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PREDICTION OF CONDITIONAL VARIANCE VOLATILITY OF REAL PRICES OF ALMOND, HAZELNUT, AND PISTACHIO BY THE DIAGONAL BEKK-GARCH (1.1) EQUATION MODEL

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Abstract

Turkey is one of the most important hazelnuts and pistachio producers in the world. In this study, it has been determined what kind of volatility and pass-through there is between the real prices of almonds, hazelnuts, and pistachios in Turkey. In addition, whether a shock in the markets creates uncertainty in its own market and other markets have been revealed. Diagonal-Bekk Garch (1,1) model was used under the Full-rank constraint with 192 monthly data sets between the period 2005M1-2020M12. The results of the research have put forth that the shocks that will occur in the almond market increase the uncertainty in its own market. Similarly, a shock in the hazelnut market increases the uncertainty both in its own market and in the pistachio market, while a shock in the pistachio market increases the uncertainty in its own market. Moreover, the shocks in the almond and hazelnut market are permanent in these markets in the short and long term, but the shocks in the pistachio market do not have a permanent effect in the short and long term.

Key words**:** *price volatility, Diagonal-Bekk Garch (1,1) model, nuts industry*

INTRODUCTION

The agricultural sector is the sector with the highest price volatility compared to other sectors. Agricultural price fluctuations create uncertainties for producers and consumers [20]. Although there are many reasons for the increases in agricultural product prices, they are the result of many factors that are interrelated [21]. Almond, hazelnut, and pistachio markets have an important position in the Turkish economy and are competitive product markets. While Turkey ranks first in hazelnut production and 3rd in pistachio production, it meets 1% of almond production in the world [18]. Possible developments in the dried nuts market also affect the markets of products that are substitutes for each other. The demand for the almond market has increased due to high increases in almond production, which is a substitute for pistachio, and less fluctuation in price compared to pistachio [17]. Turkey's foreign dependency on agricultural production is one of the most important problems in the agricultural sector. Excessive price volatility poses a threat to the future of the relevant markets. Despite global efforts and various controls, world food prices show a constantly rising trend for many years. Since the 2007-2008 food crisis, international organizations, governments, and non-governmental organizations have expressed their concerns about the increased volatility and fluctuations in food markets. Uncertainty in food prices, combating hunger and malnutrition, efforts to increase food production, and stabilizing consumer food prices are seen as the main problems. The fact that there are many parameters that affect the prices of agricultural products makes it difficult to calculate the effect of price volatility on producers and consumers [16]. As a matter of fact, there are important studies on agricultural product price volatility in the previous works. On the other hand, studies on price volatility between markets reveal that they have an effect on the interdependence of markets. In this regard, sudden and high increases in oil prices emerge as one of the most important problems. As a matter of fact, the effect of oil prices on the input costs of agricultural products is directly proportional

to the size of agricultural food demand [9]. The increase in the input costs of petroleum and derivative products causes prices to rise and creates risks and uncertainty in the markets. Indeed, it was similarly determined that there is a volatility interaction between corn and wheat markets while another study reported that 24 agricultural product markets and oil prices between 1980 and 2010 affected agricultural commodity prices. [5, 13]. The volatility of sugar prices in Turkey was determined using monthly prices between 1994 and 2020 [15]. In the study, which draws attention to the commodity financialization of the level of interdependence between agricultural commodities (corn, wheat, soybean, and soybean oil) in 2017, it has been found that there is more spill over in the corn and wheat market. In particular, the soybean and soybean oil markets and surprising economic news have a strong impact on the volatility of agricultural commodities [10]. In the research examining the interaction between pistachio and exchange rate markets in 2016, it was observed that the pistachio market was directly and indirectly affected by the long-term uncertainty of other markets [3]. In a similar work, when the conditional variance volatility of the exchange rate of hazelnut and gasoline market prices is examined, it is concluded that the markets are affected both by their own short and long-term uncertainty and by the short and long-term uncertainty of other markets [4].

Therefore, the aim of this study is to analyze the volatility and pass-through in the real price returns of almonds, hazelnuts, and pistachios in Turkey, using the Diagonal BEKK GARCH (1,1) model with monthly data set for the period 2005:M1-2020M12. For this reason, first of all, empirical methods and data sets to be applied to the variables are introduced, empirical results are reported and policy recommendations are presented. Moreover, it has been revealed how the macro variables of the related markets are affected by the uncertainty in their variances in the face of negative or positive news. It has been quantitatively determined how the markets' own short and long-term uncertainties and how the uncertainties of the competitor's market reflect on the markets. With this research, it has been investigated how the almond, hazelnut, and pistachio markets in Turkey affect each other, and how the changes affect their own and other markets. With the results obtained from the study, policies have been determined on how to protect producers and consumers from price fluctuations that will occur in the future, in the face of negative or positive shocks that will mobilize the markets such as rising input costs.

MATERIALS AND METHODS

Data set

For almond, hazelnut, and pistachio prices, a data set was created using monthly 192 data from the Turkish Statistical Institute (TSI) for the period 2005M01-2020M12 [19]. The raw data of the three markets for the analysed period have been converted to real terms for analysis. The returns of the series are determined by the equation $R_{i,t} = \Delta \log(P_t) = 100 * \log(\frac{P_t}{P_{t-1}}), i = 1,2,3$.

In this equation, P_t gives the current real prices of the relevant markets, while P_{t-1} represents the prices of the previous period.

