

What Triggers the ISTFIX Bubbles?

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ABSTRACT: *The aim of this study is to determine the factors that influence the probability of price bubble formation in the İstanbul Freight Index (ISTFIX). In this direction, firstly the price bubbles were determined by generalized sup augmented Dickey-Fuller (GSADF) test. Following the GSADF test, a logit regression model was established by creating dummy variables from bubble dates and it was tried to determine the factors affecting bubble formation. The dataset consists of 354 weekly observations and covers the dates between 18.03.2011 and 31.12.2017. According to the results, 4 bubble periods with lengths ranging from 6 to 12 weeks were detected. In the logit model, it was found that “euro” and “fuel price” variables increase the probability of bubble formation and the marginal effect of “euro” is much higher.*

Keywords: Price bubbles, Maritime, GSADF, Logit regression, Freight index.

JEL Codes: C22, C58, O24, R41

ISTFIX Balonlarını Ne Tetikler?

ÖZ: *Bu çalışmanın amacı İstanbul Navlun Endeksi'nde (ISTFIX) fiyat balonları oluşma olasılığına etki eden faktörleri tespit etmektir. Bu doğrultuda ilk olarak genelleştirilmiş eküs Augmented-Dickey-Fuller (GSADF) testi ile fiyat balonları tespit edilmiştir. GSADF testini takiben de balonların görüldüğü tarihlerden kukla değişken oluşturularak lojistik regresyon modeli kurulmuştur ve balon oluşumunu etkileyen faktörler tespit edilmeye çalışılmıştır. Veri seti 18.03.2011 ve 31.12.2017 tarihleri arasında kapsayan 354 gözlemden oluşmaktadır. Sonuçlara göre uzunlukları 6 ila 12 hafta arasında değişen 4 balon dönemi tespit edilmiştir. Lojistik regresyonda ise “avro” ve “yakıt fiyatı” değişkenlerinin balon oluşma olasılığını arttırdıkları ve “avro” değişkeninin marjinal etkisinin çok daha yüksek olduğu tespit edilmiştir.*

Anahtar Kelimeler: Fiyat balonları, Denizcilik, GSADF, Lojistik regresyon, Navlun endeksi

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1.Introduction

Maritime transport has a derived demand structure, thus, the demand for merchant ships cannot be determined by analyzing only the cargo flows (Stopford, 2009: 610). Maritime transportation industry is highly dependent on the world economy, therefore reflections of positive or negative changes in the economy can be felt instantly in this industry. In addition, there is also a development effect of maritime transport on the economy due to the supply-led effect that is caused by reduced transport costs and expanded transport networks (Cowie, 2009: 16). Moreover, having maritime transport facilities, especially for developing maritime nations, is very important for national security, for international trade and for overall economic development (Odeke, 1984: 9).

Turkey is one of the developing maritime nations understood the importance of maritime transport and aims to have a say in this industry by taking advantage of the geographical location and qualified workforce. In this framework, ISTFIX was initiated for the purpose of following the regional developments and the market conditions for coaster type vessel operations. It is also aimed to make the market more readable by establishing an index with the same name. By the help of this index, the impact of regional and global developments on Turkish ship operators can be monitored and analyzed. Naturally in accordance with the structure of the shipping industry, fluctuations of varying sizes and lengths can occur in the index. In order to understand the causes of these fluctuations, it is necessary to investigate the factors affecting freight rates.

Freight rates depend on the demand elasticity of the transported cargo, ratio of transport cost to the cost of the cargo carried, the substitutability of the cargo transport process, the conditions (tariffs, salaries, locations, fuel costs), and the cost of processes such as receiving information, negotiating, and contracting (Rodrigue, 2013: 236). Since the amount of transported cargo is directly related to the demand for international trade, it is a fact that one of the most important factors affecting maritime transport demand is the purchasing power differences between countries and the most important indicators of purchasing power differences are exchange rates (Shenkar and Luo, 2008: 251). Therefore, the effect of exchange rates on international trade is inevitable.

