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TESTING THE EFFICIENT MARKET HYPOTHESIS: A RESEARCH ON STOCKS OF CONTAINER SHIPPING COMPANIES[1]

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ABSTRACT

The aim of this study is to determine whether the efficient market hypothesis is valid in the stock prices of the 8 liner shipping companies that are placed in the top 10 in global container transportation. In this respect, Brock, Dechert and Scheinkman (BDS) test is used to test the efficient market hypothesis in the weak form. The data set used in this study consists of 397 observations on a weekly basis and covers the period between 5.11.2010 – 10.07.2018. According to the results of the study, efficient market hypothesis in the weak form is not valid in the stock prices of all liner shipping companies. This result shows that the stock prices of the companies are related to their historical prices and it is possible to obtain excess profits by using historical data of the stocks and by developing commercial strategies.

Keywords: Efficient Market Hypothesis, Container Companies, Stock Values, BDS Test.

Jel Codes: F65, O16, R4.

ETKİN PİYASA HİPOTEZİNİN TEST EDİLMESİ: KONTEYNER TAŞIMACILIĞI YAPAN FİRMALARIN PAY SENETLERİ ÜZERİNE BİR ARAŞTIRMA

ÖZET

Bu çalışmanın amacı, küresel konteyner taşımacılığında ilk 10'a giren ve pay senedi değerlerine ulaşılabilen düzenli hat taşımacılığı yapan 8 şirketin pay senedi değerlerinde etkin piyasa hipotezinin geçerli olup olmadığının tespit edilmesidir. Bu doğrultuda, zayıf formda etkin piyasa hipotezinin test edilmesi için Brock, Dechert ve Scheinkman (BDS) testi kullanılmaktadır. Çalışmada kullanılan veri seti haftalık bazda 397 gözlemden oluşmaktadır ve 5.11.2010 – 10.07.2018 dönemini kapsamaktadır. Araştırmanın sonucuna göre tüm düzenli hat taşımacılığı şirketlerinin hisse değerlerinde zayıf formda etkin piyasa hipotezi geçerli değildir. Bu sonuç şirketlerin hisse değerlerinin geçmiş değerleriyle bağlantılı olduğunu göstermektedir. Bu sonuçlar, bu hisse senetleriyle geçmiş veriler kullanılarak ve ticari stratejiler geliştirilerek olağanüstü karlar elde edilebilmesinin mümkün olduğunu göstermektedir.

Anahtar Kelimeler: Etkin Piyasa Hipotezi, Konteyner Şirketleri, Hisse Değerleri, BDS Testi.

Jel Kodları: F65, O16, R4.

1. INTRODUCTION

The efficient market hypothesis is examined in three forms in the literature and these are classified according to the information they contain. If the current price includes all past price information, the form is weak; the market is semi-strong form efficient if it includes all public information as well as historical information; if they contain all the private information along with public information, they are called strong form efficient. The most practical form to be determined by applying statistical analyses on these prices is the weak form efficiency. The significance of dependence on past prices can be determined by statistical methods and it can be concluded that if a dependency exists, prices are not efficient in the market.

In this context, this study aimed to determine whether the stock prices of the 8 companies from the top 10 liner shipping companies, whose stock values are available and there are no technical breaks in the values, are

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efficient in the weak form. Stock prices were analyzed with Brock, Dechert and Scheinkman (BDS) tests with 397 data on a weekly basis between the years of 2010 and 2018.It is hoped that, unlike traditional efficiency tests, it will yield more accurate results in efficiency measures. In addition, although it is often used in studies investigating measures of efficiency in general markets (Stengos and Panas, 1992; Al-Loughani and Chappell, 1997; Blasco et al., 1997; Afonso and Teixeira, 1998; Dorina and Simina, 2007; Lim and Brooks, 2011; Bhattarai and Margariti, 2018), the fact that it was not used in stock prices in maritime sector increases the motivation of using this method.

As a result of the analyses, it has been concluded that the stock value prices of the all companies in the sample are correlated to the past prices, therefore the prices have long memory capacity and therefore they are not efficient in the weak form. This shows that it is possible to obtain extraordinary profits above the average by using technical and commercial strategies based on historical data. The originality of this study is thought to arises from two different aspects. First one is a related to contribution to maritime literature and the second one is related to methodological aspect. The studies examining Efficient Market Hypothesis in maritime sector are very rare and their contributions are related to the freight, secondhand, newbuilding and demolition markets. A study on the behavior of the stock prices of maritime companies has not been found in the literature. In addition, the method used comes to the fore in terms of detecting non-linear dependencies.

The rest of the study is organized as follows; in the second section, related literature is reviewed; in the third section, the liner shipping market in the world is briefly mentioned; in the fourth section, the efficient market hypothesis is defined; in the fifth section, the method and data set used in the study are examined; the findings obtained are presented in the sixth section; and finally conclusion and discussion of the study is presented.