Econometric Method

The financial time series of the relevant markets, which are the subject of the study, are generally macroeconomic variables with high volatility. An important feature of financial time series in the recent period is that they contain price volatility or varying variance (heteroscedasticity) over time. When the price volatilities in the time series of the three markets are analysed, high and low price volatility are examined from time to time. When it comes to volatility measurements in the markets, [6] developed the ARCH technique, which shows conditional variance. In multivariate models, the effect of shocks in the variables measures the effects that may occur both in their own markets and in the variances of other variables. Various approaches have been developed in order to measure the price volatility of such markets and to reveal the effects of shocks both in their own markets and in other markets, and

one of them is explained with the Diagonal BEKK approach, which is discussed in the study.

The possible price volatility spread is evaluated with the diagonal BEKK approach [7]. In this study, Diagonal BEKK GARCH (1,1) method was preferred under Full Rank limitation to evaluate price volatility among almond, hazelnut, and pistachio markets.

Diagonal BEKK-GARCH is formulated as follows;

$$H_t = C^{"}C + B^{'}H_{t-1}B + A^{'}\varepsilon_{t-1}\varepsilon^{'}_{t-1}A \quad (1)$$

In this formula, C represents the constant matrix coefficients, while A, B represents the effect of short and long term shocks in the markets.

The matrix expansion in the BEKK approach is as follows [7]:

Assuming Ω is equal to an 3x3 matrix, C ′C,

$$= \begin{bmatrix} c_{11} & 0 & 0 \\ c_{12} & c_{22} & 0 \\ c_{13} & c_{23} & c_{33} \end{bmatrix} \begin{bmatrix} c_{11} & c_{12} & c_{13} \\ 0 & c_{22} & c_{23} \\ 0 & 0 & c_{33} \end{bmatrix} \quad (2)$$

$$\begin{bmatrix} c^2 & c_{11}c_{12} & c_{11}c_{13} \\ c_{11}c_{12} & c_{12}^2c_{22}^2 & c_{12}c_{13}+c_{22}c_{23} \\ c_{11}c_{13} & c_{12}c_{13}+c_{22}c_{23} & c_{13}^2c_{23}^2c_{33} \end{bmatrix}$$

The Ht matrix is shown as follows;

$$H_t = \begin{bmatrix} h_{11,t} & h_{12,t} & h_{13,t} \\ h_{21,t} & h_{22,t} & h_{23,t} \\ h_{31,t} & h_{32,t} & h_{33,t} \end{bmatrix} \quad (3)$$

The final state of the equation is expressed as:

$$H_t = \begin{bmatrix} h_{11,t} & h_{12,t} & h_{13,t} \\ h_{21,t} & h_{22,t} & h_{23,t} \\ h_{31,t} & h_{32,t} & h_{33,t} \end{bmatrix} = \begin{bmatrix} \Omega_{11,t} & \Omega_{12,t} & \Omega_{13,t} \\ \Omega_{21,t} & \Omega_{22,t} & \Omega_{23,t} \\ \Omega_{31,t} & \Omega_{32,t} & \Omega_{33,t} \end{bmatrix}$$

$$+ \begin{bmatrix} a_{11} & 0 & 0 \\ 0 & a_{22} & 0 \\ 0 & 0 & a_{33} \end{bmatrix}^{'} \left(\begin{bmatrix} u_{1,t-1} \\ u_{2,t-1} \\ u_{3,t-1} \end{bmatrix} \begin{bmatrix} u_{1,t-1} \\ u_{2,t-1} \\ u_{3,t-1} \end{bmatrix}^{'} \right) \begin{bmatrix} a_{11} & 0 & 0 \\ 0 & a_{22} & 0 \\ 0 & 0 & a_{33} \end{bmatrix}$$

$$+ \begin{bmatrix} b_{11} & 0 & 0 \\ 0 & b_{22} & 0 \\ 0 & 0 & b_{33} \end{bmatrix}^{'} \begin{bmatrix} h_{11,t-1} & h_{12,t-1} & h_{13,t-1} \\ h_{21,t-1} & h_{22,t-1} & h_{23,t-1} \\ h_{31,t-1} & h_{32,t-1} & h_{33,t-1} \end{bmatrix} \begin{bmatrix} b_{11} & 0 & 0 \\ 0 & b_{22} & 0 \\ 0 & 0 & b_{33} \end{bmatrix} \quad (4)$$

In this context, each conditional variance and covariance equation is represented as:

$$h_{11,t} = \Omega_{11} + a_{11}^2 u_{1,t-1}^2 + b_{11}^2 h_{11,t-1} \quad (5)$$

$$h_{12,t} = \Omega_{12} + a_{11}a_{12}u_{1,t-1}u_{1,t-1} + b_{11}b_{22}h_{12,t-1} \quad (6)$$

$$h_{13,t} = \Omega_{13} + a_{11}a_{33}u_{1,t-1}u_{3,t-1} + b_{11}b_{33}h_{13,t-1} \quad (7)$$

$$h_{22,t} = \Omega_{22} + a_{22}^2 u_{2,t-1}^2 + b_{22}^2 h_{22,t-1} \quad (8)$$

$$h_{23,t} = \Omega_{23} + a_{22}a_{33}u_{2,t-1}u_{3,t-1} + b_{22}b_{33}h_{23,t-1}$$

$$h_{33,t} = \Omega_{33} + a_{33}^2 u_{3,t-1}^2 + b_{33}^2 h_{33,t-1} \quad (9)$$

$$h_{33,t} = \Omega_{33} + a_{33}^2 u_{3,t-1}^2 + b_{33}^2 h_{33,t-1} \quad (10)$$

RESULTS AND DISCUSSIONS

In the study, 192 monthly data sets for the period 2005M01-2020M12 were created and some analyses were carried out to investigate the effect of inter-market price volatility after the current prices were converted to real.

