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Effect of the Exchange Rate and Oil Price on the *Borsa İstanbul* Industrial Index: Co-integration and Causality Analysis

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Abstract: Industry is important for development and sustainability. Countries attach importance to industrialization in order to reduce their foreign dependency and gain competitiveness. It is expected that companies which competitiveness has increased with industrialization will have a positive effect on the national economy and financial markets. The raw materials used in the production process of the enterprises whose main activity is based on industry and the supply of these raw materials are among the issues that should be taken into consideration in industrial production. In this study, the relationship between oil price, exchange rate and *Borsa Istanbul* Industrial Production Index has been examined. In the study, Johansen co-integration and Granger causality tests were carried out using secondary data for the period January 2000 - September 2020. The results of the Johansen co-integration test; imply that there is a co-integration relationship between variables. The results of Granger causality test; imply that there is a bidirectional causality relationship between Borsa Istanbul Industrial Production index and exchange rate, and a racket effect causal re-

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lationship between Borsa Istanbul Industrial Production index and oil price. In addition, it is concluded that there is no causal relationship between exchange rate and oil price. The findings about the relation-ship between the oil price and exchange rate of the industry, which has an important place in terms of economic growth and competition, is the contribution of this paper to the existing literature.
Keywords: Oil Prices, Exchange Rate, Causality, Co-integration.

1. INTRODUCTION

Oil is a trade good that is used as a basic input in many production processes. In the event of possible fluctuations, uncertainty, or any risk in the oil price, oil-exporting and oil-importing countries are both affected. For oil-exporting countries, a possible increase in the oil price causes an increase in the country's income, and a fall in oil prices causes a decrease in the country's income (Baimaganbetov at al. 2019: 2). The continuation of the increase in the oil price for a certain period will create a current account surplus for an oil-exporting country and a current account deficit for an oil-importing country. An increase in the distribution of wealth in a country with a current account surplus leads to different portfolio preferences (Golub, 1983: 577). Different portfolio preferences are also expected to affect financial markets, which have an important place in the country's economy.

The exchange rate is an economic indicator that has an important place in the field of finance and in the global economic market. Governments and enterprises evaluate their purchasing power by considering different currencies before trading and investing (Wang at al. 2020: 1). There is a deep-rooted theoretical connection between the international oil price and the US dollar exchange rate (Tiwari and Albulescu, 2016: 272). This is because the connection between oil prices and exchange rate requires multiple macroeconomic interactions. At least three countries are in interaction in oil trade, including the oil-

exporting country (particularly OPEC and other oil-exporting countries), the importing country for using the oil in industry, and the country that owns the currency used in the oil trade (Krugman, 1980:1). Despite the oil production occurring in Turkey, it is inadequate at meeting its oil consumption needs. For this reason, oil is imported in line with the oil requirements. This oil importation incorporates Turkey within a global interaction.

In this study, based on the connection between oil price, exchange rate, and industry, the relationship between oil price, exchange rate, and Borsa Istanbul Industrial Production Index closing prices has been examined. First of all, the data to be used in the study were compiled and made ready for analysis. The relationship between oil price, exchange rate, and the Borsa Istanbul Industrial Production Index was then tested with Granger causality and Johansen co-integration analysis. Finally, the correlation between the variables used in the study was examined. As a result of the Johansen co-integration test, it was concluded that there is a co-integration relationship between the variables. As a result of the Granger causality test, it was concluded that there is a bidirectional causality relationship between the Borsa Istanbul Industrial Production Index and the exchange rate, and there is a unidirectional causality relationship between the oil price and the Borsa Istanbul Industrial Production Index. In addition, it was concluded that there is no causality relationship between the exchange rate and oil price. When the correlation between variables was examined, it was concluded that the relationship between all variables is positive and the interaction between the Borsa Istanbul Industrial Production Index and the exchange rate is strong.

2. LITERATURE REVİEW

With industrialization, which has an important place in the economy of the country, it is expected to increase welfare with development. In the 1980s, industrialization activities began in Turkey and any deci-

sion made about the economy both nationally and on a global scale was planned to finalize the process of industrialization (Dalgıç, 1996). The Borsa Istanbul Industrial Production Index, which started to be calculated in 1990, has been one of the steps taken in the industrialization process. The Borsa Istanbul Industrial Production Index is calculated on the basis of the changes in the stock prices of 161 companies operating only in industry.

