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THE IMPACT OF OIL PRICE AND EXCHANGE RATE ON AGRICULTURAL COMMODITY PRICES: EVIDENCE FROM TURKEY

Ziya Ç. Yurttançıkmaz [1]

Almabrok F. Ahmid [2]

Turan Öndeş [3]

Reşat Karcıoglu [4]

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Abstract

Hunger remain a serious problem for all around the world and too many people around the world in need of food. Furthermore, these days, the increasing of the food price is global issue which led to global food crisis. Also Turkey affected by rising world food prices and internal dynamic. In this paper the researchers examine the long-term relationship between Oil Price and Exchange Rate on Agricultural Commodity Prices (Wheat, Barley, Oat, rye and Corn). Evidence from Turkey. This examination is based upon the data set covering the yearly period of 1969 to 2019. By using time series analysis the empirical results show that Oil Price and Exchange Rate affected Agricultural Commodity Prices positively. Increases in the exchange rate and the rise in oil prices lead to an increase in costs, which leads to an upward pressure on product prices, leading to an increase in prices.

Keywords: Oil Price, Exchange Rate, Agricultural Commodity Prices.

[1] Asst. Prof at Ataturk University Faculty of Economics and Administrative sciences, department of Economics, Erzurum Turkey. ziya@atauni.edu.tr.

[2] Corresponding author: PhD student at Ataturk University Faculty of Economics and Administrative sciences, department of accounting and finance. Erzurum Turkey. almabrokahmid@gmail.com

[3] Prof at Ataturk University Faculty of Economics and Administrative sciences, department of accounting and finance. Erzurum Turkey. tondes@atauni.edu.tr

[4] Prof at Ataturk University Faculty of Economics and Administrative sciences, department of accounting and finance. Erzurum Turkey. rkarci@atauni.edu.tr .

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PETROL FİYATI VE DÖVIZ KURUNUN TARIMSAL EMTİA FİYATLARI ÜZERİNDEKİ ETKİSİ: TÜRKIYE ÜZERİNE BİR UYGULAMA

Özet

Açlık hala tüm dünyada ciddi bir sorun ve dünya çapında gıda ihtiyacı olan çok fazla insan bulunmaktadır. Ayrıca bu günlerde gıda fiyatının artması gıda krizine yol açan küresel bir sorun olmuştur. Türkiye de artan dünya gıdaları ve iç arz ve talep dinamiklerinden etkilenmektedir. Bu çalışmada, petrol fiyatları ile döviz kuru değişimlerinin Türkiye'deki tarımsal ürün fiyatları (buğday, arpa, yulaf, çavdar ve mısır) üzerindeki uzun dönemli etkisini incelenmişlerdir. Çalışma 1969-2019 dönemi yıllık veri setine dayalı olarak yapılmıştır. Zaman serisi analizi kullanılarak elde edilen ampirik sonuçlar, petrol fiyatları ve döviz kurundaki değişimlerin tarımsal emtia fiyatlarnı pozitif yönlü etkilediği görülmüştür. Döviz kurundaki artışlar ve petrol fiyatlarının yükselmesi, maliyetlerde artışa yol açarak, ürün fiyatları üzerinde yukarı yönlü bir baskıya yol açmakta ve fiyat artışlarına neden olmaktadır.

Anahtar Kelimeler: Petrol Fiyatı, Döviz Kuru, Tarımsal Emtia Fiyatları.

1. INTRODUCTION

In recent years in the world and Turkey, issues such as global partnerships, justice and effective institutions, peace, terrestrial ecosystems, marine resources, climate change, consumption and production, sustainable cities and communities, inequality, innovation and infrastructure, industry, economic growth, energy, clean water and sanitation, gender equality, education, public health, poverty and hunger are discussed in Sustainable Development Goals (SDGs). Furthermore hunger remain a serious problem for all around the world as the number of hungers are increasing year by year. (McGuire, 2015).

To meet basic human needs, the availability of supply and demand for food commodities should be considered. Furthermore, disturbances in both natural conditions in climate, limitation and conversion of agricultural land and international geopolitical conditions are all factors which have great impact on the availability of food and agricultural commodities. (Sujai, 2011). Moreover, one of the factors leading to high food prices is the length of marketing chain in commodity distribution or more precisely the delay in food fulfillment which will be after that difficult to control it. (Nurhemi, Soekro, and Suryani, 2014).