The descriptive statistics of the research findings are given in Table 1, the stationarity test of the series in Table 2, and the Diagonal BEKK-Garch (1,1) research findings of the series in Table 3.

In addition, other graphics that summarize the research findings are the price volatility of real prices over time in Figure 1, 2, and 3 and the combined price volatility of the price returns of the three markets over time in Figure 4.

Finally, variance, conditional variance and conditional correlation graphs are given in Figures 5 and 6, respectively.

Table 1. Descriptive statistics table of prices (TL/kg) of almonds, hazelnuts, pistachios*

	r_almond	**r_hazelnut**	**r_pistachio**
Mean	18.485	16.148	10.753
Median	16.277	11.750	8.810
Maximum	41.847	47.430	23.060
Minimum	11.637	6.180	4.390
Standard deviation	5.938	10.861	5.579
Distortion	1.676	1.273	0.586
Kurtosis	5.906	3.60	1.986
Jarque-Bera	157.555	54.853	19.238

Source: [19] *Calculated by author.

Table 1 presents the descriptive statistical results of the three markets that are the subject of the study. As a result of the monthly data of Almond, Hazelnut, and Pistachio for the period 2005M01-2020M12, the average price of almonds is 18.48₺, hazelnuts 16.14₺ and pistachios 10.75₺.

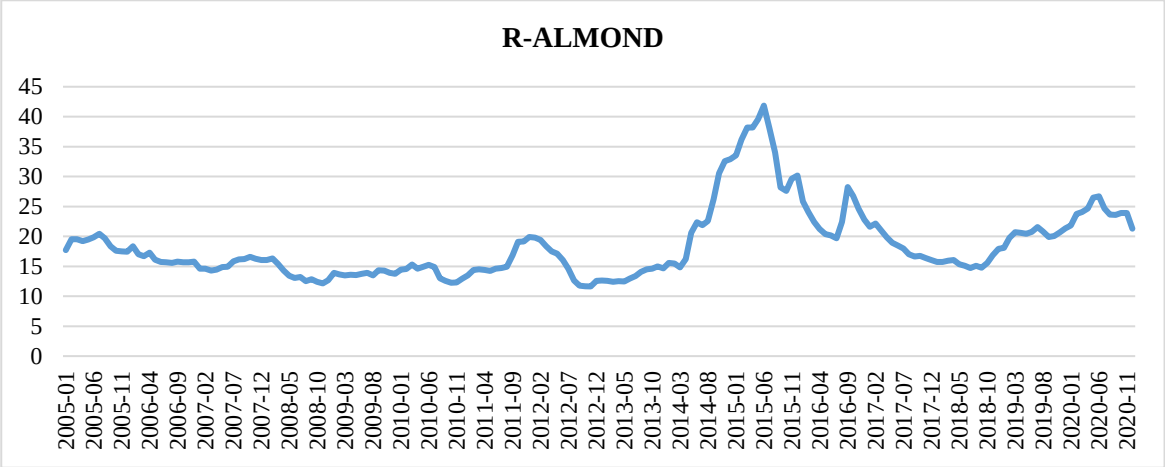

Fig. 1. Price volatility graph of real almond prices over time (TL/kg)
Source: [19].

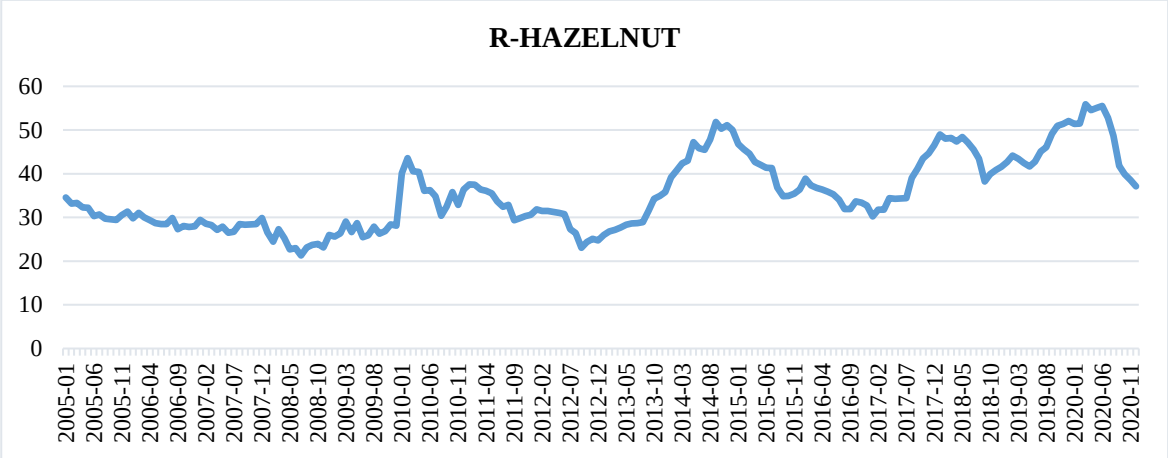

Fig. 2. Price volatility graph of real hazelnut prices over time (TL/kg)
Source: [19].

