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EMPIRICAL ANALYSIS OF THE VOLATILITY EFFECT OF THE COVID-19 PANDEMIC PROCESS ON NATURAL GAS FUTURE TRANSACTIONS IN TURKEY

COVİD-19 PANDEMİ SÜRECİNİN TÜRKİYE'DE DOĞAL GAZ VADELİ İŞLEMLER ÜZERİNDEKİ VOLATİLİTE ETKİSİNİN AMPİRİK ANALİZİ

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Abstract

The aim of this study is to investigate the volatility movements in natural gas returns, which is one of the financial investment instruments in futures markets, before and after the Covid-19 pandemic, using GARCH family models. For this purpose, daily data from 30.08.2017 to 10.03.2020 before the Covid-19 Pandemic, and daily data from 11.03.2020 to 21.09.2021 after the Covid-19 Pandemic were used. The return on natural gas futures before the Covid-19 Pandemic was expressed as RLNPO and the return on natural gas futures after the Covid-19 Pandemic was expressed as RLNPS. For RLNPO, TGARCH was determined as the most suitable volatility model according to Schwarz Information Criteria, and EGARCH was determined as the most suitable volatility model for RLNPS. As a result of these analyzes, it has been seen that natural gas futures returns can be explained by asymmetric volatility models before and after the Covid-19 Pandemic, but there is no leverage effect as a result of asymmetric volatility, and positive shock asymmetries have a greater effect on volatility. The asymmetric effect tends to decrease in the post-Covid-19 Pandemic period.

Key Words: Covid-19 Pandemic, GARCH Family Models, Natural Gas Futures, Volatility
Jel Codes: C13, C58, D81

Öz

Bu çalışmanın amacı vadeli işlem piyasalarında finansal yatırım araçlarından biri olan doğal gaz getirilerinde Covid-19 Pandemisi öncesi ve sonrası dönemlerde oluşan volatilite hareketlerinin GARCH ailesi modellerinin kullanılarak araştırılmasıdır. Bu amaçla Covid-19 Pandemisi öncesi olarak 30.08.2017 tarihinden 10.03.2020 tarihine kadar günlük veriler, Covid-19 Pandemisi sonrası olarak da 11.03.2020 tarihinden 21.09.2021 tarihine kadar günlük veriler kullanılmıştır. Covid-19 Pandemisi öncesi doğal gaz vadeli işlemler getirisi RLNPO ve Covid-19 Pandemisi sonrası doğal gaz vadeli işlemler getirisi ise RLNPS olarak ifade edilmiştir. RLNPO için Schwarz Bilgi Kriterine göre en uygun volatilite modeli olarak TGARCH, RLNPS için en uygun volatilite

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modeli olarak EGARCH belirlenmiştir. Bu analizler sonucunda doğal gaz vadeli işlemler getirilerinin Covid-19 Pandemisi öncesinde ve sonrasında asimetrik volatilite modelleri ile açıklanabildiği, fakat asimetrik volatilite sonucunda kaldıraç etkisi olmadığı, oynaklık üzerinde daha büyük etkiye sahip pozitif şoklu asimetrilerin olduğu görülmüştür. Asimetrik etki Covid-19 Pandemisi sonrası dönemde ise azalma eğilimindedir.

Anahtar Kelime: Covid-19 Pandemi, GARCH Ailesi Modelleri, Doğal Gaz Vadeli İşlemler, Volatilite

Jel Kodları: C13, C58, D81

INTRODUCTION

The novel coronavirus, also known as the unofficially known as the Wuhan coronavirus, was first seen in the Wuhan region of China in early December 2019 and was identified by the authorities in this region, causing respiratory tract infection and is a contagious virus transmitted from person to person. The World Health Organization (WHO) has determined the official name of the virus as SARS-CoV-2 (Severe Acute Respiratory Syndrome-Coronavirus-2). The World Health Organization uses the term COVID-19 to describe the disease caused by the virus. On January 30, 2020, COVID-19 was declared a global health emergency by the World Health Organization and a global epidemic on March 11, 2020 (acibadem.com; Arslan & Şahin, 2022: 2).

The COVID-19 Pandemic has caused more suffering from other infectious diseases around the world than any other disease, and has significantly slowed down the entire world's economies. Travels were banned, workplaces were closed, and social isolation measures were taken within the scope of a series of measures taken by countries to prevent the COVID-19 Pandemic. These measures have brought many sectors of the economy to a standstill or even shut down. In this period, decreases were observed in the indicators of the basic economic and financial sectors (Duran & Acar, 2020: 55-57; Tekin, 2020: 337). As of October 1, 2022, the total number of cases announced around the world approached 623.2 million people and the death toll reached 6.6 million (Worldometer, 2022), in this period, it is seen that the COVID-19 epidemic threatens the economic stability of countries (Çetin, 2020: 344; Yetgin, 2020: 656; Gürsoy, Tunçel & Sayar, 2020: 2).

One of the important energy inputs in my economic life is natural gas. Interest in the use of natural gas is increasing in the world, and in this case, natural gas has become an important foreign trade product. Natural gas is bought and sold in the world stock markets through bilateral and multiple international agreements (Göral, 2015: 13). If a precise date for the start of pricing of natural gas in national and international markets can be established, it is April 1990, the NYMEX futures market start date based on Henry Hub (HH) trading center spot prices in the United States (Gürbüz & Erdem, 2021: 124).

During the Covid 19 Pandemic, there has been a contraction in sectors such as production, distribution, marketing and logistics in economic life. In addition, there have been differences in the returns offered to individual investors by the financial markets formed by spot and futures transactions. In particular, the determination of price and yield fluctuations (volatility) related to natural gas traded in the futures market has gained importance. Volatility spillover can be defined as the spread of volatility in one market to another. This interaction can be interpreted as risk contamination between markets under the influence of different economic fundamentals (Yağcılar, 2022: 472). In financial markets, volatility can be defined as the variance of the time series representing the return of financial assets. Volatility is basically a function of uncertainty. Volatility can be measured using the standard deviation or variance between the returns earned in the same security or market indices (Eraslan & Koç, 2022: 656).

