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Article

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International Journal of Energy Economics and Policy

Provided in Cooperation with:
International Journal of Energy Economics and Policy (IJEEP)

Reference: Sabenova, Baltaim/Baubekova, Indira et. al. (2023). Comparative analysis of volatility structures of stock index and energy company returns in Kazakhstan. In: International Journal of Energy Economics and Policy 13 (2), S. 200 - 206.
https://econjournals.com/index.php/ijeep/article/download/14054/7201/32612.
doi:10.32479/ijeep.14054.

This Version is available at:
http://hdl.handle.net/11159/630181

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International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2023, 13(2), 200-206.

Comparative Analysis of Volatility Structures of Stock Index and Energy Company Returns in Kazakhstan

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Received: 10 January 2023 **Accepted:** 12 March 2023 **DOI:** https://doi.org/10.32479/ijeep.14054

ABSTRACT

Kazakhstan Stock Exchange (KASE) is established on November 17, 1993, with the participation of 23 leading Kazakh banks under the leadership of the National Bank of the Republic of Kazakhstan. KASE has had an important position in the country's economy since then. This study comparatively analyses the volatility structures of the return of the KASE Composite Index and the returns of the oil and energy companies traded in the KASE in the period between January 05, 2021 and January 04, 2023. The preliminary test (ARCH LM) showed that the volatility structure of the past period is effective on the current period in all four returns. Based on this finding, the structure of the series was evaluated with four different models. All four return series conformed with the GARCH-M (1, 1) model. Accordingly, the finding that oil and energy companies and the stock market composite index have the same volatility structure is important for investor decisions. Moreover, the finding that any past financial shock or volatility fluctuation affects the current return will positively affect the estimation of the future value of financial assets.

Keywords: Kazakhstan, KASE, Stock Return, Stock, Oil, Energy
JEL Classifications: C13, C20, C22

1. INTRODUCTION

Like the other former Soviet republics, Kazakhstan, after gaining its independence from the USSR in 1991, extensively restructured its economy to both recover its economy and integrate with global markets. During this period, the free market economy was adopted, most of the small and medium-sized enterprises were privatized and the banking sector is comprehensively reformed (Oskenbayev, 2011). Although it was painful, this period started to bear fruit in 2000 and Kazakhstan's economy began to boom. The basis of this success lies in the structural arrangements adopted, as well as the rich natural energy resources of Kazakhstan (Myrzabekkyzy et al., 2022; Bolganbayev et al., 2022).

On November 15, 1993, Kazakhstan's national money, Tenge was introduced. Soon after, on November 17, 1993, the Kazakhstan Stock Exchange (KASE) was founded with the participation of 23 leading Kazakh banks under the leadership of the National Bank of the Republic of Kazakhstan. KASE has had an important position in the country's economy since then. It is the only exchange where stock and foreign exchange transactions, which are an integral part of financial markets, can be carried out in Kazakhstan (https://kase.kz/en/history/). The largest shareholder of KASE is the National Bank of Kazakhstan with a 50.1% share, and KASE is responsible for regulating the national currency market of Kazakhstan. Like other developing country stock markets, KASE differs from the developed country stock markets in terms of its returns and volatility of the stocks traded in it (Bekaert and Harvey, 1997). For example, KASE, which lost 44% of its value in 2015, brought the highest profit in 2016 among developing country stock markets (Syzdykova, 2018).

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The concept of volatility was introduced to the literature by Markowitz (1952) with portfolio theory and has been used in many analysis models since then. Volatility is a concept that expresses the spread of all values that a variable can take and is defined as the statistical measurement of changes in the price of an asset traded in financial markets. Poon explained the concept of volatility in 2005 as the spread of all possible outcomes of an uncertain variable (Poon, 2005). Mandelbrot (1963) introduced the concept of volatility clustering. He stated that large fluctuations in financial series are followed by large fluctuations, and small fluctuations are followed by small fluctuations (Kazova and Ercan, 2021).

This study compares the volatility structures of the Kazakhstan stock market composite index (KASE) returns and the returns of oil and energy companies (KazTransOil JSC, KazAtomProm Kazakhstan National Atomic Organization, Kazakhstan Electricity Grid Operating Company) traded in the Kazakhstan stock exchange in the period between January 05, 2021 and January 04, 2023. Research data were obtained from https://tr.investing.com/(Access Date: January 04 2023).