According to Food and Agriculture Organization (FAO) data, the world facing global food crisis due to the rise in food prices since 2000 to 2014 also the same case in Some Asian countries. Abbott et al. In (Nazlioglu and Soytas, 2011) Excess demand, the value of US dollar (exchange rate), and the energy-agriculture linkage are the three key determinants of the spike on agricultural commodity prices. The fertilizer, irrigation, crop processing, packaging until transport processing in distributing of agricultural commodities, all of them need oil, which uses in the modern agriculture to produce food commodities. In other words, food prices can reflect oil price. Dancy in (Aye, 2016).

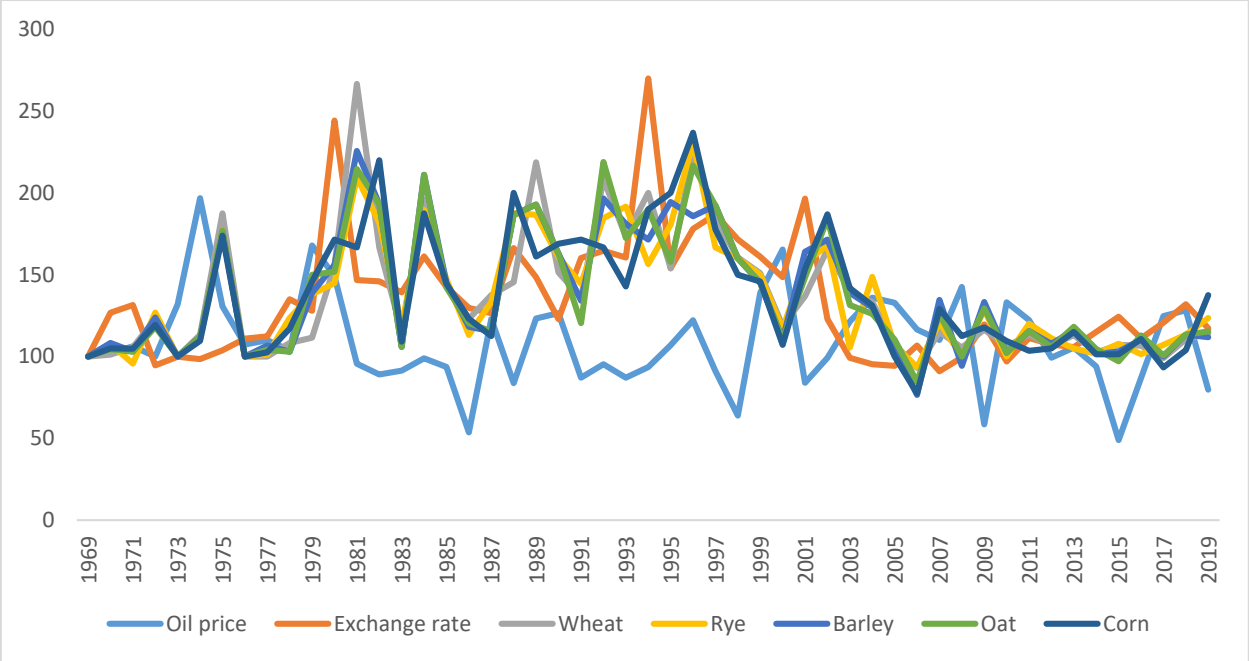
Some empirical studies found a significant relationship between world oil prices and agricultural commodity prices such as (Saghaian, 2010); (Chen, Kuo and Chen, 2010); (Esmaeili and Shokoohi, 2011); (Baffes and Dennis, 2013); (Ibrahim, 2015). On the other hand some other studies provide evidence that no relationship exist between oil price and exchange rate to agricultural commodity price such as (Zhang, Lohr, Escalante, and Wetzstein, 2010); (Nazlioglu and Soytas, 2011); (Fowowe, 2016).

The fluctuating of the oil price can be seen in the figure 1. On other words the non-stability of the world oil price can affect the Turkish economy by impacting prices. The increasing of the oil price will lead to the increase of petroleum products such as gasoline which might lead to the increasing of the selling prices of agricultural commodities.

Considering some selected agricultural commodity prices in Turkey, such as Wheat, Barley, Oat, rye and Corn, prices have increased along with each other Figure 1. On the other hand, when the oil prices drop over a certain period, the price of agricultural commodities

does not show a decline in prices. The fife types of agricultural commodities are selected based on their staple of food that are mostly consumed by the Turkish population and has a direct or indirect relationship to oil prices.

