Effect of Monetary Indicators on Agricultural Prices: Evidence from Turkiye

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Abstract: This study sought to reveal the effects of Turkish Lira and US dollar exchange rate (EXR), money supply (M2) on agricultural commodity producers' prices. The direction and the size of the relationship among the data was estimated using VECM Vector Error Correction Model (VECM). The results reveal that the causality runs from M2 to agricultural price (AP) in the short run, but not from AP to M2. In the long run the effect of EXR is more than M2. The coefficient of error correction term in the agricultural price equation is 0.0726 and is statistically significant at 1%. Referring to it, all of the system instability can be adjusted approximately in 14 months. This research shows that the exchange rate (EXR) and money supply (M2) have important long-run effects on agricultural prices (AP). In order to control agricultural prices, it is necessary to follow these macro variables closely.

Keywords: Agricultural price, monetary policy, food inflation, applied econometrics

Parasal Göstergelerin Tarım Fiyatları Üzerindeki Etkisi: Türkiye'den Kanıtlar

Öz: *Bu çalışma, Türk Lirası ve ABD doları döviz kurunun (EXR), para arzının (M2) tarımsal emtia üreticilerinin fiyatları üzerindeki etkilerini ortaya koymayı amaçlamıştır. Veriler arasındaki ilişkinin yönü ve boyutu VECM Vektör Hata Düzeltme Modeli (VECM) kullanılarak tahmin edildi. Sonuçlar, nedenselliğin kısa vadede M2'den tarım fiyatına (AP) doğru olduğunu ancak AP'den M2'ye doğru olmadığını ortaya koymaktadır. Uzun vadede EXR'nin etkisi M2'den daha fazladır. Tarım fiyat denkleminde hata düzeltme terimi katsayısı 0,0726 olup istatistiksel olarak %1 düzeyinde anlamlıdır. Buna göre sistem kararsızlıklarının tamamı yaklaşık 14 ayda ayarlanabilmektedir. Bu araştırma, döviz kurunun (EXR) ve para arzının (M2) tarım fiyatları (AP) üzerinde uzun vadeli önemli etkileri olduğunu göstermektedir. Tarım fiyatlarının kontrol edilebilmesi için bu makro değişkenlerin yakından takip edilmesi gerekmektedir.*

Anahtar Kelimeler: Tarımsal fiyat, para politikası, gıda enflasyonu, uygulamalı ekonometri

INTRODUCTION

In recent years, it has been observed that global liquidity has rapidly changed direction by moving towards developing countries. High liquidity reinforced the upward pressure on foreign exchange rates and asset prices. This, in return, precipitated the upward movements of prices in developing markets (Dooley 2000). As a developing market, Turkiye has been exposed to excessive global foreign currency liquidity, particularly since 2002. While the cumulative proportion of the capital inflow to GDP was 15.3% between 1995 and 2000, it increased to 25.7% between 2003 and 2007 (Anonymous, 2007). This created rapid growth in the Turkish economy. Despite these positive developments, a distinctive upward trend dominated food prices; a trend that was significantly different from the volatility of the international food prices (Central Bank of Turkiye 2014). These developments strengthen the hypothesis that the price increases may be attributable to domestic economic dynamics in Turkiye. The increase in the food prices in Turkiye may have been caused by the money supply. Therefore, the goal of this study is to determine the effect of the money supply and exchange rate mobility on the general level of food prices in Turkiye.

A review of the literature yields a limited number of studies investigating the influence of macro-economic factors (M2 money supply, inflation, interest rates and foreign exchange rates) on increased commodity prices. The common finding in the literature is that monetary liquidity is a determinant of the prices. By using a vector autoregressive model, Sousa and Zaghini (2008) noted that global liquidity is indicative of changes in commodity prices. Another study conducted on the commodity prices of countries within the Organization for Economic Co-operation and Development (OECD) emphasized the significance of the global liquidity on prices (Belke et al. 2010). This research was conducted with cointegrated vector autoregression models and identified linear relationships between global money supply and commodity prices. In their study based on panel data sets,