VIOP was established on 21 December 2012. Initially, Equity Futures and Stock Option Contracts were traded, and on April 5, 2013, Index Options Contracts were traded. The risk-return relationship gained importance as investors began to evaluate their savings in the capital markets. In this context, the aim of investors is to minimize risks and maximize returns. Futures contracts are legal financial instruments that stipulate the delivery or receipt of a certain quality and quantity of a good or financial instrument at a future date at a price determined today. Futures contracts can be preferred because of their low transaction costs, leverage and high liquidity. It is important to determine the volatility spreads of futures contracts, which provide significant advantages for investors (Elçiçek & Kayalıdere, 2021: 204; Borsaistanbul.com).

Futures market transactions are more complex than spot market transactions. For this reason, mostly professional investors trade in these markets. Futures markets aim to minimize future price, interest and exchange rate risks to their participants and to provide an effective hedging against these systematic risks. The risks of change in economic, political and other environmental conditions that affect the efficiency of all investment instruments are expressed as systematic risk (Ürkmez, 2022: 405). Systematic risks are those that concern the entire economy and that the business management cannot intervene. Systematic risk, includes macro risks. Examples of systematic risks are currency risk, market risk, purchasing power risk, political risk and interest rate risk.

GARCH models that measure symmetrical responses are insufficient, especially since the volatility of financial return instruments used in emerging financial markets does not always give the same response to market information. For this, EGARCH and TGARCH models have been put forward to complete this missing aspect of the GARCH models (Kuzu, 2018: 611). There are also multivariate volatility models such as CCC-GARCH, DCC-GARCH, VEC-GARCH and BEKK-GARCH.

Knowing the volatility that may arise in the natural gas markets, which is one of the return instruments traded in the futures markets, is important in terms of the risks and decisions that portfolio managers, institutional and personal investors can take. The aim of this study is to investigate the volatility movements in natural gas returns, which is one of the financial investment instruments in futures markets, before and after the Covid-19 Pandemic, using GARCH family models. At the same time, using the model selection criteria as a result of the research, it is to reveal the best Autoregressive Conditional Variance Model that models the volatility in natural gas returns. It is thought that the findings to be obtained as a result of this study, which covers the global Covid-19 Pandemic epidemic process before and after 2020, will contribute to the literature.

1. LITERATURE REVIEW

Today, futures contracts gain more importance due to the globalization of trade, the increase in the variety of financial income instruments and the advancement of technological opportunities. In futures markets, investors aim to make a profit by predicting the future. Considering the studies in the literature, no study has been found that examines the volatility movements of natural gas futures returns in Turkey before and after the Covid-19 Pandemic. There are different studies in the literature on volatility analysis in the futures market. In these studies, volatility between futures market and bitcoin Kılıç (2022), volatility between futures and indices Kalaycı, Demir and Gök (2010), Özdemir (2020), Yağcılar (2022) and between futures and macroeconomic factors Elçiçek and Kayalıdere (2021) volatility relationships were examined.

Girma & Mougoue (2002) investigated the relationship between futures spread volatility, trading volume and open interest, using the GARCH model for oil futures contracts in NYMEX. As a result of the study, it was determined that the simultaneous and lagged trading volume gave significant results for the futures spread volatility, and that the lagged trading volume and open position were used simultaneously in the conditional variance equation and greatly affected the volatility.

Kalaycı, Demir & Gök (2010) examined the return volatility-traded volume relationship on the Index-30 futures contracts in the Futures and Options Exchange in their study. In the study, the E-GARCH model was used, and it was determined that the changes in the trading volume were one of the factors affecting the return volatility. At the same time, it was determined that the leverage effect was valid in the study. Negative shocks affect volatility more than positive shocks.

Gök and Kalaycı (2013) investigated the stability of spot markets after the start of index futures markets with the GARCH(1,1) model in their study. As a result of the study, it was determined that the spot markets did not move away from stability after index futures transactions.

In their study, Tian & Zheng (2013) investigated the effect of CSI 300 stock index futures in China on spot market volatility from the start date. In the study, the analysis was made with the GARCH (1,1) model, and as a result of the analysis, it was stated that the index futures caused a slight decrease in the spot market volatility and this had a positive effect.

Karthikeyan & Karthika (2016) investigated the effect of CNX Nifty index futures on CNX Nifty index volatility in India. The study covers the period between 1990 and 2015, before and after 2000, which is the starting year of index futures transactions. Famous closing prices were used in the study, and as a result of the analyzes made with the GARCH model, it was determined that index futures decreased the CNX Nifty index volatility.

In their study, Zhang & Liu (2018) investigated the spread between natural gas spot and futures prices traded on the New York Mercantile Exchange. As a result of the study, they determined a two-way causality between natural gas spot and futures prices with the non-linear VAR-BEK-GARCH method.

Özdemir (2020) investigated the return volatility effect of the VIX index on the futures contract based on the BIST 30 stock index and the BIST 30 stock index. In the study, daily data was used and the asymmetry determination of the volatility of the BIST30 index and BIST30 futures returns was estimated with the EGARCH model. As a result of the EGARCH model, it has been determined that there is a leverage effect in both return series.

