, which makes it difficult for shipowners to calculate their revenues [16]. The freight rates affect the other three markets, taking place as a trigger for the market cycle.

According to maritime economics theory, the freight rates direct the supply decisions of the market, which include new ship building, utilization of the existing fleet, and scrapping of ships [1]. Therefore, freight rates have a direct impact on the decision to increase the fleet capacity of transport operators [13].

The boom in the world economy also stimulates world trade and indirectly increases the demand for maritime transportation services. Due to the fixed net fleet, the amount of cargo transported increases and freight rates rise. The only way to increase supply in the short run is to increase the speed of the fleet, because new shipbuilding activity takes a long time and varies between one and three years [10].

Koopmans [11] has described this as a consequence of the shape of the tanker transport capacity supply curve, which shows a transition from an elastic state to an inelastic state according to the situation of freight rates. As shown in Figure 1, the supply curve takes the shape of an inverted 'L' in the short run. Freight rates in zone I are elastic, and freight rates are not significantly affected even if there are relatively large increases in demand. However, when the demand reaches zone II, small changes in demand will cause significant changes in the freight rates, as the transport capacity in the market is fixed in the short run [8]. In the short run, the only means of increasing the transport capacity is increasing speed, because the new construction process lasts between two and three years. This inelastic condition also holds true for the reverse scenario, when the equilibrium is provided in zone II. Even a small increase in supply causes large reductions in freight rates. In the maritime industry, freight rates sometimes increase and sometimes fall into a loop, causing the industry to be volatile. This forms shipping cycles that are derived from the movements of the inelastic demand curve over the supply curve [15]. Thus, freight rates, ship prices, and fleet size are dynamically interdependent [2].

Modern views have emerged that explain the mechanism of freight rates, as well as the traditional supply–demand equilibrium model. In this model, freight rates are the equilibrium rates in the bargaining game, and players represent rational expectations about economic conditions. In other words, when the shipowner and the charterer start negotiating, the rate they negotiate can be below or above the current price according to the bargaining power of each party. If the charterer's bargaining power is higher than that of the shipowner, the rate will be formed at less than the current rate; that is, the deviation from the current rate will be negative. If the bargaining power of the shipowner is higher than that of the charterer, the new rate will deviate from the current rate in the positive direction, and will be formed above the current rate. When market conditions are good, the shipowner's bargaining power is higher, whereas the charterer's bargaining power is higher under poor market conditions [10]. In this modern view, the supply–demand balance still plays an important role, but it also includes bargaining power and economic expectations in maritime business transactions.

Freight rates throughout history have been moving in cycles due to these imbalances between supply and demand, and due to the differentiation in bargaining power. Between 1971 and 2007, 22 cycles were discovered, with an average duration of 10.4 years. The shortest of these cycles lasted for three years and the longest for 15 years [15]. The market is highly volatile, capital intensive, and open to shock, and it is therefore vital for the market to read the cycle well [5]. Thus, earnings can be maximized and uncertainty-associated risks can be minimized. Timely purchasing and selling decisions are of vital importance for stakeholders, and a bad decision can have irreversible consequences [1]. At this point, only those who can read the market well can be regarded as good maritime stakeholders [14].

Periods during which the highest level of income is obtained in these cycles are called boom periods; these can often be characterized by easy earned capital, high freight rates, and high share returns. For this reason, shipowners can easily order new ships [5]. After the boom periods of the past, the market has constantly recovered to normal levels. Nevertheless, maritime investors have repeated their mistakes and have continued to make false invest-

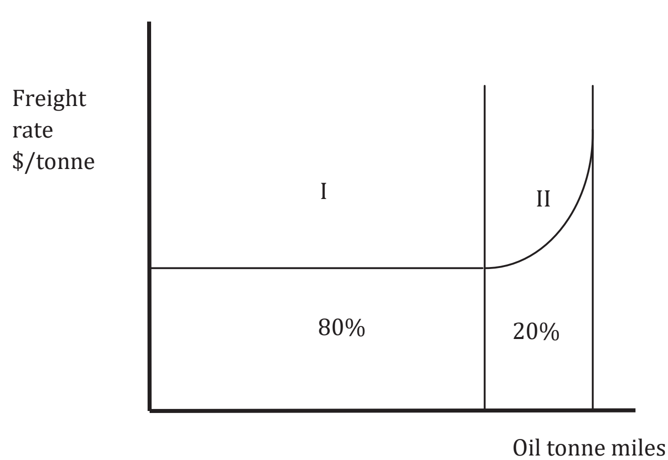

Figure 1 Short-run Supply Curve for Tanker Shipping Services
Source: [8]

ment decisions throughout history. This can be defined as the 'zero memory' characteristics of shipowners [20]. Investors' decisions to focus on their own intuition and on the movements of their competitors rather than follow market trends has led to repetition of mistakes made in the market cycle [14].