Figure 1. World Oil Prices, Exchange Rates and Agricultural Commodity Prices, 1969-2019



Source: Energy Information Administration (EIA) (2019) & Central Bank of Turkey (2019), Turkish Grain Board (TMO) (2019)

Furthermore, one of the factors that might impact agricultural commodity prices is exchange rate. The changing in the prices of imported goods either finished goods or raw materials might be affected by fluctuations of exchange rate. Generally, the increasing of import prices due to rising marginal costs resulted by the depreciating of currency in a country. (Hyder and Shah, 2005).

Figure 1 shows that the Turkish exchange rate against the US dollar from 1969-2019 shows depreciation or decline in the value of currency.it is understood that energy needs and some food commodities still have to be imported from other countries. This means that the price of agricultural commodities in Turkey will rise when the Turkish lira depreciates against other currencies and decreases as the Turkish lira strengthens.

Research on this topic is one of the most important things to study. The objectives of this study to understand the relationship and the influence of the world oil prices and the Turkish lira exchange rate per US dollar in affecting food commodity prices. Eventually, maintaining the stability of food commodity associated with world oil price variables and

exchange rates some policies can be found and can be taken. Which would might restrain more inflation caused by the impact of food commodity price fluctuations. Based on this background, it is indispensable to analyze the relationship between world oil price and exchange rate to agricultural commodity price in Turkey by selecting the types of food crops (Wheat, Barley, Oat, Rye and Corn).

2. LITERATURE REVIEW

There were many studies examining the relationship of oil prices and exchange rates to agricultural commodity prices by using number of techniques or approaches. Moreover the most test widely used are linear regression models such as Vector Autoregression (VAR), Vector Error Correction Model (VECM), cointegration and causality tests. (Harri, Nalley and Hudson, 2009) found a long-run equilibrium relationship between oil prices and commodity prices for corn, cotton, and soybeans, however, there was no relationship in wheat prices are not by using Johansen Trace Cointegration, moreover over time the exchange rates play a role in the relationship in the prices.

By using VECM and Granger Causality (Saghaian, 2010) studied the relationship between oil price, ethanol, corn, soybeans and wheat. The study showed a strong correlation between oil price and commodity price, in addition to that crude oil prices Granger cause corn, soybean and wheat prices. By using Autoregressive Distributed Lag (ARDL) (Chen et al, 2010) showed that the changing in the price on (corn, soybeans, and wheat) are robustly affected by the changing in the price of crude oil also by other grain prices.

According to (Esmaeili and Shokoohi, 2011) by using Principal Component Analysis and Granger Causality found that crude oil prices have an indirect impact on food prices on another hand crude oil prices have a direct impact on the food production index. By using Cointegration test (Bakhat and Wurzburg, 2013), found that what lead to food prices to be associated with crude oil prices is the increasing in the use of biofuel. Particularly food products used to produce biofuels.

According to (Baffes and Dennis, 2013) and by using model Reduce Form, the study found that the oil price contribute significantly to agricultural price, in particular, when the oil prices are rising sharply. Moreover, (Jati, 2013b) used the VECM model in Brazil, India, France and Indonesia which is considered as the sugar-producer countries, and the results showed there were negative response of Brazilian, Indian, French sugar price from shock of exchange rate.

By using panel econometric methods with and without unobserved heterogeneous effects, (Rezitis, 2015), studied the long-term relationship between crude oil prices, US dollar exchange rates, and the prices of thirty selected international agricultural prices and five international fertilizer prices. The study concluded that the effect of crude oil price changes

on agricultural prices is positive and significant in the long run, on the other hand the effect of US dollar exchange rate changes was negative and significant.

By using Panel Cointegration and Granger Causality, (Nazlioglu and Soytas, 2012), examined the relationship between 24 international agricultural commodity prices and oil price. The results showed that there was transmission from world oil price to agricultural commodity prices on another hand, a positive effect of the weak dollar on food prices.

On the contrary of above and by using VECM dan Granger Causality (Zhang et al, 2010) who studied the relationship between fuel (oil, gasoline and ethanol) prices and food prices (corn, soybeans, wheat, sugar and rice), they found no long run and short-run causality between them and they found a positive impact of sugar prices on both oil prices and agricultural commodities.