Elçiçek & Kayalıdere (2021), in their study, investigated the macroeconomic factors affecting the VIOP 30 futures contract return, transaction volume and volatility. As a result of the stepwise regression analysis using monthly data, it has been determined that some macroeconomic variables affect the VIOP 30 futures contract return, transaction volume and volatility

Kılıç (2022) investigated the volatility relationship between bitcoin and the futures market with the DCC-GARCH model. As a result of the study, BIST30 determined that the volatility in gold and foreign exchange futures and bitcoin markets is permanent. He also stated that the volatilities formed are unidirectional and bidirectional.

In their study, Eraslan &Koç (2022) analyzed the volatility relationship and the direction of this relationship between stock indices and futures on which these indices are the underlying asset. The volatility relationship between BIST 30 index and BIST 30 index futures has been examined with GARC family methods. As a result of the study, a bidirectional volatility relationship between both markets has been determined.

Yağcılar (2022), in his study, analyzed the relationship between the spot market and the futures market, using daily data for BIST-30 index futures contracts and USD-TL futures contracts, based on the spot markets they are related to, and VAR-BEK-GARCH and VAR-DCC-GARCH. investigated with models. As a result of the study, it has been determined that the spot market leads the index and there is a bidirectional relationship in the foreign exchange market.

2. DATA AND DESCRIPTIVE STATISTICS

The aim of the study is to determine and model the volatility movements of natural gas futures contract returns, one of the financial return instruments traded on the futures exchange, before and after the Covid-19 Pandemic.. For this purpose, daily data from 30.08.2017 to 10.03.2020 before the Covid-19 Pandemic, and daily data from 11.03.2020 to 21.09.2021 after the Covid-19 Pandemic were used. Natural gas futures market data is obtained from https://www.investing.com/ website. All data are publicly available and their use does not require Ethics Committee approval or any special permission. The natural logarithm of the data was taken in order to minimize the measurement differences of the data of the returns used in the research.

RLNPO variable, natural gas futures yield before the Covid-19 Pandemic; The RLNPS variable, on the other hand, expresses the natural gas futures return after the Covid-19 Pandemic.

The returns (Rt) in the financial system are expressed in local currencies. The RLNPO and RLNPS returns investigated in the model are calculated as the first differences in the natural logarithms of the natural gas futures returns.

RLNPO=100*d (LNPO) RLNPS=100*d (LNPS)

Descriptive statistics about RLNPO and RLNPS return data are given in Table 1. When the results are examined, according to the Jaque-Bera test statistics for RLNPO, it is seen that the series is not normally distributed, the skewness value is negative, that is, the series is skewed to the left, and the kurtosis value is quite higher than the critical value of 3, that is, the series is pointed and leptokurtic (thick tail). It can be said that there is a distribution The average return is negative. The standard deviation is 2.79. Looking at the Jaque-Bera test statistic for RLNPS, the series is not normally distributed, the skewness value is negative, that is, the series is skewed to the left, and the kurtosis value is considerably higher than the critical value of 3, that is, the series has a pointed tip and shows a leptokurtic (thick tail) distribution. can be said. The average return is positive. The standard deviation is 4.28. Both return series have high Jarque-Bera and low probability values. For this, the variance properties showing the change around the mean as well as the mean of the RLNPO and RLNPS return series, and their volatility, which is a reflection of them, should be examined with non-normal distribution methods (ARCH – GARCH).

Table 1. Descriptive Statistics

	RLNPO	RLNPS
Mean	-0.062586	0.211410
Median	-0.077429	0.254345
Maximum	16.50638	19.79844
Minimum	-18.05452	-18.06609
Std. Dev.	2.797588	4.289195
Skewness	-0.089115	-0.070635
Kurtosis	9.878064	5.209080
Jarque-Bera	1315.644	136.1789
Probability	0.000000	0.000000
Observations	667	667

At this stage, it will be investigated whether ARCH effect exists in the series so that ARCH type models can be used in modeling RLNPO and RLNPS return series.

Figure 1. Graph of LNPS and LNPO Return Series

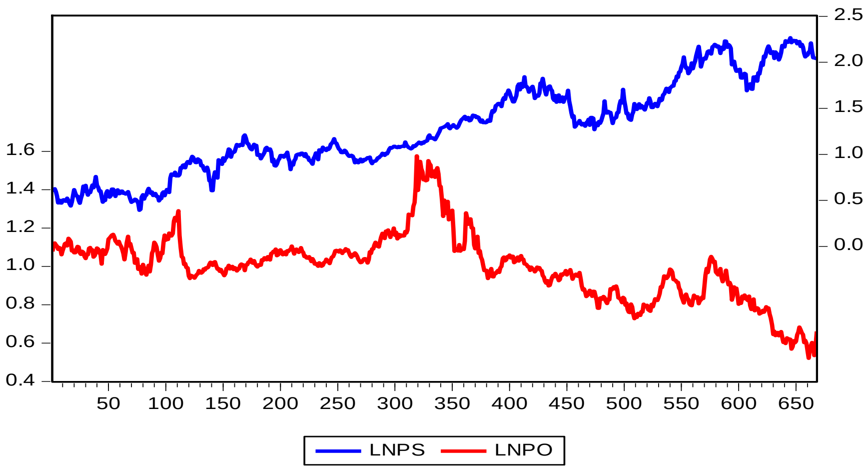

Figure 1 shows the movements of the natural gas futures return series at the I(0) level before the Covid-19 Pandemic (LNP0) and after the Covid-19 Pandemic (LNPS). The LNPO return series tended to decrease as the Covid-19 Pandemic approached its start date. The LNPS return series, on the other hand, shows an increasing trend from the start date.