As a non-renewable energy resource, oil is a trade good that has a striking effect on the world's countries. Economic slowdowns in developing countries, trade deficits, high inflation, and uncertain investment environments have been generally attributed to sudden and large fluctuations in oil prices (Bhattacharya and Bhattacharya, 2019: 15). Oil, used in many areas such as transport and energy, is important for Turkey.

The U.S. dollar is used as the currency in international markets for transactions. The use of dollars in international trade is valid for many products. Most countries use the dollar as the currency in oil exports. For this reason, a causal relationship is expected between oil prices and exchange rates (Din, Jin, and Ying, 2020: 117). Since Turkey is an oil-importing country, it is expected that there is a causal relationship between Turkish industry, oil prices, and the exchange rate.

There are many studies in the literature on oil price, exchange rate, and stock certificates. When these studies are examined, it is seen that most have addressed oil price-exchange rate or oil price-exchange rate-stock certificates. Causality and co-integration analysis have been generally used in these studies (Nurmakhanova and Katonova, 2019; Jung at al. 2020; Musa at all. 2020; Hussin at al. 2012).

Jung et al. (2020) stated that there is a bidirectional causality relationship between oil price and the US dollar exchange rate, and this relationship is from the exchange rate to the oil price. Nguyen, Nguyen, and Nguyen (2020) concluded that oil price has a positive effect on the Vietnam Share Indices, while the exchange rate has a negative

effect. Bal and Rath (2015) found that there is a nonlinear bidirectional causality relationship between exchange rate and oil price in China and India. In China and India, the price of oil affects the exchange rate in a non-linear way, regardless of exchange rate regimes.

Zolfaghari and Sahabi (2020) investigated the effect of oil price and exchange rate on stock profits. They selected developing countries in the Middle East that export oil in their study, including Kuwait, the United Arab Emirates, Qatar, Bahrain, Saudi Arabia, and Iran. They first investigated the acceleration gain of the stock markets of the countries included in the study according to the momentum transaction volume. They concluded that according to the momentum-trading volume strategy, there is a significant acceleration gain in all exchanges in the short term (3 months), middle term (6 months), and long term (12 months). After determining the existence of momentum profit, the relationships between the exchange rate, oil price, and index profits of these countries were analyzed with the Markov switching approach. Based on their use of the momentum strategy to evaluate whether stock profits are affected by oil and exchange rates, they concluded that momentum strategy profits can be explained by a series of lagged macroeconomic variables, especially oil prices and the exchange rate.

In analysis conducted using weekly data between 2015 and 2019, Gulhan (2020) concluded that there is a causality relationship between the gold price and the Borsa Istanbul100 index, oil price, and exchange rate. Furthermore, a bidirectional relationship was found between the oil price and Borsa Istanbul100 index as a result of cointegration and vector auto-regression analysis.

Karadaş and Koşaroğlu (2020) examined the effect of oil price and exchange rate on agricultural products for the period of January 2010-December 2019 with the help of the Gregory-Hansen cointegration test. As a result of their tests, they concluded that the exchange rate has a positive effect on agricultural products. They also found that agricultural product prices are positively affected by agri-

cultural product imports and negatively affected by exports of agricultural products.

Ağazade (2020) examined the relationship between the oil price of January 1995-October 2016 and the exchange rate of Kazakhstan using the autoregressive distributed lag bound test approach. As a result of that analysis, it was concluded that there is a long-term relationship between the exchange rate index and the oil price, but this long-term relationship does not affect real exchange rate variables in the same direction.

Uğur and Bingöl (2020) examined the direction of the relationship between the stock price and the exchange rate for the period between January 4, 2000, and August 25, 2017, by using frequency distribution causality analysis. As a result of the frequency distribution causality analysis, they concluded that the direction of causality is from stock to exchange rate. They stated that there is a causality relationship between the exchange rate and the price of stocks traded in selected Borsa Istanbul indices.

Çıtak and Kendirli (2019) investigated the effect of oil prices on the Borsa Istanbul All Index and the exchange rate with autoregressive distributed lag bound test co-integration analysis. As a result of the autoregressive distributed lag bound test co-integration analysis performed using monthly data between 2010 and 2019, they stated that a negative or positive change in oil prices does not affect the exchange rate and stock prices in the index in the long run. In addition, they concluded that there is no direct asymmetric transfer between the oil variable and other variables included in the study, and that a fluctuation in oil price does not affect the exchange rate or stock price.