By using Toda-Yamamoto Causality, (Nazlioglu and Soytas, 2011), examined the long run relationship between some agricultural commodity prices (wheat, corn, cotton, soybean and sunflower) in turkey and oil price. The results showed that the agricultural commodity prices to be neutral to the effects of oil price changes. This finding is similar to (Burakov, 2016) by using Granger Causality, the researcher found that agricultural prices are not especially sensitive to changes in oil prices and the exchange rate is noticed just in case of imported agricultural goods.

By using Vector Error Correction Model in Indonesia (VECM), (Pratomo, 2016) the results showed that the price of crude oil can affect the domestic maize price, furthermore the world price of rice wheat indirectly affect the domestic price of wheat in long run. Moreover the crude oil price can affect the domestic rice prices. None the less, this paper did not find clear evidence relationship between domestic petroleum prices and domestic prices of food commodities either in short nor long term. In Indonesia as well and by using Vector Autoregressions (VAR) model, (Jati, 2013a) found a positive response of the sugar price from shock of the change of oil price.

By using Non-Linear Autoregressive Distributed Lag (NARDL), (Abdulaziz, Rahim and Adamu , 2016), found the oil prices measured in US dollar are also significant also in both short and long-run in domestic a strong positive relation between oil price increase and food price in Indonesia.

By usıng Structural Break Cointegration and Nonlinear Causality, (Fowowe, 2016), in South Africa showed the prices of agricultural commodities (maize, sunflower, soybean, and oil) were not caused by increasing in the oil prices. By applying similar model in Malaysia (Ibrahim, 2015), found there is a long-run relation between oil price rising and food price on the another hand the long-term oil price decreasing and food price is non-existent.

Agricultural commodities can be affected by the world oil prices in two ways, (Gilbert and Mugera, 2014) said. Firstly crude oil is included in the aggregate production function of primary commodities. Secondly, one of the factors of the food price spike are food commodities used as an alternative to conventional fossil fuels. For example the production of ethanol is form corn and soybean crops or the production of biodiesel form other vegetable oils.

According to (Nugroho, 2010), the prices can be affected by Exchange rate movements in many ways. Firstly, direct way, the changing in the price commodities. Secondly indirect way, it can be seen in the shift of marketing orientation from domestic market to international market. Thirdly, Inflation expectation, exchange rate depreciation will cause future price increases.

Last but not least, there is no comprehensive study in the present literature exploring the linkages between world oil price and exchange rates and grain (Wheat, Barley, Oat, rye and Corn) in Turkey.

3. METHODOLOGY AND DATA

This study employed yearly secondary time-series data to examine the relationships between world oil price, USD / TRY exchange rate, and prices of agricultural commodities (wheat, rye, corn, barley and oat prices), variables that was sourced from Energy Information Administration (EIA) (2019), Central Bank of Turkey (2019) and Turkish Grain Board (TMO) (2019). The examination is based upon the data set covering the period of 1969 to 2019 in Turkey. Due to the height of the inflation in Turkey and the time interval of the series used in the model is wide, the first year was taken 100. The price of the variable increases or decreases compared to the previous year.

3.1. Model Analysis

According to (Enders, 2004) in four steps, Cointegration test between the two variables can be done. Firstly, pre-test the time series for their order of integration. By performing the augmented Dickey-Fuller (ADF) test the number of unit roots in each variable should be determined. The ADF test equation is:

$$\Delta Y_t = \alpha_0 + a_1 t + \beta Y_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta Y_{t-j} + \varepsilon_t \quad (1)$$

$\Delta Yt = Yt - Yt\text{-}1$ and Yt is the variable which will be consider, p is the number of lags in the dependent variable, and εt is the stochastic error term. The variable's stationarity will be tested by using the null hypothesis of $0=\beta$ against the alternative hypothesis of $0<\beta$. If the test statistic is less than the critical value in real terms the null hypothesis will be rejected. If the null hypothesis accepted, it means that the time series is non-stationary at the level and therefore it requires taking first or higher order differencing of the level data to establish

stationarity. (Engle and Granger, 1987) prefer the ADF test due to the stability of its critical values as well as its power over different sampling experiments. To have a reliable test result, all the coefficients in the regression must be significant and residuals should imitate a white noise process.

Johansen and Juselius suggested Johansen methodology for testing cointegration in the framework of multivariate autoregressive models (1990). On the other hand, Engle Granger Causality focuses on testing whether there is a causal link between the given two variables or not (1987).