Figure 2. Volatility Movements Chart of RLNPS and RLNPO Return Series

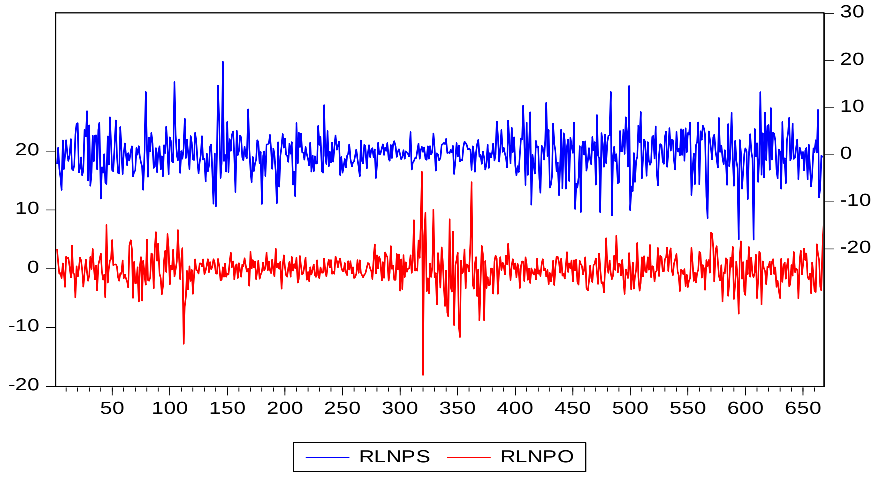

Figure 2 shows the volatility movements of the natural gas futures return series at the I(1) level before the Covid-19 Pandemic (RLNP0) and after the Covid-19 Pandemic (RLNPS). It is seen that big changes follow big changes and small changes follow small changes in return series. When Figure 2 is examined, it is seen that volatility movements generally follow each other, in other words, high fluctuations are followed by high fluctuations, and low fluctuations are followed by low fluctuations.

3. ECONOMETRIC METHOD

In the research, the stationarities of the RLNPO and RLNPS return series were analyzed with the ADF unit root test developed by Dickey and Fuller (1979, 1981). The concept of stationarity of the data forming the time series; The fact that it does not show a continuous increase or decrease in a certain time can be explained as a distribution along the horizontal axis over time. The mean and variance do not change in stationary series (Gujarati, 2003:797). In the study, the stationarity of the time series was analyzed with the ADF unit root test.

The unit root test developed by Dickey and Fuller (1981);

Simple Form:

$$\Delta Y_t = \gamma Y_{t-1} + u_t \tag{1}$$

Fixed Term State:

$$\Delta Y_t = \alpha_0 + \gamma Y_{t-1} + \text{u} \tag{2}$$

Fixed Term and Trending:

$$\Delta Y_t = \alpha_0 + \alpha_1 + \gamma Y_{t-1} + u_t \tag{3}$$

is displayed as.

By comparing the DF values found as a result of the tests with the MacKinnon critical values, the null hypothesis (H_0: $\gamma = 0$), is tested against the alternative hypothesis (H_1: $\gamma \neq 0$) (Dickey ve Fuller, 1979, 427-431). In the study, the stationarities of the time series were analyzed with the ADF unit root test developed by Dickey and Fuller (1979, 1981).

Volatility clustering is one of the important features of financial instrument returns. Because big changes in financial instrument returns are followed by big changes, and small changes are followed by small changes. The best modeling methods for this situation, which is described as volatility clustering, are the GARCH family models (Kılıç & Ayrçay, 2020: 181). These are the ARCH, GARCH, EGARCH and TGARCH models.

Engle (1982) stated that there is varying variance in the error terms of the time series, and for this reason, estimations of volatilities can be made with the autoregressive conditional variable variance (ARCH) model.

ARCH regression model proposed by Engle (1982) according to normality conditions:

$$y_t \mid \psi_{t-1} \sim N(x_t \beta, h_t) \tag{4}$$

$$h_t = \alpha_0 + \alpha_1 \epsilon_{t-1}^2 + \ldots + \alpha_p \epsilon_{t-p}^2 \quad (5)$$

$$\epsilon_t = y_t - x_t \beta, \quad (6)$$

Equation (5) shows the ARCH (p) process. In the ARCH model, h_t indicates the value of the conditional variance, the index p indicates the degree of ARCH process, and α the unknown parameter vector.

Although the ARCH model is simple, the fluctuation process is defined by a large number of parameters. Therefore, the problem of excessive parameters occurs. The solution of the excessive parameter problem encountered in the ARCH model was developed by Bollerslev (1986) with the GARCH (p,q) model. GARCH (p,q) model;

$$\epsilon_t \mid \psi_{t-1} : (0, h_t) \quad (7)$$

$$h_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i \epsilon_{t-i}^2 + \sum_{i=1}^{p} \beta_i h_{t-i} \quad (8)$$

is defined as. The pattern is specified by the ARMA (p,q) process.

The leverage effect is known as bad news about risky asset returns causing greater volatility in the future than good news. Conditional variance in the asymmetric model EGARCH model, which takes into account the leverage effect:

$$\log \sigma_t^2 = \omega + \beta \log(\sigma_{t-1}^2) + \gamma \frac{\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}^2}} + a \left| \frac{|\varepsilon_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right| \quad (9)$$

is expressed as. The presence of the asymmetric effect is measured with the γ coefficient, and if it is less than zero, it indicates that there is an asymmetric effect. The difference of the EGARCH model from the GARCH model is that it separates the effect of positive and negative shocks on volatility.

The effect of good and bad news is included in the Threshold GARCH (TGARCH) conditional equation of variance. The conditional variance equation developed independently of each other in this model

$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i \epsilon_{t-i}^2 + \gamma \epsilon_{t-i}^2 d_{t-1} + \sum_{j=1}^{p} \beta_j \sigma_{t-j}^2 \quad (10)$$

is in the form. In the model, the effect of good news is indicated by α, and the effect of bad news on the conditional variance (α + γ) (Kutlar & Torun, 2013). The impact of good and bad news is different. The effect of good news in the model is expressed as α and the effect of bad news in the model is expressed as α+λ. If λ > 0, negative shock asymmetry with greater effect on volatility is mentioned. It can be stated that there is a leverage effect. If λ < 0, there is a positive shock asymmetry that has a greater effect on volatility (Emeç & Özdemir, 2014: 89).