There are multiple different views on the effect of exchange rates on international trade. According to the first point of view, fluctuations in the exchange rate cause the producers who are avoiding the risk to turn to the domestic market and decrease the international trade. According to another view, these fluctuations and shocks will be a separate motivation for the producers. Because of the fluctuations, extreme profit opportunities arise, thereby increasing the volume of international trade. According to the last point of view, producers avoid the risks arising from the exchange rate with the application of precautionary measures such as hedging. Consequently, exchange rate fluctuations are not an important

contributor to the international trade (Serenis and Tsounis, 2014). At this point, the question that comes to mind is; how do the exchange rates change? According to Alexander (1952), in countries that produce more than they can use, the production surplus comes to the foreground and the value of that currency increases, whereas, in countries with production deficit, a budget deficit form and their currency loses value. At this point, some countries are purposefully devaluing their currencies and by doing so, boosting their exports all the while discouraging imports.

In this context, these differences in views are reflected in the results of the studies and it is observed that studies in the literature related to exchange rate-trade relationship have reached contradicting results. In terms of exchange rates' effects on trade, Sekmen and Saribas (2008) investigated the relationship between foreign trade and exchange rates in Turkey, and found that exchange rates could not be effective in the variation between imports and exports. In another study, Chaudhary et al. (2016) investigated the relationship of exchange rate with exports and imports of major South-Asian and Southeast Asian Economies. While the study provided little sample verification of the impact of exchange rates on import, significant relationships about exports were found between more than half of the sample.

There are also many studies that have been done in this regard and have reached different results (Asteriou et al., 2016; Sharma and Pal, 2018; Senadza and Diaba, 2017; Šimáková, 2014). When maritime studies related to this topic were examined, few studies were found. The study by Chi and Cheng (2016) explored the impact of exchange rate fluctuations on the volume of maritime trade with Australia's main partners, along with several economic variables. As a result, authors found that exchange rate volatility has a significant effect on maritime export volume of Australia with its major Asian trading partners. In another study, Kim (2016) explored the impact of exchange rate movements, global economic activity and freight rates (Baltic Dry Index) on South Korea's loaded port throughput. Eventually he found that the increase in the nominal exchange rate had a positive effect on the amount of loaded cargo throughput in the South Korea's port. In line with this information which examines the effect of exchange rates on the global trade and maritime industry, it was decided to use the exchange rate variables in the determination of bubbles in ISTFIX. Since the differentiation in the purchasing powers will affect the demand for international trade, therefore it will also affect the demand for maritime transport.

Another important factor affecting freight rates was determined to be the fuel costs (Rodrigue, 2013: 236). The costs of the running vessels are generally classified as operating costs, voyage costs, cargo handling costs and capital costs (Stopford, 2009: 233). Voyage costs include port posts, canal dues and bunker (fuel) costs, and according to Stopford (2009: 225), bunker costs form nearly 76% of the voyage costs. As shipowners do not have control over fuel prices, they can

only restructure freight rates and fuel consumption policies. Increasing freight rates does not cause inconvenience, unless there is a problem in demand, but if the demand is weak, shipowners configure the speed of the vessels to consume the least amount of fuel. In addition, if the fuel prices are high, profitability of the shipping company decreases (Chen et al, 2014: 43), and high prices prevent freight rates to drop below a certain point (Wijnolst and Wergeland, 2009: 128). Due to the above mentioned reasons, in this study, fuel prices were used as a variable that could have bubble effects on ISTFIX.

Although many other factors exist that may affect freight bubbles, exchange rates and fuel prices have been used in the model of this study in terms of data matching and data accessibility. There are continuous business cycles in different lengths and structures in the maritime market (Stopford, 2009: 105), and it can be said that from the data of this study, seasonal cycles are more likely to be observed, when the frequency of data and the time covered are taken into consideration. Some events in these seasonal cycles may result in price bubbles as they cause booms in freight rates. Some of the examples found in the literature are; weather related events such as storms, heavy rains; cultural events such as holidays, feasts; operational factors such as long voyage agreements, port congestions (Fearnley, 2018); political factors such as closing of the Suez Canal, stockpiling some commodities (Stopford, 2009: 134), and adjacent market factors such as cargo transfers from other type of ships because of their shortage in the market (Lamper and Tasto, 2015: 18). These factors are also worth examining, but exchange rate and fuel price variables were included in the model in terms of data matching and accessibility.

When the literature on both price bubbles and maritime transportation were investigated, it can be seen that freight bubbles on the maritime market have not been studied. In addition, the superiority of GSADF over the traditional methods provided by its success in the determination of multiple price bubbles, led the authors to the idea of implementing the method for the first time in freight indices. Moreover, exchange rate and bunker price which are thought to be of an important role in the formation of price bubbles, believed to be investigated for the first time by using Logit regression model.