The effect of global liquidity on commodity and stock prices is even more apparent in developed countries compared to more developing economies Brana et al. (2012). Hye and Asghar (2009) found that monetary shocks had a unilateral effect on food prices in the underdeveloped Bangladesh economy. On the other hand, Ratti and Vespignani (2015) noted that the effect that money supply shocks had on food prices was even more apparent in BRIC countries. Similarly, using a Panel VAR model, Mallick and Sousa (2013) found that contractionary monetary policies caused a decline in BRICS (Brazil, Russia, India, China and South Africa) country commodity prices. According to Beckmann et al. (2014), global liquidity exerts an important influence on commodity

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prices. In addition to previous studies found in the literature, Kang et al. (2016) observed that the relationship between money supply and commodity prices became stronger in the aftermath of the 2008 global economic crisis. Hammoudeh et al. (2015) emphasized that contractionary monetary policy led to a rise in the commodity prices in the USA based on the results of their study conducted with a structural VAR model. On the contrary, Belke et al. (2013) noted that there is positive and long-run relationship between global liquidity and food prices. Orkun et al., (2023) revealed that money supply and dollar exchange rate affect food prices in Turkiye. The literature review reveals an agreement regarding how global liquidity affects prices. While the severity of this effect varies from one country to another, the rise in the liquidity boosts the overall level of prices, particularly in the developing countries. On the other hand, there is no agreement on the relationship between the exchange rate and food prices in the literature. International agricultural commodities are generally traded in USD (McCalla, 2009). For this reason, the appreciation of USD against other currencies should be used as an indicator of the increase in the prices of agricultural commodities. Nazlioglu and Soytas (2011) noted that the agricultural commodity prices and the lira/dollar exchange rate do not show any response to the oil price shocks in the short-run. Chen (2015) emphasized that in China the response of response of common price movements based on weighted averages across commodity sectors (including the agricultural commodity sector), to global oil shocks has been stronger than the response to domestic macro-economic fluctuations. Thus, they also supported the findings of Nazlioglu, Erdem, and Soytas (2013). However, Baek and Koo (2010) showed that the exchange rate is an important determinant of US food prices. Yin and Han, (2016) and Lombardi et al. (2012) supported this argument. Similarly, Rezitis (2015) reported that USD exchange rates affect international commodity prices. The author emphasized the bilateral causal relationship between USD exchange rates and international agricultural food prices. In addition, Harri et al. (2009) contended that the exchange rate is an indirect determinant of the prices of corn, cotton and soybeans in the USA. Baffes and Haniotis (2016) found a negative relationship between real exchange rates and food prices. Nazlioglu and Soytas (2012) reached the significant conclusion that the depreciation of the USD increases many international agricultural commodity prices. Veysel et al., (2023) determined that food prices in Turkey are affected by exchange rates.

These examples show that there are three different cases for the relationship between exchange rates and agricultural More advanced techniques are needed to analyse the existence, direction and severity of causality (Figure 1). commodity markets. In some cases, the USD exchange rate affects agricultural prices positively. In other cases, it has a negative effect on agricultural prices. Finally, sometimes the USD does not affect agricultural prices. The effect of the M2 money supply and USD exchange rate on agricultural prices was examined. This study offers additional evidence for the debates that currently exist in the literature. The findings from this study may provide helpful information for decision-makers regarding which policies and policy tools should be followed.

MATERIAL and METHODS

Monthly time series from January 1998 to December 2015 were used in this study for the following three indicators: the agricultural production price index (AP), the Turkish Lira and US dollar (EXC) exchange rate and the money supply (M2). There may have been significant structural breaks in the economy due to the Covid 19 outbreak. This research did not focus on the economic damage that structural breaks could cause. That's why data periods are limited to these dates.

The M2 money supply was used as one of the indicators of the total amount of currency circulated in the economy. Many studies in the literature have proved that this variable can be used as an indicator of the money supply. Furthermore, relative prices were used so that players in the same sector can comprehend the changes better. Turkish Lira/US dollar exchange rate (EXR) and money supply (M2) data were obtained from the data dissemination system of TurkStat. The exchange rate was measured as the value of Turkish lira per USD. For this reason, an increase in the exchange rate means depreciation of the Turkish Lira (TL). Monthly changes in the variables applied in the analysis are depicted in Figure 1.