2. LITERATURE REVIEW

There is a large literature consisting of a large number of studies on the economy of Kazakhstan. However, there are few studies on the Kazakhstan Stock Exchange (KASE). Here, we will only mention the significant ones.

Patra and Poshakwale (2006) investigated short-term asset changes and long-term equilibrium of various macroeconomic variables, including trade volume and stock returns, in the Greek Stock Market in the period 1990-1999. Their findings showed that there is a long-run equilibrium between the Athens stock market, inflation, money supply, trading volumes, and stock prices. They also observed that there is no short- and long-term equilibrium between interest rates and stock prices.

Oskenbayev et al. (2011) investigated the causality relationship between macroeconomic indicators and the KASE index in the 2001-2009 period. They determined the existence of cointegration between the series, indicating that the market efficiency hypothesis is violated, and they argued that their results are not only compatible with theory but also with practice. The long-term relationships of the series are examined using the boundary test approach within the framework of the Autoregressive Distributed Latency (ARDL) model. Tests (Johansen, Engel-Granger, and Granger) revealed that the main determinants of KASE are per capita income, inflation, and the exchange rate and dummy variables that explain the impact of the worldwide crisis. They also found that oil price fluctuations affect the stock index.

Yalçın (2015) analyzed the effects of oil price increases due to supply and demand shocks on the stock markets of Russia, Kazakhstan, and Ukraine using the structural VAR model in the period 2000:01-2013:07. The real returns of the world real economic activity index, world oil production, real crude oil prices, and closing prices of MICEX, KASE, and PFTS stock exchanges are analyzed monthly. The 2008 crisis is taken as a benchmark and differences are determined by comparing the periods before and after 2008.

Syzdykova (2017) analyzed the impact of oil price changes on KASE for January 2000-March 2017. Using the Johansen cointegration test, the research found a long-term relationship between the variables. In addition, the Granger causality test revealed a unidirectional relationship between oil prices and stock returns.

Syzdykova (2018) analyzed the relationship between five macroeconomic variables, namely the inflation rate, interest rate, exchange rate, industrial production index, and the KASE stock market index. This study proved that the changes in interest rate, industrial production index, exchange rate, CPI, and oil prices explain the KASE index by 62%. Moreover, it has been observed that oil price and exchange rate are statistically significant and affect the stock market negatively. It is determined that a 1% increase in oil prices decreased the stock market by 1.14%, while a 1% increase in the exchange rate decreases the stock market by 1.72%.

Syzdykova (2019), in his doctoral thesis, examined the effects of oil prices on the stock markets of developed and developing countries for January 2010-August 2018 using the panel data analysis method. The relationship between the stock market index and oil price changes in 23 developed and developing countries have been analyzed comparatively. Macroeconomic variables such as Brent crude oil prices, inflation, industrial production index, real effective exchange rate, and short-term interest rate are also included.

Öztürk and Altınöz (2019) analyzed the effects of US import duties on Chinese goods and China's import duties on US goods on the Shanghai Stock Exchange Composite Index for the period 1991-2016. They used China's main macroeconomic variables as control variables and used the ARDL boundary test. They found that increases in US import duties negatively affected the Shanghai stock market index in the long run. In addition, they determined that the M2 money supply and inflation rate have positive effects on the Stock Market Index. They concluded that the US-China trade war, waged with import duties imposed by the US on Chinese goods, damaged the Chinese stock market.

Gnahe (2020) analyzed the effects of macroeconomic variables on stock market returns in Kazakhstan. The analysis variables were quarterly indices, GDP, interest rate, inflation rate, exchange rate, and foreign direct investment from 2000 to 2019. Johansen cointegration test and Vector Error Correlation Model (VECM) showed that controlled inflation rates have a positive effect on stock returns, while high-interest rates have a negative effect. In addition, a negative relationship was found between exchange rates and stock market returns.

Gazel et al. (2022) analyzed the relationships between stock market index returns in Russia, Turkey, Kazakhstan, and Ukraine and selected macroeconomic variables such as GDP growth rate, inflation, exchange rate, imports, exports, and interest rates.

