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Article

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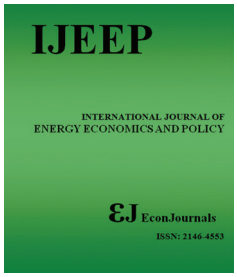

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The Relationship between the Oil Prices and Stock Prices: An Application in BIST Chemical, Oil, Plastic Index

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ABSTRACT

The purpose of this study is to examine the relationship between oil prices and stock prices. The study consists of a daily data set over the period between December 03, 2010 and December 06, 2017. Firstly, the relationship between the variables was measured by the Spearman's rank correlation coefficient. The result of the analysis found that there was a statistically significant negative correlation between oil prices and stock prices, and it was also identified that 15% of the changes in stock price were as result of changes in oil prices. Secondly, in addition to correlation analysis, Augmented Dickey-Fuller and Philipps-Perron unit root test with Engle and Granger cointegration analysis was conducted in order to measure the long term relationship between oil prices and stock prices. As a result of analysis, it was determined that oil and stock prices reached equilibrium in the long run.

Keywords: Oil Prices, Stock Prices, Engle Granger Analysis
JEL Classifications: Q41, G15, C22

1. INTRODUCTION

Energy, which is the most fundamental input for social and economic development throughout the world and in Turkey, maintains its place and importance today and is expected to retain its position in the future as well. The increase in energy consumption experienced with increasing world population and development of technology requires the close monitoring of developments and changes taking place in this sector. It is necessary to closely monitor the changes taking place in this sector that is the changes on the crude oil. The increase in crude oil prices leads to concern especially in developing countries and oil importing countries. This concern is also in true of Turkey which imports almost all of the oil and natural gas consumed throughout the country (Yaylalı and Leba, 2012, p. 44-45).

High oil prices affect the global economy through various channels including the transfer of wealth from oil consumers to oil producers, increase in the production costs of goods and services, and the impact of this on inflation, consumer confidence and financial markets (Lin et al., 2009, p. 1). That is to say; oil is one of the important input sources that is used to produce goods and services such as labour, capital and materials. Changes in the prices of these inputs also affect the cash flows. The increase in oil prices increases production costs, on the other hand, high production costs reduce cash flows. This causes stock prices to fall. The increase in oil prices also affects the discount rate. Increasing oil prices cause the central bank to raise interest rates and thus leading to the formation of an inflationary environment. This situation makes the bond desirable compared to stocks in the eyes of investors. The effect of the increase experienced in oil prices varies depending on whether the country is an oil producer or consumer. However, the increase in oil prices is expected to have a negative impact on the stock market since there are more oil importing countries in the world than oil exporting countries (Basher and Sadorsky, 2006, p.225-226).

The objective of this study is to investigate the relationship between oil prices and stock prices. In the first chapter of the study,

the literature related to the subject is discussed and; information is provided about the data set and method of the study in the following chapter. In the last chapter, the findings obtained from the analysis are interpreted.

2. LITERATURE REVIEW

One of the first studies examining the relationship between stock prices and oil prices was conducted by Faff and Brailsford (1999). Examining the relationship between Australian stock returns and oil prices, Faff and Brailsford (1999) posited that there was a positive relationship between oil prices and stock returns of the oil, gas, and diversified product sectors; and that there was a negative relationship between oil prices and stock returns of paper and packaging sectors. Arouri and Rault (2012) examined the long-term relationship between the stock market and the oil prices seen in the Gulf Arab Countries between the dates of January 1996 and December 2007, and as a result of the analysis, they concluded that the increase in oil prices positively affected stock prices in other countries except Saudi Arabia. Likewise, in a study conducted by Sarwar and Hussan (2016) examining the relationship between oil prices and stock prices, they revealed that there was a positive significant relationship between oil prices and stock prices. Chittedi (2012) concluded that Indian stock prices affected oil prices after examining the long-term relationship between Indian stock prices and oil prices. In the study conducted by Christofi (2014), the relationship between oil prices and stock prices was investigated in the period between February 1982 and June 2014 and it was determined that the effect of falls in oil prices on stock prices was significant. Chen and Lv (2015) investigated the dependence between the Chinese stock market and the crude oil price and presented a positive and over-dependent relationship between the various stock returns and crude oil prices. Anoruo (2011), on the other hand, examined the linear and non-linear causality relationship between stock returns and crude oil prices, and revealed that there was a non-linear bidirectional relationship between oil prices and stock returns. Basher and Sadorsky (2006) who had examined the relationship between oil price risk and returns of 21 developing stock markets, found that oil price risk had an effect on stock market returns of the developing countries.