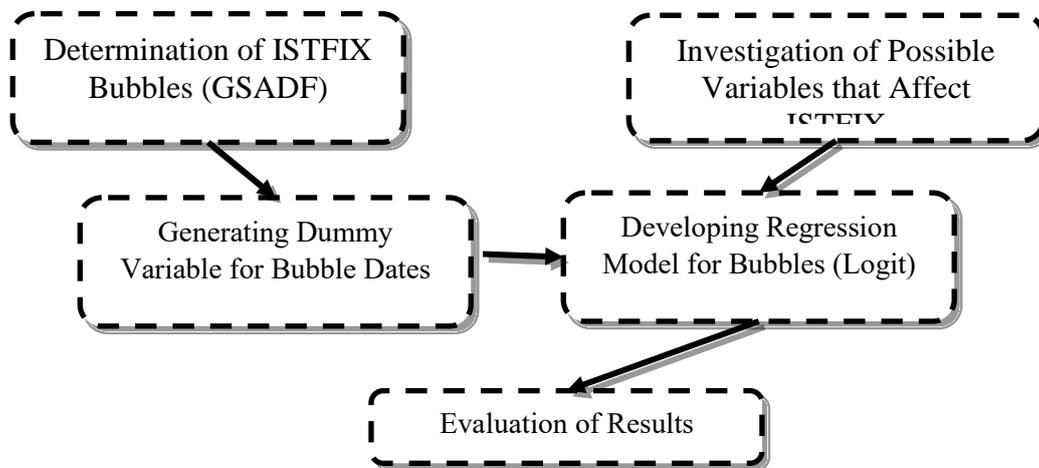
The remainder of this study is organized as follows: methods are introduced in section 2; the results of the analysis are presented in section 3; lastly, the conclusions are made and the study is finalized.

2. Methodology

Before introducing the methods, it is useful to define what the price bubble is. According to the Kindleberger (1987), a bubble is a sharp rise in price of an asset or service. In a bubble, the price of the asset or service deviates from its fundamental value (Visco, 2005: 165).

The methodology of the study consists of two phases. First, the GSADF method described below was used to identify the bubbles and their dates in the ISTFIX database. Then a dummy variable was generated by giving the value of 1 to the bubble dates. Lastly, the results were analyzed by establishing a logit regression model, where the variables that might cause the index value to rise were independent variables. GSADF and logit regression methods are introduced in the subheadings.

Figure 1: Research Model of the Study



2.1. GSADF Test

In the determination of price bubbles, methods such as left-tailed unit root and co-integration were among the first to be used in the literature. But over time, it turned out that these methods have various setbacks. Evans (1991) pointed out that these traditional methods are difficult to detect explosive bubbles when there are collapsing bubbles in the series. After identifying the missing aspects, Philips et al. (2011) suggested the sup ADF method in order to overcome this deficiency.

SADF test is based on right tail distribution when checking the presence of bubbles. This test continuously estimates the ADF model with the expanding sequence of samples. It tests hypotheses based on the corresponding sequential ADF test statistics. SADF is effective when there is a single bubble event, but there is evidence that multiple bubbles may appear when the sample is large (Su et al. 2017). In other words, it can be said that this test is designed to analyze a single bubble episode. If there are two bubbles and the second bubble's duration is shorter than the first one, then the SADF test cannot estimate the bubble's starting and ending times consistently (Su-Ling and Hsien-Hung, 2015).

Due to the weakness in measuring multiple episodes of bubbles, Philips et al. (2012) proposed an alternative model called generalized SADF, which was more successful in measuring multiple bubbles. The GSADF test idea is based on the repeated application of the right-tailed ADF test, and it extends the sample

sequence. The GSADF test shifts the start and end dates of the sample sequence in the form of a reasonable flexible window (Krishnan, 2016). Therefore, it can consistently detect and date-stamp multiple bubble episodes. This test rarely makes false detections (Caspi et al. 2015). Therefore, this method was chosen in this study to detect ISTFIX bubbles and the procedure suggested by Caspi (2013) was used.

2.2. Logit Regression

The examination of econometric relations can be carried out in many different ways. Regression analysis is one of the most widely known and used econometric methods. This method deals with the dependence of a variable (dependent variable) on one or more variables (independent variables) and determines if the relationship is statistically significant. The results obtained are used in estimating dependent variable or interpreting the theoretical and practical validity of the coefficients (Gujarati, 2004: 18).