In the study, the volatility movements of the RLNPO and RLNPS return series were estimated using the traditional GARCH models, ARCH and GARCH models, and the ARCH models that take into account asymmetry, TGARCH and EGARCH models, after determining the average equation. The estimated alternative models were compared according to the predictive performance criteria and the most successful model was tried to be determined (Ertuğrul, 2019: 64).

4. EMPIRICAL FINDINGS

The Dickey Fuller (ADF) test was used to determine the stationarity of the RLNPO and RLNPS return series. Return series are statistically tested at constant, constant and trend levels. As a result of the unit root tests performed over the level value for the RLNPO and RLNPS return series, it is seen in Table 2 that the data are significant and stationary at the 1% significance level.

Table 2. Unit Root Test Results

	ADF UNIT ROOT TEST			
	Constant		Constant and Trend	
Variable	t-Statistic	Prob.	T-İstatistiği	Prob.
RLNPO	-20.27155	0.0000	-20.26950	0.0000
	ADF UNIT ROOT TEST			
Variable	Constant		Constant and Trend	
	t-Statistic	Prob.	T-İstatistiği	Prob
RLNPS	-27.16511	0.0000	-27.14548	0.0000

After determining that the RLNPO and RLNPS return series are stationary at the I(0) level, the results of the volatility analyzes of these series are given below. The analysis was performed separately for the RLNPO and RLNPS return series.

4.1. Volatility Results for RLNPO

After determining that the RLNPO return series is stationary, the mean equation needs to be estimated. In the process of determining the most appropriate ARMA (p,q) process for the RLNPO return series, the estimated models were compared according to the AIC value, and the ARMA Model (3,4) process was determined as the most appropriate and meaningful model. The estimation of the ARMA Model (3,4) for the RLNPO return series in the estimation made with the least squares method is shown in Table 3.

Table 3. ARMA Model (3,4) Average Model Results (Method: OLS)

Variables	**Coefficient**	**Stand. Error**	**t-Statistic**	**Prob. (p) Value**
C	-0.062734	0.112278	0.558739	0.5765
AR(1)	-0.913027	0.335332	-2.722756	0.0066
AR(2)	0.520098	0.607179	0.856580	0.3920

AR(3)	0.475711	0.296315	1.605424	0.1089
MA(1)	0.900623	0.335689	2.682906	0.0075
MA(2)	-0.64286	0.609572	-1.054611	0.2920
MA(3)	-0.45909	0.282422	-1.625576	0.1045
MA(4)	0.139654	0.041712	3.348084	0.0009
R^2	0.057863			
Adjusted R^2	0.035692			
Durbin-Watson stat	1.979483			
F-statistic	3.044349			
Prob. (F-S)	0.002271			

Since the F-Statistics probability value is significant in the mean model and the sum of the AR(3) and MA(4) coefficients is less than 1, the varying variance test should be performed for the existence of the ARCH effect. As seen in Table 4, the existence of the variable variance was accepted with the validity of the H_1 variable variance hypothesis at the 1% significance level, despite the H_0 hypothesis of no varying variance. In addition, since the Breusch-Godfrey LM test result for the existence of autocorrelation in the RLNPO return series was 0.5436, it was seen that there was no autocorrelation in the RLNPO return series.

Table 4. Heteroskedasticity Test: ARCH

F-statistic	1.191821	Prob. F(1,664)	0.0000
Obs*R-squared	1.013497	Prob. Chi-Square(1)	0.0000

Therefore, volatility movements in the RLNPO return series will be investigated with ARCH, GARCH, EGARC and TGARCH models that allow changing variance conditions.

Table 5. ARCH Model Mean and Equation of Variance Results

Variables	**Coefficient**	**Stand. Error**	**t-Statistic**	**Prob. (p) Value**
C	-0.130990	0.090091	-1.453.983	0.1460
AR(1)	-0.381782	0.399135	-0.956523	0.3388
AR(2)	-0.893919	0.082598	-1.082.250	0.0000
AR(3)	-0.431798	0.376898	-1.145.662	0.2519
MA(1)	0.374361	0.400834	0.933956	0.3503
MA(2)	0.820338	0.084759	9.678.498	0.0000
MA(3)	0.425965	0.370037	1.151.140	0.2497
MA(4)	-0.049706	0.036949	-1.345.258	0.1785
Variance Equation				
C	5.145.131	0.252538	2.037.368	0.0000
RESID(-1)^2	0.171429	0.022915	7.481.126	0.0000
Schwarz criterion	4.8166			
ARCH Test	0.0188			

In Table 5, it is seen that the coefficients in the mean equation in the ARCH model are not statistically significant except for AR(2) and MA(2). Since the sum of all coefficients in the mean equation is less than 1, the stationarity condition is satisfied. In the variance equation, the coefficients of RESID(-1)^2, which shows the ARCH effect with a fixed coefficient, are statistically significant. For the ARCH model to be valid, the stationarity condition must be met. For this, the coefficient of RESID(-1)^2 must be both statistically significant and greater than zero and less than 1. Since these conditions are met, the ARCH model becomes a valid model for volatility movements in the RLNPO return series. Shocks affect volatility at a rate of 0.1714 in general. Since the probability value was found as 0.0188 in the Heteroskedasticity Test performed to check whether the ARCH effect continues, it can be said that the existence of the ARCH effect continues.

