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IMPACT OF VOLATILITY OF WORLD OIL PRICES ON TURKEY'S FOOD PRICES: GARCH APPROACH

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ABSTRACT

This study aims at analyzing the effects of global oil price shocks on food price volatility in Turkey. GARCH models are used to analyze monthly data of the said variables covering a period of 1995-2000. The results show that the global oil prices significantly affect the volatility of the food prices in Turkey. Moreover, the oil price shocks have delayed effect on the food price volatility. This may be a result of agricultural products' low elasticity of supply and taxes on oil prices. Furthermore, the delayed effect of the oil price shocks provides opportunity for policy makers and market participants to take necessary measures to reduce its impact.

Keywords: Producer Price Index of Agricultural Products, Oil prices, GARCH model, Turkey.

JEL Classifications: E31, G10, B40.

DÜNYA PETROL FIYATLARI OYNAKLIĞININ TÜRKIYE'DEKI GIDA FIYATLARINA ETKİSİ: GARCH YAKLAŞIMI

ÖZET

Bu çalışmada, küresel petrol fiyat şoklarının Türkiye'de gıda fiyatları oynaklığına etkileri incelenmiştir. 1995-2000 dönemini kapsayan aylık verileri analiz etmek için GARCH modelleri kullanılmıştır. Sonuçlar, küresel petrol fiyatları oynaklığının önemli ölçüde Türkiye'de gıda fiyatlarına etkisi olduğunu göstermektedir.Bunun yanısıra, petrol fiyat şoklarının gıda fiyatları oynaklığına etkisi gecikmelidir. Bu durum tarımsal ürünlerin düşük arz elastikiyeti ve petrol fiyatlarından alınan vergilerin sonucu olabilir. Ayrıca, petrol fiyat şoklarının gecikmeli etkisi, etkisileri azaltarak gerekli önlemleri almak için politika yapıcılara ve piyasa katılımcılarına fırsat sağlayabilir.

Anahtar kelimeler: Tarım ürünleri üretici fiyat endeksi, Petrol fiyatları, GARCH model, Türkiye.

JEL Kodu: E31, G10, B40.

1. INTRODUCTION

Commodity markets volatility has seen a tremendous increase since 2005. Moreover, the commodity market prices tend to move together with oil prices especially after 2000 (IMF, 2015). This motivated many researchers to analyze the relation between the oil prices and commodity markets. Timilsina et. al., (2011) simulate the effect of increase in oil prices on food supply and conclude that the oil price increase, leading to increase in biogas production, will reduce the food supply. If this prediction turns true, the uncertainty in food price may increase. This will affect the oil-dependent economies to a greater extent. Turkey, being one of the important emerging markets, fulfills 28 percent of its energy demands from crude oil (ETKB, 2016: 36). In 2014, Turkey produced almost 49,000 barrel per day crude oil, whereas, its demand was 718,000 barrel per day; meaning the local supply met only 7 percent of its demand (see Figure 1). These figures show that Turkey is heavily-dependent on oil imports to meet its energy demands. Therefore, the Turkish economy is highly sensitive to the developments in world oil prices.

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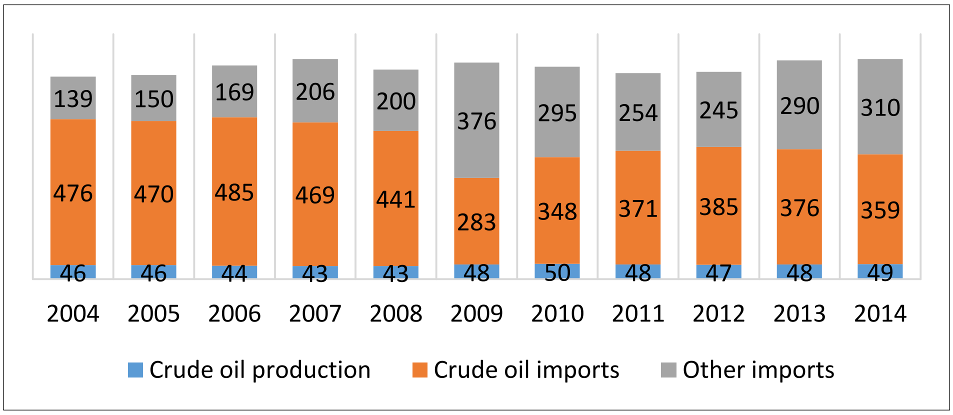

Source: Rebuplic of Turkey Ministry of Energy and Natural Resources

Figure 1. Local Production and Consumption of Oil in Turkey

On the other hand, oil is also one the most important input in agriculture. Besides, it also plays a vital role in transportation of fertilizers, seeds and forage. Therefore, oil prices affect the agriculture production cost, directly or indirectly. Based on the above arguments, this study analyzes the effects of world oil price shocks on food prices volatility in Turkey. The findings may help in developing policies and measures for rational pricing.

