THE EFFECTS OF GLOBAL ECONOMIC GROWTH ON DRY BULK FREIGHT RATES

KÜRESEL EKONOMİK BÜYÜMENİN KURU DÖKME YÜK NAVLUN PİYASASINA ETKİSİ

Assoc. Prof. Dr. Sadık Özlen BAŞER[1]

Res. Asst. Abdullah AÇIK[2]

Abstract

Dry bulk freight market is one of the most important indicators of global economic activity as it is the market for the transportation of raw materials that make up final products. So, the world economy is one of the most important demand factors for maritime transport. But supply in the maritime market is inelastic and the market cannot immediately respond to sudden demand growth and rates declines in the short run. Therefore, the sudden increases and decreases in the economy result in extraordinary income changes in the freight market. In this framework, the influence of economic growth on freight rates is an important issue to be examined. This study aims to contribute to the current literature by empirically examining the effect of economic growth on the dry bulk market. World GDP (Gross Domestic Product) was selected as a measure of economic activities, and BDI (Baltic Dry Index) was chosen as a measure of dry bulk freight rates. The dataset covers the years between 1985 and 2016 on annual basis and consists of 32 observations. The relationship between variables was tried to be determined by correlation and regression analysis. According to the results of the study, the positive relationship between the variables was determine and the BDI's response to GDP changes was found to be greater. These results confirm how risky the maritime market is.

Keywords: *World Economy, Freight Market, Dry Bulk, Market Risk.*

JEL Codes: *C43, R41.*

Öz

Kuru dökme yük navlun piyasası, nihai ürünlerin üretiminde kullanılan ham maddelerin taşımacılığının gerçekleştirildiği bir piyasa olduğu için küresel ekonomik aktivitelerin en önemli göstergelerinden biridir. Bu nedenle dünya ekonomisi deniz taşımacılığı için en önemli talep faktörlerinden birdir. Ancak denizcilik piyasasında kısa dönemde arz inelastiktir ve ani talep değişimlerine anında karşılık verememektedir ve böylece piyasadaki navlunlar düşmektedir. Bu nedenle ekonomik aktivitelerdeki ani artışlar ve azalışlar navlun piyasasında olağandışı gelir değişimlerine neden olmaktadır. Bu çerçevede, ekonomik büyümenin navlun oranlarına olan etkisi incelenmek için önemli bir konudur. Bu çalışma ekonomik büyümenin kuru dökme yük piyasasına olan etkisini ampirik olarak inceleyerek mevcut literatüre katkıda bulunmayı amaçlamaktadır. Dünya GSYİH (Gayri Safi Yurt İçi Hasıla) değişkeni küresel ekonomik aktivitelerin bir ölçüsü olarak seçilmiştir, ve BKYE (Baltık Kuru Yük Endeksi) kuru dökme yük piyasasındaki navlun oranlarının bir ölçüsü

[1] Associate Professor, Dokuz Eylul University, Maritime Faculty, ozlen.baser@deu.edu.tr
[2] Research Assistant, Dokuz Eylul University, Maritime Faculty, abdullah.acik@deu.edu.tr

olarak seçilmiştir. Çalışmada kullanılan veri seti 1985 ve 2016 yılları arasını kapsayan yıllık bazda 32 gözlemden oluşmaktadır. Değişkenler arasındaki ilişki korelasyon ve regresyon analizleriyle tespit edilmeye çalışılmıştır. Çalışmanın sonuçlarına göre, değişkenler arasında pozitif anlamlı bir ilişki olduğu ve BKYE'nin GDP'ye tepkisinin oldukça yüksek olduğu tespit edilmiştir. Bu sonuçlar denizcilik piyasasının ne kadar riskli bir piyasa olduğunu doğrulamaktadır.

Anahtar Kelimeler: *Dünya Ekonomisi, Navlun Piyasası, Kuru Dökme Yük, Piyasa Riski.*

JEL Kodları: *C43, R41.*

1. INTRODUCTION

Society's continued evolution and movement away from a subsistence-based economy towards one with an ever increasing demand for more material goods and services are the real driving force behind increase on trade. Either international or domestic, these can be only procured by trade which generates demand for transport activities (Cowie, 2009:14). Furthermore, improved shipping technology and reduced transport costs has encouraged world trade (Lundgren, 1996).