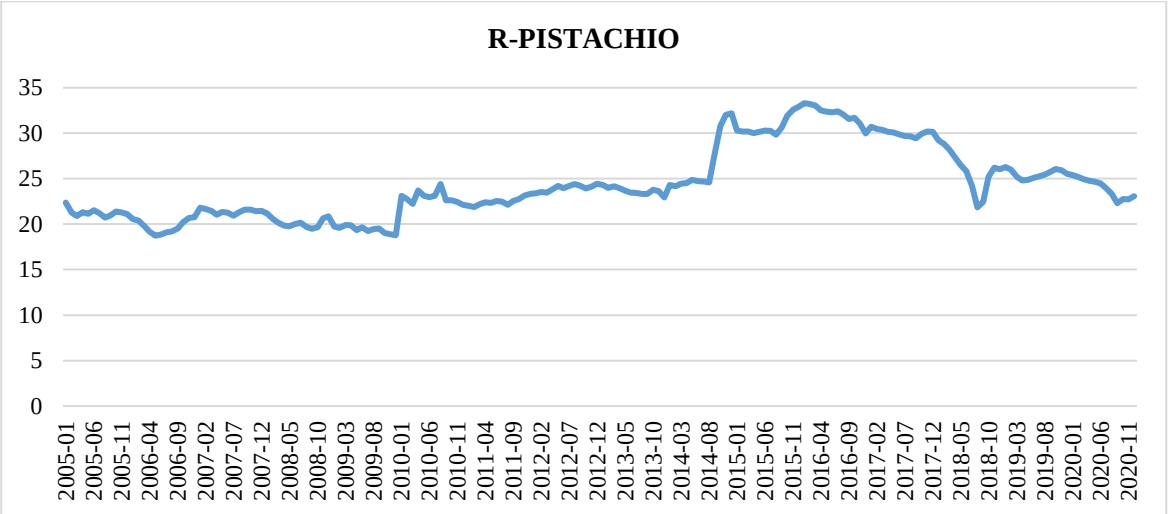

Fig. 3. Price volatility graph of real pistachio prices over time (TL/kg)
Source: [19].

When the maximum and minimum values were examined, the maximum values of the three markets were determined to be 41.84₺ for almonds, 47.43₺ for hazelnuts, and 23.06₺ for pistachios, respectively. distribution was not observed. In addition, the market price volatility clustering phenomenon clearly shows itself in the graphs of the return series in Figures 1, 2, and 3.

It is seen on the charts that there is price volatility in the markets. When Figure 1 is analysed in detail, the highest price volatility occurred between 2014-07 and 2016-07. The hazelnut market has a more active market than the almond market. While price volatility in the hazelnut market increased in 2010-01,2015-01,2018-01 and 2020-01, there was a decrease in prices in 2012-07 and 2017-01. Finally, when Figure 3 is observed in detail, it is noteworthy that the pistachio market exhibits less volatility than the other two markets, while the general level of prices in 2014-2015 increased, while there was a decrease in prices in the 2018-07 period.

Table 2. Results of the Stationarity Test of the Series*

Dickey-Fuller (ADF) Test Statistic						
	Extrinsic Variable: None		Extrinsic Variable: Constant		Exogenous Variable: Constant and Trend	
	t-statistic	possibility	t-statistic	possibility	t-statistic	possibility
r.almond	-8.821	0.000	-8.795	0.000	-8.769	0.000
r.hazelnut	-11.872	0.000	-11.842	0.000	-11.809	0.000
r.pistachio	-10.951	0.000	-10.923	0.000	-10.925	0.000

(1) The lag length for all series was chosen as 1 according to the Schwarz information criterion.
Source: *Calculated by author.

The results of the ADF unit root test applied for the series are given in Table 2. The series are based on constant and no-trend, only constant, and both constant and trend-containing regressions, respectively. As a result of the ADF tests, it was found that the series did not contain unit roots and were stationary.

In Table 3, under the BEKK-technique full rank constraint, the first three coefficients (C (1), C (2), and C (3)) show the long-term average of the respective markets. It shows the fluctuation caused by a shock that may occur in the variables, even if there is no variance and covariance effect. The first variable represents the almond market, the second variable represents the hazelnut market and the third variable represents the fresh pistachio market. Considering the average equation coefficients, the coefficients of all markets were found to be significant at the 1% significance level. First of all, a shock that may occur in the almond market causes fluctuations of 0.9% in the almond market, 1.7% in the hazelnut market, and 1.3% in the pistachio market, even if there is no variance and covariance pass-through. In a study, as a result of volatility transmission modelling on the determinants of agriculture, energy, and metal market risks in Brazil, it was found that US bond markets cause volatility in commodity markets [14]. In another study, which expresses the effect of volatility interaction between markets in the results obtained, the importance of the effect of interdependence between markets in the absence of a financial crisis is emphasized [8]. When the coefficients of variance equations are examined, C(4-15) ARCH and GARCH coefficients are C(4), C(7), C(8), C(9), C(10), C(11), C(12), C. (13), C(14) seems to be statistically significant (Table 3). The fact that the ARCH coefficients, which express the short-term uncertainty in the markets, are statistically significant, shows that the short-term shocks in the markets have a permanent effect. The fact that the coefficients giving the GARCH effect are statistically significant and at the same time the sum of the coefficients giving the ARCH and GARCH effect is greater than one, is an indication that shocks have a permanent effect in the short term and long term. Indeed, the correct determination of the relationship between the markets is very important for policymakers to make effective interventions on the spot [11].