When considering the near-time cycles in the bulk market, it can be seen that the demand for dry bulk shipping at the beginning of the new millennium was quite stable and was mostly based on coal trade. This has changed with China returning as the biggest steel producer and increasingly demanding iron ore at a pace that market players could not predict. Between 2003 and 2008, bursts in freight and time charter rates were mainly due to the extraordinary increase in China's iron ore imports. As a result, investments in new vessels have accelerated since 2003. Nevertheless, the increase in demand for China's raw material continued to exceed expectations and continued to heat up the market, causing port congestion. The latter reduced the productivity of the fleet and caused the freight market to be affected positively. It was followed by suppliers at longer distances that entered the market to export raw materials to China, thus influencing the global freight market positively [12].

In recent years, the patterns of trade in the freight market are dominated by east–west trade. The increase of the importance of Asian trade in the world also strengthens this pattern. Shifting production activities from the west to the Asian region and outsourcing from this region have led to raw material transport to the Asian region. Thus, the Asian region has become one of the most important actors in the bulk cargo market [16]. In terms of freight rates, supply–demand balance in the dry bulk market in recent years has been shaped in favour of the shippers by pushing shipowners to poor earnings [12]. In other words, the bargaining power of the shipper is higher than that of shipowners in the freight market [10].

It is relatively difficult to monitor the bulk freight market, because it is close to the perfect competition market. Therefore, an index named the Baltic Dry Index was established in 1985 as a follow-up to the prices in the bulk market, and has gained importance as a demonstration of the maritime industry. The BDI reflects changes in dry bulk freight transport in different segments as a component indicator [1]. It covers dry bulk shipping rates and provides an assessment of the price of moving the major raw materials by sea. The index consists of 26 shipping routes measured on a time charter and voyage basis [7]. In addition, the maritime markets, and especially the dry cargo market, have an extremely volatile structure because they are highly influenced by global developments. Therefore, BDI is accepted by many analysts as an early sign of global trade and economic activities [5].

In the above section, we have briefly evaluated the formation of market and freight rates. In the section below, we shall provide a brief review of China's position in the world trade.

3 China in International Trade

China has been the most dynamic trading nation in the world since 1978, when it initiated economic reforms [22]. Since opening its doors in 1978, it has not only been the fastest growing economy, it has also been a very large exporter and the center of a large part of Foreign Direct Investment (FDI). It has become the world's workshop [18]. China entered the World Trade Organization (WTO) in 2001 to capture more opportunities in the international market. These new opportunities emerged mainly in the field of labor-intensive production of high-tech products. The reason for China's export boom after entering the WTO is that it offers competitive prices in the international market due to cheap labour. Additionally, factors such as rapid participation in the production process and strong demand from the world have also been leading to an export boom [22]. With all these developments, the Chinese economy has taken its place among the top economies by steadily increasing its share in world trade, and it has become one of the main demanders of maritime transport services. China's share of the world trade volume rose from 2% in 1985 to 12% by the year 2015 [19].

When the countries ranked in the top 10 in 2016 by export value, import value and total value are examined, it can be seen that China is in the forefront of exporting countries with the highest export of 2097 billion dollars in 2016, followed by the USA with 1451 billion dollars. The difference between the two countries is about $ 600 billion dollars, indicating how China has become a production factory for the world economy. When import values are examined, the US tops the list with 2250 billion dollars, followed by China with about 1588 million dollars. The two countries are close in terms of total trade volumes. The US reached 3701 billion dollars, passing China with a slight difference of $ 16 billion dollars. China, on the other hand, reflected its strong position in the world economy by having a difference of nearly 1300 billion dollars to Germany, the closest country on the list [19]. The data assist us to understand China's position in the world economy, and as Stradenes [16] has stated, demand for maritime logistics is directly affected by world economic activity. Therefore, the impact of the Chinese economy on the maritime market is inevitable when considering trade volumes.