Baimaganbetov et al. (2019) investigated the relationship between oil price and exchange rate with the help of panel data analysis. In their study, they used 2003-2017 monthly data of ten oil-exporting developing countries. As a result of Westerlund panel co-integration analysis, they concluded that the exchange rate of developing oil-

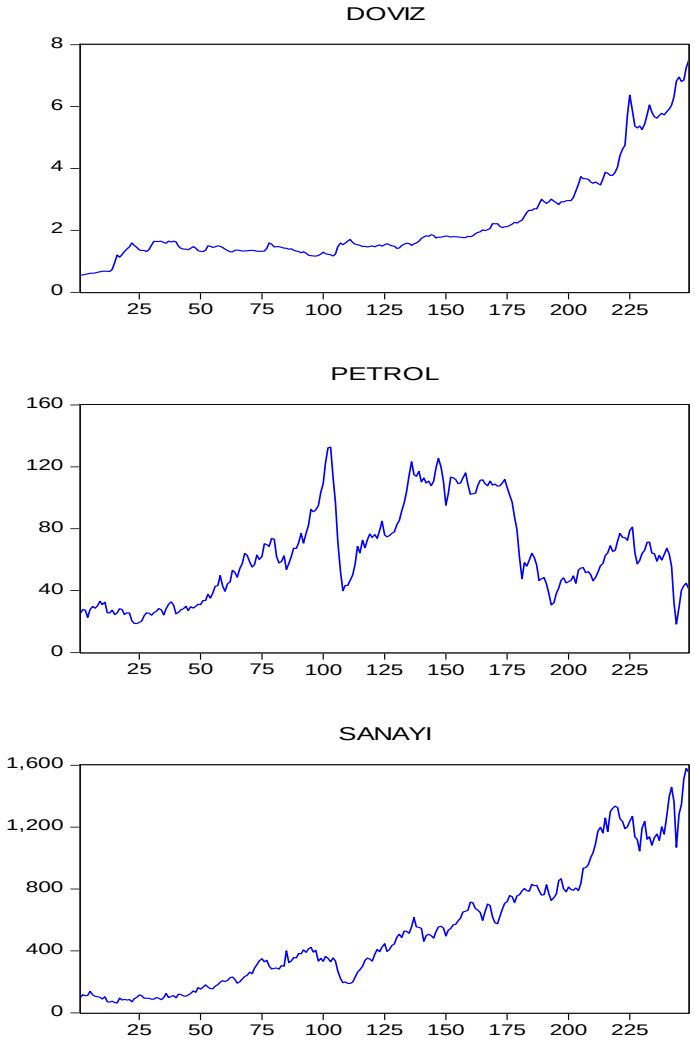
exporting countries is affected by the developments in the oil price.

Bayramoğlu et al. (2019) investigated the relationship between the exchange rate and oil price by causality analysis. In their study, the data of oil price and exchange rate for the period of January 2012-August 2018 were tested using average causality, causality in variance, and asymmetric causality analyses. It was found that there is no linear relationship between exchange rate and oil price. They also concluded that there is a causality relationship from positive shocks in the exchange rate to negative shocks in the oil price, and, finally, according to the results of the asymmetric causality analysis, there is causality from oil price volatility to exchange rate volatility.

Nurmakhanova and Katenova (2019) investigated the relationship between stocks, exchange rates, and oil prices using monthly data on stocks, exchange rates, and oil prices of Kazakhstan for the period of October 2007 - December 2017 with Granger causality and Johansen and Juselius co-integration tests. According to their Granger causality test results, exchange rates and stock prices are affected by oil prices. The authors created binary and multiple equations between variables. As a result of the co-integration analysis carried out by taking the equations into account, they concluded that there is no long-term relationship for equations consisting of two variables, but there is a long-term relationship for multivariate equations. In addition, the authors stated that, in line with the findings of their study, policy-makers should take into account the effects of the exchange rate on the financial market while achieving exchange rate policy targets in Kazakhstan.