The transformed coefficients of variance results are presented in Table 3. M from the covariance matrices shows the transition effect of the coefficient variables. M(1,1),M(2,2),M(2,3) and M(3,3) are statistically significant.

Table 3. Diagonal BEKK-GARCH (1,1) Analysis Results*

System:SYS04				
Prediction Method: ARCH Maximum Likelihood (Marquardt)				
Covariance Type: Diagonal BEKK				
	Coefficient	Standard error	z-statistic	Probability
C (1)	0.991698***	0.005960	166.3787	0.0000
C (2)	1.770028***	0.020101	88.05798	0.0000
C (3)	1.313004***	0.018341	71.58655	0.0000
Coefficient of Variance Equation				
C (4)	0.265069***	0.039465	6.716500	0.0000
C (5)	0.381899	0.691665	0.552145	0.5808
C (6)	0.613862	0.450049	1.363990	0.1726
C (7)	2.036634***	0.197065	10.33486	0.0000
C (8)	1.494834***	0.227192	6.579592	0.0000
C (9)	0.702245***	0.193440	3.630305	0.0003
C (10)	0.537893***	0.077690	6.923615	0.0000
C (11)	1.026156***	0.106573	9.628642	0.0000
C (12)	0.921288***	0.095599	9.636986	0.0000
C (13)	0.864643***	0.021822	39.62248	0.0000
C (14)	0.277561***	0.071933	3.858579	0.0001
C (15)	0.211410	0.078662	2.687574	0.0072
Log likelihood	-1252.785			
Akaike info criterion	13.27523			
Hannan-Quinn criter	13.37869			
Schwarz criterion	13.53065			
Covariance Type: Diagonal BEKK				
GARCH = M + A1*RESID(-1)*RESID(-1)'*A1 + B1*GARCH(-1)*B1				
M = full rank matrix, A1= diagonal matrix, B1= diagonal matrix				
Converted Coefficients of Variance				
	Coefficient	Standard error	z-statistic	Probability
M (1,1)	0.068349***	0.020062	3.406876	0.0007
M (1,2)	0.145481	0.191009	0.761644	0.4463
M (1,3)	0.141000	0.108294	1.302011	0.1929
M (2,2)	4.200261***	0.628376	6.684314	0.0000
M (2,3)	3.039001***	0.475235	6.394728	0.0000
M (3,3)	2.848040***	0.441610	6.449213	0.0000
A1(1,1)	0.282782***	0.078512	3.601774	0.0003
A1 (2,2)	1.029064***	0.209830	4.904276	0.0000
A1 (3,3)	0.834776***	0.174932	4.772000	0.0000
B1(1,1)	0.751591***	0.035850	20.96511	0.0000
B1 (2,2)	0.076243**	0.032903	2.317192	0.0205
B1 (3,3)	0.087944**	0.039121	2.247986	0.0246

*, ** and *** indicate the significance level at 10%, 5% and 1%, respectively.
Source: *Calculated by author.

A shock in the almond market increases the uncertainty in its market (M(1,1) = 0.068). A shock in the hazelnut market increases both the uncertainty in its market (M(2,2) = 4.200) and the uncertainty in the pistachio market (M(2,3) = 3.039). One of the covariance matrices M(3,3), a shock in the pistachio market also increases the uncertainty in its market (M(3.3) = 0.087). Similarly, it has been found that the conditional variance of the hazelnut yield is directly affected by its long-term shocks [4]. A1 and B1 coefficients show the ARCH and GARCH effect, and A1 coefficients indicate whether the short-term shocks of the said markets have a permanent effect, and B1 indicates the effect of long-term shocks. In this context, the coefficients A1(1,1), A(2,2), and A(3,3) were found to be statistically significant. Therefore, it has been determined that the short-term shocks in the almond, hazelnut, and pistachio markets have a permanent effect. When the B1(1,1), B(2,2),

and B(3,3) coefficients, which represent the persistence of long-term shocks, are examined in detail, the B(1,1) coefficient is statistically significant at the 1% significance level, B(2, 2) and B(3,3) were found to be statistically significant at the 5% significance level. On the other hand, when we look at the sum of the coefficients giving the ARCH and GARCH effect, it is seen that the ARCH and GARCH coefficients of the almond and hazelnut market (A1(1,1) + B1(1,1) =1,003), (A1(2,2)+B1(2,2)=1.09) indicates the persistence of short and long-term shocks that will occur in these two markets. However, the fact that the sum of ARCH and GARCH coefficients of the pistachio market (A1(3,3)+B1(3,3)=0.91) is less than one indicates that the shocks are not permanent for this market.

The price volatility of the returns of the almond, pistachio, and hazelnut markets over time is given in Figure 4. When the price volatility of the markets is analyzed simultaneously, a simultaneous increase was detected in the hazelnut and pistachio markets in 2010, while volatility was not determined in the almond market in the same year. While an increase was detected in the hazelnut and almond market in 2014, pistachio continued at the same level. Also, there was an increase in pistachio and almond prices in the 2015-01 period. While the excessive increase in almond prices was remarkable in 2016, it is noteworthy that the prices of hazelnut and pistachio remained at the same level.