In the next sections, the methods used in this study have been briefly introduced and a research model presented.

4 Methodology

Correlation and regression analyses have been applied, in line with the objectives of the study. The directions and powers of relations have been determined by correlation analysis, and the econometric relationship has been modeled by regression analysis. Correlation analysis is important to understand how the variables move in relation to each other. The direction and strength of these relations allow, theoretically, to make inferences. However, they are insufficient to understand whether or not a variable affects the other variable or how it affects it. At this point, regression modeling is one of the most widely used simple econometric methods. They have been used to model relationships and to define the coefficients of relationships to develop policies. In this section, these two methods have been briefly mentioned.

4.1 Correlation analysis

A number of correlation analysis techniques are available in econometrics. The fields of use vary according to the distributions of the data. One of the most common methods used in normal distribution data is the Pearson technique. Pearson's correlation coefficient R is a measure of the strength and direction of the linear relationship between two variables. It is defined as the covariance of the variables divided by the product of their standard deviations. The absolute value of Pearson's correlation coefficients is not larger than 1. Correlations equal to 1 or -1 correspond to data points lying exactly on a straight line [4]. The formula for the Pearson correlation has been presented below.

$$r = \frac{n(\Sigma XY) - (\Sigma X)(\Sigma Y)}{\sqrt{[n(\Sigma X^2) - (\Sigma X)^2][n(\Sigma Y^2) - (\Sigma Y)^2]}} \quad (1)$$

After Pearson's correlation coefficient is obtained by (1), the t statistics of the coefficient should be calculated to determine whether the coefficient is significant or not. The calculated t value by (2) is compared with the table values of the t-distribution. If it is larger than the critical value, the coefficient is significant.

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}} \quad (2)$$

4.2 Regression analysis

Regression analysis is concerned with the study of the dependence of one variable on one or more independent variables. The explanatory variables attempt to explain the dependent variable. The results gained after analysis have been used for estimating and/or predicting the mean or average value of the former in terms of the known or fixed values of the latter [9]. A simple model of the regression equation is presented in (3). Y_i is the dependent variable of the equation; $\hat{\beta}_1$ is the predicted constant of the equation; and $\hat{\beta}_2$ is the predicted coefficient of the independent variable X_i. Lastly, $\hat{u}_i$ is the residual that cannot be explained by the existing model. Equation (4) presents the calculation of the coefficient of the independent variable, and (5) presents calculations of the constant coefficient. Significances of the coefficients are calculated by (6).

$$Y_i = \hat{\beta}_1 + \hat{\beta}_2 X_i + \hat{u}_i \quad (3)$$

$$\hat{\beta}_2 = \frac{n\sum X_i Y_i - \sum X_i \sum Y_i}{n\sum X_i^2 - (\sum X_i)^2} \quad (4)$$

$$\hat{\beta}_1 = \bar{Y} - \hat{\beta}_2 \bar{X} \quad (5)$$

$$tstat(\hat{\beta}_2) = \hat{\beta}_2 / se(\hat{\beta}_2) \quad (6)$$

$$lnY_i = ln\,\beta_1 + \beta_2 lnX_i + u_i \quad (7)$$

The log-log regression model (7) has been used for our study. One attractive feature of the log-log model, which has made it popular in applied work, is that the slope coefficient $\hat{\beta}_2$ measures the elasticity of Y with respect to X, that is, the percentage change in Y for a given (small) percentage change in X [9]. In addition, using logarithmic values in data makes them a continuous series. The theoretical model of the study has been explained in the next section.

5 Research Model

The research model is based on the supply–demand relationship developed by Koopmans [11]. It examines the effects of China on the maritime market, assuming that China, which is one of the world's largest economies, forms the demand side of this relationship. The world's fleet is considered as the supply side, while the sum of China's total export and import values is considered as the demand side. As mentioned in the literature, the supply and demand sides are in a continuous interaction, and this interaction derives freight rates. As shown in Figure 2, an increase on the demand side has a positive effect on the freight rates, while an increase on the supply side has a negative effect.