Table 6. GARCH Model Mean and Equation of Variance Results

Variables	**Coefficient**	**Stand. Error**	**t-Statistic**	**Prob. (p) Value**
C	-0.070984	0.151294	-0.469183	0.6389
AR(1)	1.264455	0.390952	3.234295	0.0012
AR(2)	-0.204218	0.660461	-0.309206	0.7572
AR(3)	-0.420425	0.368034	-1.142354	0.2533
MA(1)	-1.284136	0.379211	-3.386.338	0.0007
MA(2)	0.129136	0.636086	0.203016	0.8391
MA(3)	0.590293	0.348449	1.694.062	0.0903
MA(4)	-0.085951	0.053698	-1.600.632	0.1095
Variance Equation				
C	4.968929	4.694175	1.058531	0.2898
RESID(-1)^2	0.029723	0.010485	2.834807	0.0046
GARCH(-1)	0.479723	0.470205	1.02.244	0.3076
Schwarz criterion	4.9592			

In Table 6, it is seen that the coefficients of all the variables in the mean equation in the GARCH model are not statistically significant. For the GARCH model to be valid, the coefficients of RESID(-1)^2 and GARCH(-1) must be statistically significant greater than zero and their sum must be less than 1. Since the GARCH(-1) coefficient is not statistically significant, the GARCH model is not a valid model for volatility movements in the RLNPO return series.

Table 7. EGARCH Model Mean and Equation of Variance Results

Variables	**Coefficient**	**Stand. Error**	**t-Statistic**	**Prob. (p) Value**
C	0.068877	0.079119	0.870546	0.3840
AR(1)	-0.33433	0.439087	-0.761427	0.4464
AR(2)	-0.87894	0.066886	-1.314098	0.0000
AR(3)	-0.47523	0.423831	-1.121282	0.2622
MA(1)	0.343001	0.434316	0.789750	0.4297
MA(2)	0.843620	0.054811	1.539136	0.0000
MA(3)	0.499455	0.419925	1.189390	0.2343
MA(4)	-0.04815	0.048015	-1.002.871	0.3159
Variance Equation				

C(9)	-0.153585	0.031070	-4.943150	0.0000
C(10)	0.224641	0.037127	6.050596	0.0000
C(11)	0.073890	0.018728	3.945435	0.0001
C(12)	0.991598	0.006437	1.540497	0.0000
Schwarz criterion	4.6476			
ARCH Test	0.2223			

In the EGARCH model, which explains the asymmetric effects on volatility in Table 7, it was seen that other coefficients were not statistically significant except for the AR(2) and MA(2) coefficients in the mean equation. The coefficient of C(11)*RESID(-1)/@SQRT(GARCH(-1)) which expresses the asymmetric effect and leverage effect in the variance equation is statistically significant. Therefore, there is an asymmetric and leverage effect in the EGARCH model. A positive sign of this parameter indicates that positive shocks increase volatility more than negative shocks. C(12) GARCH coefficient satisfies the conditions of stationarity and significance. Since the probability value was found as 0.2223 in the Heteroskedasticity Test performed at the stage of checking whether the ARCH effect continues, it can be said that the existence of the ARCH effect has disappeared.

Table 8. TGARCH Model Mean and Equation of Variance Results

Variables	**Coefficient**	**Stand. Error**	**t-Statistic**	**Prob. (p) Value**
C	0.015313	0.079955	0.191519	0.8481
AR(1)	0.435722	0.414493	1.051218	0.2932
AR(2)	-0.555372	0.372500	-1.490.931	0.1360
AR(3)	-0.453053	0.404866	-1.119.019	0.2631
MA(1)	-0.436129	0.407808	-1.069.447	0.2849
MA(2)	0.505999	0.346307	1.461.128	0.1440
MA(3)	0.519756	0.383181	1.356.425	0.1750
MA(4)	-0.059446	0.046543	-1.277.245	0.2015
		Variance Equation		
C	0.077826	0.041408	1.879496	0.0602
RESID(-1)^2	0.170932	0.030395	5.623655	0.0000
RESID(-1)^2*(RESID(1)<0)	-0.102630	0.030029	-3.417698	0.0006
GARCH(-1)	0.881669	0.020903	4.217928	0.0000
Schwarz criterion	4.6470			
ARCH Test	0.1137			

In Table 8, it is seen that the coefficients of all the variables in the mean equation in the TGARCH model, which explains the asymmetric effects on volatility, are not statistically significant. In the variance equation, all coefficients are statistically significant. The coefficient of RESID(-1)^2*(RESID(-1)<0), which is called gamma, which expresses the leverage effect with asymmetric effect in the model, is statistically significant. Therefore, there is an asymmetric and leverage effect in the TGARCH model. It can be stated that if the coefficient is negative, there is a positive shock asymmetry that has a greater effect on volatility. Since the probability value was found as 0.1137 in the Heteroskedasticity Test performed at the stage of checking whether the ARCH effect continues, it can be said that the existence of the ARCH effect has disappeared.

4.2. Volatility Results for RLNPS

After determining that the RLNPS return series is stationary, the mean equation needs to be estimated. In the process of determining the most appropriate ARMA (p,q) process for the RLNPS return series, the estimated models were compared according to the AIC value, and the ARMA Model (3,2) process was determined as the most appropriate and meaningful model. The estimation of the ARMA Model (3,2) for the RLNPS return series in the estimation made with the least squares method is shown in Table 9.