There are various types of regression analysis, but the type of interest in this study is Qualitative Response Regression Models. In such models, depending on the groupings represented by the dependent variable, values such as 0, 1, 2 can be obtained. The models which include only two probabilities from among them are called binary choice models. These two-valued dependent variable analysis can also be carried out by linear probability model (LPM). However, Logit and Probit models have been developed due to the difficulty in estimating the dependent variable between 0 and 1, lower R^2 , non-normal distribution characteristics and heteroscedasticity of error terms (Verbeek, 2017: 216). Logit and Probit models are nearly same, so there is no convincing reason to choose one over the other. In practice many researchers choose the Logit model due to its comparative mathematical simplicity (Gujarati, 2004: 614). In this perspective, the Logit model was chosen for this study.

The following process was proposed by Emeç (2018), and it was used for the calculation of the average marginal effects in this study. First, the regression equation (1) is estimated in accordance with the logit model. The variable consisting of 2 options is selected as the dependent variable which is “1” in the bubble days, and “0” in the remaining days.

$$Y_t = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon_t \quad (1)$$

Then the coefficients of the equation (1) and the mean of the independent variables they belong to are used to find Z by using the equation (2).

$$Z = \beta_0 + \beta_1 \overline{X_1} + \beta_2 \overline{X_2} \quad (2)$$

Afterwards, equation (3) is used to calculate the standard logistic distribution function after the Z value is found. This function is represented by $f(Z)$.

$$f(Z) = \frac{dp}{dZ} = \frac{e^{-Z}}{(1 + e^{-Z})^2} \quad (3)$$

At the end of the process, marginal effects of each independent variable are calculated by (4) multiplying the logistic distribution function by their coefficients.

$$\text{Marginal Effect}_i = f(Z)\beta_i \quad (4)$$

Logit models can also present probability in certain conditions in independent variables. However, since marginal effects of independent variables are more important in the direction of this study, they have been taken into consideration. In the next section, the data set is introduced.

2.3. Data Set

Descriptive statistics for all raw variables used in the study are shown in Table 1. In addition to these statistics, when the risks of variables according to fluctuations (Std.Dev./Mean) were examined, the volatilities of the variables were 10%, 20%, 26%, 0.09% and 37% respectively. These values showed that the fuel price fluctuates too much during the period covered. While the relatively high fluctuations in the foreign exchange rates except the cross exchange rate were also observed, ISTFIX observed a normal fluctuation course of 10%.

Table 1: Descriptive Statistics of Raw Variables

	ISTFIX	EURO	USD	EURO/USD	FUEL OIL
Mean	639.4689	3.031058	2.536807	1.217162	484.6546
Median	622.0000	2.906780	2.289280	1.224780	411.0000
Maximum	889.0000	4.682680	3.942280	1.390340	774.0000
Minimum	550.0000	2.202580	1.751800	1.042840	164.0000
Std. Dev.	65.68795	0.608758	0.669311	0.107535	182.9244
Skewness	0.906575	0.716756	0.490200	0.013654	-0.059636
Kurtosis	3.267987	2.746103	1.918046	1.454656	1.383096
Jarque-Bera	49.55014	27.99402	28.15763	31.55252	34.71947
Probability	0.000000	0.000001	0.000001	0.000000	0.000000
Observations	354	317	317	317	317

Source: ISTFIX, CBRT

The number of observations for ISTFIX was 354 and 317 for the remaining variables, which were acquired as a result of the SADF and GSADF analysis. As the window size effect accounts for the first 37 weeks, the process of calculating the price bubble covers the remaining 317 weeks. The window size provides a prediction of a fixed range by shifting the starting point of the predicted regression within the sample. Because of this, the size of the window was selected as 37 by default and the number of observations was reduced since the first observations constituted the dependent variables of the first estimation. In the following section, the analysis was carried out and the results were evaluated.

3. Findings and Results

In the econometric time series analysis, the stationarity of the series is important in terms of the reliability of the results and for the estimators to have least amount of deviation. Therefore, the Augmented Dickey-Fuller unit root test was applied and it was determined that the series are I (1), which means, when the first differences are taken, unit roots are removed from the series. ADF test results are presented in Table 2.