This is a brief but comprehensive introduction of the study. The rest of the study is organized as follows. The next section provides a brief review of the literature. Later on, data and methodology is explained. The later section gives findings and discussion on the results. Lastly, conclusion of the study is provided.

2. LITERATURE REVIEW

The increased volatility in world food and commodity prices motivates many researchers to search for its possible causes. Oil price, because of its close relation with the production cost and economy, in general, can be one of the primary causes. Previous academic studies analyzing the relation between oil markets and food prices can be grouped into three.

The first type of studies analyzes causality between oil prices and the prices of various agri-products (Nazlıoglu 2011; Kapusuzoglu and Ulusoy, 2015). A popular opinion in this regard is that the relation between oil prices and agri-products prices is different before and after the subprime economic crisis (Pala, 2013; Nazlioglu, et. al., 2013). The studies show that the agri-products prices have become more sensitive to global oil prices after this structural break.

The second type of studies analyzes the relation between oil prices and agri-products prices, indirectly. Esmaeili and Shokoohi (2011) find an indirect effect of crude oil prices on food prices. Moreover, Harri et. al, (2009) also includes exchange rate to explain the relation between oil and food prices. In emerging economies, internal dynamics of agri-products markets may be different from the global markets. This depends on the elasticity of agri-products and oil products of the concerned economy.

In this perspective, the third type of studies analyzes the shocks in global oil markets in the light of agriculture data of the respective country. For example, Zhang and Qu (2015), using ARJI-GARCH model and ARMA-GARCH model, find that the global oil price shocks may have various effects on agri-products in China. ZhengWei, et. al., (2015) find that the food prices (soybean, maize, wheat, colza and rice) are not affected by the oil price shocks. Some other studies also find no relation among the said markets (e.g. Nazlioglu and Soytas, 2011). In contrast, in US, energy prices effect agri-products prices in the long run (Baek and Koo 2010; Gohin and Chantret, 2010). Moreover, the findings in Indonesia also support the relation between food and oil prices (Abdlaziz, et. al., 2016). In nutshell, the relation may vary depending on type of agri-products and the local dynamics of the respective economy. Therefore, this study, in contrast with most of the studies, analyzes the local agri-products prices of Turkey instead of global prices. Moreover, GARCH model is used in order to see the lagged effects of global oil price shocks on food price volatility.

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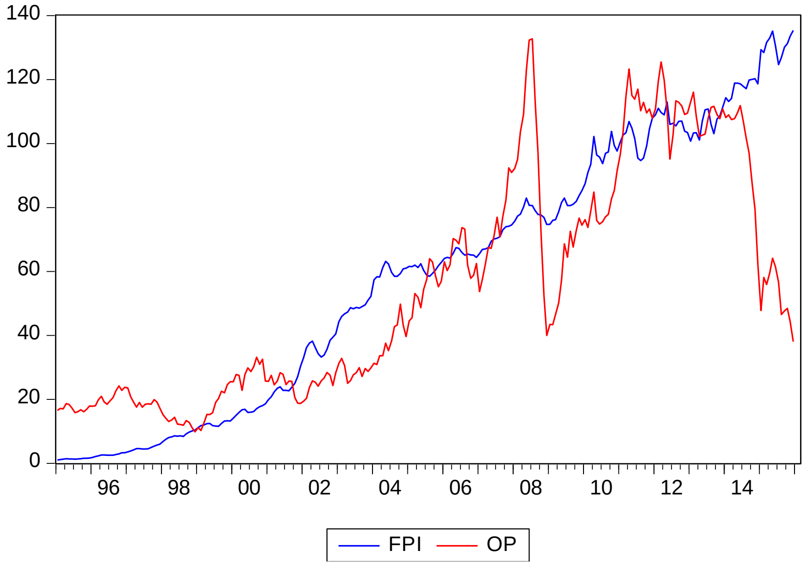
3. DATA AND MODEL