Similarly, it was predicted that the effects of the slowdown in the economy would be felt relatively less in 2008 and 2009, but that agricultural prices would remain above the long-term averages [12]. The competitiveness of the product in international markets may also have an impact on price volatility. Indeed, the increase in export values and the decrease in the product supplied to the domestic market may also cause fluctuations in prices in the domestic market [1, 2].

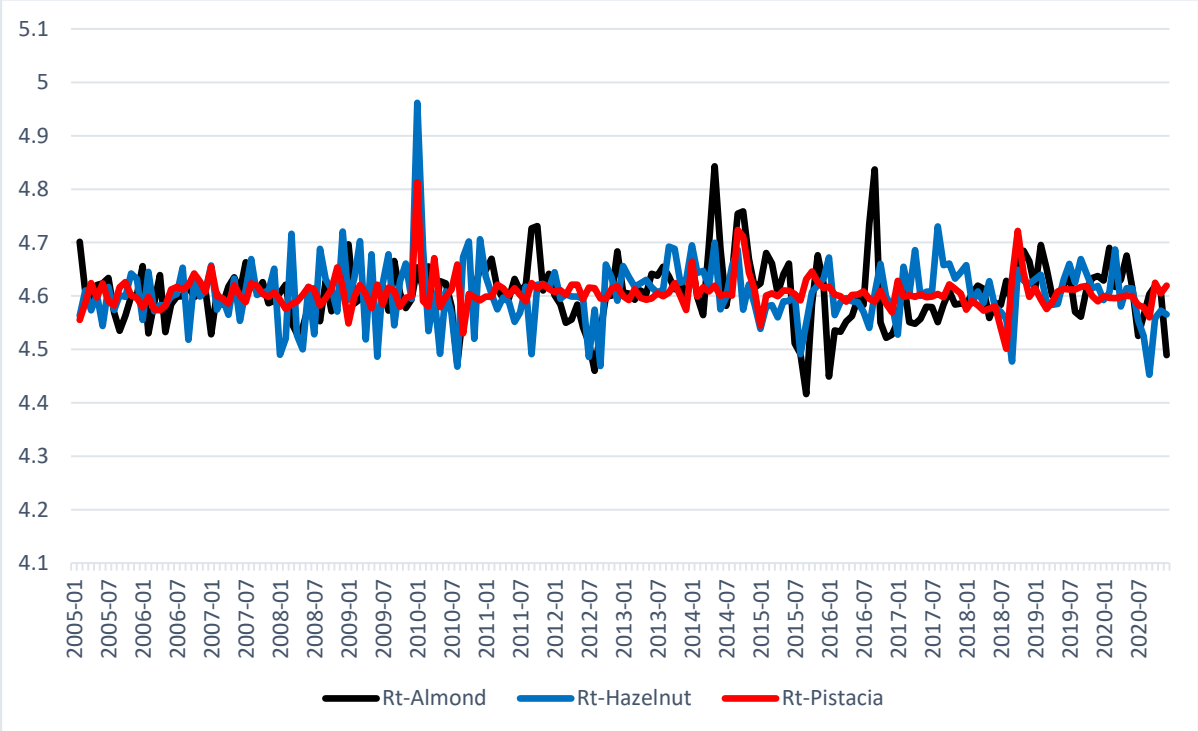

Fig. 4. Combined price volatility graph of yields over time (TL/month)*
Source: *Calculated by author.