2. LITERATURE REVIEW

Studies examining the validity of the efficient market hypothesis in the maritime literature have examined the freight market, newbuilding market, the second hand market and the ship demolition market, which are defined as the four main shipping markets. Although the stock market has a more dynamic structure, a study examining the stock values of maritime companies could not be found in the literature. Therefore, this study is considered to provide an original contribution to the maritime literature.

In the freight market literature, Koekebakker et al (2006) investigated the stationarity of the spot freight markets considering the nonlinearity. Although the purpose of the study is not to test the efficient market hypothesis, the results can be interpreted in this way, as stationarity also shows the efficiency situation of the market and if the series includes unit root, it means that the market is efficient (Hassan et al., 2007). In the study, the authors applied a nonlinear unit root test to the freight variables and found that the freight markets were nonlinear stationary. According to this result, the mentioned spot markets do not move randomly and are not efficient in weak form. Goulas and Skiadopoulos (2012) investigated whether the efficient market hypothesis is valid in the IMAREX freight futures. The authors first made forecasts using the forecasting methods and made transactions using commercial strategies according to these forecasts. Then they evaluated the performance of commercial strategies. They concluded that freight futures can be forecasted and result in significant positive returns. Açık and Başer (2018a), tested the market efficiency in the freight markets in a weak form through the Baltic Dry Index. In their studies, they used both unit root test, variance ratio test and BDS independence test. According to the results obtained, they determined that the BDI variable is not efficient in the weak form. According to these results, it is possible to make extraordinary profits in the freight market by following commercial strategies and using historical data. In the newbuilding and secondhand market literature, paper of Hale and Vanags (1992) is one of the preliminary studies examining the efficient market hypothesis in second hand ship values. Following the research question they examined with the help of co-integration analysis, the researchers stated that they were skeptical about the validity of the efficient market hypothesis in the second hand prices of dry bulk ships, in contrast to the accepted opinion of that day related to the efficiency. Kavussanos and Alizadeh (2002) investigated the validity of the EMH in the secondhand and newbuilding prices of the dry bulk ships. According to the results obtained, they determined that both secondhand and newbuilding ship prices could not be determined efficiently. In this case, it is possible to make abnormal profits with commercial strategies and price estimations for asset traders.

The validity of the efficiency in the demolition prices were examined by Açık and Başer (2018b). Demolition prices of the five main demolition countries in the world, which are Bangladesh, China, India, Pakistan and Turkey, were analyzed through the BDS independence test. According to the results obtained, it was determined that the effective market hypothesis is not valid in both general and tanker ship demolition prices

in all mentioned countries. This result is not surprising considering that demolition countries follow each other's prices (Açık and Başer, 2019).

As can be seen from all mentioned papers, there are studies on testing the efficient market hypothesis, albeit limited, in the four main maritime markets. All the studies have concluded that the maritime markets are not efficient. Our study aims to open a new window in the maritime economy literature by testing the market efficiencies of stock prices of companies that are prominent in container transportation in the world.

3. LINER SHIPPING IN THE WORLD

Liner shipping market plays a central role in the maritime industry and in the global trade network (Stopford, 2009). The global container transportation sector which handles about 60 percent of the value of seaborne merchandise trade, has demonstrated some developments leading to major market consolidations (through mergers and acquisitions or alliances) since 2016. The consolidation activities between the years of 2016–2018 represent the reaction of the industry to cope with the challenging market situation faced since the 2008 global financial crisis by cargo pooling, improving economies of scale and reducing operating costs (UNCTAD, 2018a). The major mergers and acquisitions in recent years including the merger of the Japanese container ship operator groups as "ONE" which is a joint venture established between Nippon Yusen Kabushiki Kaisha, Mitsui Osaka Shosen Kaisha Lines and Kawasaki Kisen Kaisha on April, 2018 (Ocean Insights, 2018). Cosco Shipping Holdings has received all the approvals required for its takeover of Orient Overseas International on June, 2018 (Sea Trade, 2018). Hapag-Lloyd completed integration with the United Arab Shipping Company (UASC) on May, 2017 (World Maritime News, 2018). Maersk Line completed the acquisition of Hamburg Süd on November, 2017 (Maersk, 2018).

In January 2018, the top 15 container line companies controlled almost 70 per cent of all container ship capacity. Six months later, in June 2018, the top 10 liner companies controlled almost the same (70 per cent) container fleet capacity (UNCTAD, 2018b). Table 1 shows the global top 10 liner shipping companies according to consolidated TEU (Twenty-foot Equivalent Unit) capacity data obtained from Alphaliner.