One of the first studies examining the response of stock markets to oil shocks was conducted by Jones and Kaul (1996). Jones and Kaul (1996) found that US and UK stock returns responded more negatively when compared with those in Japan and Canada after examining the response of international stock markets (America, Canada, Japan, England) to oil shocks. Likewise, Cong et al. (2008) examined the relationship between the Chinese stock market and oil shocks in the time period between January 1996 and December 2007, and concluded that oil price shocks had no significant effect on Chinese stock market returns, except for manufacturing and some oil companies. In the study conducted by Park and Ratti (2008), the relationship between 13 European countries and the US stock market and oil price shocks was investigated, and it was concluded that oil price shocks affected stock returns, that the increase in oil prices significantly reduced stock returns for many European countries, except for the US and, that there was a positive relationship between Norwegian stock returns and oil prices unlike other countries. In addition, Abhyankar et al. (2013) examined the relationship between the Japanese stock market and oil price shocks and demonstrated that the Japanese stock market reacted negatively to oil price increases, that oil price shocks were caused by changes experienced in global demand, and that supply and demand shocks in the global crude oil market affected Japanese stock market returns. Analysing the impact caused by the oil price shocks on Norwegian stock returns, Bjornland (2009) concluded that higher oil prices had a stimulating effect on the Norwegian economy and that a 10% increase, which would take place in oil prices, would increase stock returns by about 3%. Sahu (2014) suggested that there was a positive long-term relationship between oil prices and the Indian stock market after examining the relationship between oil price shocks and the Indian stock market. Cunado and Gracia (2014) analysed the impact of oil shocks on the stock returns of 12 European oil-exporting countries and concluded that the impact of changes experienced in oil prices on stock returns of many countries was significant and negative. You et al. (2017) investigated the impact of crude oil shocks and China's economic policy uncertainty on stock returns in the time period between1998 and 2013. Unlike other studies, Tsai (2015) discussed the relationship between stock returns and oil shocks for different periods. Tsai (2015) examined how US stock returns responded to oil price shocks before, during and after the financial crisis periods. As a result of the analysis study, it was determined that positive and negative oil price shocks had an asymmetric effect on stock returns during and after the crisis periods, and that the energy sector reacted negatively to oil price shocks before and during the crisis periods.

One of the studies examining the relationship between oil prices and economic activities was conducted by Sadorsky (1999). Sadorsky (1999) concluded that oil prices were an important factor in accounting for the change in stock returns, that changes taking place in oil prices affect economic activities, however that changes in economic activities had little effect on oil prices by means of examining the relationship between oil prices and economic activities in the time period between January 1947 and April 1996. Likewise, Papapetrou (2001) examined the relationship between stock prices, interest rates, real economic activity and unemployment took place in Greece between January 1989 and June 1999 and concluded that oil price changes had an impact on real economic activity and unemployment, and that oil prices were an important factor in accounting for stock price movements. Rahman and Mustafa (2008) investigated the short- and long-term effects caused by oil prices and money supply on the US stock market (S and P500), and concluded that negative money supply and oil shocks reduced the US stock market as a result of their analysis study. Analysing the relationship between Nigerian stock returns and oil price, exchange rates and world market index, Chaudary et al. (2014) determined that Nigerian stock prices responded positively to world market and oil prices. In another study, Li and Wen (2012) examined the effects of some selected macroeconomic factors (such as consumer price index, producer price index, interest rate, industrial production growth rate and crude oil) on the stock market industry price index and concluded that the producer price index and interest rate had a negative effect on the stock exchange industry price index and that the consumer

price index and crude oil prices had a positive effect on the stock exchange industry price index.

One of the first studies analysing the relationship between stock prices and oil prices in Turkey was conducted by İşcan (2010). İşcan (2010) found that there was no long-term relationship between stocks and oil prices after examining the relationship between oil prices and stock prices. Investigating the impact of oil prices on the stock prices of the energy sector traded on the Istanbul Stock Exchange (ISE), Güler et al. (2010) determined that oil prices and stock prices moved together in the long run and that oil prices affected stock prices. Similarly, Kapusuzoğlu (2011) investigated the relationship between ISE National 100, National 50 and National 30 indices and oil prices in the period between January 4, 2000 and January 4, 2010 and revealed that there was a long-term relationship between each of the three indices and oil prices and that there was a one-way causality from all indices of the stock market to oil prices. Şener et al. (2013) examined the long-term relationship between ISE closing prices and oil prices and concluded that the increases and decreases taking place in oil prices had an effect on stock prices. In addition to this, Güler and Nalın (2013) investigated the relationship between oil prices and ISE 100, ISE Industrial and ISE Chemicals-Petroleum-Plastics indices, and concluded that there was a long-term relationship between stock prices and oil prices, however that there was no causality relationship between variables in the short term. A similar study was conducted by Karabayır and Barut (2016) and a negative relationship between oil prices and stock returns and a unidirectional causality from stock returns towards oil prices were determined.