This figure shows that the changes reached 781.3 billion TL by the end of 2012, and they reached 1.060 billion TL in 2015. In 2015, the respective figures were 257.1 billion TL and 802.9 billion TL. The amount of money supply has increased by approximately four-fold in the last eight years. However, the rate of increase in the USA money supply has been half of that in Turkiye. An analysis of the general level of agricultural prices reveals a continuous upward trend since 1994 (2010=100). On the other hand, when the upward trend of the exchange rate between 1994 and 2001 is examined, exchange rate volatility is revealed between 2002 and 2008, which was later replaced by an upward trend. In the last five years, the Turkish lira has depreciated against the USD by more than two-fold, with its parity rising from 1.55 to 2.91. This exchange rate has been at 30% in the last two years. Figure 1 shows that the data are correlated and a shock experienced in one market may affect other markets. For this reason, a relative increase in prices may be attributable to loose policy. However, correlation does not prove the existence of a relationship.

The present study was conducted using the natural logarithm of the study variables (Tables 1).

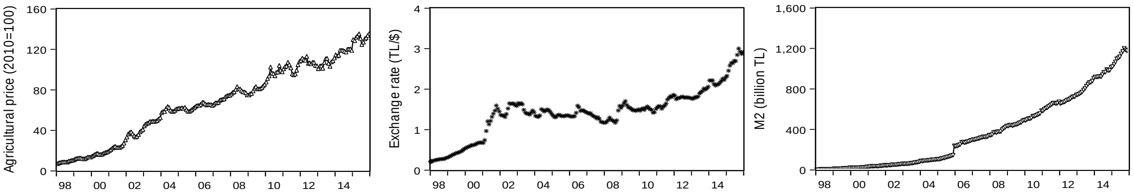

Figure 1. Monthly changes in agricultural prices, money supply and exchange rate

Table 1. Descriptive Statistics

	LOG-AP	LOG-EXR	LOG-M2
Mean	3.979404	0.228713	30.48015
Median	4.203443	0.382067	31.02719
Maximum	4.907650	1.098822	32.42241
Minimum	1.916886	-1.556419	27.06154

The vector autoregressive model (VAR) can be employed in order to calculate the inter-variable dynamic relationships and the effects of the shocks encountered. However, as shown by Sims et al. (1990), the variables need to be stationary and cointegrated at the same level in order for the causal reasoning to be valid. If there is at least one co-integration equation among the variables, the vector error correction model is applied for estimation (Johansen and Juselius, 1990; Johansen 1991). The error model provides a long-term mathematical equation. However, short-run relationships are determined in this interaction. For this reason, the Wald test is applied on the delayed error correction parameters and short-run causality can be tested. If the test statistic is significant, the 'no Granger causality', which is a null hypothesis, is rejected.

The aim of this research is to determine the spillover effect of money supply and exchange rate on agricultural prices. The existence of endogeneity among these variables is expected. The use of the Vector Error Correction Model (VECM) proved to be adequate, considering both the presence of endogeneity among variables and the presence of cointegration relationships (Marques et al., 2014).

The VEC model is important in that it shows the dynamic transmission among different markets. The VEC model was applied in this study in order to analyse the long-run and short-run dynamics of Turkish agricultural markets.

Autoregression (VAR) model applied in the study can be defined as follows:

$$At= \beta 0+ \beta 1At\text{-}1 +\ldots+ \beta kAt\text{-}k + \varepsilon t \qquad (1)$$

where At=(LAPt, LEXRt, LM2t), β0 is a 3×1 vector of constants, β1 are 3×3 coefficient matrices, and εt are white noise residuals.

After Equation (1), the VECM equilibrium can be written as

$$\Delta APt= c + \alpha 1\Delta Gt\text{-}1 + \beta 1\Delta APt\text{-}1 + \beta 2\Delta EXRt\text{-}1 + \beta 3\Delta M2t\text{-}1 + \varepsilon t \quad (2)$$

where AP is the vector of agricultural prices; Gt=APt+ρEXRt+δM2t+μt is a long-term equilibrium relationship between the three variables; and c, α, β, ρ and δ are parameters to be estimated.