Table 2: Augmented Dickey Fuller Test

ISTFIX	Level	-2.437913
	First difference	-6.498203***
EURO	Level	1.064324
	First difference	-12.16893***
USD	Level	0.310730
	First difference	-12.81585***
EUROUSD	Level	-1.442787
	First difference	-14.82428***
FUELOIL	Level	-0.992607
	First difference	-16.48521***
Test critical values:	1% level***	-3.451011
	5% level**	-2.870532
	10% level*	-2.571631

Table 3: Descriptive Statistics of Differenced Variables

	Δ ISTFIX	Δ EURO	Δ USD	Δ EUROUSD	Δ FUEL
Mean	0.875354	0.006506	0.006205	-0.000466	-0.897152
Median	0.000000	0.002878	0.002995	2.75E-05	-1.500000
Maximum	48.00000	0.241000	0.195140	0.030580	56.50000
Minimum	-40.00000	-0.104840	-0.110320	-0.038880	-46.00000
Std. Dev.	11.44162	0.042853	0.034776	0.011691	13.39710
Skewness	0.440712	0.785026	0.728620	-0.111510	0.444699
Kurtosis	5.491375	5.789382	6.116201	3.251356	5.059738
Jarque-Bera	102.7210	134.9019	155.8177	1.486744	66.27508
Probability	0.000000	0.000000	0.000000	0.475508	0.000000
Observations	353	316	316	316	316

Source: ISTFIX, CBRT

The descriptive statistics of the stationary series are presented in Table 3. If average values were to be examined during the period covered, it can be seen that ISTFIX increased by 0.87 points on average, Euro increased by ₺ 0.0065 on average, Dollar increased by ₺ 0.0062 on average, Euro-Dollar parity decreased by \$ 0.004 and oil price decreased by \$ 0.89. The impact of news can be evaluated with the examination of skewness values. Positive values indicate the impact of the effect of increasing news is higher, while negative value indicates the

opposite. In a maritime stakeholder's perspective, a positive value for ISTFIX shows that good news is more influential on the index value, for the other variables this varies according to market stakeholder positions. For a shipowner, positive value of fuel price means bad news, at the same time it is good news for the bunker supplier. Other variables in the table can also be interpreted in the same way. The next step is the implementation of the GSADF test.

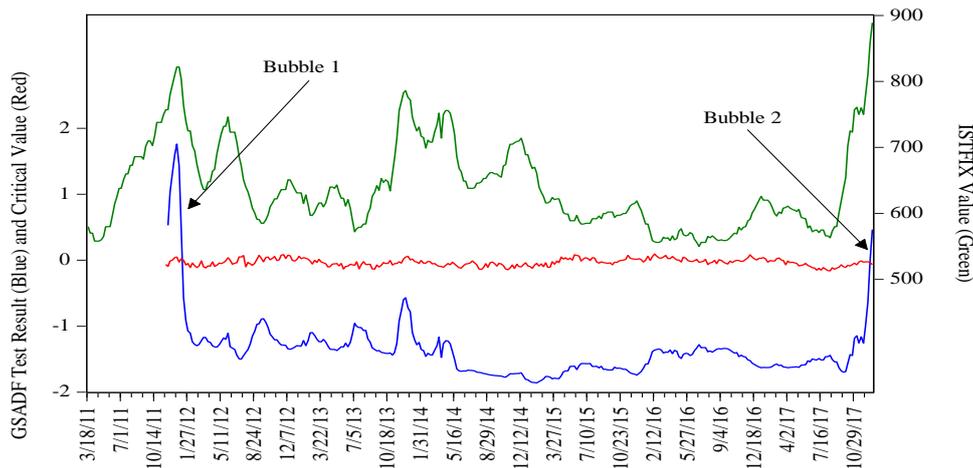
Initial window size selected as default value which was 37 observations, in the next step critical values were calculated based on Monte Carlo simulation. Sup ADF test was first applied and the null hypothesis was rejected. The null hypothesis of these tests is that there is no price bubble in the series. According to the results presented in Table 4, the null hypothesis in the SADF test was rejected at the 95% confidence interval and it was determined that the ISTFIX includes price bubble(s). In Figure 2, the positions of the bubbles in the series can be followed.