The study uses monthly time series data of Agri-products Producers Price Index (FPI) of Turkey and global oil prices (OP) for the period of 1995 to 2015. Figure 1 shows the time series of the two variables. The said index assumes 2010 as base year and tracks monthly changes in the first hand prices of the agri-products in Turkey. It is calculated using NACE Rev.2 classification (TUIK, 2016). The oil prices are obtained from Energy Information Administration. The FPI series shows an upward trend with lots of ups and downs over the period. However, the OP series shows an upward trend till the end of 2007 following sharp decline in 2008 probably because of the global financial and economic crisis. Later on, it recovers till the end of 2012. Following that it undergoes a period a high volatility and drops significantly till end of December, 2015. Apparently, there seems no linear relation between the series, especially in the post crisis period. However, the oil prices may be helpful in explaining the volatility in food prices. The obvious choice for modeling volatility is ARCH (Autoregressive Conditional Heteroskadasticity) - type models.



Source: Turkish Statistical Institute and U.S. Energy Information Administration

Figure 1. Time Series of Food Price Index (FPI) and Oil Prices (OP)

Before modeling, the series are tested for stationarity condition in order to avoid spurious regression problem. As, there are trends in the series, the following ADF test equation is used.

$$\Delta y_t = \alpha + \gamma y_{t-1} + \lambda t + \sum_{s=1}^{m} a_s \Delta y_{t-s} + \varepsilon_t \quad (1)$$

Here, y_t is the time series used, t is the trend and s is the number of lags to remove the autocorrelation between the residuals. Schwarz's Bayesian Information Criterion (SBIC) is used to determine the no. of lags. (e.g. Sayyan, 2005). Table 1 shows the ADF unit root test results. The series are I (1) stationary

Table 1. ADF Unit Root Test Results

	I(0)		I(1)	
	t-statisitic	**Prob.**	**t-statisitic**	**Prob.**
FPI	-3.27	0.07	-14.33	0.00
OP	-2.15	0.51	-10.52	0.00

An important prerequisite for the ARCH-type models is the presence of ARCH-effects. Figure 2 shows the residuals of the FPI series regressed against a constant. The volatility is low at start of 1995 followed by a period of low volatility till the end of 1998. There are periods of high volatilities in 2002 and 2010 followed by the periods of high volatilities. This phenomena is so-called ‘volatility clustering’. The presence of volatility clustering is a sign of the presence of ARCH effects. Figure 3 shows the descriptive statistics and normality test of the residuals. The Jarque-Bera normality test rejects the null hypothesis of normality of the series.