Table 1. Global Top 10 Liner Shipping Companies

Rank	Liner Operator	TEU	Market share
1	APM Maersk	4,188,283	18.0 %
2	Mediterranean Shipping Co.	3,385,175	14.8 %
3	COSCO Group	2,822,551	12.3 %
4	CMA CGM Group	2,660,681	11.6 %
5	Hapag-Lloyd	1,700,337	7.4 %
6	ONE (Ocean Network Express)	1,552,186	6.8 %
7	Evergreen Line	1,245,643	5.4 %
8	Yang Ming Marine Transport Corp.	671,339	2.9 %
9	Hyundai Merchant Marine	436,768	1.9 %
10	PIL (Pacific Int. Line)	405,870	1.8 %

Source: Alphaliner TOP 100 / 21 April 2019 (Alphaliner, 2019)

According to UNCTAD report, the container freight market improved considerably after a difficult market condition in 2016. In 2017, the global container demand increased by 6.4 per cent and global supply of container ship-carrying capacity increased by 3.8 percent. A better balance in supply and demand by a stronger demand, is the main factor for improved freight rates in container markets. The container shipping industry reached approximately a total profit of $7 billion with a significant increase by the end of 2017 (UNCTAD, 2018b).

4. EFFICIENT MARKET HYPOTHESIS

According to the Effective Market Hypothesis (EMH), no investor can obtain extraordinary profits as all accessible information is reflected in the prices at any time. Because it is not possible to obtain information that is not public (Fama, 1970).

The efficient market hypothesis is divided into 3 forms and analyzed. The first one is called as the weak form, and the price of an asset contains all the information of its past prices according to this form. The latter is called a semi-strong form, and the price of an asset includes all publicly available information as well as its past price information according to this form. The third and the last is called the strong form, and according to this form the price of an asset includes all public and private information (Adland and Strandenes, 2006).

According to EMH in the weak form, current prices include all past information. This means that no investor can make excessive profits by modeling past prices and developing commercial strategies as the prices are moving randomly according to this form. According to EMH in the semi-strong form, since the prices include public information as well as historical information, no investor can make above-average or excessive profits by using publicly available information. Thirdly, as the prices in the strong form include all public and private information such as information obtained from someone from inside and opinions of the managers, investors cannot make an above-average profit using this information, whether or not they are printed (Ogilvie, 2005).

Although there are several markets where these three forms of efficiency are valid, the easiest one to measure with econometric techniques is the efficient market hypothesis in the weak form. Because, at this form of efficiency, the dependence between the current values and the past values is important, and it is possible to measure this dependence statistically. According to these evaluations made, trading in a weak form efficient market by using technical and commercial strategies based on past prices should not cause excessive profits (Adland and Koekebakker, 2004).

Two of the most popular models supporting the efficient market hypothesis are the random walk and the martingale model (Ogilvie, 2005). According to the random walk model, price changes have no memory and therefore historical data cannot be used to predict future prices (Fama, 1965). In other words, the price of tomorrow is independent of today's price. According to the Martingale model, if the market is efficient, today's price includes all the information and the price of tomorrow is equal to today's price unless a new information is obtained. Therefore, asset prices are unpredictable (Karakitsos and Varnavides, 2014). According to these models, if the market is martingale or if the prices are following a random walk, the market is efficient.

5. METHODOLOGY AND DATASET

In this section, the method and data set used in the study are introduced. Then, the process of research is explained with the help of a scheme.

5.1. BDS Independence Test

In testing the efficient market hypothesis, many methods are used to measure randomness (Brooks, 2014). Some of these tests, which aim to reach the results from different angles, consist of unit root test, variance ratio test and runs test. More recently, although it is a relatively older method, the BDS test has started to take its place in the literature in determination of the efficient market hypothesis. The BDS test is named by its developer researchers who are Brock, Dechert and Scheinkman. This test is used to detect the time-based dependencies in the series and is applied to the residuals of the predicted model (Brock et al., 1987). The null hypothesis of this test indicates that the series shows independent and identical distribution (Brock et al., 1996). In other words, if the null hypothesis cannot be rejected, it is concluded that there is weak form efficiency in the series (Afonso and Teixeira, 1998).

5.2. Dataset

The data set used in the study covers the periods between 5 November 2010 and 10 July 2018, and consists of 397 observations on a weekly basis.

Firstly, the data used in the study have been converted to the return series by taking logarithmic differences. The formula used in this conversion process is below.

$$Return\ Stock_i = ln\left(\frac{Stock_i}{Stock_{i-1}}\right)$$

The descriptive statistics of the data set converted into the return series are presented in Table 2. The sign of skewness values indicates what kind of news (shocks) are most effective in the covered period. The negative value indicates that the series is mostly exposed to negative impacts while the positive value indicates that the

series is mostly exposed to positive impacts. In addition, according to the JB test, rejection of the null hypotheses which indicates the normal distribution by most companies may be interpreted as an indication that they do not comply with the efficient market structure.