The theoretical basis of the research has been presented in the form of curves as shown in Figure 3. The supply side cannot respond quickly to the increase in demand in the short run. Therefore, when there is a sudden increase in demand, the curve shifts to the right (D1 to D2) and freight rates increase (P1 to P2). However, in the long run, the supply side increases, shifting the supply curve to the right (S1 to S2) and bringing the freight rates to a lower level (P2 to P3). This has led to shipping cycles of different lengths and characteristics. It is very important for maritime stakeholders to position themselves in the market according to these cycles. For this reason, it is necessary to understand the effects of macroeconomic variables on the market well.

The hypothesis of this study in this framework consists of two assumptions. First, it is assumed that the increase in China's trade volume will have a positive impact on the BDI. Second, it is assumed that the increase in the world dry bulk fleet will have a negative impact on BDI.

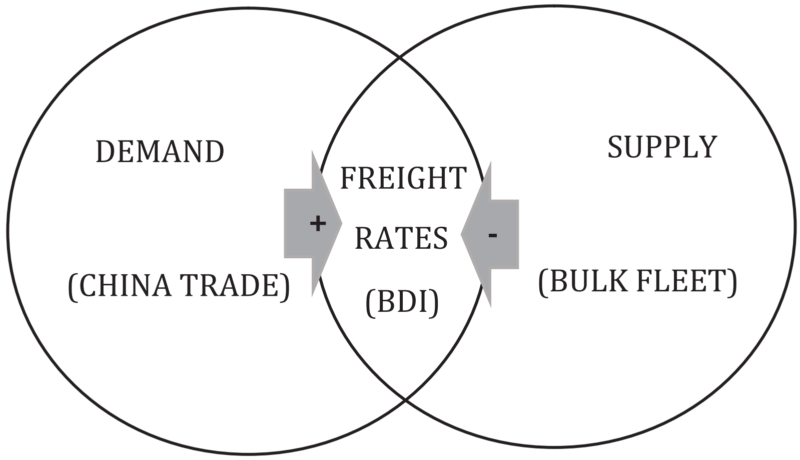

Figure 2 Research Model of the Study
Source: Authors

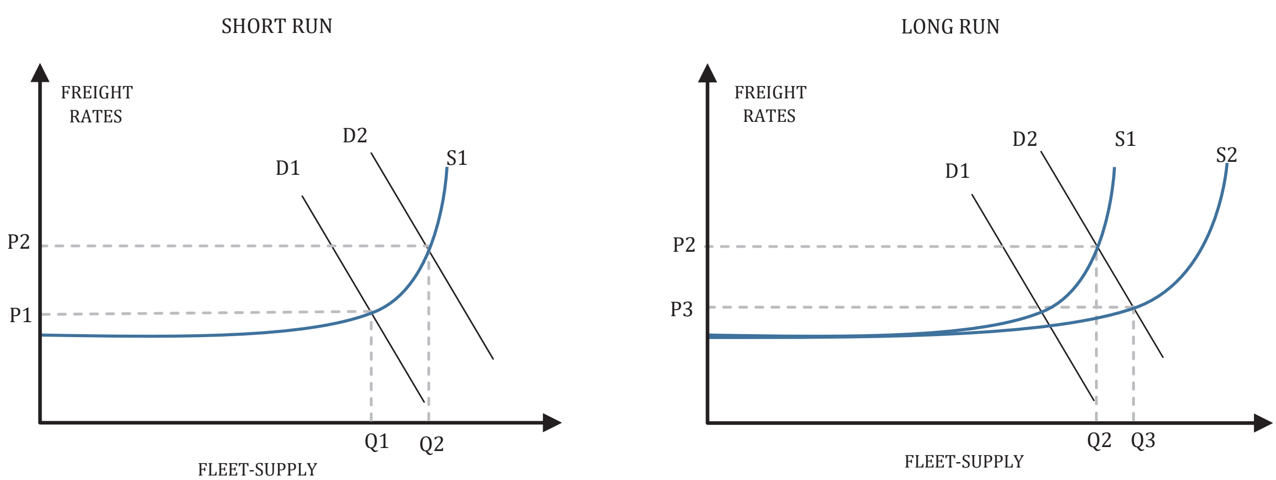

Figure 3 Short-run and Long-run Equilibrium of Freight Rates
Source: Authors

As a result, the econometric model of the study has been established with these variables in this framework.