Quarterly data from 2009 to 2021 were used in the analysis with the panel regression model. They found that growth rates in Russia, Turkey, Kazakhstan, and Ukraine are the main determinants of price movements in stock market indices and that the growth rate has a positive and significant effect on the stock market index. They also found that increases in import and export transactions and increases in exchange rates affect index returns negatively.

3. METHODS

Estimation studies with models based on regression analysis assume constant variance. However, the variance does not remain constant due to shocks and fluctuations in financial time series such as stock returns, inflation, and exchange rates. This distorts the statistical properties (impartiality and efficiency) of estimators (Güriş and Çağlayan, 2013). Therefore, it is important to model the varying variance and volatility in the analysis of financial time series.

First, Engle (1982) developed the ARCH (Autoregressive Conditional Heteroskedasticity) model. Later, Bollersev (1986) developed the GARCH (Generalized Autoregressive Conditional Heteroskedasticity) model by including the effect of variance.

The mathematical expression of the models is as follows:

$$y_t \mid \Psi_{t-1} \sim\sim N\left(x_t \beta, h_t\right) \tag{1}$$

$$h_t = \left(\varepsilon_{t-1}, \varepsilon_{t-2}, \ldots, \varepsilon_{t-p}, \alpha\right) \tag{2}$$

$$\varepsilon_t = y_t - x_t \beta \tag{3}$$

Under the general notation, the ARCH (1) model is expressed by the following equation (Engle, 1982):

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 \quad \left(\alpha_0, \alpha_1 > 0 \quad , \quad \alpha_0 + \alpha_1 < 1\right) \tag{4}$$

And GARCH (1, 1) model is expressed by the following equation (Nelson and Cao, 1992).

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} \quad \left(\alpha_0, \alpha_1, \beta_1 > 0 \quad , \quad \beta_1 + \alpha_1 < 1\right) \tag{5}$$

ARCH-M (Autoregressive Conditional Heteroskedasticity in Mean) and GARCH-M (Generalized Autoregressive Conditional Heteroskedasticity in Mean) models add conditional variance or conditional standard deviation to the equation.

ARCH-M (1) model is expressed as:

$$y_t \mid \Psi_{t-1} \sim N\left(x_t \beta + \lambda \sqrt{h_t}, h_t\right) \tag{6}$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 \quad \left(\alpha_0, \alpha_1 > 0 \quad , \quad \alpha_0 + \alpha_1 < 1\right) \tag{7}$$

$$\varepsilon_t = y_t - x_t \beta - \lambda \sqrt{h_t} \tag{8}$$

(Merton, 1980).

GARCH-M (1, 1) model is expressed as:

$$y_t \mid \Psi_{t-1} \sim N\left(x_t \beta + \lambda \sqrt{h_t}, h_t\right) \tag{9}$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} \quad \left(\alpha_0, \alpha_1 > 0 \quad , \quad \alpha_0 + \alpha_1 < 1\right) \tag{10}$$

(Tsay, 2010).

In the evaluation of both ARMA (p, q) and autoregressive models, LL (Log Likelihood), SIC (Schwarz Info Criterion), and AIC (Akaike Info Criterion) criteria are taken into account. First, the model with the highest LL value, then the model with the lowest AIC and SIC value was selected.

4. DATA AND FINDINGS

This study aims to examine the volatility structure of the returns of oil and energy companies traded on KASE. The KASE index return is also included to assess the relative status of firms' return structures. Thus, four financial series were analyzed. Variable codes and descriptions are given in Table 1.

The selected analysis period is 489 trading days from 5.01.2021 to 4.01.2023. The data was taken from the website https://tr.investing.com/(Access Date: January 04 2023). The variable codes given in Table 1 are the ones used in the KASE.

Descriptive statistics are given in Table 2 and their changes over time are given in Graph 1. KZTO's average return is negative,