Table 2. Descriptive Statistics of the Variables

	HYU.	KAW.	MITS.	NIP.	ORI.	COS.	EVG.	YAN.
Mean	-0.010	-0.001	-0.001	-0.001	0.000	-0.004	-0.001	-0.004
Median.	-0.012	-0.002	-0.001	0.000	-0.000	-0.008	-0.001	-0.004
Maximum	0.432	0.145	0.152	0.123	0.208	0.398	0.153	0.161
Minimum	-0.267	-0.155	-0.135	-0.162	-0.289	-0.237	-0.123	-0.221
Std.Dev.	0.065	0.041	0.043	0.040	0.041	0.051	0.035	0.040
Skewness	0.92	-0.141	-0.059	-0.22	-0.491	2.02	0.31	-0.23
Kurtosis	9.27	3.99	3.82	3.80	10.79	19.4	5.08	6.27
Jarque-Bera	708.5	17.7	11.5	14.1	1022	4754	78.0	180
JB Prob.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observation	397	397	397	397	397	397	397	397

Source: Investing, 2018

In the next section, the method applied in the research is explained by presenting a step-by-step flow chart.

5.3. Process of the Research

The process of the study is illustrated in Figure 1. The BDS test must be applied to residuals that are free of deterministic elements. Firstly, the available data are converted to the return series by taking logarithmic differences since using return series when studying with financial series is a highly recommended technique. Then, the most suitable ARMA (p, q) model should be determined for the detection of deterministic elements in the model. The automatic forecasting function in an econometric software has been used in order to determine the most appropriate model for the series. Akaike information criterion (AIC) has been used for the selection of the model. The p and q values that make the AIC value smallest have been determined as the optimal lags. After selecting the most appropriate ARMA (p, q) model, the model is estimated by least squares method according to the lags detected. After the model is estimated, the model must be significant according to the F test and the roots of AR and MA must be smaller than 1. If these conditions are met, the residuals in the model are separated from the model. Afterwards, the efficient market hypothesis test in the weak form has been completed by applying BDS independence test.

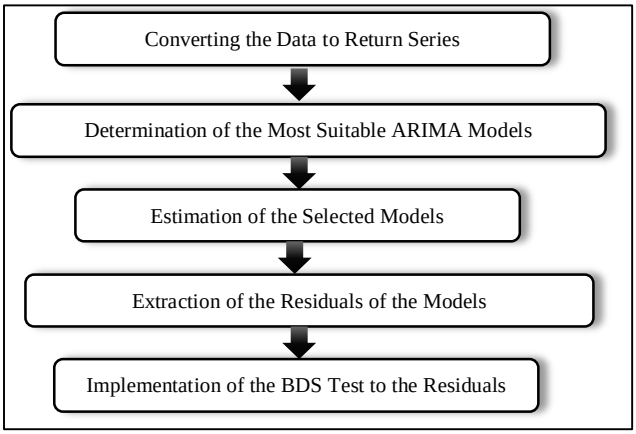

Figure 1. Research Process of the Variable

In the next process, the flow described herein is applied for the stock prices of the all companies. However, due to the area limitation, detailed results have been presented only for COSCO company and the summary information have been mentioned for other companies.

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6. FINDINGS

Before starting the analysis, it is important to perform a unit root test as a pre-test. The reason for this is that the series must be stationary in order to be able to make analyzes with the financial return series. For this purpose, augmented Dickey-Fuller (1979) and Phillips-Perron (1988) tests have been applied to the series converted to logarithmic return series, and the results are presented in Table 3. According to the results of ADF test, all series are stationary at the level and do not contain any unit root. This result also provides a preliminary information about the validity of the efficient market hypothesis. According to Hassan et al (2007), the unit root test can be used for determination of the market efficiency, as being efficient requires randomness in the series. In this context, if the series contains unit roots, it can be said to be moving randomly. According to this evaluation, since the series are I (0), they do not include this randomness, and this result provides a preliminary idea about their inefficiencies. However, the econometric series does not always have a linear structure. Unexpected shocks and events change the structure of the series (Bildirici and Turkmen, 2015), and the determinations made by the linear ways can be misleading. Therefore, in order to obtain more accurate results, the BDS test, which can detect non-linear dependencies, is started to be implemented.

Table 3. ADF Unit Root Test Results

	ADF		PP	
Company	**Intercept**	**Trend and Intercept**	**Intercept**	**Trend and Intercept**
Cosco	-14.018*	-14.043*	-15.117*	-15.109*
Ever Green	-15.326*	-15.305*	-15.330*	-15.309*
Hyundai	-16.913*	-16.908*	-16.809*	-16.802*
Kawasaki	-15.444*	-15.429*	-15.472*	-15.429*
Mitsui	-14.308*	-14.305*	-15.204*	-15.188*
Nippon	-14.209*	-14.196*	-15.614*	-15.594*
Orient	-15.289*	-15.402*	-15.100*	-15.174*
Yang Ming	-14.875*	-14.869*	-14.910*	-14.904*

Critical Values: For intercept; -3.44* at %1, For trend and intercept -3.98* at %1.