Table 4: SADF and GSADF Test Results

Included observations: 354		t-Statistic	
Null hypothesis: ISTFIX has a unit root		SADF	GSADF
Window size: 37		1.761317**	6.407780***
Test critical values*:	99% level	1.921119	2.925782
	95% level	1.518989	2.211916
	90% level	1.183664	1.964009

Note: *Critical values are based on a Monte Carlo simulation, **Significant at 95%, ***Significant at 99%

Figure 2: SADF Test Results for ISTFIX Data



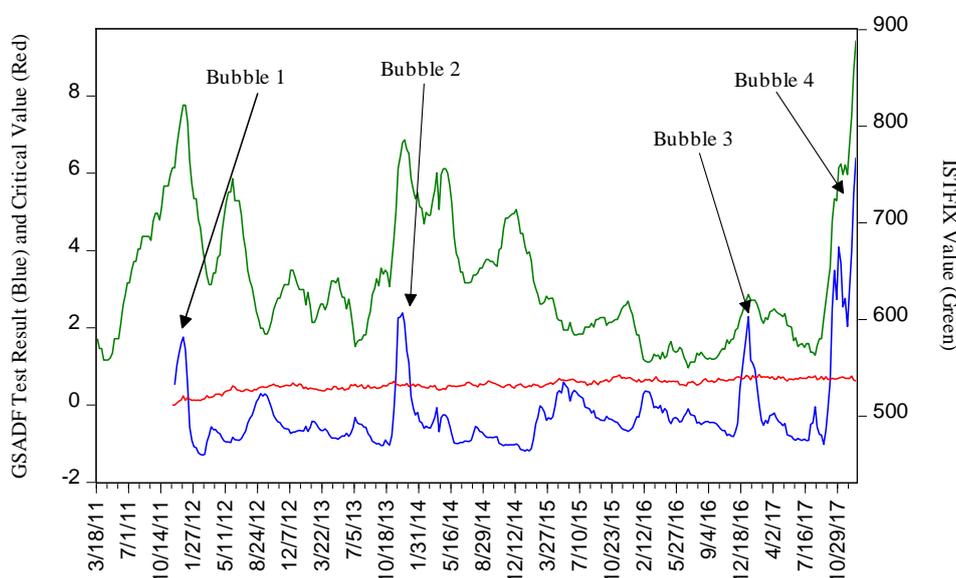
The red line in Figure 2 shows the critical values of the SADF test. Where the blue line is over the red line are the times when price bubbles were formed. Two price bubbles can be seen, one at the beginning of the series and the other at the end. However, as described in the methodology section, if there are multiple

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bubbles in the series, the SADF test can not be effective, consequently the GSADF test was applied. According to the results in Table 4, the null hypothesis was rejected at the 99% confidence interval. The positions of the reconsidered bubbles in the series can be seen in Figure 3.

When Figure 3 was examined, it could be seen that the first price bubble period was the same as the SADF test period. However, there were two additional bubble periods in total. This results confirmed that the effectiveness of the SADF test after the first price bubble had disappeared and it couldn't detect subsequent bubbles.

Figure 3: GSADF Test Results for ISTFIX Data



If the dates and lengths of the price bubbles are investigated, a total of 4 bubbles appear to be formed between 6-12 weeks. First bubble lasted 6 weeks between the dates of 05th December 2011 and 09th January 2012, second bubble lasted 7 weeks between 18th November 2013 and 30th December 2013, third bubble lasted 7 weeks between 19th December 2016 and 30th January 2017, and final bubble lasted 12 weeks between 9th October 2017 and 25th December 2017. However, this last bubble will presumably continue to exist for a while, as it is located at the end of the data set, there is not a sure way of saying it has reached its end. After the bubble dates were determined, they were assigned a dummy variable "1" and the regression analysis phase was initiated.

The choice of arguments was taken into account for the most optimal data available for reasons such as data accessibility, frequency matching. As mentioned in the introduction section, one of the most influential factors in international trade are exchange rates. Therefore, USD, EURO and EURO-USD variables were chosen. USD is one of the most dominant currencies in international trade. 47.1% of total export value of Turkey are comprised of trade

carried out with EU countries (TSI, 2018). Besides that, due to the economy based on the import of intermediate goods, raw materials and energy in Turkey, EURO-USD rate were eligible to be included in the model. Since the decrease in USD-based input prices and the increase in EURO-based export prices will lead to significant profit opportunities for the producers. This is likely to become an important element in shaping the demand for maritime transport. In addition, since bunker costs form nearly 76% of the voyage costs (Stopford, 2009: 225), FUEL variable that represents bunker price were included in the study, since the rise in bunker prices will put pressure on shipowners to raise freight rates and this may cause price bubbles.