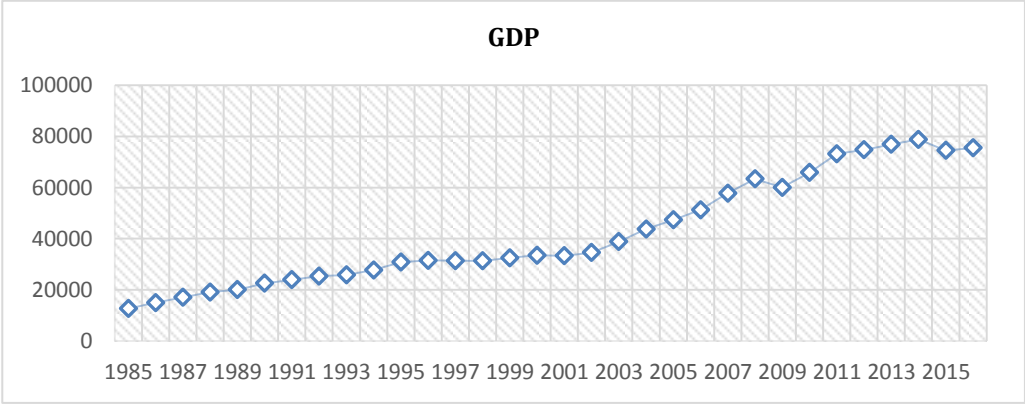
The question of why world trade has grown easily is related to relentless technological improvement in the communication and transport sectors, computers, containers and supertankers (Jacks and Pendakur, 2010). When sailing and wooden ships were replaced by vessels equipped with steam engines and steel bodies, it was a big revolution for maritime transport industry. In addition to that, a new revolution has occurred in 1950s which was introduction of new technology related to average ship sizes and this decreased freight levels about 65% until 1980s. These developments have eased the international trade and triggered economic growth (Lundgren, 1996). Also Bernanke (2006) contributed this explanation by expressing that new technologies that reduce the cost and communication have been major factors for supporting global economic growth and integration.

But some researchers thought transport costs were not that important. Baier and Bergstrand (2001) argued that a general equilibrium gravity model of international trade implies that roughly two-thirds of the growth of world trade after 1950 can be explained by income growth, one fourth by tariff reductions, and less than one-tenth by transport cost reductions.

Beside reduction of transport costs by technological improvements, supply and demand interaction in the maritime industry is a key factor for determining transport costs. Koopmans (1939) investigated the determinants of freight rates in terms of a model of supply and demand. If the supply exceeds demand, freight rates fall, but if the demand exceeds supply, freight rates rise. Stopford (2009:136) determined five factors that affect the demand for sea transportation from many influences on the shipping market. These are world economy, seaborne commodity trades, average haul, random shocks and transport costs. Particularly world economy is one of the main determinants of freight levels because of its weight on the demand side. The interest of this study covers that relationship.

World economy is represented by gross domestic product (GDP) in this study, and annual values are presented in Figure 1. In 2014, the highest value of all time was reached as 79 trillion dollars, and in the last year of research, 2016, it was about 76 trillion dollars. GDP measures the value of production that takes place within a specific interval of time that is usually a year or a quarter. GDP measures the economy's flow of income and expenditure during that interval. GDP is the sum of the market value of all final goods and services produced within a country in a given period of time (Mankiw and Taylor, 2014:439). These economic activities fluctuate over time with the influence of some macro factors and generate business cycles that vary according to sectors. Freight cycles are one of these cycles.

Figure 1. World Gross Domestic Product by Years (billion $)

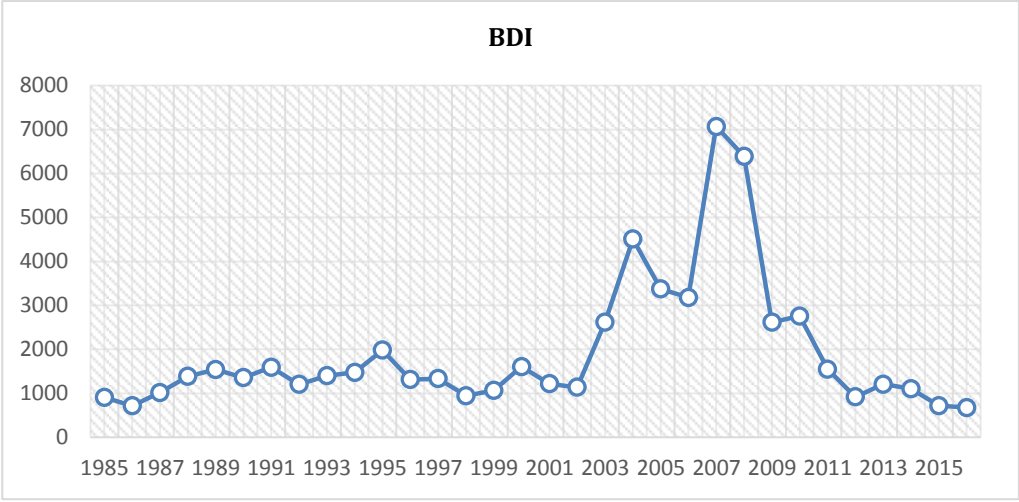


Source: Worldbank, 2017

The business cycle lays the foundation for freight cycles. Fluctuations in the rate of economic growth deal with seaborne trade and generate a cyclical pattern of demand for ships (Stopford 2009:140). The effects of business cycles over bulk shipping is greater than other because industrial commodities that are vital for industrial production are carried by bulk transport. Also in many ways the bulk shipping markets are very close to perfect competition market features since there are a large number of small sized buyers and a large number of small sized sellers (Gubbins, 1986:77). This situation increases their business risks and they often exposure to impacts of business fluctuations.

The Baltic Dry Index (BDI) was born in 1985 due to the need for a common indicator for monitoring the dry bulk market. It covers dry bulk shipping rates and consists of 26 shipping routes measured in time charter and voyage basis (Geman, 2008:181). Since its establishment, the BDI has become one of the primary indicators on the cost of shipping in the world (Lin and Sim, 2013). So it is selected as an indicator of dry bulk freight earnings in the market. The annual average values of the Baltic Dry Index are shown in Figure 2. The index reached 11793 points in 2008, the highest level of all time. Since the used data is annual basis consisted of averages of daily points, the highest value of it is 7070 points in 2007.