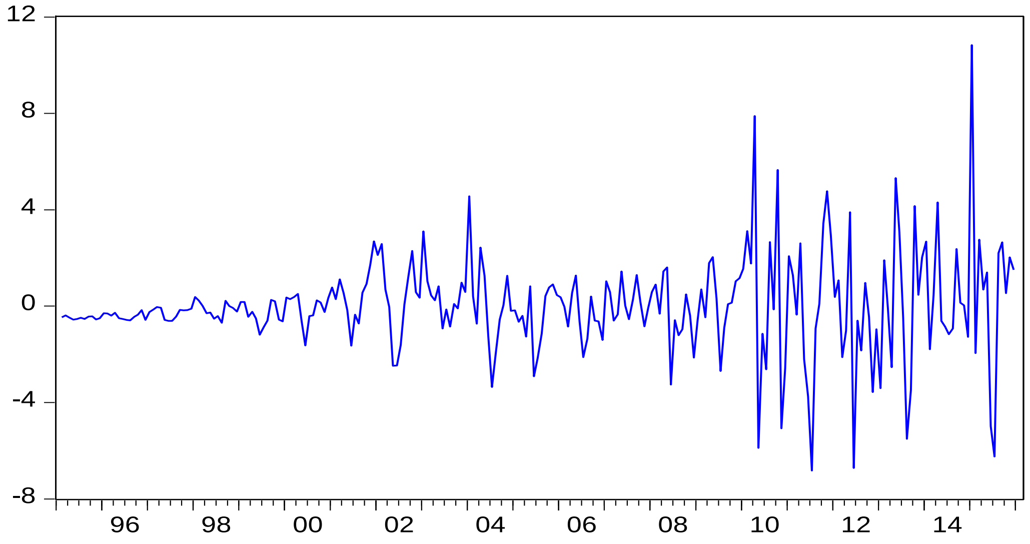


Figure 2. Residuals of the Food Price Index Series

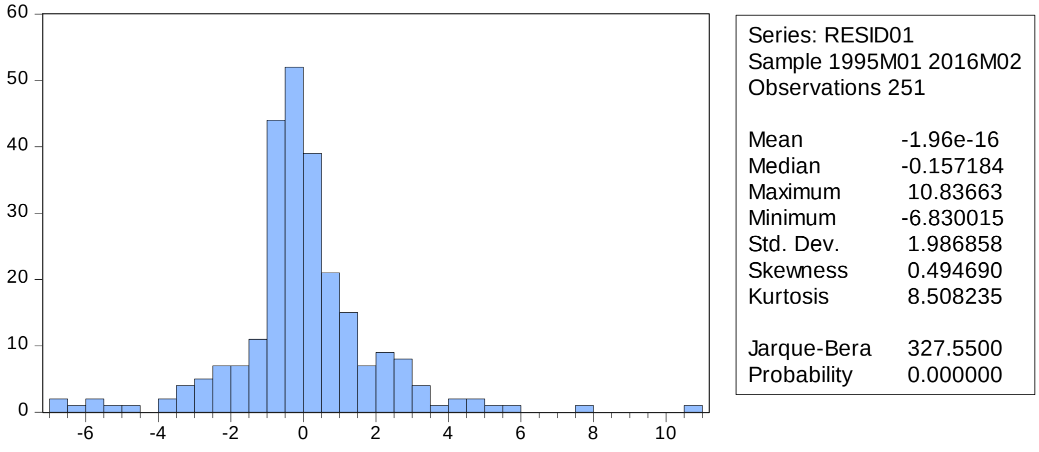


Figure 3. Descriptive Statistics and Normality Test of the Residuals

Another criterion to justify the ARCH-type models is heteroskadasticity of the residuals. Table 2 shows the correlogram of the residuals squared. There is sufficient evidence that the residuals are heteroskedastic. Another important criterion to check the presence of ARCH effects is the ARCH-LM test. The test is rejects the null hypothesis of no ARCH effects (F-statistic = 11.05, Prob. = 0.001).

Table 2. Correlogram of the Residuals Squared

	AC	PAC	Q-Stat	Prob
1	0.207	0.207	10.833	0.001
2	0.050	0.008	11.481	0.003
3	0.070	0.061	12.736	0.005
4	0.065	0.040	13.824	0.008
5	0.161	0.144	20.521	0.001
6	0.293	0.244	42.741	0.000
7	0.128	0.028	46.995	0.000
8	0.093	0.054	49.276	0.000

Since there is sufficient evidence for the presence of ARCH-effects in FPI series, ARCH-type models can be used to model its volatility. The following generalized ARCH (GARCH) model is fitted.

$$FPI_t = c + \varepsilon_t \quad (2)$$

$$\varepsilon_t \sim N(0, h_t) \quad (3)$$

$$h_t = \alpha + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} + \delta_p OP_{t-p} + e_t \quad (4)$$

Eq. 2 is the mean equation. Eq. 3 shows that the residuals of the mean equation are time varying, i.e. they are heteroskedastic. Eq.4 models the time varying variance (h_t) one lagged squared errors (ε_{t-1}^2) and the time varying variance term (h_t). The oil prices (OP) is also used as variance regressor.

4. FINDINGS AND DISCUSSION

Table 3 shows the coefficient estimates of the fitted GARCH model. The coefficients of the variance equation meats the persistency condition ($\alpha > 1, \alpha_1+\beta_1>1$). The sum of the all variance coefficients (0.90) excluding constant, show that the variance shocks persist for a medium term. The closer the coefficient to 1, the higher is the persistency. A value equal to 1 shows that the shocks do not disappear and persist for a prolonged time. An interesting finding is that the oil price shocks at level and one lagged period are significant at 5% and 10% level of significance, whereas the shocks at third and fourth lag are significant at 1% level of significance with higher coefficients. It shows that oil price shocks in third and fourth month have stronger effect on the food price volatility as compared to the recent shocks. In other words, the food prices do not respond immediately to the oil price shocks; it takes two to three months for the shocks to fully reflect in the market. Generally, the supply elasticity of agri-products is low because of the factors like perishability and presence of alternative products. Moreover, government taxes on oil prices may be a basic reason for delayed effects of the global oil price shocks on the prices of agri-products.