In this literature review, it has been found that there are many studies examining the relationship between oil and the exchange rate. In these studies, the relationship between variables has generally been examined by causality and co-integration analysis. However, no study directly examining the relationship between exchange rate, oil price, and the Borsa Istanbul Industrial Production Index has been found.

Figure 1. Data



Source: Author

3. OBJECTIVE AND METHOD

In this study examining the co-integration and causality relationship between exchange rate, oil price and the Borsa Istanbul Industrial Pro-

duction Index, January 2000-September 2020 was selected as the time frame. The Borsa Istanbul Industrial Production Index closing prices were compiled from www.investing.com, oil prices from www.eia.gov.tr (Energy Information Administration) and exchange rates (USD / TRY) from www.evds.com.tr (CBRT). PETROL, DOVIZ, and SANAYI codes have been used for variables in the analyses performed in the study. After the data were compiled and the natural logarithm was obtained, Johansen co-integration and Granger causality analyses were performed with the Eviews 8 package program and efforts were made to examine the relationship between variables. The structure of the variables to be used in the study is presented in Figure 1.

4. FINDINGS

The values of the series in a previous period may affect the values of the following period. Through unit root tests, information is obtained both about the long-term process of the series and about the stationary of the series (Tarı, 2010: 387). Even if there are long-term fluctuations in stationary series, since the series will take values around the same average, the current average will be preserved and will have an unchanging finite variance. The problem of spurious regression is also eliminated in the analyses that will be made. The replicated Dickey-Fuller test (autoregressive distributed lag bound test) is one of the frequently used unit root tests (Kutlar, 2017: 147-148). The results of this unit root test as performed in the present study are displayed in Table 1.

H_0: There is a unit root in the series.
H_1: There is no unit root in the series.

According to the replicated Dickey-Fuller unit root test analysis results presented in Table 1, the series that are not stationary at the same level have been made stationary by taking the first-level differences. All series have become stable at the same level.

Table 1. Dickey-Fuller Unit Root Test

		Grade Level	
Variable	t-value	Possibility Value	Decision
PETROL	-2.340765	0,1601	H_0 Approve
SANAYİ	-0.780582	0.8224	H_0 Approve
DÖVİZ	-0.435441	0,8996	H_0 Approve
		First Difference	
Variable	t-value	Possibility Value	Decision
D PETROL	-11.15408	0.0000	H_0 Rejection
D SANAYİ	-18.12646	0.0000	H_0 Rejection
D DÖVİZ	-7.679732	0.0000	H_0 Rejection

* 5 %, ** 10 % Level of Significance

Table 2. Calculating Lag Length

Lag Length	**AIC**
0	-7.306483
1	-7.536597
2	-7.574194 *
3	-7.573575
4	-7.524064

The Johansen co-integration test is a type of analysis that allows the estimation of all possible co-integration relationships between variables. The Johansen co-integration test was created based on the relationship between matrix rank and characteristic roots. In other words, it is an extended version of the Engle and Granger method with multiple equations (Kutlar, 2017: 62).

Before using the Johansen co-integration analysis, the lag length should be determined. Among the parameters used in the calculation

of the lag length, the *Akaike information criterion* is a frequently used information criterion (Işık at al. 2004: 336). The appropriate lag length calculated by considering the Akaike information criterion is presented in Table 2.

Table 3. Johansen Co-integration Test

Unlimited Co-integration Sorting Test					
[1]	[2]	[3]	[4]	[5]	[6]
r = 0	0.153061	84.23297	29.79707	0.0001*	H_0 Rejection
r = 1	0.139394	44.36254	15.49471	0.0000*	H_0 Rejection
r = 2	0.034130	8.334173	3.841466	0.0000*	H_0 Rejection
[1]	[2]	[7]	[4]	[5]	[6]
r = 0	0.153061	39.87043	21.13162	0.0000*	H_0 Rejection
r = 1	0.139394	36.02837	14.26460	0.0000*	H_0 Rejection
r = 2	0.034130	8.334173	3.841466	0.0000*	H_0 Rejection

▪ [1] Number of CE Assumed ▪ [2] Eigenvalue ▪ [3] Trace Statistics
▪ [4] 0.05, Critical Value ▪ [5] Probability Value ▪ [6] Decision
▪ [7] Maximum Eigenvalue Statistics

Maximum Eigenvalue Test shows 3 equations co-integrated at 0.05 levels.
* 1% level of significance

According to the lag length results presented in Table 2, the appropriate lag period for the Johansen co-integration analysis was determined as two because, at 2 lag, the Akaike information criterion has the highest absolute value. After deciding the lag length, the Johansen co-integration test was conducted. The hypotheses for the co-integration test were as follows:

H_0: There is no co-integration.
H_1: There is co-integration.