Kılıç et al. (2014) who examined the relationship between the BIST Industrial price index and crude oil prices, concluded that there was a long-term relationship between stock prices and oil prices and that oil prices affected stock prices. Çelik et al. (2015) concluded that the changes taking place in oil prices had no effect on the return volatility of BIST 100, BIST Industrial and BIST Petro-Chemicals by means of examining whether oil prices had an impact on return volatility in BIST 100, BIST Industrial and BIST Petro-Chemical indices. In another study, Yıldırım et al. (2014) examined the impact of international crude oil and natural gas prices on industrial companies that were traded on Borsa Istanbul and concluded that there was a long-term relationship between international crude oil and natural gas prices and BIST Industrial index, that oil prices affected ISE industrial index prices and ISE industrial index prices affected natural gas prices, and that the effect of crude oil prices and natural gas prices on stock prices was positive. In addition, the relationship between stock prices of companies listed in the ISE Chemical, Petroleum and Plastic Index and oil prices was examined in the study conducted by Kaya and Binici (2014) and it was observed that there was a long-term relationship between stock prices and oil prices and it was concluded that the oil prices affected the stock prices.

One of the studies addressing the relationship between stock prices and oil prices on the basis of ISE main sectors and sub-sectors was conducted by Gencer and Demiralay (2013). Gencer and Demiralay (2013) concluded that there was a cointegration relationship between oil prices and banks, food and beverage, chemical-oil-plastic, ISE 100, services and industry index, that there was a unidirectional causality from oil prices towards the chemistry-oil-plastic index, and that sector indices positively responded to oil price shocks by examining the relationship between sectoral returns of 18 sub-indices listed in ISE and crude oil prices. Similarly, the relationship between the stock prices of the main sectors and sub-sectors within the scope of ISE and oil prices was examined in the short and long terms in the study conducted by Abdioğlu and Değirmenci (2014) and it was concluded that oil prices did not affect stock prices; on the contrary, oil prices were explained by stock prices.

3. METHODOLOGY, DATA AND RESULTS

3.1. Data and Methods

In this study, the relationship between the closing prices of the ISE Chemical, Petroleum and Plastic Indices and Brent oil prices was examined using the daily data set of the variables over the period of December 03, 2010 and December 06, 2017. Index returns and Brent oil prices were obtained from the following website: Investing.com. In addition, Brent oil prices obtained in US Dollars were calculated in Turkish Liras by multiplying the daily effective exchange selling rates provided by the Central Bank of the Republic of Turkey data distribution system.

In this study, it was aimed to account for the relationship between oil prices and stock prices by using correlation analysis. In addition to correlation analysis, Engle and Granger cointegration analysis was conducted in order to measure the long term relationship between oil prices and BIST CHEM-OIL-PLAS index. For this purpose, firstly unit root test was applied in order to measure the stationarity of series. Augmented Dickey and Fuller (ADF, 1979) and Philips and Perron (PP, 1988), which are frequently used in the literature, were used for unit root testing of the series. Then, cointegration analysis was used to determine the existence of long-term relationship.

3.2. Descriptive Statistics

In this sense, descriptive statistics of variables for normal distribution were obtained and the results were shown in Table 1.

In Table 1, the arithmetic mean and median of both variables are not equal; however, it is observed that the coefficient of skewness of the stock is −0466, the standard error of skewness is 0.058, the coefficient of kurtosis is −0.448, the standard error of kurtosis is 0.117 and the skewness coefficient of oil is 1.354, the standard error of skewness is 0.058; and that the coefficient of kurtosis is 1.305 and the standard error of kurtosis is 0.117. When the necessary calculations are made, it is observed that coefficients of skewness for stocks and oil price variables are respectively −8.03 (−0466/0.058) and 23.34 (1.354/0058) and also, the kurtosis values of both variables are respectively −3.8 (−0.448/0.117) and 11.15 (1.305/0.117).