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Table 3. Coefficient estimates of fitted GARCH model

Variable	Coefficient	Std. Error	z-Statistic	Prob.
c	0.436454	0.077166	5.656042	0.0000
Variance Equation				
α	0.557342	0.087327	6.382277	0.0000
α_1	0.558011	0.076713	7.274048	0.0000
β_1	0.408274	0.016198	25.20467	0.0000
δ_0	-0.025318	0.011603	-2.182029	0.0291
δ_1	-0.029033	0.016513	-1.758182	0.0787
δ_2	-0.115588	0.026211	-4.409970	0.0000
δ_3	0.110865	0.011319	9.794837	0.0000

Some residuals diagnostics tests are also performed to ensure that the volatility has been modeled correctly. Table 4 shows the correlogram of the residuals squared evidencing the absence of heteroskadasticity in the residuals. Figure 4 shows the normality test of the residuals of the fitted model. The Jarque-Bera normality test does not proves the normality of the residuals. However, the kurtosis of the distribution and the Jarque-Bera test statistic has been reduced. On the other hand ARCH-LM test is unable to reject the null hypothesis of no ARCH effects (F-statistic = 0.38, Prob.= 0.67). Since two of the three diagnostics criteria proves the absence of any ARCH-effects, the above GARCH (1,1) model seems to correctly model the volatility of the FPI. The findings show that the global oil price shocks cause to increases the volatility of agri-products prices in Turkey. The shocks may have permanent effects on the prices. The results are in line with the findings of Baek and Koo (2010), Gohin and Chantret, (2010) and Abdlaziz, et. al., (2016). However, they contradict with ZhengWei, et. al. (2015). This is because of the different local dynamics of the respective economies and the agri-products analyzed.

Table 4. Correlogram of the Residuals Squared

	AC	PAC	Q-Stat	Prob
1	0.002	0.002	0.0014	0.970
2	-0.056	-0.056	0.8041	0.669
3	0.000	0.000	0.8041	0.848
4	0.007	0.004	0.8169	0.936
5	0.060	0.060	1.7385	0.884
6	0.134	0.135	6.3248	0.388
7	-0.018	-0.011	6.4093	0.493
8	0.027	0.043	6.5976	0.581

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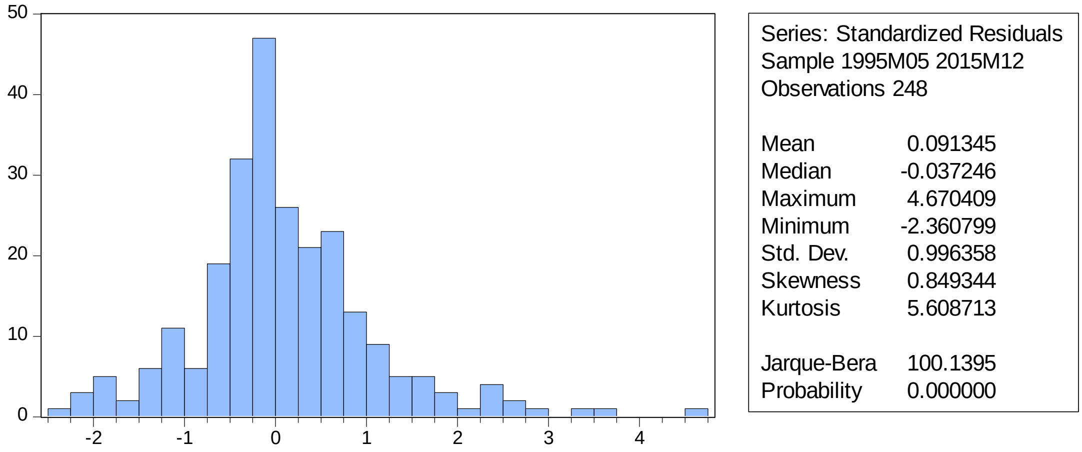

Figure 4. Descriptive Statistics and Normality Test of the Residuals of the Fitted Model

5. CONCLUSION

The study analyzes effects of the global oil price shocks on agri-products producers' price index of Turkey. The findings show the delayed effects of the shocks on food prices. This may be because of low supply elasticity of the agri-products. The measures like improving storage facilities, increasing reserves of the local agri-products and encouraging commodity futures may help in reducing the risk arising from global oil price shocks. The results of the study will help policy makers and market players to take more rational decisions.

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