Table 1: Research variables

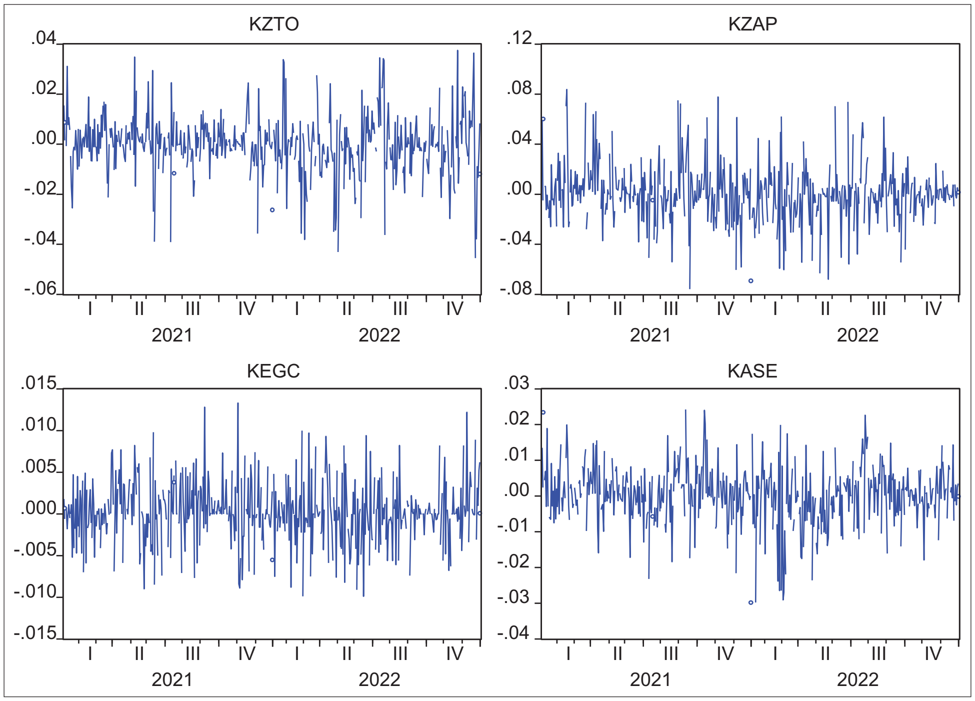
Variable code	Variable name
KZTO	KazTransOil JSC
KZAP	KazAtomProm Kazakhstan National Atomic Company
KEGC	Kazakhstan Electricity Grid Operating Company
KASE	Kazakhstan Stock Exchange Index

Table 2: Descriptive statistics of research variables

Statistics	KZTO	KZAP	KEGC	KASE
Mean	−0.00034	0.000642	0.000234	0.000335
Median	−0.0002	−0.0001	0.000000	0.000700
Maximum	0.037500	0.083700	0.013300	0.024200
Minimum	−0.0455	−0.0758	−0.0099	−0.030
SD	0.011981	0.023472	0.003753	0.008295
Skewness	−0.26134	0.359406	0.132405	−0.44903
Kurtosis	5.253270	4.908229	3.689794	4.556590
Sum	−0.16429	0.313953	0.114400	0.163767
Sum square deviation	0.070055	0.268850	0.006874	0.033577
Observations	489	489	489	489

KZTO: KazTransOil JSC, KZAP: KazAtomProm Kazakhstan National Atomic Company, KEGC: Kazakhstan Electricity Grid Operating Company, KASE: Kazakhstan Stock Exchange Index, SD: Standard deviation

Graph 1: Time path graph for research variables



while the average return of the other two firms and the KASE index is positive.

The stationarity of the series was examined with the ADF unit root test and the results are given in Table 3. The results showed that the series is stationary at the level.

To determine the ARCH effect, ARMA (p, q) models of the series were estimated and the results are given in Table 4. The appropriate model was selected according to the LL, AIC, and SIC criteria. In the second step, the ARCH effect was examined with the ARCHLM test. The ARCH effect was observed at the 5% significance level for all four series. Therefore, conditional variable variance models (ARCH and GARCH) were applied.

The heteroscedasticity findings obtained with four different models for the KASE index return series are given in Table 5. LL, AIC, and SIC criteria were examined comparatively and the best model was GARCH-M (1, 1). ARCH-LM test did not show any autocorrelation problem with varying variance in the models, and Ljung-Box-Q (LBQ) and Ljung-Box-Q2 (LB-Q2) tests applied to their residuals did not show autocorrelation problem. The findings show that the estimation values are statistically significant except for the conditional standard deviation, and the positivity condition is met. The insignificant conditional standard deviation value indicates that the GARCH-M (1, 1) model is not suitable for the KASE index. Therefore, GARCH (1, 1) model is deemed suitable for the KASE index according to the LL criterion. The fact that both ARCH (α) and GARCH (β) parameter estimates are positive and significant indicates the presence of both (the ARCH effect and GARCH effect) in the KASE index. This means that the shocks in the KASE index and the volatility of the previous period affect the current period.