The existence of the variables USD, EURO and EURO-USD in the model were expected to lead to a multicollinearity problem. Although it is not expected from them to be significant at the same time, it is aimed to reach the optimum result by sorting out insignificant variables. The following regression model was established and the model was estimated.

$$BUBBLES = \beta_0 + \beta_1 \Delta EURO + \beta_2 \Delta USD + \beta_3 \Delta EUROUSD + \beta_4 \Delta FUEL + \varepsilon_t$$

The results of the predicted model were presented in Appendix 1. According to the results, only the FUEL variable found to be significant. EURO-FUEL and USD-FUEL models were found to be significant among the results of different combinations. This leads to the existence of the problem of multicollinearity. Since one of the two models must be selected, the likelihood ratio statistics (LR statistic) values of the models were examined, as it is used for goodness-of-fit measure in maximum likelihood estimations (Baker and Kim, 2004:150). It was decided that the EURO-FUEL model should be chosen as the LR value of this model is higher ($10.27802 < 10.58573$). The results of the other model could be seen at Appendix 2. The new logit model formed in light of this information can be seen below:

$$BUBBLES = \beta_0 + \beta_1 EURO + \beta_2 FUEL + \varepsilon_t$$

The results of the selected logit regression model were presented in Table 5. The model is significant according to the LR test statistic, and the coefficients in the model are also significant. The fact that the coefficients (except C) are positive indicates that they have the potential to increase the likelihood of price bubbles. Also the fact that the coefficient of EURO is larger than that of FUEL indicates that the effect is more impactful. However, in such models, the coefficients cannot be interpreted directly. Thereafter the calculation of marginal effects was started.

Table 5: Logistic Regression Results

Dependent Variable: BUBBLE				
Method: ML - Binary Logit (Newton-Raphson / Marquardt steps)				
Sample (adjusted): 12/09/2011 12/31/2017				
Included observations: 316 after adjustments				
Convergence achieved after 6 iterations				
Coefficient covariance computed using observed Hessian				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
ΔEURO	10.80831	4.138732	2.611502	0.0090**
ΔFUEL	0.028221	0.013831	2.040415	0.0413*
C	-2.405230	0.217826	-11.04200	0.0000**
McFadden R-squared	0.052197	Mean dependent var	0.098101	
S.D. dependent var	0.297923	S.E. of regression	0.293061	
Akaike info criterion	0.627270	Sum squared resid	26.88199	
Schwarz criterion	0.662926	Log likelihood	-96.10866	
Hannan-Quinn criter.	0.641514	Deviance	192.2173	
Restr. deviance	202.8030	Restr. log likelihood	-101.4015	
LR statistic	10.58573	Avg. log likelihood	-0.304141	
Prob(LR statistic)	0.00502**			
Obs with Dep=0	285	Total obs	316	
Obs with Dep=1	31			

Significance levels: *95%, **99%

After estimating the coefficients of the model, the value of Z is calculated using the equation (2):

$$Z = 2.405230 + 10.80831 * 0.0065 + 0.028221 * -0.89715 = -2.3602$$

The standard logistic distribution was then calculated using the equation (3) and moved on to the calculation of marginal effects.

$$f(Z) = \frac{2.718^{-(-2.3602)}}{(1 + 2.718^{-(-2.3602)})^2} = 0.0788$$

For both variables, marginal effects were calculated using the equation (4):

$$ME_{EURO} = 0.0788 * 10.80831 = 0,851869285$$

$$ME_{FUEL} = 0.0788 * 0.028221 = 0,00222427$$

According to these results, the increase of 1 unit (TL) of EURO / TL parity increases the probability of price bubble formation by 85% and increase of 1 unit (\$) of FUEL price increases the probability of price bubble formation by 0.22%.

4. Conclusion

ISTFIX aims to examine the direction, quantity and route of the freight trade in the Black Sea and Mediterranean markets under the name of ISTFIX Region. It is calculated according to transportation activities between Marmara, Eastern Mediterranean, Central Mediterranean, Western Mediterranean and Continent regions (ISTFIX, 2018). In this sense, the index has an important function for monitoring and reviewing the necessary transportation services for Turkey's regional trade objectives. In addition, as it is measured by the income of the shipowners, it provides information about the situation of freight market in the region.