6 Results and Discussion

Descriptive statistics of the data set to be used in the analysis have been presented in Table 1. BDI has been calculated by taking the annual average of daily data of the variable. The highest value was 7,070 in 2007, and the lowest value was 673 in 2016. The FLEET variable represents the total dry bulk fleet in the world. The highest value of the dry bulk fleet was 778,889 thousand dwt in 2016, and the lowest value was 218,518 thousand dwt in 1985. CHINA, the third and last variable, represents China's total value of commodity exports and imports. The highest value of trade volume was $4,300,000 million in 2014, and the lowest value was $69,600 million in 1985. All the series have been converted to logarithmic series in order to make them continuous, and to calculate their elasticity as mentioned in the methodology section. In the next step, the unit root test has been applied to the series. The following table also contains descriptive statistics for the stationary series that have been obtained after the unit root test.

Unit root testing before commencing econometric analysis with time series is crucial for the reliability of the results. This follows because, if the series contains the unit root, the end results will be inevitably spurious in regression equations. The results of the correlation analysis will also induce misleading inferences. For this reason, the series should be stationary by removing the unit root from them. Therefore, the ADF (Augmented Dickey-Fuller) test, which is one of the most common methods used in the unit root test, has been applied to the data to be used in our analysis.

When the values in the level have been checked, it has been determined that the t values of all the series are smaller than the critical values, and thus the series con-

Table 1 Descriptive Statistics of the Variables

Observations	BDI	FLEET	CHINA	ΔlnBDI	ΔlnFLEET	ΔlnCHINA
	32	32	32	31	30	31
Mean	1933.734	359708.9 t	1350000 m	-0.009596	-0.000610	0.128045
Median	1369.998	280189.3 t	492000 m	-0.058493	0.001543	0.161738
Maximum	7070.256	778889.5 t	4300000 m	0.833368	0.093415	0.315444
Minimum	673.1200	218518.1 t	69600 m	-0.892940	-0.049625	-0.149403
Std. Dev.	1530.540	174400.4 t	1490000 m	0.386240	0.032084	0.114744
Skewness	2.135771	1.370588	0,874200	0.150969	0.559959	-0.460558
Kurtosis	7.014042	3.494231	2,179345	3.054525	3.701244	2.769704
Jarque-Bera	45.81147	10.34441	4,973833	0.121596	2.182449	1.164424
Probability	0.000000	0.005672	0,083166	0.941013	0.335805	0.558661

*t refers to thousand deadweight tons, m refers to billion dollars

Source: [3], [17], [19]

tain unit roots. In order to remove the unit root, the difference-taking process has been applied to the series. As a result, the BDI and CHINA variables have become stationary when the first differences have been taken. The FLEET variable has become stationary when the second difference has been taken. Thus, the series have been purified and prepared before the econometric analysis.

Visualizations of the stationary situations of the series to the BDI variable, which is the dependent variable in the analysis, have also provided the idea of the relationship between them. When Figure 4 has been examined, the negative relationship between BDI and FLEET, and the positive relationship between BDI and GDP, can be easily determined. At this point, the correlation analysis for the direction, intensity, and econometric significance of the relationship between them will be appropriate. Therefore, the correlations between the variables have been examined in the next step.

One of the most important points to note when performing the correlation analysis is the distribution of the series. As can be seen from the Jarque-Bera statistics in Table 1 and the distributions at the edges of the graphical representations, all the series have shown normal distribution characteristics. Pearson correlation analysis has been applied for this reason and according to these results there is a significant medium degree of positive correlation (0.633) between the BDI and CHINA variables. However, there has been a weak insignificant correlation (-0.201) between BDI and FLEET. Nevertheless, it has suggested that the relationship is negative and supports our research model. In the next step, the regression analysis has been applied to determine the significance and power of the econometric relationship between variables.

The equation for the regression analysis is set as follows. In the model, BDI is considered as a dependent variable and CHINA and FLEET as independent variables. After the research model has been established, the analysis of the data by regression analysis has been introduced.