The results of the analyzes are presented according to the companies in alphabetical order. Firstly, analyzes for COSCO are presented in detail. After the data set has been converted to a return series, the automatic ARIMA model estimation has been implemented by selecting the maximum AR and MA numbers as 12 for each. According to the results, the ARMA (6, 4) model with -3.15 AIC value has been determined as the most suitable one. The models with the lowest AIC values have been presented in Figure 2, then, the selected model has been estimated.

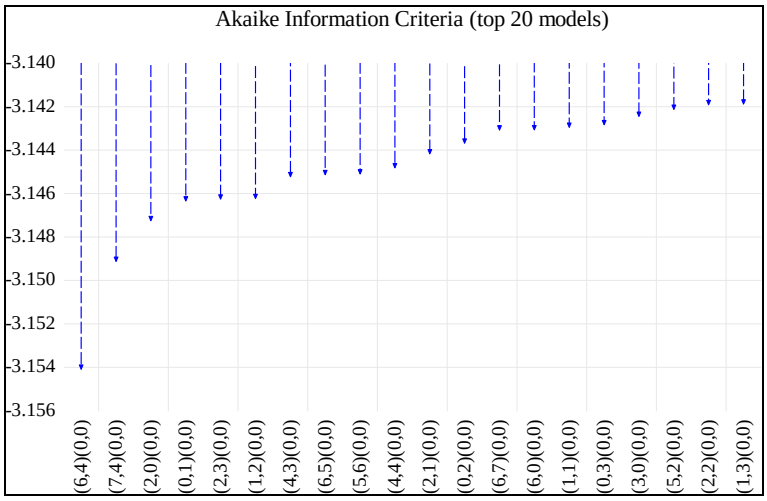

Figure 2. Selection of the Best ARIMA Model for COSCO

The determined ARMA (6, 4) model has been estimated by the least squares method and the results are presented in Table 4. When the necessary values for the significance and validity of the model have been checked, it has been seen that the model is significant (0.00 <0.05) according to F statistic, and all of the roots of AR and MA are smaller than 1. At this point, the estimated model is determined as a practicable model. Then, for the BDS test, the residuals of the model have been separated, and thus the series have been purified from the deterministic elements.

Table 4. ARIMA Estimation for COSCO

Variables	Coefficient	Std. Error	t-Stat.	Prob.
C	-0.004492	0.003208	-1.400147	0.1623
AR (1)	0.400212	0.035283	11.34282	0.0000
AR (2)	-0.178520	0.041173	-4.335852	0.0000
AR (3)	0.144041	0.035944	4.007388	0.0001
AR (4)	-0.951211	0.041253	-23.05801	0.0000
AR (5)	0.208628	0.034375	6.069110	0.0000
AR (6)	-0.149325	0.043302	-3.448461	0.0006
MA (1)	-0.144945	1.194206	-0.121374	0.9035
MA (2)	0.005502	0.168424	0.032665	0.9740
MA (3)	-0.145074	9.245448	-0.015691	0.9875
MA (4)	0.999888	61.25628	0.016323	0.9870
SIGMASQ	0.002301	0.006285	0.366121	0.7145
R-squared	0.13	Mean dependent var		-0.00
Adjusted R-squared	0.10	S.D. dependent var		0.05
S.E. of regression	0.04	Akaike info criterion		-3.15
Sum squared resid	0.91	Schwarz criterion		-3.03
Log likelihood	638.0	Hannan-Quinn criter.		-3.12
F-statistic	5.43	Durbin-Watson stat		1.99
Prob(F-statistic)	0.00			
Inverted AR Roots	.75+.66i	.75-.66i	.10-.39i	.10+.39i
	-.65-.72i	-.65+.72i		
Inverted MA Roots	.74-.67i	.74+.67i	-.67+.74i	-.67-.74i

After the residuals have been separated from the model, BDS test has been applied to them and the results are presented in Table 5. H_0 hypothesis of the BDS test indicates that there is no dependence. According to the results of the analysis, H_0 hypotheses have been rejected for all dimensions. In other words, the weak form efficiency could not be determined in the stock prices of COSCO company.

Table 5. BDS Test Results for COSCO

Dimensions	BDS Stat	Std. Error	Z Stat.	Prob
2	0.023808	0.004728	5.035247	0.0000
3	0.048708	0.007529	6.469313	0.0000
4	0.065849	0.008985	7.328887	0.0000
5	0.070102	0.009385	7.469378	0.0000
6	0.069711	0.009071	7.684772	0.0000

The process for COSCO has also been implemented for Ever Green. According to the estimation of automatic ARMA (p, q) model, the most suitable model has been determined as ARMA (6, 6) model with Akaike value of -3.92. Then the residuals have been separated from the model, the BDS test has been applied and the results are presented in Table 6. According to the BDS test, H_0 hypotheses have been rejected in all dimensions and the company's stock values has been found to be inefficient in the weak form.