Differing from Granger causality tests in the VAR specification, the Granger causality test in an VECM can be divided into short- and long-run tests. The test for the coefficient restriction on the lagged first differenced terms is called short-run test, since the coefficients Bj's of lagged variables ΔRt=j captures the short-run dynamics. In this case, the Wald x2(n) test is used to detect the Granger causal relation (Toda and Phillips 1993). However, the test for the coefficient restriction on the error correction (EC) term is called long run test, since the EC term captures the long-run equilibrium between variables (Toda and Phillips 1994; Enders, 1995).

In this study, the relationship between the variables was investigated both as long and short term with the method described above. Engle and Granger (1987) states that, by adding the term of error correction into the regression, immediate effects can be created between the variables. This immediate effect reflects the short term relationship. On the other hand, in the long-term, variables are sorted out from the effects of their previous values, and the system is identified with a defined by a process of balance. In science of economics, short term shows the sudden market shocks, where the firm balance production opportunities do not change; and the long term shows a period, in which both input and output prices are completely flexible in terms of production. Thus, long and short term structure, in accordance with the economic literature in terms of econometrics, will be obtained. Short and long term relationships may vary depending on the elasticity of the variables and the structure of the market.

The data were determined based on the level of stationarity. The outcomes of the test statistics taken from the studies of Dickey and Fuller (1979) were used. In these tests, there is a unit root in variables of the null hypothesis, and it is not stationary. The analysis conducted with Augmented Dickey Fuller shows that the variables were non-stationary at their level values, while all variables taken differently from the first level became stationary (Table 2).

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

	ADF (Level)		ADF (First Difference)	
	Constant	**Trend-Intercept**	**Constant**	**Trend-Intercept**
LOG-AP	-3.281077	-2.07882	-10.02158	-10.50026
	(0.0170)*	(0.5542)	(0.0000)*	(0.0000)*
LOG-EXR	-3.31921	-2.9715	-9.358814	-9.595614
	(0.0152)*	(0.1428)	(0.0000)*	(0.0000)*
LOG-M2	-4.767576	-2.1767	-14.41152	-15.79781
	(0.0001)*	(0.4997)	(0.0000)*	(0.0000)*
Critical Value 1%	-3.460884	-4.0015	-3.460884	-4.001516
Critical Value 5%	-2.874868	-3.4309	-2.874868	-3.430963
Critical Value 10%	-2.573951	-3.1391	-2.573951	-3.139114

Notes: MacKinnon (1996) one-sided p-values. The optimal lag-length for the test was selected by Schwarz Information Criterion * denote statistical significance at 5% level of significance respectively

RESULTS and DISCUSSION

The delay length of the VAR model of the data in the present study was determined as in (9). The consistency between this delay and the VAR model was verified through various diagnostic tests.

Inverse roots of the AR characteristic polynomials were evaluated by circle analysis. No modulus value is out of the range of reference. If no AR root lies outside the unit circle, it means that the VAR model is stationary. If the descriptive variables are collected from a limited part of the data space, or if there is a structural issue, the problem of a changing variable may occur. The White test was used to determine if changing variance was present. In the end, the null hypothesis could not be rejected (Chi-sq 342.5613; prob. 0.2291), so no heteroscedasticity was detected.

Table 3 demonstrates that the entire LM test of the model remains within the limit values. This type of series may be considered white noise and a stationary process. It can be said that consecutive interdependence is present in the VAR model due to the probability values of the LM test.

Table 3. Autocorrelation LM Test

Lags	**LM-Stat**	**Prob**
1	6.816548	0.6562
2	3.994946	0.9117
3	5.877737	0.7521
4	6.049784	0.7349
5	5.784837	0.7612
6	6.725748	0.6656
7	6.658448	0.6726
8	7.840721	0.5503
9	7.280130	0.6080
10	5.706092	0.7689
11	7.839618	0.5504
12	13.01545	0.1619

The correlogram analysis clearly reveals the absence of an autocorrelation problem in the series (Figure 2).