The nature of sea transport involves a large number of business cycles in different sizes. The point where the freight is highest is called peak and the point where it is the lowest is called collapse. In general, the movement of freight rates between these two extremes involves a trend, however at sometimes there are deviations in the positive or negative direction from this trend. Positive deviations can also be defined as price bubbles. In this framework, this study aims to identify price bubbles in the ISTFIX and determine the factors that affect the probability of their occurrence. Exchange rates and fuel prices were determined and analyzed as variables that can form price bubbles, taking into account the literature review, data matching and data availability.

SADF and GSADF tests were applied to determine price bubbles. The SADF test detected 2 price bubbles, but the GSADF test was also applied because it was emphasized by researchers that the SADF test had lost its effectiveness in the event of multiple bubble periods. 4 bubbles with lengths ranging from 6-12 weeks were identified according to the GSADF test and a dummy variable was assigned to the bubble dates for use in the logit regression analysis. Then, regression models were established as exchange rates and fuel prices were independent variables. The most appropriate one was the model in which EURO / TL and fuel price were independent variables. According to the marginal effects calculated after the coefficients found, an increase of 1 unit in currency (euro/TL) increases the probability of bubble formation by 85%, while an increase of 1 unit in fuel price (\$) increases this probability by 0.22%.

Majority of Turkey's exports (47.1% in 2017) are to EU countries and it is thought that the depreciation of the TL has increased the demand for sea transportation by boosting the exports to EU countries. Also it could be said that voyage costs also affect the freight rates, but the changes in the currency (demand) is more influential on the freight rates than the voyage costs.

This study contributes to the gap in the literature regarding the investigation of price bubbles in the maritime industry by applying the GSADF model to a freight index (namely ISTFIX) with also using Logit regression model for investigating the role of exchange rates and bunker prices in price bubble formation.

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Further studies can analyze the price bubbles originating from the demand more accurately, taking into account the cargo tonnage carried. Moreover, according to the GSADF test results, it appears that price bubbles are particularly at the turn of the years. The causes of these occurrences are also worth analyzing.

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APPENDICES

Appendix 1: Estimation Results of the First Logit Model

Dependent Variable: BUBLE				
Method: ML - Binary Logit (Newton-Raphson / Marquardt steps)				
Sample (adjusted): 12/09/2011 12/31/2017				
Included observations: 316 after adjustments				
Convergence achieved after 7 iterations				
Coefficient covariance computed using observed Hessian				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
Δ EURO	27.41430	23.52050	1.165549	0.2438
Δ EUROUSD	-56.20356	60.72384	-0.925560	0.3547
Δ USD	-16.81089	26.90608	-0.624799	0.5321
Δ FUEL	0.030555	0.013892	2.199575	0.0278*
C	-2.455462	0.226368	-10.84722	0.0000**
McFadden R-squared	0.059917	Mean dependent var		0.098101
S.D. dependent var	0.297923	S.E. of regression		0.292217
Akaike info criterion	0.634973	Sum squared resid		26.55660
Schwarz criterion	0.694400	Log likelihood		-95.32579
Hannan-Quinn criter.	0.658714	Deviance		190.6516
Restr. deviance	202.8030	Restr. log likelihood		-101.4015
LR statistic	12.15145	Avg. log likelihood		-0.301664
Prob(LR statistic)	0.016260*			
Obs with Dep=0	285	Total obs		316
Obs with Dep=1	31			

Significance levels: *95%, **99%

Appendix 2: Estimation Results of the USD-FUEL Model

Dependent Variable: BUBLE				
Method: ML - Binary Logit (Newton-Raphson / Marquardt steps)				
Sample (adjusted): 12/09/2011 12/31/2017				
Included observations: 316 after adjustments				
Convergence achieved after 6 iterations				
Coefficient covariance computed using observed Hessian				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
Δ USD	13.13874	5.128076	2.562119	0.0104*
Δ FUEL	0.029354	0.013571	2.162998	0.0305*
C	-2.409279	0.218351	-11.03398	0.0000**
McFadden R-squared	0.050680	Mean dependent var		0.098101
S.D. dependent var	0.297923	S.E. of regression		0.293023
Akaike info criterion	0.628244	Sum squared resid		26.87490
Schwarz criterion	0.663900	Log likelihood		-96.26251
Hannan-Quinn criter.	0.642488	Deviance		192.5250
Restr. deviance	202.8030	Restr. log likelihood		-101.4015
LR statistic	10.27802	Avg. log likelihood		-0.304628
Prob(LR statistic)	0.00583**			
Obs with Dep=0	285	Total obs		316
Obs with Dep=1	31			

Significance levels: *95%, **99%