Figure 2. Baltic Dry Index by Years (Points)



Source: Bloomberg Data Platform, 2017

As it has been discussed up to this point, there is a mutual interaction between economic growth and transport sector. The relationship between transport infrastructure and economic growth is described by two types of models which are supply led and demand led models. The supply model suggests that improving the transport infrastructure will automatically stimulate economic activity and stimulate economic development. Contrasting with the supply led model, the demand model suggests that transport services are always emerged as a result of the demand for it. Thereby, economic development leads to a demand for transport facilities (Cowie, 2009:16). Transport infrastructure may refer the fleet capacity in maritime industry. Providing a transport capacity may cause economic development (supply led model), and economic growth may cause transport demand and promote growth of the transport capacity (demand led model).

This study aims to examine the effects of economic growth on shipping earnings in the theoretical base of demand led model. Because undoubtedly, the most important single influence on ship demand is the world economy (Stopford 2009:140). Studies that directly examined this topic have not been found in the literature, therefore, the development of the theoretical framework has been tried to be explained above. At this point, this study aims to contribute to the current literature in a different way, presenting evidence by picking out the effect of economic growth on the dry bulk market. Although the results obtained are very general, they are considered to be important in the literature because of their empirical consideration for the first time.

The remainder of the paper is organized as follows; the method, data set and research model used in the study are introduced in the second section; results obtained from the analysis are presented in the third section; and finally, findings are evaluated in the final section.

2. METHODOLOGY

Pearson's correlation analysis and logarithmic linear regression model are used for analysis of this study. Pearson's correlation coefficient R, a measure of the strength and direction of the linear relationship between two variables, is defined as the (sample) covariance of the variables divided by the product of their (sample) standard deviations. The absolute value of Pearson correlation coefficients cannot be larger than 1. Correlations equal to 1 or -1 correspond to data points lying exactly on a straight line (Chang, 2014:78). Formula of the Pearson correlation is presented below.

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

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

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

Evaluation of the correlation analysis depends on the degree and direction of the correlation coefficient. General classification of degree of the correlation analysis is presented at Table 1. The closer the absolute value of the correlation coefficient is to 1, the stronger the relationship (Soh, 2016:40).

Table 1. Evaluation of Correlation Coefficients

Correlation Coefficient	Description
0.90 – 1.00	Very strong and very high
0.70 – 0.90	Strong or high
0.40 – 0.70	Moderate or medium
0.20 – 0.40	Weak or low
0.00 – 0.20	Very weak or very low

Source: Soh, 2016:40

Another analysis used in the study, regression analysis is concerned with the study of the dependence of one variable on one or more other variables. It helps to examine functional relationships between the concerned variables (Chatterjee & Hadi, 2015: 1). The dependent variable is tried to be explained by the explanatory variables. The results that gained after analysis are 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 (Gujarati, 2004:18). Simple model of the regression equation is presented at (3). Y_i is the

dependent variable of the equation, $\hat{\beta}_1$ is the predicted constant of the equation, $\hat{\beta}_2$ is the predicted coefficient of the X_i which is the independent variable in the model. The coefficients of the model allows to quantify a direction and strength of the statistical relationships between the variables (Esquerdo & Welc, 2018: 2). At lastly $\hat{u}_i$ is the residuals that cannot be explained by existing model. (4) presents the calculation of the coefficient of independent variable and (5) presents calculations of constant coefficient. And significances of the coefficients are calculated by (6).

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

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

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

$$\begin{matrix} tstat(\hat{\beta}_1) = \hat{\beta}_1 / se(\hat{\beta}_1) \\ tstat(\hat{\beta}_2) = \hat{\beta}_2 / se(\hat{\beta}_2) \end{matrix} \quad (6)$$

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

Log-log regression model (7) is 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 (Gujarati, 2004:176). Also by using logarithmic values, discrete series become continuous and the processability of the series increases.

The CUSUM test is based on the cumulative sum of the recursive residuals. Cumulative sum is plotted together with 5% critical lines. If the cumulative sum goes outside the area between two critical lines, it means there is a parameter instability (Brown et al., 1975). Theoretical model of the study is tried to be explained in the next section.

2.1. Data

Baltic Dry Index data is consisted of annual averages of daily BDI values and it is gathered from Bloomberg Data Platform. Gross Domestic Production (GDP) data is current U.S dollars prices of the total world countries and it is gathered from Worldbank statistics. The descriptive statistics of normal data, logarithmic data and logarithmic differenced data are presented in Table 2. When BDI data is analyzed, it is seen that the highest value is 7070, the lowest value is 673 and mean is 1933. This wide range between the highest and lowest values, and the position of the average value prove how extraordinary market fluctuations are.