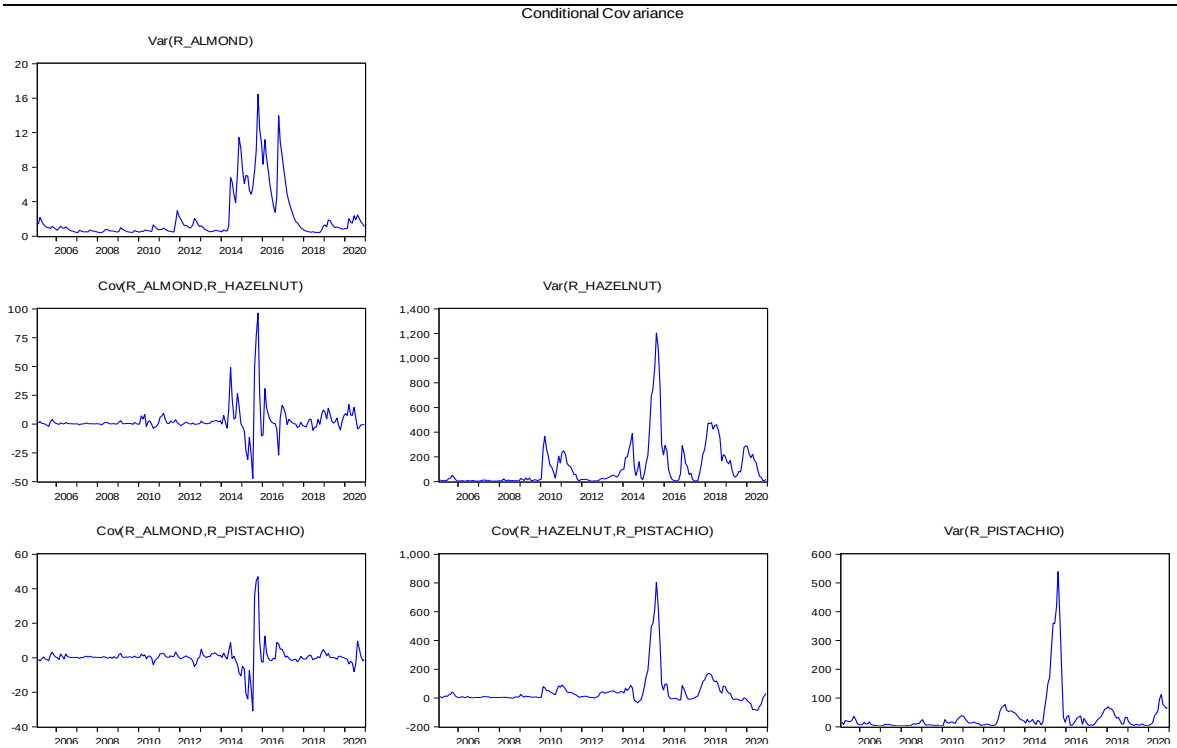

Fig. 5. Variance and conditional covariance graphs of data series*
Source: *Calculated by author.

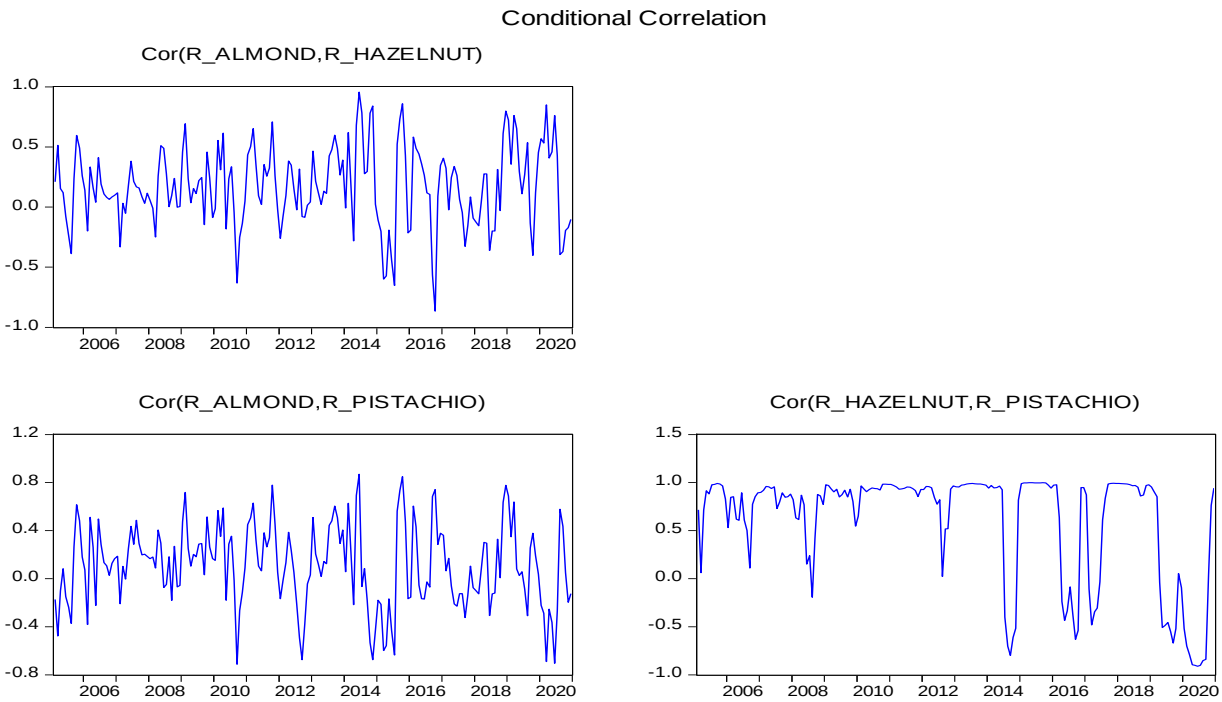

Fig. 6. Conditional correlation graphs of data series*
Source: *Calculated by author.

When the variance and conditional variance and conditional correlation graphs are examined, it is seen that the markets exhibited high volatility in 2010, 2014, 2015, 2016, and 2020 (Figures 5 and 6). This situation can be explained by the effect of the economic crisis in Turkey in the mentioned years. Beyond, the continuing effects of the world food crisis in 2010 and after, the economic crises, and the effects of the COVID-19 pandemic in 2019 affected the markets. The markets have negatively been affected by different factors such as climate change, drought, and the increase in input costs in recent years. These

may be shown as a few of the reasons for price volatility in the markets.