Table 9. ARMA Model (3.2) Average Model Results (Method: OLS)

Variables	**Coefficient**	**Stand. Error**	**t-Statistic**	**Prob. (p) Value**
C	0.212049	0.155787	1.361143	0.1739
AR(1)	-1.040736	0.037977	-2.740463	0.0000
AR(2)	-1.037900	0.037287	-2.783519	0.0000
AR(3)	-0.085949	0.035933	-2.391921	0.0170
MA(1)	1.002148	0.008855	1.131770	0.0000
MA(2)	0.991055	0.009332	1.061952	0.0000
R^2	0.033183			
Adjusted R^2	0.024394			
Durbin-Watson stat	2.005075			
F-statistic	3.775399			
Prob. (F-İ)	0.001051			

Since the F-Statistics probability value is significant in the mean model and the sum of the coefficients AR(3) and MA(2) is less than 1, the varying variance test should be performed for the existence of the ARCH effect. As seen in Table 10, the existence of the variable variance was accepted with the validity of the H_1 variable variance hypothesis at the 1% significance level, despite the H_0 hypothesis of no varying variance. In addition, since the Breusch-Godfrey LM test result for the presence of autocorrelation in the RLNPS return series was 0.1670, it was seen that there was no autocorrelation in the RLNPS return series.

Table 10. Heteroskedasticity Test: ARCH

F-statistic	5.283964	Prob. F(4,658)	0.0003
Obs*R-squared	2.063368	Prob. Chi-Square(4)	0.0004

Therefore, volatility movements in the RLNPO return series will be investigated with ARCH, GARCH, EGARC and TGARCH models that allow changing variance conditions.

Table 11. ARCH Model Mean and Equation of Variance Results

Variables	Coefficient	Stand. Error	t-Statistic	Prob. (p) Value
C	0.351397	0.121387	2.894844	0.0038
AR(1)	1.492140	0.047633	3.132605	0.0000
AR(2)	-0.849087	0.073642	-1.152991	0.0000
AR(3)	-0.068876	0.046015	-1.496820	0.1344
MA(1)	-1.587774	0.001970	-8.058082	0.0000
MA(2)	0.999479	0.002013	4.965303	0.0000
Variance Equation				
C	1.223737	0.580950	2.106441	0.0000
RESID(-1)^2	0.299063	0.058301	5.129634	0.0000
Schwarz criterion	5.816765			
ARCH Test	0.1169			

In Table 11, it is seen that the coefficients in the mean equation in the ARCH model are statistically significant, except for AR(3). Since the sum of all coefficients in the mean equation is less than 1, the stationarity condition is satisfied. In the variance equation, the coefficients of RESID(-1)^2, which shows the ARCH effect with a fixed coefficient, are statistically significant. In order for the ARCH model to be valid, the stationarity condition must be met. For this, the coefficient of RESID(-1)^2 must be both statistically significant and greater than zero and less than 1. Since these conditions are met, the ARCH model becomes a valid model for volatility movements in the RLNPS return series. Shocks affect volatility at a rate of 0.2990 in general. Since the probability value was found as 0.1169 in the Heteroskedasticity Test performed to check whether the ARCH effect continues, it can be said that the existence of the ARCH effect has disappeared..

Table 12. GARCH Model Mean and Equation of Variance Results

Variables	Coefficient	Stand. Error	t-Statistic	Prob. (p) Value
C	0.277737	0.279590	0.993372	0.3205
AR(1)	0.993053	1.097070	0.905186	0.3654
AR(2)	-0.275248	0.889111	-0.309577	0.7569
AR(3)	-0.008460	0.103515	-0.081728	0.9349
MA(1)	-1.050429	1.100896	-0.954159	0.3400
MA(2)	0.300792	0.949455	0.316806	0.7514
Variance Equation				
C	1.196338	8.008019	1.493925	0.1352
RESID(-1)^2	0.135278	0.104306	1.296932	0.1947
GARCH(-1)	0.585278	0.253445	2.309288	0.0209
Schwarz criterion	5.976537			

In Table 12, it is seen that the coefficients of all the variables in the mean equation in the GARCH model are not statistically significant. For the GARCH model to be valid, the coefficients of RESID(-1)^2 and GARCH(-1) must be statistically significant greater than zero and their sum must be less than 1. Since the RESID(-1)^2 coefficient is not statistically significant, the GARCH model is not a valid model for volatility movements in the RLNPS return series.

Table 13. EGARCH Model Mean and Equation of Variance Results

Variables	Coefficient	Stand. Error	t-Statistic	Prob. (p) Value
C	0.248332	0.017902	1.387180	0.0000
AR(1)	0.247990	0.559377	0.443332	0.6575
AR(2)	0.650304	0.534691	1.216224	0.2239
AR(3)	0.025788	0.037780	0.682575	0.4949
MA(1)	-0.304277	0.556629	-0.546643	0.5846
MA(2)	-0.691233	0.554877	-1.245740	0.2129
Variance Equation				
C(7)	-0.058054	0.014829	-3.914988	0.0001
C(8)	0.089614	0.018300	4.896950	0.0000
C(9)	0.033361	0.012060	2.766127	0.0057
C(10)	0.996371	0.003418	2.914809	0.0000
Schwarz criterion	5.699275			
ARCH Test	0.9030			

In the EGARCH model, which explains the asymmetric effects on volatility in Table 13, it was seen that other coefficients were not statistically significant except for the constant coefficient in the mean equation. The coefficient of C(9)*RESID(-1)/@SQRT(GARCH(-1)) which expresses the asymmetric effect and leverage effect in the variance equation is statistically significant. Therefore, there is an asymmetric and leverage effect in the EGARCH model. A positive sign of this parameter indicates that positive shocks increase volatility more than negative shocks. C(10) GARCH coefficient satisfies the conditions of stationarity and significance. Since the probability value was found as 0.9030 in the Heteroskedasticity Test performed at the stage of checking whether the ARCH effect continues, it can be said that the existence of the ARCH effect has disappeared.