3.3. Spearman Correlation Analysis

Correlation analysis is a statistical method used in order to test the linear relationship between two variables or the relationship of one

Table 1: Descriptive statistics

Stock price LN Hisse	Statistics	Standard error	Oil price LN Hisse	Statistics	Standard error
Average	1839.059	−0.00601	Average	56039.5071	0.00573
Median	191.0417		Median	48693.5900	
Variance	1278.854		Variance	0.032	371514682.2
Standard deviation	35.76106		Standard deviation	0.17901	9274.84584
Minimum	84.59		Minimum	10.46	31391.40
Maximum	252.47		Maximum	11.18	123151.37
Distortion	−0.466	0.058	Distortion	1.354	0.058
Stickiness	−0.448	0.117	Stickiness	1.305	0.117

variable with two or more variables and to measure the degree of this relationship (if any). The method is applied in two different ways including Spearman rank correlation and Pearson correlation coefficient. Although Pearson correlation coefficient is used in cases where the distribution of variables is normal or close to normal, Spearman rank correlation is used in cases where the distribution of variables is far from normality. Spearman rank correlation is also assigned between −1 and +1 like Pearson correlation coefficient. If the correlation coefficient is +1, this indicates a perfect positive linear relationship between variables, on the other hand, if it is −1, this indicates a perfect negative relationship between variables (Kalaycı, 2010, p. 117). It is necessary to determine whether the variables are suitable for normal distribution before proceeding to correlation analysis. Statistics such as arithmetic mean, median, skewness and kurtosis regarding the variables can be looked into for normal distribution. In this context, if the arithmetic mean, mode and media are equal or close to each other, if the coefficients of skewness and kurtosis are close to 0 within ± 1 limits, if the skewness and kurtosis indexes calculated by dividing the skewness and kurtosis coefficients by their standard errors are close to 0 within ± 2 limits, then it is considered as evidence for the existence of normal distribution (Demir et al., 2016, p. 133).

In the light of this information, it can be said that both variables are not appropriate for normal distribution. As it is previously mentioned, Spearman rank correlation should be used in cases where both variables do not provide normal distribution. Therefore, Spearman rank correlation was used in order to determine the relationship between the variables and the obtained result was shown in Table 2.

According to Table 2, it is seen that the Spearman Rank Correlation coefficient is −0.392 (R = −0.392) and the significance level is 0.000. If the significance level is <5% (0.000<0.05), this indicates a statistically negative relationship between stock prices and oil prices. Therefore, stock prices are decreasing as oil prices, which are considered as independent variables, are increasing. Also, R^2 value (−0.392), which shows the power of independent variables accounting for each other, was calculated as 15% (−0.392). In this context, it can be said that 15% of the changes taking place in the stock prices are explained by the changes taking place in the oil prices. The remaining 85% is explained by other variables that have not been included in the analysis.

3.4. Unit Root Test

According to ADF (1979) and PP (1988) unit root tests, the null hypothesis and alternative hypothesis and related equations (eq. 1 and eq. 2) are as follows:

Table 2: Results of spearman correlation analysis

Stock price	LNINDEX	LNOIL
Correlation coefficient	1.000	−0.392**
Significance level		0.000
Number of observations	1751	1751
Oil price		
Correlation coefficient	−0.392**	1.000
Significance level	0.000	
Number of observations	1751	1751

** Significant at 0.05 level

H_0: The series are not stationary (series have a unit root)
H_1: The series are stationary (series have not a unit root)

$$\Delta Y_t = \beta_0 + \beta_1 t + \delta Y_{t-1} + \sum_{i=1}^{m} \beta_i \Delta Y_{t-i} + u_t \quad (1)$$

$$\Delta Y_t = \alpha_0 + \alpha_1 (t - \frac{T}{2}) + \alpha_2 Y_{t-1} + \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_t \quad (2)$$

Table 3 and Table 4 show the results of the ADF and PP unit root tests. According to Table 3, it is seen that the series are not stationary in both intercept and trend and intercept at level. The values in parentheses indicate significance levels.

Since the series are not stationary at the level, the first differences are taken and the unit root tests are performed and the results are presented in Table 4. According to both ADF and PP tests, the unit roots disappeared and the series became stationary. Therefore, the cointegration test can be applied in the next step.

3.5. Cointegration Analysis

According to Engle and Granger (1987), even if the time series is not stationary, if their linear combinations are stationary, there is a cointegration relationship between these variables. In this case, the unit root test of each variable should be examined separately. According to the results if the stationarity in first level is determined, unit root test is applied to error terms. If the error terms in the test is stationary, it is understood that the variables are cointegrated. According to Gujarati (1999), the cointegration of the variables means that there is a long-term relationship between the variables. Hypothesis related to cointegration has been formed as follows:
H_0: There is no cointegration between the series
H_1: There is cointegration between the series.