This paper attempts to contribute to the literature by investigating the role of oil price movements and US dollar depreciation on a large set of agricultural commodity prices. In that respect, this study brings new insights into the literature on the energy-food nexus. Based on the discussions above, agricultural prices are described as a function of oil prices and exchange rate. The empirical model form is specified as follows, where WHE is Wheat price, RYE is RYE price, BAR is BARELEY price, CORN is CON price, OAT is OAT price OIL is the world crude oil price and EXC is the US dollar Turkish liras exchange rate. The impact of oil prices on agricultural commodity prices is expected be positive. Oil prices are an important factor in the production costs of agricultural commodities and food. Therefore, a rise in oil prices may result in higher market prices of agricultural commodities.

$$\text{Model 1. } WHE = B0+B1\ EXC + B2\ OIL + \varepsilon \quad (2)$$

$$\text{Model 2. } CORN = B0+B1\ EXC + B2\ OIL + \varepsilon$$

$$\text{Model 3. } BAR = B0+B1\ EXC + B2\ OIL + \varepsilon$$

$$\text{Model 4. } RYE = B0+B1\ EXC + B2\ OIL + \varepsilon$$

$$\text{Model 5. } OAT = B0+B1\ EXC + B2\ OIL + \varepsilon$$

First, stationarity properties of the variables are investigated using ADF unit root tests. Second, the cointegration relationship is tested, followed by estimating the long-run cointegration parameters. Finally, causal relationships among the variables are examined based on the Granger causality test.

4. RESULTS AND DISCUSSIONS

Table 1. Augmented Dickey Fuller (ADF) Unit Root Test Results for Level Values

Variable	T-Statistics	Prob- value	Conclusion
EXC	-4.170489	0.0095	H_0 rejection
OILTR	-5.285392	0.0004	H_0 rejection
BAR	-4.147793	0.0101	H_0 rejection
CORN	-4.134453	0.0105	H_0 rejection

OAT	-4.291543	0.0069	H_0 rejection
RYE	-4.517473	0.0037	H_0 rejection
WHE	-4.415143	0.0049	H_0 rejection

The Ho hypothesis states that the series contains a unit root. Ho acceptance means that the series are not stationary. Ho reject is interpreted as stagnant series. Constant trend unit root results are given. All series are stable in stationary level.

Table 2. Augmented Dickey Fuller (ADF) Unit Root Test Results of Different Series

Variable	**T-Statistics**	**Prob**	**Conclusion**
EXC	-7.640178	0.0000	H_0 rejection
OILTR	-6.041952	0.0000	H_0 rejection
BAR	-9.604231	0.0000	H_0 rejection
CORN	-10.67543	0.0000	H_0 rejection
OAT	-7.706865	0.0000	H_0 rejection
RYE	-10.95468	0.0000	H_0 rejection
WHE	-8.642952	0.0000	H_0 rejection

After taking the first order differences of all variables, the series were stable. Cointegration Test Results:

After that cointegration tests were conducted for all cereals.

Table 3. Wheat, oil price and exchange rate cointegration test

Series: WHE OILTR EXC				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.523797	73.60913	42.91525	0.0000
At most 1 *	0.480705	37.25545	25.87211	0.0013
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.523797	36.35368	25.82321	0.0014
At most 1 *	0.480705	32.10886	19.38704	0.0004

Trace and Max-eigenvalue tests indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Wheat, oil price and exchange rate have a cointegration relationship. Moreover according to the model it was understood that there were two cointegrated vectors among the mentioned variables.

Table 4. Rye, oil price and exchange rate cointegration test

Series: RYE OILTR EXC				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.497347	67.88326	29.79707	0.0000
At most 1 *	0.454730	34.17832	15.49471	0.0000
At most 2 *	0.087020	4.461044	3.841466	0.0347
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.497347	33.70494	21.13162	0.0005
At most 1 *	0.454730	29.71727	14.26460	0.0001
At most 2 *	0.087020	4.461044	3.841466	0.0347

Trace and Max-eigenvalue tests indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Rye, oil price and exchange rate have a cointegration relationship. Moreover according to the model it was understood that there were two cointegrated vectors among the mentioned variables.

Table 5. Oat, oil price and exchange rate cointegration test

Series: OAT OILTR EXC				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.496978	71.96892	42.91525	0.0000
At most 1 *	0.487698	38.29996	25.87211	0.0009
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.496978	33.66896	25.82321	0.0038
At most 1 *	0.487698	32.77316	19.38704	0.0003

Trace and Max-eigenvalue tests indicates 2 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Oat, oil price and exchange rate have a cointegration relationship. Moreover according to the model it was understood that there were two cointegrated vectors among the mentioned variables.