Table 2. Descriptive Statistics of the Variables

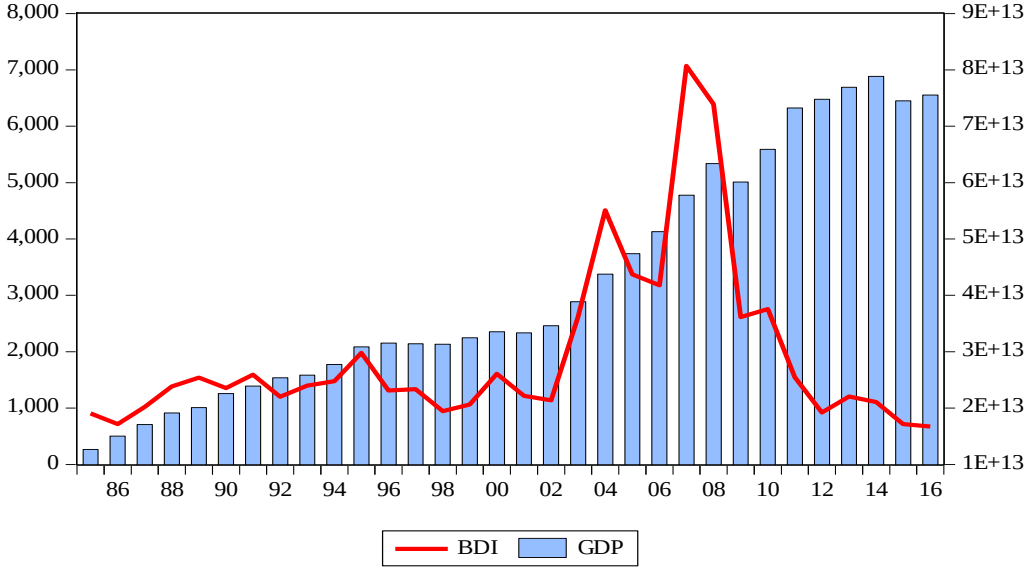
	BDI	GDP	ln BDI	ln GDP	Δln BDI	Δln GDP
Observations	32	32	32	32	31	31
Mean	1933.7	42215.45 b	7.36	31.24	-0.00	0.05
Median	1369.9	33439.58 b	7.22	31.14	-0.05	0.05
Maximum	7070.2	78870.12 b	8.86	31.99	0.83	0.16
Minimum	673.1	12681.69 b	6.51	30.17	-0.89	-0.05
Std. Dev.	1530.5	21217.32 b	0.59	0.52	0.38	0.05
Skewness	2.13	0.48	0.94	-0.12	0.15	-0.16
Kurtosis	7.01	1.82	3.31	2.01	3.05	2.44
Jarque-Bera	45.8	3.09	4.92	1.37	0.12	0.54
Probability	0.00	0.00	0.08	0.50	0.94	0.76

*b refers to billon dollars

Source: Bloomberg, 2017; Worldbank, 2017

In Figure 3 the two variables are overlapped and the relationship between them is shown. Until the 2008 economic crisis, the relationship between the series generally co-existed, but it is deteriorated after the crisis.

Figure 3. Graphical Display of Baltic Dry Index and World Gross Domestic Product ($)



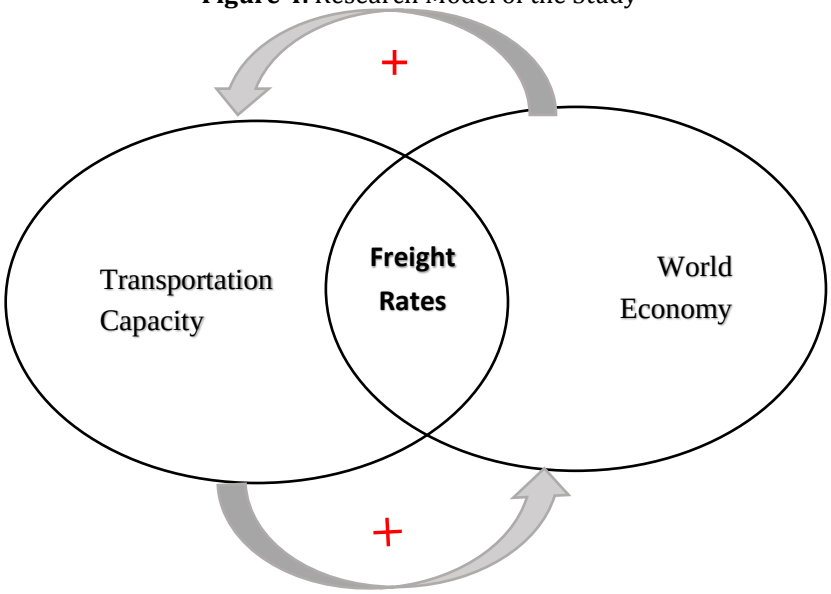
Source: Bloomberg, 2017; Worldbank, 2017

2.2. Research Model

A simplified model of the study is presented in Figure 4. As mentioned in previous chapters, the increase in economic activities lead to transport demand, and the

increase in the carrying capacity also supports economic activities. They support each other with a two-way relationship between them. The assumption to be used in our study is the demand-led model, and thus the effects of economic activities on the transportation demand have been tried to be investigated. Freight rates derive from the interaction of these two sides, and if the increase in transport demand by economy is faster than the increase in capacity, the equilibrium price of freight rates is going to climb higher points.

Figure 4. Research Model of the Study



Demand changes in the short run are followed by extraordinary fluctuations in the freight rates, but world economy and transport capacity follow a balanced course in the long run. Capacity surplus is eliminated from the market thanks to shipbreaking activities and new optimum equilibrium points are reached.