Test results are presented in Table 3. According to the analysis results presented in Table 3, there is at least one co-integrated vector as the 5 % critical test value for r = 0 is 29.79 < 84.23 (the trace value is greater than the critical value). Since this situation is also valid for r = 1 and r = 2, it is concluded that there are three co-integrating equations at the 5% significance level. Thus, according to the results obtained, there is a long-term relationship between oil price, the Borsa Istanbul Industrial Production Index, and exchange rate, and the variables affect each other in the long term.

Regression analysis, which is frequently used in studies, determines the dependency relationships between variables. A dependency relationship existing between variables does not mean that there is absolute causality between the variables. Statistically, a tight relationship between variables indicates unity. The analysis to be conducted to obtain information about which variable affects another or whether the variables affect each other mutually is causality analysis. The causality test was developed by Granger in 1969. The Granger causality test gives the direction of the relationship between two variables (Tarı, 2010: 436). The following hypotheses were established regarding Granger causality:

H_0: There is no Granger causality.
H_1: There is Granger causality.

Results of the Granger causality test performed with the PETROL, DOVIZ, and SANAYI variables are shown in Table 4. According to the Granger causality analysis results given in Table 4, no causality relationship could be established between the variables of oil price and exchange rate at 5 % and 10 % significance levels and hypothesis H_0 was accepted. A causality relationship was established between the Borsa Istanbul Industrial Production Index and the exchange rate at both 5 % and 10 % significance levels and hypothesis H_0 was rejected. A dual causality relationship has been established

between the Borsa Istanbul Industrial Production Index and the exchange rate. A unidirectional causality relationship at the 5% significance level was established between the Borsa Istanbul Industrial Production Index and the oil price. While the Borsa Istanbul Industrial Production Index is not the cause of the oil price, the oil price is considered to be the Granger cause of the Borsa Istanbul Industrial Production Index.

Table 4. Granger Causality Test

[1]	[2]	[3]	[4]	[5]	[6]
PETROL - DOVİZ	Granger	0.13533	0.7133	H0 Accept	—
DOVIZ - PETROL	Granger	2.4E-07	0.9996	H0 Accept	—
SANAYI - DOVIZ	Granger	3.72847	0.0547**	H0 Reject	↔
DOVIZ - SANAYI	Granger	5.27604	0.0225*	H0 Reject	↔
SANAYI - PETROL	Granger	0.05840	0.8092	H0 Accept	←
PETROL - SANAYI	Granger	4.75119	0.0302*	H0 Reject	←

▪ [1] Variables ▪ [2] Causality Test ▪ [3] F-statistics
▪ [4] Probability Value ▪ [5] Decision ▪ [6] Direction of Relationship

***** 5 %, ****** 10 % Level of Significance

Correlation is used to determine the relationship between two variables and its direction. Correlation takes a numerical value between -1 and +1. While negative and positivity terms are used to express the direction of the relationship, the correlation number indicates the strength of the relationship. The fact that the correlation number approaches 1 indicates the strong relationship between variables. The correlation analysis for the variables used in this study is presented in Table 5. According to Table 5, there is a positive correlation between all variables included in this study. A possible change in any variable will affect other vari-

ables positively. While the relationship between the exchange rate and oil price is weak, the relationship between the Borsa Istanbul Industrial Production Index and exchange rate was found to be strong.

Table 5. Correlation Table

	PETROL	SANAYI	DOVIZ
PETROL	1	0.5943	0.1612
SANAYI	0.5943	1	0.8089
DOVIZ	0.1612	0.8089	1

5. RESULT

With the development of industrial sector, production, competitiveness, and export income increase and the country's external dependence decreases. The expected increase in the performance of industrial companies also affects the stocks of companies. An increase in the performance of the company will ensure the value of the company's shares in the market, and this will increase the investors' expectations of earning profits from their investments. The currency used in oil and oil exports, which are basic inputs in industrial production, is among the important macroeconomic factors affecting industrial production.