Table 6. BDS Test Results for Ever Green

Dimensions	BDS Stat	Std. Error	Z Stat.	Prob
2	0.010980	0.004382	2.505534	0.0122
3	0.016962	0.006982	2.429424	0.0151
4	0.020823	0.008335	2.498138	0.0125
5	0.027408	0.008710	3.146744	0.0017
6	0.032850	0.008421	3.900946	0.0001

In the process applied for the stock price of Hyundai company, the most appropriate model has been determined as ARMA (4, 6) model with Akaike value of -2.63. Then, in the BDS test applied to the residuals of the model, H_0 hypotheses have been rejected for all dimensions which indicates that the stock price of the company is not efficient in the weak form.

Table 7. BDS Test Results for Hyundai

Dimensions	BDS Stat	Std. Error	Z Stat.	Prob
2	0.030985	0.004487	6.905397	0.0000
3	0.057357	0.007130	8.044034	0.0000
4	0.076050	0.008491	8.956682	0.0000
5	0.084981	0.008850	9.602339	0.0000
6	0.086489	0.008535	10.13328	0.0000

In the process applied for Kawasaki company, the most suitable model for the company has been determined as ARMA (12, 5) model with the Akaike value of -3.57. According to the results presented in Table 8, H_0 hypotheses have been rejected in all dimensions and the stock price of the company has been found to be inefficient in the weak form.

Table 8. BDS Test Results for Kawasaki

Dimensions	BDS Stat	Std. Error	Z Stat.	Prob
2	0.008362	0.003928	2.128834	0.0333
3	0.014683	0.006239	2.353586	0.0186
4	0.022852	0.007424	3.078160	0.0021
5	0.031361	0.007732	4.055900	0.0000
6	0.036402	0.007451	4.885395	0.0000

The most suitable model for Mitsui has been determined as ARMA (2, 9) with -3.48 Akaike value. The BDS test has been applied to the residuals obtained from the model and the results are presented in Table 9. According to the results, H_0 hypotheses have been rejected in all dimensions except 2 dimensions and it has been determined that there is dependence in the series. In other words, the efficient market hypothesis in the weak form has not been confirmed in the stock prices of the company.

Table 9. BDS Test Results for Mitsui

Dimensions	BDS Stat	Std. Error	Z Stat.	Prob
2	0.010016	0.004020	2.491736	0.0127
3	0.017400	0.006381	2.726782	0.0064
4	0.022806	0.007589	3.005030	0.0027
5	0.027366	0.007900	3.463967	0.0005
6	0.030756	0.007609	4.042056	0.0001

In the analysis carried out for Nippon company, the most suitable model has been found to be ARMA (4, 12) with -3.66 Akaike value. The results of the BDS test applied to residuals are then shown in Table 10. According

to the results, the null hypotheses have been rejected in all dimensions which indicates the inefficiency of the stock prices in the weak form.

Table 10. BDS Test Results for Nippon

Dimensions	BDS Stat	Std. Error	Z Stat.	Prob
2	0.013266	0.003809	3.483205	0.0005
3	0.022625	0.006040	3.745986	0.0002
4	0.024552	0.007176	3.421277	0.0006
5	0.024337	0.007462	3.261263	0.0011
6	0.021218	0.007180	2.955241	0.0031

In the automatic model selection application for the stock price of Orient company, ARMA (8, 6) model with -3.59 Akaike value has been determined as the most suitable model. Afterwards, H_0 hypotheses have been rejected by the applied BDS test, and it has been determined that stock price of the company is not efficient in weak form.

Table 11. BDS Test Results for Orient

Dimensions	BDS Stat	Std. Error	Z Stat.	Prob
2	0.016105	0.004305	3.741058	0.0002
3	0.026132	0.006840	3.820402	0.0001
4	0.031731	0.008144	3.896273	0.0001
5	0.031974	0.008487	3.767534	0.0002
6	0.030836	0.008183	3.768188	0.0002

Finally, the same process has been applied for the stock prices of Yang Ming company. The ARMA (8, 12) model with an Akaike value of -3.69 has been determined as the most suitable model, and H_0 have been rejected in all dimensions according to the BDS test applied. In other words, efficient market hypothesis in the weak form has not been found to be valid in Yang Ming's stock prices.