CONCLUSIONS

Price volatility in the almond, hazelnut and pistachio markets is clearly demonstrated using the Diagonal-Bekk Garch (1,1) model under the Full-rank constraint. Analysis results reveal that shocks in the almond market increase the uncertainty in its own market, while a shock in the hazelnut market increases the uncertainty both in its own market and in the pistachio market. In addition to these, it was revealed that a shock in the pistachio market increased the uncertainty in its own market. It has been determined that the shocks in the almond and hazelnut market are permanent in the short and long term, but the shocks in the pistachio market do not have a permanent effect in the short and long term. Agricultural price volatility and fluctuations in the markets in Turkey show parallelism with the world markets. There are many reasons for agricultural price fluctuations, such as the contraction in product supply due to the drought that has seriously affected the agricultural sector recently, and the increase in oil prices increasing the input costs in production. The necessity of creating a more stable market structure that will eliminate the uncertainties of these three markets, which have a significant share in the Turkish economy, is extremely important. It is recommended that policy makers responsible for the economy should primarily carry out studies that will increase productivity, improve marketing opportunities and ensure greater organization of the producer in order to eliminate price fluctuations. On the other hand, it is recommended both to implement policies for drought-resistant product diversification in order to prevent fluctuations in product supply caused by global climate change, and to monitor climate effects in the agricultural process for the sustainability of agricultural production. It is extremely important that policy makers provide support for producers with low income levels who will experience loss of real income as price fluctuations in the markets continue to be high in the medium and long term. Producers should be supported in order to guarantee production and reduce high price volatility. Finally, establishing strong systematic links between these markets will not only benefit the producers of the almond, hazelnut and pistachio markets, but also for national and international investors.

REFERENCES

[1]Aksoy, A., Kaymak, H.Ç., Avcıoğlu, Ü., 2020, Walnut (*Juglans regia* L.) trade: competition power of Turkey with Balkan countries. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 20(4):11-18.

[2]Aksoy, A., Kaymak, H.Ç., 2021, Competition power of Turkeys tomato export and comparison with Balkan countries. Bulgarian Journal of Agricultural Science, 27(2):253-258.

[3]Aşkan, E., Urak, F., Bilgiç, A., Dağdemir, V., 2018a, Determining the volatility in the conditional variances of hazelnut, gasoline real prices and exchange rates in Turkey: VECM BEKK MGARCH approach. International Agricultural Science Congress, Van, Türkiye, 9-12 May. P:131.

[4]Aşkan, E., Urak, F., Dağdemir, V., Bilgiç, A., 2018b, Estimating the volatility of the conditional variances of pistachio, gasoline real prices and exchange rates in Turkey with the VAR (1)-BEKK GARCH model. International Agricultural Science Congress,, Van, Türkiye, 9-12 May. pp.130.

[5]Du, X., Yu, C.L., Hayes, D.J., 2011, Speculation and volatility spillover in the crude oil and agricultural commodity markets, A Bayesian Analysis. Energy Economic, 33:497-503.

[6]Engle, R.F., 1982, Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. Econometrica: Journal of the econometric society, 987-1007.

[7]Engle, R.F., Kroner, K.F., 1995, Multivariate Simultaneous Generaliz ARCH. Econometric Theory, 11, 122-150.de

[8]Forbes, K. J., Rigobon, R.., 2002, No contagion, only interdependence: measuring stock market comovements. The journal of Finance 57(5):2223-2261.

[9]Gilbert, C. L., 2010, How to understand high food prices? J. Agric. Econ., 61:398-425.

[10]Hamadi, H., Bassil, C., Nehme, T., 2017, News surprises and volatility spillover among agricultural commodities: The case of corn, wheat, soybean and soybean oil. Research in International Business and Finance, 41:148–157.

[11]Ibragimov, R., Jaffee, D., Walden, J., 2011, Diversification disasters. Journal of financial economics, 99(2):333-348.

[12]Kıymaz, T., Saçlı, Y., Sektörler, İ., Müdürlüğü, K.G., 2008, Problems and suggestions in the prices of agricultural and food products. State Planning Organization General Directorate of Economic Sectors and Coordination Department of Agriculture, Publication number: 2767.
[13]Nazlioğlu, S., Erdem, C., Soytas, U., 2012, Volatility spillover between oil and agricultural commodity markets. Energy Economics, 36:658-665.
[14]Oliveira, F.A., Maia, S.F., de Jesus, D.P., Besarria, C.D.N., 2018, Which information matters to market risk spreading in Brazil? Volatility transmission modelling using MGARCH-BEKK, DCC, t-Copulas. The North American Journal of Economics and Finance, 45:83-100.
[15]Şahinli, M.A., 2021, Predicting and analyzing of Turkish sugar price with Arch, Garch, Egarch and Arima Methods. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 21(3):703-712.
[16]Şengül, S., Lopcu, K., 2018, The volatility of food prices in Turkey: an econometric approach. Cukurova University Journal of the Social Sciences Institute, 27(2):111-122.
[17]TEBGE, 2021, Agricultural products market pistachio, almond, hazelnut. https://arastirma.tarimorman.gov.tr/tepge/Menu/27/Tarim-Urunleri-Piyasalari, Accessed on Jan 11, 2022.
[18]Temel, O., Aksoy, A., 2020, Simultaneous model estimation of Turkey pistachio sector. YYU Journal of Agricultural Science, 30(1):80-89.
[19]TSI, 2022, Turkey Statistical Institute. https://biruni.tuik.gov.tr/medas/?kn=110&locale=tr, Accessed on Jan. 09, 2022.
[20]Urak, F., Bozma, G., Bilgiç, A., 2018, Estimating the volatility in the conditional variances of wheat, barley, gasoline real prices and exchange rates in Turkey with the VAR (1)-ASIMETRIC BEKK-GARCH (1, 1) model. Journal of Agriculture and Nature, 21(4):565-579.
[21]Von Braun, J., Torero, M., 2009, Implementing the Physical and Virtual Food Reserves to Protect the Poor and Prevent Market Failure. Washington, DC: International Food Policy Research Institute.