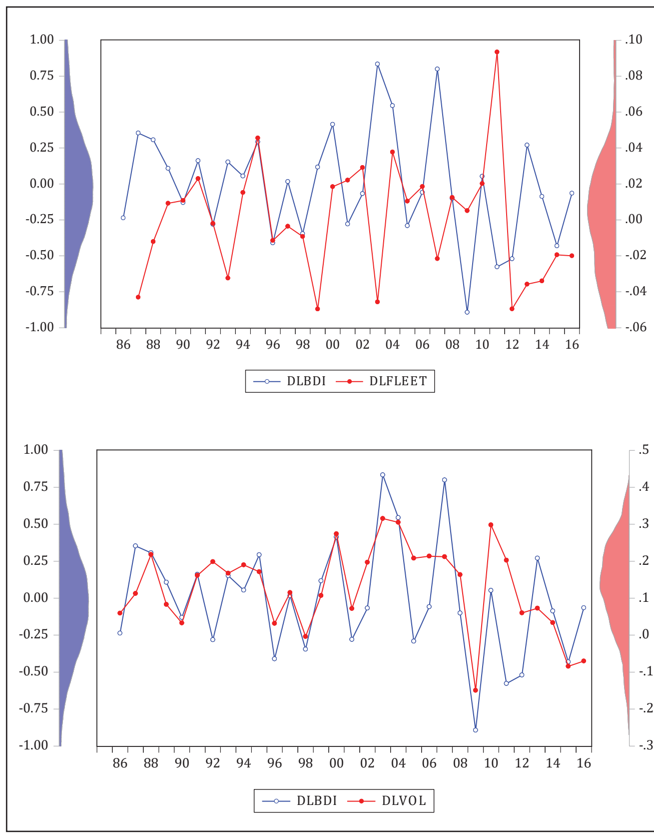

Figure 4 Graphical Display of the Relationship between the Dependent and Independent Variables
Source: Authors

$$\Delta LnBDI_i = Ln\beta_1 + \beta_2 \Delta LnCHINA_i + \beta_3 \Delta LnFLEET_i u_i$$

The output of the regression analysis has been presented in Table 2. When the results of analysis are interpreted, the model is significant as a whole according to the probability of the F statistic. In addition, two independent variables, including the constant variable, are significant according to their probabilities. In addition, changes in

Table 2 Regression Model Equation Results

Dependent Variable: ΔlnBDI				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	-0.336827	0.076598	-4.397343	0.0002*
ΔlnCHINA	2.544393	0.449676	5.658276	0.0000*
ΔlnFLEET	-5.187433	1.625497	-3.191290	0.0036*
R-squared	0.561045	F-statistic		17.25488
Adjusted R-squared	0.528530	Prob (F-statistic)		0.000015*
S.E. of regression	0.268131	Sum squared resid		1.941143

Significance levels = * 1%

Source: Authors

the independent variables account for about 53% of the changes in the dependent variable. When the regression coefficients are interpreted, it has been determined that the 1% change in China's trade volume causes a 2.54% change in the Baltic Dry Index. Moreover, a 1% change in the total dry bulk fleet volume causes a -5.66% change in the Baltic Dry Index. However, in econometric models, some tests have to be applied to residuals of the model to test the robustness of the results. To test these robustness assumptions, several tests, including autocorrelation, serial correlation, heteroscedasticity and a normal distribution, have usually been applied.

The first test to be applied to residuals is the autocorrelation test. For the autocorrelation test, 16 lags have been selected; the null hypothesis of this test assumes that residuals do not indicate autocorrelation problems. According to the test results, the null hypothesis cannot be rejected at all lags. Another test applied to residuals is the LM test, which is a serial correlation test. The null hypothesis of this test has assumed that residuals do not contain serial correlation problems. While large samples have been evaluated according to Chi-Square probability, small samples, such as ours, have been interpreted according to the F probability. According to the results obtained, the null hypothesis cannot be rejected (p=0.772) as it is in the autocorrelation test. Heteroscedasticity test has been used to test the assumption that there has been no changing variance. The null hypothesis of this test has assumed that there has been no heteroscedasticity in the residuals. As mentioned above, we have a model with small sample characteristics, and an evaluation should therefore be made according to the F statistic. According to the probability value of the F statistic the null hypothesis cannot be rejected (p=0.84).