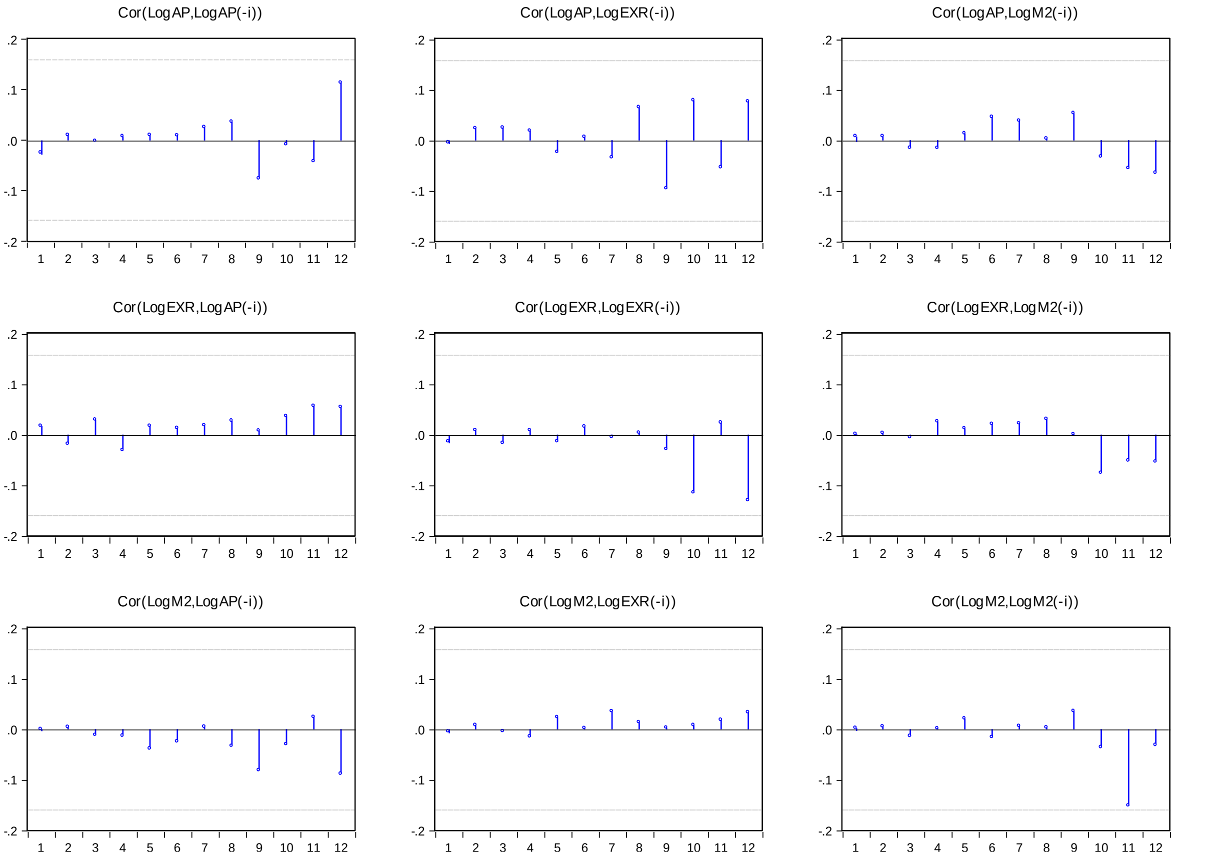

Figure 2. Autocorrelations with ±2 standard error bounds

All tests performed show that the VAR delay 9 model meets the consistency requirements. It is possible to test whether the series AP, EXC and M2 are cointegrated based on this information. Cointegration is used to define a long-term stationarity relationship. The table shows that the null hypotheses r=0 were rejected at the 5% significance level. For this reason, the number of cointegration vectors in the model equal to one (Table 4). There may be a long-term relationship among the variables of AP, EXC and M2 according to the results of the cointegration test.