Table 12. BDS Test Results for Yang Ming

Dimensions	BDS Stat	Std. Error	Z Stat.	Prob
2	0.013399	0.003829	3.498981	0.0005
3	0.018700	0.006071	3.080084	0.0021
4	0.020292	0.007211	2.813928	0.0049
5	0.023192	0.007497	3.093572	0.0020
6	0.025097	0.007211	3.480464	0.0005

7. CONCLUSIONS AND DISCUSSION

Testing the efficient market hypothesis has attracted researchers' attention for a long while. Although there have been many completed and finalized research, studies examining this hypothesis in maritime sector are very rare. In particular, no studies have been conducted to investigate the market efficiency in the maritime sector with the BDS test which are used to detect non-linear relationships. In addition, although an efficient market hypothesis has been tested in the four main markets of shipping, the freight market (Koekebakker et al., 2006; Goulas and Skiadopoulos, 2012; Açık and Başer, 2018a), the second-hand & new buiding market (Hale and Vanags, 1992; Kavussanos and Alizadeh, 2002) and the demolition market (Açık and Başer, 2018b), no study examining the stock market of the shipping companies has been found. Therefore, this study opens a new window for the maritime economy and plays a complementary role to the previous valuable literature.

The maritime market has a derived demand structure and is immediately affected by the developments in the world economy. Although controlling the supply side in the market is partly possible in liner shipping market

with the generated bargaining powers, it is not possible in the other maritime markets. This suggests that the balance between the supply and demand in the transport activities forms unexpectedly. For this reason, it is theoretically reasonable to think that the foreseeable market conditions are reflected in the share values and that the share values show random walking. However, the findings show that the stock prices of the liner shipping companies do not move randomly and they are dependent on the prices of previous periods. The deterministic elements in stock prices have been separated and the BDS tests, which is a nonlinear method used to test efficiency, have been applied to stochastic parts consisting of residuals of the model. Considering that the financial series are subject to continuous structural breaks and unexpected shocks, it is thought that implementing a non-linear efficiency test provides a great advantage in terms of reliability and consistency of the results. According to the results of the tests, several dependencies between residuals have been found. These dependencies show that prices do not move randomly and include information about their past values. In other words, the market efficiency in the weak form has not been determined in the stock prices of the world's largest liner shipping companies, which are thought to be highly affected by non-sectoral factors. These results suggest that although there are a lot of unexpected shocks and uncertainties, it is possible to predict future prices and obtain extraordinary profits by using historical information with some commercial and technical strategies.

Compared to the general results of the maritime literature, it can be said that invalidity of efficient market hypothesis in the other four main maritime markets (Hale and Vanags, 1992; Kavussanos and Alizadeh, 2002; Koekebakker et al., 2006; Goulas and Skiadopoulos, 2012; Açık and Başer, 2018a; Açık and Başer, 2018b) may be reflected in the stock prices of the shipping companies. Because while the freight market determines the commercial performance of the companies, the other three markets (secondhand, newbuilding, demolition) cause major changes in their assets. This situation is reflected in their balance sheets and shape the behavior of their stock investors.

In the further studies, the efficiency in the stock prices of the dry bulk shipping companies whose market are closer to the perfect competitive market and which are even considered as the best perfect competitive market in the world by some researchers may be examined. In this way, it can be seen that the risks and uncertainties in the maritime market are reflected in the stock prices or not. In addition, companies in the tanker and special shipping markets are also worth examining.

REFERENCES

AÇIK, Abdullah and Sadık Özlen BAŞER (2018a). "Is BDI Efficient?", **Journal of Yaşar University**, 13(50), 140-149.

AÇIK, Abdullah and Sadık Özlen BAŞER (2018b). "Market Efficiency in Ship Demolition Prices", **International Conference on Empirical Economics and Social Sciences,** (780-792).

AÇIK, Abdullah and Sadık Özlen BAŞER (2019). "Price Volatility Spillover in Ship Demolition Markets", **Optimum Ekonomi ve Yönetim Bilimleri Dergisi**, 6(2), 311-322.

ADLAND, Roar and Siri STRANDENES (2006). "Market Efficiency in the Bulk Freight Market Revisited", **Maritime Policy & Management: The Flagship Journal of International Shipping and Port Research**, 33(2), 107-117.

ADLAND, Roar and Steen KOEKEBAKKER (2004). "Market Efficiency in the Second-Hand Market for Bulk Ships", **Maritime Economics & Logistics**, 6, 1–15.

AFONSO, Antonio and João TEIXEIRA (1998). "Non-Linear Tests of Weakly Efficient Markets: Evidence from Portugal", **ISEG Economics Department Working Paper,** 6/98.

AL-LOUGHANI, Nabeel and David CHAPPELL (1997). "On the Validity of the Weak-Form Efficient Markets Hypothesis Applied to the London Stock Exchange," **Applied Financial Economics**, 7(2), 173-176.

ALPHALINER [Access Link: https://alphaliner.axsmarine.com, Access Date: 03.04.2019].

BHATTARAI, Keshab and Vasi MARGARITI (2018). "An Empirical Test of the Theory of Efficient Markets of Stock Prices", **Finance and Market**, 3(2), 1-30.