In this study, the relationship between oil price, exchange rate, and the Borsa Istanbul Industrial Production Index has been examined. Johansen co-integration and Granger causality tests have been carried out using secondary data for the period of January 2000-September 2020. As a result of the Johansen co-integration test, it was concluded that there is a co-integration relationship between the variables.

Taking the differences of the non-stationary series and reducing them to stationary did not eliminate the long-term relationship between

the series. Thus, there is a relationship between the series in the long term. The co-integration test results of Baimaganbetov et al. (2020), Gülhan (2020), and Karadaş and Koşaroğlu (2020) show consistency with the results of this study. As a result of the Granger causality test, it was concluded that there is a bidirectional causality relationship from the Borsa Istanbul Industrial Production Index to the exchange rate, from the exchange rate to the Borsa Istanbul Industrial Production Index, and from the oil price to the Borsa Istanbul Industrial Production Index. This result is consistent with the findings of Çıtak and Kendirli (2019), Ağazade (2020), and Bayramoğlu et al. (2020). Although the US dollar is generally used as the currency in the oil trade, this study has concluded that there is no causality relationship between exchange rate and oil price. The lack of a causal relationship between the exchange rate and the oil price may be due to the fact that Russia in 2014, Iran in 2015, and Venezuela in 2017 were not using the US dollar as currency for oil exports. In addition, there is a positive correlation between all variables included in this study. While the relationship between oil price and exchange rate was weak, the relationship between the Borsa Istanbul Industrial Production Index and the exchange rate was found to be strong.

In this study, which was designed while considering the relationship between oil price, exchange rate, and industry, the relationship thought to exist between these variables was revealed. The feature that distinguishes this study from other studies in the same field is the investigation of the relationship between the oil price and exchange rate of industry, which has an important place in terms of economic growth and competition. The fact that such a study has not been conducted on the Borsa Istanbul Industrial Production Index in the literature before makes this study unique. Furthermore, for planning in the field of industry or economy, the oil price and exchange rate should be taken into consideration to achieve more effective results due to the relationship between them.

Döviz Kuru ve Petrol Fiyatının
BİST Sınai Endeksi Üzerine Etkisi:
Eşbütünleşme ve Nedensellik Analizi

Özet: Sanayi, kalkınma ve sürdürülebilirlik açısından önem taşımaktadır. Ülkeler dışa bağımlılığını azaltmak ve rekabet gücü elde etmek için sanayileşmeye önem vermektedir. Sanayileşme ile birlikte rekabet gücü artan şirketlerin ülke ekonomisi ve finansal piyasalar üzerinde olumlu bir etki oluşturması beklenmektedir. Ana faaliyet konusu sanayi üzerine kurulmuş işletmelerin üretim sürecinde kullandıkları hammaddeler ve bu hammaddelerin temin edilişi sanayi üretiminde göz önünde bulundurulması gereken hususlardan biridir. Bu çalışmada petrol fiyatı, döviz kuru ve BİST Sınai Endeksi arasındaki ilişki incelenmiştir. Çalışmada Ocak 2000 - Eylül 2020 dönemine ait ikincil veriler kullanılarak Johansen eşbütünleşme ve Granger nedensellik testleri yapılmıştır. Yapılan Johansen eşbütünleşme testi sonucunda değişkenler arasında eşbütünleşme ilişkisi olduğu sonucuna ulaşılmıştır. Granger nedensellik test sonucunda ise; BİST Sınai Endeksi ile döviz kuru arasında çift yönlü nedensellik ilişkisi olduğu, BİST Sınai Endeksi ve petrol fiyatı arasında ise tek yönlü nedensellik ilişkisi bulunduğu sonucuna ulaşılmıştır. Ayrıca, döviz kuru ile petrol fiyatı arasında nedensellik ilişkisi bulunmadığı sonucuna ulaşılmıştır. Ekonomik büyüme ve rekabet açısından önemli bir yere sahip olan sanayinin petrol fiyatı ve döviz kuru ile olan ilişkisinin araştırılması bu çalışmayı aynı alanda yapılan diğer çalışmalardan ayıran bir özelliğidir.

Anahtar Kelimeler: Petrol Fiyatları, Döviz Kuru, Nedensellik, Eşbütünleşme

Jel Kodları: F31, G10

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