Table 4. Results of Johansen's cointegration tests (Linear intercept and trend)

Hypothesized No. of CE(s)	Trace Statistic	0.05 Critical Value	Max-Eigen Statistic	0.05 Critical Value
None	60.44659	42.91525	36.56935	25.82321
At most 1	23.87724	25.87211	13.60830	19.38704

Table 5 shows the study's cointegration coefficients, coefficients of the stationary error correction term, standard equation coefficients, and standard error and t-statistics values.

Based on the results of VECM long term, we solved the regression for the cointegration equation between the three variables as follows:

APt = 0.557736EXRt + 0.046850M2t + 0.002759trend + 2.147666

It is possible to state that there is a long-term positive correlation between AP and EXR and M2 in Turkiye. The model is in logarithmic form. So it can be interpreted as redirects. It can be asserted that the EXR bean has greater impact on AP. Hence, while the acquired coefficient for EXR is 0.557736, this ratio is 0.046850 for M2. These coefficients show that AP increases by 0.5557% in the face of the increase by 1% in EXR. On the other hand, the M2 increase by 1% leading to a rise in AP by 0.046%.

The coefficient of the error correction term in the agricultural price equation is -0.072678, which is statistically significant at 1% (tetc statistic= -5.41099; p=0.0000). Since the error correction coefficient is smaller than 1, the system is equitable. The negative mark indicates that there is movement towards equilibrium again in the case of deviation from the equilibrium.

These results suggest that the error correction mechanism can be used. The absolute value of error correction statement shows the necessary measure to adjust the disequilibrium arose within one month on the model. Specifically, the value of 7.2678% shows the adjustment amount of disequilibrium within one month. Referring to it, all of the system instability can be adjusted approximately in 14 months. This shows that the exchange rate and M2 money supply have long-run effects on agricultural prices.

Table 5. Estimation results of VECM

Variable	**Coefficient**	**Standart error**	**t-statistic**
CointEq1	-0.072678	0.01343	-5.41099
D(Log-AP(-1))	0.241429	0.07109	3.39627
D(LOG-AP(-2))	0.014810	0.07254	0.20418
D(LOG-AP(-3))	-0.188705	0.07164	-2.63396
D(LOG-AP(-4))	-0.033048	0.07276	-0.45419
D(LOG-AP(-5))	-0.153470	0.07231	-2.12249
D(LOG-AP(-6))	-0.082571	0.07370	-1.12043
D(LOG-AP(-7))	-0.115674	0.07371	-1.56935
D(LOG-AP(-8))	-0.105637	0.07379	-1.43154
D(LOG-AP(-9))	-0.103121	0.07165	-1.43917
D(LOG-EXR(-1))	-0.020459	0.05568	-0.36745
D(LOG-EXR(-2))	-0.049476	0.06146	-0.80494
D(LOG-EXR(-3))	-0.054199	0.06355	-0.85285
D(LOG-EXR(-4))	-0.025215	0.06407	-0.39356
D(LOG-EXR(-5))	-0.028929	0.06386	-0.45298
D(LOG-EXR(-6))	-0.026415	0.06379	-0.41408
D(LOG-EXR(-7))	-0.003459	0.06394	-0.05409
D(LOG-EXR(-8))	0.003976	0.06098	0.06520
D(LOG-EXR(-9))	-0.072228	0.05499	-1.31341
D(LOG-M2(-1))	0.047497	0.05058	0.93911
D(LOG-M2(-2))	-0.013803	0.05132	-0.26895
D(LOG-M2(-3))	-0.037441	0.05129	-0.73006
D(LOG-M2(-4))	0.054547	0.05033	1.08385
D(LOG-M2(-5))	-0.017158	0.04965	-0.34559
D(LOG-M2(-6))	-0.099559	0.04989	-1.99571
D(LOG-M2(-7))	-0.043612	0.05017	-0.86928
D(LOG-M2(-8))	-0.020404	0.05029	-0.40572
D(LOG-M2(-9))	0.016943	0.04987	0.33971
C	0.026147	0.00524	4.98964