The final test applied to residuals is the Jarque-Bera test, which has tested whether the variables have normal distribution characteristics. The null hypothesis of this test has assumed that the residuals show normal dis-

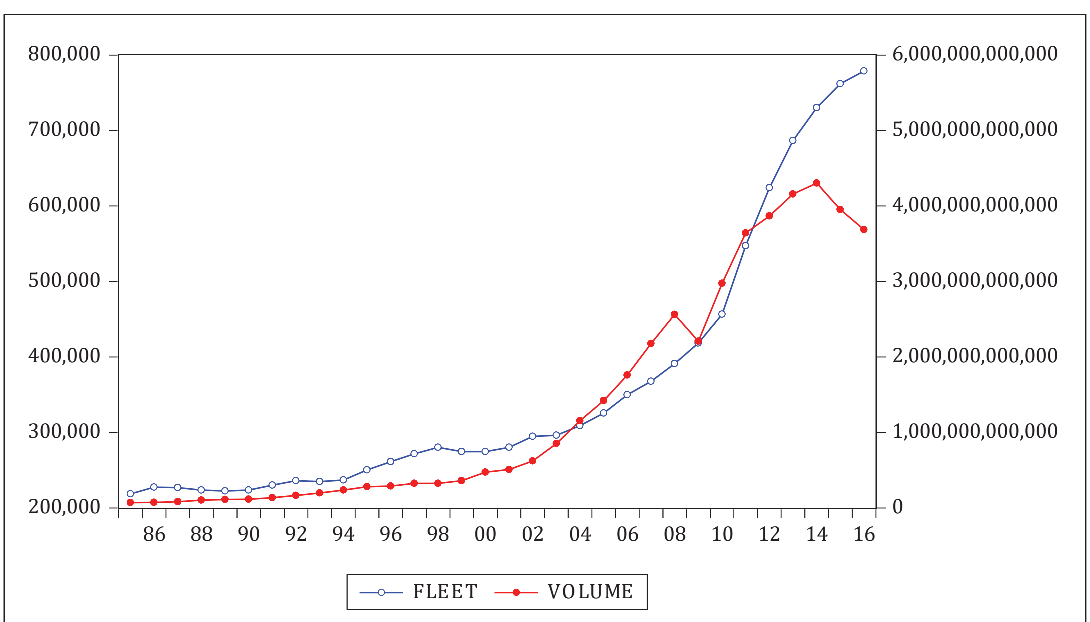

Figure 5 Bulk Fleet and China Trade Volume
Source: Authors

tribution properties. According to the results the probability of Jarque-Bera (0.818) is greater than the critical value of 0.05, and in this case the null hypothesis cannot be rejected.

According to the results of the robustness tests, the residuals of the model have met all the necessary assumptions. There have been no autocorrelation, serial correlation, heteroscedasticity, and residuals that have shown normal distribution characteristics. As a result, the model is suitable for economic interpretations in the direction of the objectives of the study.

It has been determined that a 1% change in China's trade volume has caused a 2.54% change in the Baltic Dry Index, and a 1% change in the total dry bulk fleet volume has caused a -5.66% change in the Baltic Dry Index. These coefficients have indicated that freight rates are more sensitive to changes in the supply side. It is possible to understand why the dry bulk market has collapsed after the global economic crisis in 2008, when it has been examined in Figure 5 beside the obtained coefficients. Until 2008, the trend of variables, which generally follow a parallel course, has been differentiated from this year. As the slope of the fleet variable has become even steeper, the rate of increase of the demand variable declined and then fell. Considering that the change in demand would increase the freight rates by 2.54%, while the change in supply would decrease by 5.66%, it is not difficult to understand why the market has collapsed after 2008.

The dry bulk freight market has characteristics similar to a perfect competition market. There are many buyers (shippers) and sellers (shipowners) in the market, and no participant alone has the power to influence the price (freight rate). The freight rate is formed by the balance between supply and demand and the bargaining power of the parties over each other, according to market conditions. The classical supply and demand model has been adapted and used in line with the objectives of this study. China's trade volume has been regarded as the demand side of the model. It has been one of the biggest economies in the world, and has recently caused a boom in the freight market. As for the supply side of the model, dry bulk fleet has been selected because China has been considered a production center for the labor-intensive phase of high-tech products hence the import of raw materials would be high for this kind of activity. The BDI has been accepted as the indicator for the price formed by the equilibrium between supply and demand. The hypothesis of the model has been developed as follows: China's trade volume has a positive impact on freight rates, and dry bulk fleet size has a negative effect on freight rates. The results of the implemented regression analysis have shown that a 1% change in China's trade volume has caused a 2.54% change in the BDI. Moreover, a 1% change in the total dry bulk fleet volume has caused a -5.66% change in the BDI. The directions of these coefficients have been found to be appropriate to maritime theory. In addition, it has been found that freight rates are much more sensitive to changes on the supply side (5.66>2.54).