Table 14. TGARCH Model Mean and Equation of Variance Results

Variables	Coefficient	Stand. Error	t-Statistic	Prob. (p) Value
C	0.250977	0.023094	1.086774	0.0000
AR(1)	0.596033	0.818615	0.728099	0.4666
AR(2)	0.307783	0.785739	0.391711	0.6953
AR(3)	0.042845	0.039361	1.088494	0.2764
MA(1)	-0.648832	0.818748	-0.792469	0.4281
MA(2)	-0.348076	0.816928	-0.426080	0.6700
Variance Equation				
C	0.050693	0.041020	1.235813	0.2165
RESID(-1)^2	0.064574	0.012971	4.978274	0.0000
RESID(-1)^2*(RESID(1)<0)	-0.020975	0.015477	-1.355246	0.1753
GARCH(-1)	0.945668	0.010140	9.326120	0.0000
Schwarz criterion	5.695238			
ARCH Test	0.7344			

In Table 14, it is seen that the coefficients of all the variables in the mean equation in the TGARCH model, which explains the asymmetric effects on volatility, are not statistically significant except for the constant coefficient. In the equation of variance, the coefficient of RESID(-1)^2*(RESID(-1)<0), which is called gamma, which expresses the asymmetric effect and leverage effect in the model, is not statistically significant. Therefore, there is no asymmetric and leverage effect in the TGARCH model. Since the RESID(-1)^2*(RESID(-1)<0) coefficient is not statistically significant, the TGARCH model is not a valid model for volatility movements in the RLNPS return series.

CONCLUSION

Investors who aim to maximize profits by using the instruments of the financial system do not prefer to invest under uncertainty conditions. Therefore, it is important for investors to determine the loss of earnings caused by catastrophic risks. Revealing the differences and similarities of the returns obtained from the financial system during the Covid 19 Pandemic with the returns obtained before the Covid 19 Pandemic will be preliminary information in the financial instrument return strategies to be taken for investors in such cases. For this purpose, knowing the volatility that may arise in the natural gas markets, which is one of the return instruments traded in the futures markets, is important in terms of the risks and decisions that portfolio managers, institutional and personal investors can take. In this study, volatility movements in natural gas returns, which is one of the financial investment instruments in futures markets, were investigated by using GARCH family models.

In the study, daily data from 30.08.2017 to 10.03.2020 before the Covid-19 Pandemic, and daily data from 11.03.2020 to 21.09.2021 after the Covid-19 Pandemic were used. Natural gas futures market data is obtained from https://www.investing.com/ website. In order to use ARCH type models in modeling RLNPO and RLNPS return series, the existence of ARCH effect in the series was investigated and it was determined that there was an ARCH effect. The volatility movements of the RLNPO and RLNPS return series were estimated using the traditional GARCH models ARCH and GARCH models, and the ARCH models TGARCH and EGARCH models, which take into account asymmetry, after determining the average equation. The estimated alternative models were compared according to the predictive performance criteria and the most successful model was tried to be determined.

When the volatility results for RLNPO are examined, it is seen that the ARCH model is a valid model for the volatility movements in the RLNPO return series, and the shocks affect the volatility by 0.1714 in general. Since the GARCH(-1) coefficient is not statistically significant, the GARCH model is not a valid model for volatility movements in the RLNPO return series. In the EGARCH model, which explains the asymmetric effects on volatility, the coefficient expressing the leverage effect and the asymmetric effect in the variance equation were statistically significant. The EGARCH model has an asymmetric and leverage effect and the positive sign of this parameter indicates that positive shocks increase volatility more than negative shocks. In the TGARCH model, which explains the asymmetric effects on volatility, the coefficient called gamma, which expresses the asymmetric effect and the leverage effect, was statistically significant. It can be stated that if the coefficient is negative, there is a positive shock asymmetry that has a greater effect on volatility. These results are consistent with the results of the study of Emeç & Özdemir (2014). According to the Schwarz Information Criteria, the most suitable volatility model was determined as the TGARCH model. Therefore, the effect of shocks in the natural gas futures market before the Covid-19 Pandemic on volatility was 17%, the effect of the previous period's volatility on the current period volatility was 88%, and the effect of positive shocks on volatility was 10%.

When the volatility results for the RLNPS are examined, it is seen that the ARCH model is a valid model for the volatility movements in the RLNPS return series, and the shocks affect the volatility by 0.2990 in general. Since the GARCH(-1) coefficient is not statistically significant, the GARCH model is not a valid model for volatility movements in the RLNPO return series. In the EGARCH model, which explains the asymmetric effects on volatility, the coefficient expressing the leverage effect and the asymmetric effect in the variance equation were statistically significant. The EGARCH model has an asymmetric and leverage effect and the positive sign of this parameter indicates that positive shocks increase volatility more than negative shocks. In the TGARCH model, which explains the asymmetric effects on volatility, the coefficient called gamma, which expresses the asymmetric effect and the leverage effect, was not statistically significant. The TGARCH model is not a valid model for volatility movements in the RLNPS return series. These results are consistent with the results of the study of Emeç & Özdemir (2014). According to the Schwarz Information Criteria, the most suitable volatility model was determined as the EGARCH model. Therefore, after the Covid-19 Pandemic, the effect of the previous period's volatility on the current period volatility in the natural gas futures market was 99%, and the effect of positive shocks on the volatility was 3%

As a result of these analyzes, it has been seen that natural gas futures returns can be explained by asymmetric volatility models before and after the Covid-19 Pandemic, but there is no leverage effect as a result of asymmetric volatility, and positive shock asymmetries have a greater effect on volatility. The asymmetric effect tends to decrease in the post-Covid-19 Pandemic period. The fact that investors trading in the natural gas futures market should consider these results will be effective in their investment decisions. In future studies, the return volatility that emerged before the Covid-19 Pandemic and in the post-Covid-19 Pandemic period can be examined on other financial return instruments.

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