R-squared	0.372668	Log likelihood	467.1116
Sum sq. resids	0.129372	Schwarz SC	-3.785023
S.E. equation	0.027035	Mean dependent	0.012780
F-statistic	3.755 265	S.D. dependent	0.031717

Short-run causality was determined using the Wald test for delay equilibrium in the error correction model. A causality between the M2 money supply to agricultural prices was identified at a 5% significance level. However, no causality was found between the USD exchange rate and agricultural prices, nor between agricultural prices, the M2 money supply and the USD exchange rate. This may emphasize the importance of monetary policies in Turkiye. The results of the tests on the variables are displayed in Table 6.

Table 6. VEC-M short run Causality/Block Exogeneity Wald Test Results

Null Hypothesis	Test-statistic	Value	Prob.	Causal Relation
There is no short run causality from Log-M2 to Log-AP	F-statistic	2.022832	0.0392**	Log(M2) → Log(AP)
	Chi-square	18.20548	0.0329**	
There is no short run causality from Log-AP to Log-M2	F-statistic	0.977599	0.4602	No causal relation
	Chi-square	8.798395	0.4561	
There is no short run causality from Log-EXR to Log-AP	F-statistic	1.047275	0.4045	No causal relation
	Chi-square	9.425475	0.3990	
There is no short run causality from Log-AP to Log-EXR	F-statistic	1.128480	0.3449	No causal relation
	Chi-square	10.15632	0.3380	

** denote statistical significance at 5% level of significance respectively

Based on the above-mentioned findings, two important phenomena were identified for the Turkish agricultural sector.

First, it was determined that agricultural prices did not respond to the volatility of the Turkish Lira/ USD exchange rate in the short-run. However, it is necessary to specify that the agricultural prices give statistically significant responses to the volatility of exchange rate in the long run. This finding overlaps with those of the studies conducted by Baek and Koo (2010) and Gohin and François (2010). Turkiye is a net importer, in terms of general foreign trade. In general, USD is the predominant currency used trade activities. In addition, both various agricultural products and the important inputs of agricultural production (such as fertilizers and diesel fuel) are imported in Turkiye. For this reason, it is natural that domestic nominal food prices are affected by the USD parity in the long-run. However, Turkiye is a self-contained and self-reliant country in terms of various agricultural products. Thus, this finding may contradict research conducted on a per-product basis (Nazlioglu and Soytas, 2011).

Second, the relationship between expansionary monetary policy and food prices in the long-run was determined. This finding supports previous studies in the literature, such as Beckmann, Belkea, and Czudaj (2014) and Kang et al. (2016). Keynes' Liquidity Preference Theory foresees that an increase in the money supply would decrease the interest rates and increase the inflation rate. The rise in inflation is basically the rise in the general price levels. In Turkiye's case, M2 money supply has increased significantly in recent years. This finding identifies the money supply as one of the significant drivers of food price inflation in Turkiye.

CONCLUSION

This study sought to identify various factors that affect agricultural price levels in Turkiye. It was found that economic factors are among the most important drivers of the fluctuations in agricultural prices in the long-run. Empirical findings proved that monetary policy, exchange rates and agricultural prices are in equilibrium in the long-run. To this end, it can be argued that stable economic development is essential for the stability of agricultural prices. An analysis of the consumption expenditures of households throughout Turkiye reveals that food and non-alcoholic beverages account for the second largest share (19.7%) of total expenditure. Further, the expenses of food and non-alcoholic beverages are 28.8% of total household expenditures for the 20% of the population with the lowest income (TurkStat, 2015). These findings enhance the probability that an increase in the money supply may reinforce agricultural inflation pressures in a general sense. This, in return, may force such households to decrease their demand for food items, as well as other goods and services, due to the decrease in their purchasing power. Therefore, it is important to consider that excessive expansionary monetary policy may harm the lowest income group and sharpen income distribution inequalities. In the context of producers, policy makers should keep an eye on the sensitivity of agricultural prices to exchange rate movements. Obviously, some adjustments may be needed in order to manage producer risk in cases of exchange rate market shocks.

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