Table 6. Corn, oil price and exchange rate cointegration test

Series: CORN OILTR EXC				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.556235	77.40942	42.91525	0.0000
At most 1 *	0.482911	37.59889	25.87211	0.0011
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.556235	39.81054	25.82321	0.0004
At most 1 *	0.482911	32.31743	19.38704	0.0004

Trace and Max-eigenvalue tests indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Corn, oil price and exchange rate have a counteraction relationship. Moreover according to the model it was understood that there were two cointegrated vectors among the mentioned variables.

Table 7. Barley, oil price and exchange rate cointegration test

Series: BAR OILTR EXC				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.540749	75.09640	42.91525	0.0000
At most 1 *	0.477861	36.96668	25.87211	0.0014
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.540749	38.12972	25.82321	0.0007
At most 1 *	0.477861	31.84121	19.38704	0.0005

Trace and Max-eigenvalue tests indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Barley, oil price and exchange rate have a cointegration relationship. Moreover, according to the model it was understood that there were two cointegrated vectors among the mentioned variables.

Table 8. Correlation Test

variables	CORN	EXC	OILS	BAR	OAT	RYE	WHE
EXC	0.609	1	0.669	0.555	0,570	0,584	0,567
OILS	0.378	0.669	1	0.3256	0,309	0,345	0,353

According to the correlation table 8, there is a positive relationship between exchange rate and oil prices and corn, wheat, barley, rye and oat. In particular, the correlation values with the exchange rate were higher. In other words, exchange rates seem to be more effective on agricultural commodity price.

Granger Causality test among the variables for which the cointegration relationship has been observed. The null hypothesis for the Granger causality test is that variable x does not granger cause the variable y. So, basically the granger causality test provides an estimate for the direction of the causal relationship between the two variables.

Table 9. Granger Causality Analyses Results

Null Hypothesis	F-Statistic	Prob.	Conclusion
EXC does not Granger Cause OILTR	3.70225	0.0327	H_0 rejection
OILTR does not Granger Cause RYE	7.13553	0.0021	H_0 rejection
EXC does not Granger Cause RYE	9.02426	0.0005	H_0 rejection
OILTR does not Granger Cause WHE	9.51857	0.0004	H_0 rejection
EXC does not Granger Cause WHE	11.0262	0.0001	H_0 rejection
OILTR does not Granger Cause OAT	10.5945	0.0002	H_0 rejection
EXC does not Granger Cause OAT	12.0862	7.E-05	H_0 rejection

OILTR does not Granger Cause CORN	7.95471	0.0011	H_0 rejection
EXC does not Granger Cause CORN	11.3583	0.0001	H_0 rejection
OILTR does not Granger Cause BAR	8.02879	0.0011	H_0 rejection
EXC does not Granger Cause BAR	10.4030	0.0002	H_0 rejection

The hypothesis H0, which claims that the exchange rate does not affect wheat, rye, barley, corn and oat, was rejected and the exchange rate was found to have an effect on the prices of these agricultural products. Similarly, the hypothesis H0, which argues that oil, wheat, rye, barley, corn and oat prices do not affect the change in oil prices, was rejected and it was understood that oil prices had an effect on the prices of these agricultural products.

5. CONCLUSION

In this study, the effects of exchange rate and oil prices on agricultural commodities price were investigated. Then, the variables were grouped and cointegration analysis was done. In the cointegration analysis between wheat, oil price and exchange rate, two cointegrated vectors were found. In the Rye, oil price and exchange rate cointegration test analysis, there were three cointegrated vectors. Two cointegrated vectors have been found to examine the corn, oil price and exchange rate tests. In the cointegration analysis, it was understood from the normalization coefficients that increases in exchange rates and oil prices had a positive effect on the prices of agricultural products. Later, Granger causality analyses were conducted among the variables and causality relationships were found between some of the variables. These results show us that the exchange rate on prices of agricultural products in Turkey and demonstrate that effective oil prices. Increases in the exchange rate and the rise in oil prices lead to an increase in costs, which leads to an upward pressure on product prices, leading to an increase in prices. The researchers recommended, for further research, other economic indicators can also be explored which has impact on agriculture price.

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