In the framework of the presented model, the main hypothesis of the study is that there is a positive relationship between economic activities and freight rates. Because of the derived demand structure, the economic revival increases the demand for transportation operations. This increase in demand for transportation naturally leads to higher levels of equilibrium in freight rates in the market. Correlation and regression analyzes are used to test this hypothesis and the results are presented in the next section.

3. FINDINGS

The logarithms of the series have been taken, since by doing so the discrete series become continuous and the processability of the series increases. In addition, taking logarithms can help to show better distributional properties of the series (Shahbaz et al., 2017). The variables that is going to be used to construct our econometric models must be stationary in order to avoid spurious regression problems. Therefore, unit root tests are applied to variables before the econometric analysis. Augmented Dickey-Fuller

(Dickey and Fuller, 1979) and Philips Perron (Phillips and Perron, 1988) tests are widely used and accepted tests that are used to determine whether a unit root exists or not in the financial series. The null hypotheses of the tests indicate that the original series has a unit root which means the series is non-stationary. If the absolute values are smaller than the reported critical values, we fail to reject the null hypothesis which means tested series is non-stationary. The ADF and PP Unit Root tests are applied to the both of the series and results are presented in Table 3. According to the results of the tests, both of the variables become stationary when their first differences are taken, so it can be said that ln BDI and ln GDP are integrated of order one, I(1).

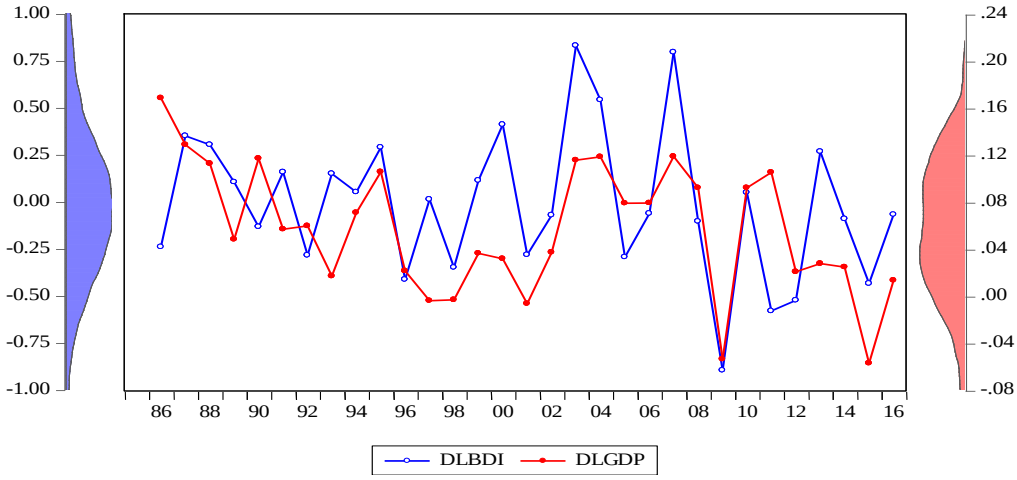
Table 3. ADF Unit Test Results

		ADF		**PP**	
		Intercept	**Trend and Intercept**	**Intercept**	**Trend and Intercept**
Level					
ln BDI		-1.684	-1.358	-1.772	-1.263
ln GDP		-2.663	-2.190	-2.264	-2.548
First Differences					
Δ ln BDI		-5.226***	-5.132***	-5.225***	-5.501***
Δ ln GDP		-3.968***	-4.094**	-3.954***	-4.090**
Critical Values	1%	-3.661	-4.296	-3.661	-4.296
	5%	-2.960	-3.568	-2.960	-3.568
	10%	-2.619	-3.218	-2.619	-3.218

Significance levels = * 10%, ** 5%, *** 1%

Logarithmic series have been stabilized by taking first differences, and the possibility of giving a spurious regression model has been eliminated. Graphical representations of the stationary series are presented in Figure 5. When the figure is examined, the positive relationship between the variables can be identified, and it can be said that the variables generally move parallel to each other. In addition, it can be said that the series have normal distribution from the distribution indicators located at the axis of the figure. The statistical validity of distribution can be also confirmed from the Jarque-Bera statistic in Table 1 whose null hypothesis implies normal distribution.

Figure 5. Graphical Display of ΔlnBDI and ΔlnGDP and Their Distributions



Since Pearson's correlation analysis is more appropriate to apply to normal distributed series, it is implemented to variables. As seen at Table 2 and Figure 5, both of the variables have normal distribution specifications that are confirmed by Jarque-Bera statistics. The significance of the correlation analysis depends on the t statistics and the value of the correlation coefficient. According to the results presented in Table 4, there is a medium degree positive significant correlation between BDI and GDP variables. This result reveals that the series generally move together, ie the freight rate and economic growth increase or decrease together.