At this point, shipowners cannot be very influential on the demand side, but the supply side is partly under their control. Of course, it is necessary to offer extra carrying capacity to the growing trade volume requirement, but the desire to earn too much in the short run with new investments is eliminating the long-term gains. Apart from trying to gain more by increasing the carrying capacity immediately when gains are increased, investors should aim to achieve sustainable gains in the long run by cooperating with maritime economists, policy makers, and other maritime stakeholders.

7 Conclusions

This research aims to contribute to current maritime economics literature by assuming China as one of the main demand sources of maritime transport. Thus, freight rates have been modeled on the Chinese situation, proving how macro variables are influential in the maritime market. In this regard, maritime stakeholders should position themselves according to these developments, reducing risks from uncertainty and providing sustainable growth. Although the validity of the classical freight model has been questioned by many researchers, the results obtained in this research through Chinese economy can clearly reveal the reasons of supply-side market fluctuations. In addition, it has been thought that the fact that there is no empirically similar study in the literature has increased the originality and contribution of this research.

In future researches, other major economies of the world can also be included in the model. Alternatively, the supply–demand balance can be examined in terms of the tanker market, which can be also regarded as an indicator of global economic activities.

References

[1] Angelopoulos, J. (2017). Time–frequency analysis of the Baltic Dry Index. Maritime Economics & Logistics, 19(2), pp. 211-233.

[2] Beenstock, M., & Vergottis, A. (1989). An econometric model of the world market for dry cargo freight and shipping. Applied Economics, 21(3), pp. 339-356.

[3] Bloomberg, Baltic Dry Index, Retrieved on 20.12.2017.

[4] Chang, M. (2014). Principles of Scientific Methods. New York: CRS Press.

[5] Chistè, C., & Van Vuuren, G. (2014). Investigating the cyclical behaviour of the dry bulk shipping market. Maritime Policy & Management, 41(1), pp. 1-19.

[6] Comtois, C., & Lacoste, R. (2012). Dry bulk shipping logistics. Maritime Logistics, a complete guide to effective shipping and port management, pp. 163-176.

[7] Geman, H. (2008). Risk Management in Commodity Markets: From Shipping to Agricultures and Energy. UK: Wiley.

[8] Grammenos, C. (2010). The Handbook of Maritime Economics and Business. Great Britain: MPG Books.

[9] Gujarati, D.N. (2004). Basic Econometric, (4th Ed.). The McGraw-Hill Companies. NewYork.

[10] Karakitsos, E., & Varnavides, L. (2014). Maritime economics: A macroeconomic approach. Springer.

[11] Koopmans, T. C. (1939) Tanker Freight Rates and Tankship Building. Haarlem, Holland.

[12] Lemper, B., & Tasto, M. (2015). Demand and Supply of Maritime Transport Services: Analysis of Market Cycles. In HSBA Handbook on Ship Finance (pp. 3-32). Springer, Berlin, Heidelberg.

[13] Randers, J., & Göluke, U. (2007). Forecasting turning points in shipping freight rates: lessons from 30 years of practical effort. System Dynamics Review, 23(2-3), pp. 253-284.

[14] Scarsi, R. (2007). The bulk shipping business: market cycles and shipowners' biases. Maritime Policy & Management, 34(6), pp. 577-590.

[15] Stopford, M. (2009). Maritime economics 3e. Routledge.

[16] Strandenes, S. P. (2012). Maritime freight markets. The Blackwell Companion to Maritime Economics, 11, 107.

[17] UNCTAD, Dry Bulk Fleet, http://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx, Retrieved 14.11.2017.

[18] Wang, Y. (2006). Cheap labor and China's export capacity. China as the World Factory. Routledge, Nueva York, pp. 69-81.

[19] Worldbank, Trade Volumes of Countries, https://data.worldbank.org/indicator/NE.EXP.GNFS.CD, https://data.worldbank.org/indicator/NE.IMP.GNFS.CD, Retrieved 05.12.2017.

[20] Zanettos, Z.S. (1996). Theory of Oil Tanker Rates, MIT, Cambridge, MA.

[21] Zeng, Q., & Qu, C. (2014). An approach for Baltic Dry Index analysis based on empirical mode decomposition. Maritime Policy & Management, 41(3), pp. 224-240.

[22] Zhang, K. H. (2006). China's foreign trade and export boom: 1978–2004. China as the world factory, pp. 9-26.