The residual correction equations are as follows:

$$\Delta X_t = \alpha_0 + \sum_{i=1}^{a} \alpha_i \Delta Y_{t-i} + \sum_{i=1}^{b} \beta_i \Delta X_{t-i} + \lambda EC_{t-1+u_{xt}} \quad (3)$$

Table 3: ADF and PP unit root tests (at level=I (0))

Variables	ADF		PP	
	Intercept	Trend and intercept	Intercept	Trend and intercept
Oil prices	−1.84024 (0.3611)	−1.91317 (0.6471)	−1.92646 (0.3202)	−2.00285 (0.5988)
BIST CHEM-OIL-PLAS	−0.02035 (0.9556)	−2.20756 (0.4845)	0.14727 (0.9691)	−2.07731 (0.5576)

ADF: Augmented Dickey and Fuller, PP: Philips and Perron

Table 4: ADF and PP unit root tests (1st difference=I (1))

Variables	ADF		PP	
	Intercept	Trend and Intercept	Intercept	Trend and Intercept
Oil prices	−45.19840* (0.0001)	−45.18549* (0.0000)	−45.10897* (0.0001)	−45.09649* (0.0000)
BIST CHEM-OIL-PLAS	−40.1194* (0.0000)	−40.13336* (0.0000)	−40.21097* (0.9691)	−40.25584* (0.0000)

*Significant at 1% level. ADF: Augmented Dickey and Fuller, PP: Philips and Perron

Table 5: Unit root tests of error terms

Variables	ADF		PP	
	Intercept	Trend and intercept	Intercept	Trend and intercept
Resid01	−39.9355 (0.0001)	−39.9494 (0.0000)	−39.9420 (0.0001)	−39.9687 (0.0000)

*Significant at 1% level. ADF: Augmented Dickey and Fuller, PP: Philips and Perron

$$\Delta Y_t = \beta_0 + \sum_{i=1}^{a} \alpha_i \Delta Y_{t-i} + \sum_{i=1}^{b} \beta_i \Delta X_{t-i} + \lambda EC_{t-1+u_{yt}} \quad (4)$$

In order to perform cointegration analysis between the stationary series by taking the first differences of non-stationary series, the following regression model was created:

$$Y_t = \alpha + \beta X_t + u_t \quad (5)$$

Where; Y_t is dependent variable, X_t is independent variable and u_t is error term. In this analysis, oil prices is used as independent variable while BIST END be used dependent variable. The equation formed as a result of the analysis is as follows.

LBIST En = 0.241 (0.1150) + 0.08746 (0.000) LOILPRICE (6)

In eq. 6, the values in parentheses indicate the significance level of coefficients. As seen in the equation, the coefficient of oil prices is statistically significant. Thus, there is a positive and significant relationship between oil and stock prices.

Unit root test results for error terms are shown in Table 5.

As shown in Table 5, residuals are stable according to the unit root test results applied to residuals. Therefore, there is no unit root and the existence of a cointegrated relationship between oil and stock prices is supported. In other words, oil prices and BIST CHEM-OIL-PLAS index come to equilibrium together in the longest period.

4. CONCLUSION

Although oil is an important raw material for today's economies, it also has an important share in energy resources. From this point of view; close monitoring of the changes taking place in oil prices is important in terms of affecting both the real and financial sectors.

The objective of this study is to determine the relationship between oil prices and stock prices. The study covers the daily data set of the variables in the period of December 03, 2010 and December 06, 2017. In addition, the oil prices obtained in US Dollar were calculated in Turkish Liras by multiplying the daily effective exchange selling rates and included in the analysis. Firstly, Spearman rank correlation coefficient was used in order to determine the relationship between variables. As a result of the analysis, it is concluded that there is a statistically negative correlation between oil prices and stock prices. In this sense, it can be said that the change taking place in oil prices, which are accepted as independent variables, will decrease stock prices. At the same time, it is concluded that 30% of the change taking place in stock prices is explained by oil prices; 15% of the change taking place in oil prices is explained by stock prices as a result of the analysis. The value obtained indicates that the variables have very weak explanatory powers and the remaining 85% is explained by other variables that have not been included in the model. Secondly, the unit root test and cointegration test were applied to the series which were determined to be stationary in the first differences. As a result of the cointegration test, it was found that oil prices and stock prices reached equilibrium in the long run. These results are similar to the studies as İşcan (2010); Kapusuzoğlu, (2011); Güler and Nalın (2013) and Kılıç et al. (2014).

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