Table 4. Pearson's Correlation Coefficient between Variables

	ΔlnBDI	**ΔlnGDP**
ΔlnBDI	1.000000 - -	
ΔlnGDP	0.497175 (-3.08576) 0.0044***	1.000000 - -

***significant at 1% level, t statistics in parenthesis ()

Correlation analysis is a useful tool to determine the degree and direction of the relationship between them. However, it does not report whether the changes in the one variable cause changes in the other variable, or how much it causes. So a regression equation is estimated as freight rate is dependent variable and world gross domestic product is independent variable, which is as follow:

$$\Delta lnBDI_i = ln\beta_1 + \beta_2 \Delta lnGDP_i + u_i$$

The regression model is estimated according to the established model and the results are presented in Table 5. The most important values that must be examined when

interpreting the outputs of the model are the F statistic and the R-squared values. According to the F statistic, the model is significant as a whole, and according to the R-squared value, the changes in the independent variable (GDP) explain 24% of the changes in the dependent variable (BDI). After obtaining satisfying success in these values, the statistical relations between the variables should be interpreted according to the coefficients. It can be seen that both of the constant coefficient and the GDP coefficient are significant according to their probabilities. The coefficient of GDP indicates that a change of 1% in GDP causes a change of 3.5% in BDI. However, this explanatory power is relatively low, and the reasons for this low value in the model should be examined.

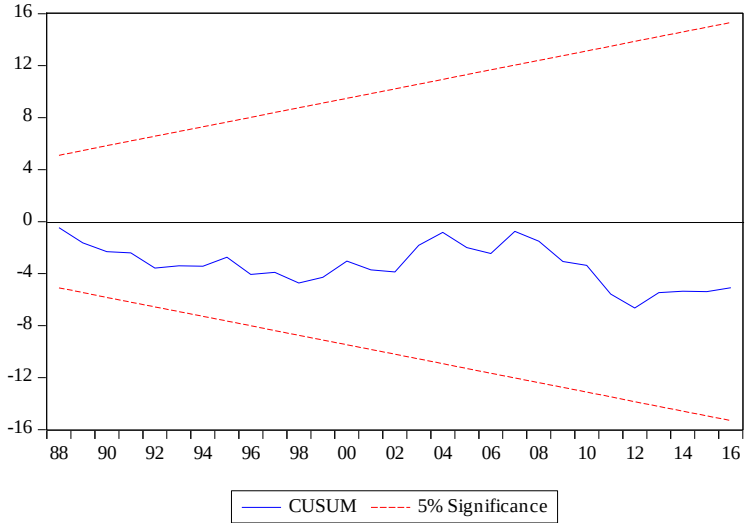
Table 5. Regression Model Equation Results

Dependent Variable: ΔlnBDI				
Variable	**Coefficient**	**Std. Err.**	**t-Stat.**	**Prob.**
C	-0.211	0.089625	-2.360	0.025**
ΔlnGDP	3.508	1.137124	3.085	0.004***
R-squared	0.247	**F-statistic**		9.52
Adjusted R-squared	0.22	**Prob (F-statistic)**		0.004***
S.E. of regression	0.34	**Sum squared resid**		3.369188

Significance levels = * 10%, ** 5%, *** 1%

CUSUM test, which is based on the cumulative sum of the recursive residuals, is applied to examine the structure of the model, as the problems in the structure of the model may cause a drop in the power of the model. According to the test, if the cumulative sum goes outside the area between two critical lines, it means there is a parameter instability. The test is implemented to the estimated model and the result is presented in Figure 6. When the figure is evaluated, it is seen that the middle (blue) line does not exceed the critical lines (red). However, at this point, even if the blue line does not exceed the critical values, it can be seen that the line follows a declining trend between 2008-2012. This may indicate the effect of a variable not included in the model in this period. As a pro-argument, when Figure 3 is analyzed, it can also be noticed that the BDI variable has shown an extreme decline after 2008, which is independent of GDP.

Figure 6. CUSUM Structural Change Test



In the period after 2012, it is seen that the co-movement between the variables is restored. Therefore, to eliminate the lack of variables in the model between 2008 and 2012, the dummy variable consisting of "1" values is added to the model as an independent variable. The dummy variable added to the model is named as "D1" and then the new model is re-estimated. The results of the new model are presented in Table 6.

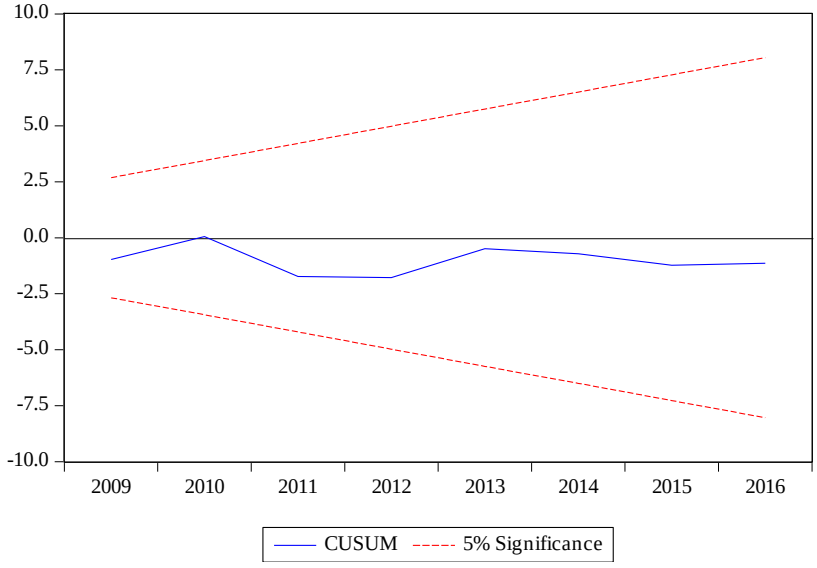
Table 6. New Regression Model Equation Results