BILDIRICI, Melike E. and Ceren TURKMEN (2015). "Nonlinear causality between oil and precious metals", **Resources Policy**, 46, 202-211.

BLASCO, Natividad; Cristina DEL RIO and Rafael SANTAMARÍA (1997). "The Random Walk Hypothesis in the Spanish Stock Market: 1980–1992", **Journal of Business Finance & Accounting**, 24(5), 667-684.

BROCK, William; Davis DECHERT; Jose SHEINKMAN (1987). "A Test for Independence Based On the Correlation Dimension", **Manuscript,** Social Systems Research Unit, University of Wisconsin.

BROCK, William; Davis DECHERT; Jose SHEINKMAN and Blake LEBARON (1996). "A Test for Independence Based on the Correlation Dimension", **Econometric Reviews,** 15(3), 197–235.

BROOKS, Chris (2014). **Introductory Econometrics for Finance**, UK: Cambridge University Press.

DICKEY, David A. and Wayne A FULLER (1979). "Distribution of the Estimators for Autoregressive Time Series with A Unit Root", **Journal of The American Statistical Association**, 74, 427-431.

DORINA, Lazar and Ureche SIMINA (2007). "Testing Efficiency of the Stock Market in Emerging Economies", **The Journal of the Faculty of Economics-Economic Science Series,** 2, 827-831.

FAMA, Eugene (1965). "Random Walks in Stock Market Prices", **Financial Analysts Journal**, 55-59.

FAMA, Eugene (1970). "Efficient Capital Markets: A Review of Theory and Empirical Work", **Journal of Finance**, 25, 383-417.

GOULAS, Lambros and George SKIADOPOULOS (2012). "Are Freight Futures Markets Efficient? Evidence from IMAREX", **International Journal of Forecasting**, 28(3), 644-659.

HALE, Chris and Alf VANAGS (1992). "The Market for Second-Hand Ships: Some Results on Efficiency Using Cointegration", **Maritime Policy & Management**, 19(1), 31-39.

HASSAN, Arshad; Muhammad Shoib ABDULLAH and Zulfiqar Ali SHAH (2007). "Testing of Random Walk and Market Efficiency in an Emerging Market: An Empirical Analysis of KSE", **Business Review Cambridge**, 9(1), 271-281.

INVESTING (2018). "Stock Price Values of Liner Shipping Companies", [Access Link: https://tr.investing.com/, Access Date: 03.10.2018].

KARAKITSOS, Elias and Lambros VARNAVIDES (2014). **Maritime Economics: A Macroeconomic Approach**, London: Springer.

KAVUSSANOS, Manolis. G. and Amir H. ALIZADEH (2002). "Efficient Pricing of Ships in The Dry Bulk Sector of the Shipping Industry", **Maritime Policy & Management**, 29(3), 303-330.

KOEKEBAKKER, Steen, Roar ADLAND and Sigbjørn SØDAL (2006). "Are Spot Freight Rates Stationary?", **Journal of Transport Economics and Policy (JTEP)**, 40(3), 449-472.

LIM, Kian-Ping and Robert BROOKS (2011). "The Evolution of Stock Market Efficiency Over Time: A Survey of the Empirical Literature", **Journal of Economic Surveys**, 25(1), 69-108.

MAERSK [Access Link: https://www.maersk.com/en/news/2017/11/30/ml-final-regulatory-approval-hamburg-sud, Access Date: 03.10.2018].

OCEAN INSIGHT [Access Link: https://www.ocean-insights.com/liner-news/ocean-network-express/, Access Date: 03.10.2018].

OGILVIE, John and PARKINSON, C. (2005). **Management Accounting – Financial Strategy**, Great Britain: Elsevier.

PHILLIPS, Peter C. B. and Pierre PERRON (1988). "Testing for a Unit Root in Time Series Regression", **Biometrika**, 75(2), 335-346.

SEA TRADE [Access Link: http://www.seatrade-maritime.com/news/asia/cosco-takeover-of-oocl-cleared-for-completion.html, Access Date: 03.10.2018].

STENGOS, Thanasis and Epaminondas PANAS (1992). "Testing the Efficiency of the Athens Stock Exchange: Some Results from The Banking Sector", **Empirical Economics**, 17(2),239-252.

STOPFORD, Martin (2009). **Maritime Economics**, 3rd ed. London: Routledge.

UNCTAD (2018a). "Market Consolidation in Container Shipping: What Next?", [Access Link: https://unctad.org/en/PublicationsLibrary/presspb2018d6_en.pdf, Access Date: 03.10.2018].

UNCTAD, (2018b). **Review of Maritime Transport 2018**, New York: United Nations Publications.

WORLD MARITIME NEWS [Access Link: https://worldmaritimenews.com/archives/236677/hapag-lloyd-completes-integration-of-uasc/, Access Date: 03.10.2018].