Dependent Variable: ΔlnBDI				
Variable	**Coefficient**	**Std. Err.**	**t-Stat.**	**Prob.**
C	-0.130	0.083	-1.565	0.12
ΔlnGDP	3.359	1.001	3.353	0.00***
D1	-0.450	0.146	-3.074	0.00***
R-squared	0.437	**F-statistic**		10.87
Adjusted R-squared	0.39	**Prob (F-statistic)**		0.000***
S.E. of regression	0.29	**Sum squared resid**		2.518

The F statistic in the re-estimated model is significant and higher than the previous model. Furthermore, the explanatory power of the new model is increased to 43% according to the R-squared value. As for the statistical and economic interpretations of the variables in the model, the GDP and D1 variables are significant, while the constant variable is insignificant. The coefficient of the main independent variable, GDP variable, is 3.35, indicating that 1% change in GDP affects BDI by 3.5%. When the other independent variable, which is the dummy one, is examined, it can be said that there has been a decrease of 45% in average annual rate of BDI in the dummy period despite the positive impact of GDP. After the coefficients in the model are interpreted, the structural situation of the new model is examined and the CUSUM test result is presented in Figure 7. It can be concluded that, the blue line in the middle becomes more stable and the structure of

the model becomes stronger. After this point, some robustness tests need to be done in order to support practicability of the model. These tests generally consist of as autocorrelation test, partial correlation test, heteroscedasticity test and normal distribution test, and applied to the residuals of the model.

Figure 7. CUSUM Structural Change Test after Dummy Variable



The first tests to be implemented to the residuals of the model are autocorrelation and serial correlation tests. In the tests, the default value of 16 lags is selected and the obtained probabilities are evaluated. The null hypothesis of this test indicates that there is no autocorrelation between the residuals and it is rejected in all lags according to the probability values. Another test that is used for analyzing serial correlation is Breusch-Godfrey Serial Correlation LM Test. The null hypothesis of this test indicates that there is no serial correlation problem. As seen in Table 7, the null hypothesis is cannot be rejected for two lags, which means there is no serial correlation problem.

Table 7. Breusch-Godfrey Serial Correlation LM Test Results

F-statistic	2.133843	**Prob. F(2,26)**	0.1387
Obs*R-squared	4.370940	**Prob. Chi-Square(2)**	0.1124

ARCH heteroscedasticity test is used for evaluation of possibility of varying variance in the series. The null hypothesis of this test refers that there is no heteroscedasticity problem. According to the test results presented in Table 8 for two lags, the null cannot be rejected.

Table 8. ARCH Heteroskedasticity Test Results

F-statistic	1.849144	**Prob. F(2,27)**	0.1847
Obs*R-squared	1.858490	**Prob. Chi-Square(2)**	0.1728

Distribution of the residuals should be normal in order to obtain robust results in the regression equation. Histogram normality test is used for testing distribution characteristics of the residuals, according to the results, probability of the Jarque-Bera statistics is bigger than critical value. The null hypothesis of the test indicates that residuals are normally distributed, and it cannot be rejected according to the results presented in Table 9.

Table 9. Histogram Normality Test Results

Skewness	-0.096924
Kurtosis	2.768629
Jarque-Bera	0.117683
Probability	0.942856

As results of the robustness tests, it is understood that the residuals of the model provide the requirements to be used practically in the explanation of hypothesized relationship.

4. CONCLUSIONS

The BDI indirectly represents the demand for cargo carried in the bulk shipping market. These cargoes usually consist of raw materials used to produce final products, so dry bulk freight market is directly affected by global economic activities. In addition to this, the supply in maritime market is inelastic in the short run because of time-to-build effect which causes delays on the new ship deliveries (Başer and Açık, 2018), therefore the effect of sudden changes in economic activities are felt more in the market.

According to the results of the correlation analysis, there is a moderately significant positive correlation between BDI and GDP variables. This is a normal outcome, as the demand for transportation increases when the economic activity increases in the world. But the correlation analysis shows direction of movement rather than an econometric modelling, therefore a regression analysis has been additionally applied. Since structural problems are identified in the first regression model, the model is re-estimated by adding a dummy variable covering the dates between 2008 and 2012. According to the regression estimation results, 1 unit change in economic activities causes 3.35 unit change in dry bulk freight rates. Since our model is established logarithmically, these units can be interpreted as corresponding to the percentages, which means that an increase of 1% in GDP causes an increase of 3.35% in BDI. Besides, average 45% annual decline in the BDI has also experienced between the years of 2008 and 2012 regardless of the changes in GDP. The decline between these years is thought to be caused by the volatility of the supply-demand balance.

The high level of BDI's response to GDP is due to the maritime market's derived demand characteristics. It is also an indication of how volatile and risky the maritime freight market is. As the coefficients obtained from the regression estimation results show the change degree, the results can be also interpreted like that 1% decline in GDP would lead to a 3.5% decline in the BDI. This results indicate that a slight deterioration in the world economy leads to greater negative impacts on the maritime freight market, and

a small advance in the world economy leads to greater positive impacts on the maritime freight market.

With the increase in demand for maritime transport caused by buoyancy in the world economy, the revenues of the carriers in the maritime market have increased extensively and the volume of new orders has also increased. On the other hand, economic activities have slowed down due to the impact of the 2008 global crisis and the rate of economic growth has decreased in the following periods. As the pace of increase on the supply side has exceeded the pace of increase on the demand side, the maritime market has gone into a sudden collapse after 2008 global economic crisis. Because supply in the maritime market is inelastic in the short run, and the market cannot immediately respond to sudden demand growth. Therefore, the sudden increases and decreases in the economy result in extraordinary income changes in the maritime freight market as can be experienced from the analysis results. As the dummy variable shows, high investments have been made on the supply side (new construction) due to high incomes before the global 2008 economic crisis. In addition to the recession in the economy, this rise on the supply side has resulted in a collapse in the maritime market, resulting in an average decrease of 45% per year between 2008 and 2012.

As a result, this study has revealed that only economic growth is not enough to revive maritime markets. In addition to the demand generated by the economic growth, keeping the supply side in balance is vital in terms of ensuring sustainable income. The supply in the maritime market is inelastic in the short-run, so the market is vulnerable to sudden collapse and explosion. This large fluctuation seems to be a great risk, but it offers opportunities for some investors by timing their asset investments. Excessive increases in freight markets are reflected in ship values and cause their values to rise extraordinary. In this way, it is possible to obtain revenues that cannot be achieved by transportation activities. So, relationship between economic growth and ship values are also worth examining and may be considered for further researches.

The model can be improved by adding the supply side of the maritime transportation into the model in further studies. Also freight rates can be diversified with monetary values or with sub-indices of the BDI, and effects of economic growth can be examined for several maritime freight markets. The methods that enable the study of the relationship between data at different frequencies may be also used. Finally, since the maritime market is a very vulnerable market for shocks, and the relationship mentioned in the study can be evaluated by using non-linear methods. The biggest limitation of this study is related to the data set. If the wider dataset can be used in some way by increasing the frequencies, healthier results can be obtained.

REFERENCES

Baier, S. L. and Bergstrand, J. H. (2001). The growth of world trade: tariffs, transport costs, and income similarity. *Journal of international Economics,* 53(1), 1-27.

Başer, S. Ö. and Açık, A . (2018). The Response of shipbuilding activities to freight rates. *Uluslararası İktisadi ve İdari Bilimler Dergisi*, 4 (1), 120-136.

Bernanke, B. S. (2006) Global economic integration: what's new and what's not? (No. 226).

Bloomberg Data Platform (2017). *Baltic Dry Index*, Retrieved in 10.05.2017

Brown, R. L., J. Durbin, and J. M. Evans (1975). Techniques for testing the constancy of regression relationships over time. *Journal of the Royal Statistical Society,* 37, 149–192.

Chang, M. (2014). *Principles of Scientific Methods*. CRC Press.

Chatterjee, S. and Hadi, A. S. (2015). *Regression Analysis by Example*. John Wiley & Sons.

Cowie, J. (2009). *The Economics of Transport: A Theoretical and Applied Perspective.* Routledge.

Dickey, D. A. and Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, 74, 427–431.

Esquerdo, P. J. R. and Welc, J. (2018). *Applied Regression Analysis for Business*. London: Springer.

Frankel, J. and Romer, D. (1999). Does trade cause growth?. *American Economic Review,* 89(3), 379-399.

Geman, H. (Ed.). (2009). *Risk Management in Commodity Markets: From Shipping to Agriculturals and Energy (Vol. 445).* John Wiley & Sons.

Grammenos, C. T. and Arkoulis, A. G. (2002). Macroeconomic factors and international shipping stock returns. *International Journal of Maritime Economics*, 4(1), 81-99.

Gubbins, E J (1986). *Shipping Industry: The Technology and Economics of Specialization Gordon and Breach Science Publishers*. New York, London, Paris, Montreux and Tokyo.

Gujarati, D. N. (2004*). Basic Econometrics*. Tata McGraw-Hill Education.

Jacks, D. S. and Pendakur, K. (2010). Global trade and the maritime transport revolution. *The Review of Economics and Statistics*, 92(4), 745-755.

Kaycheng Soh (2016). *Understanding Test And Exam Results Statistically: An Essential Guide For Teachers And School Leaders*. Springer, Singapore

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

Lin, F. and Sim, N. C. (2013). Trade, income and the Baltic Dry Index. *European Economic Review,* 59, 1-18.

Lundgren, N. G. (1996). Bulk trade and maritime transport costs: The evolution of global markets. *Resources Policy.* 22(1-2), 5-32.

N. Gregory Mankiw and Mark P. Taylor (2014). *Economics (3.ed).* USA: Cengage Learning.

Phillips, P.C.B. and Perron, P. (1988). Testing for unit root in time series regression. *Biometrica,* 75, 335-346.

Shahbaz, M., Van Hoang, T. H., Mahalik, M. K. and Roubaud, D. (2017). Energy consumption, financial development and economic growth in India: New evidence from a nonlinear and asymmetric analysis*. Energy Economics*, 63, 199-212.

Stopford, M. (2009). *Maritime Economics 3e.* Routledge.

Worldbank (2017). *World Gross Domestic Product Statistics*, Retrieved in 15.10.2017