Table 3: ADF unit root test findings for research series

Variable code	Level	
	t-statistics	P
KZTO	−18.56559	0.0000
KZAP	−21.17154	0.0000
KEGC	−27.43669	0.0000
KASE	−12.69107	0.0000
Test critical values (%) level		
1	−2.569719	
5	−1.941475	
10	−1.616263	

KZTO: KazTransOil JSC, KZAP: KazAtomProm Kazakhstan National Atomic Company, KEGC: Kazakhstan Electricity Grid Operating Company, KASE: Kazakhstan Stock Exchange Index

Table 4: Autoregressive moving average (P, *Q*) and autoregressive conditional heteroskedasticity effect test results for research variables

Variable code	Structure of time series	ARCH LM test results *F* (probability)
KZTO	ARMA (2, 0)	33.991 (0.000)
KZAP	ARMA (1, 1)	4.782 (0.029)
KEGC	ARMA (2, 1)	4.117 (0.043)
KASE	ARMA (2, 1)	13.191 (0.000)

KZTO: KazTransOil JSC, KZAP: KazAtomProm Kazakhstan National Atomic Company, KEGC: Kazakhstan Electricity Grid Operating Company, KASE: Kazakhstan Stock Exchange Index, ARMA: Autoregressive moving average, ARCH: Autoregressive conditional heteroskedasticity

The heteroscedasticity findings of four different models for the KEGC return series are given in Table 6. LL, AIC, and SIC criteria were compared and GARCH-M (1, 1) was selected as the best model. ARCH-LM test did not show any variable variance autocorrelation problem in the models, and Ljung-Box-Q (LBQ) and Ljung-Box-Q2 (LB-Q2) tests applied to their residuals did not show autocorrelation problems. The estimation values were statistically significant except for the conditional standard deviation, and the positivity condition is met. The insignificant conditional standard deviation value indicates that the GARCH-M (1, 1) model is not suitable for the KEGC return. Therefore, the GARCH (1, 1) model is deemed appropriate for the KEGC return according to the LL criterion. The fact that both ARCH (α) and GARCH (β) parameter estimates are positive and significant indicates the presence of both (the ARCH effect and GARCH effect) in the KEGC return. This means that the shocks in the KEGC return and the volatility of the previous period affect the current period.

The heteroscedasticity findings of four different models for the KZAP return series are given in Table 7. LL, AIC, and SIC criteria were compared and GARCH-M (1, 1) was selected as the best model. ARCH-LM test did not show any variable variance autocorrelation problem in the models, and Ljung-Box-Q (LBQ) and Ljung-Box-Q2 (LB-Q2) tests did not show autocorrelation problems. The estimation values were statistically significant except for the conditional standard deviation, and the positivity condition is met. The insignificant conditional standard deviation value indicates that the GARCH-M (1, 1) model is not suitable for the KZAP index. The insignificant conditional standard deviation value indicates that the GARCH-M (1, 1) model is not suitable for the KZAP index. Therefore, GARCH (1, 1) model is deemed suitable for the KASE index according to the LL criterion. The fact that both ARCH (α) and GARCH (β) parameter estimates are positive and significant indicates the presence of both (the ARCH effect and GARCH effect) in the KZAP return. This means that the shocks in the KZAP return and the volatility of the previous period affect the current period.

Table 5: Kazakhstan stock exchange autoregressive conditional heteroskedasticity and generalized autoregressive conditional heteroskedasticity model KE estimation findings for index return

Coefficients	ARCH (1)		GARCH (1, 1)		ARCH-M (1)		GARCH-M (1, 1)	
	Estimate	Probability	Estimate	Probability	Estimate	Probability	Estimate	Probability
Phi					0.546806	0.119	0.684378	0.106
Alpha 0	4.88E-05	0.000	1.82E-05	0.006	5.14E-05	0.000	1.92E-05	0.005
Alpha	0.253349	0.001	0.127581	0.016	0.193818	0.008	0.124723	0.021
Beta			0.581934	0.000			0.566407	0.000
ARCH-LM (*F*)	0.405275	0.525	0.149733	0.699	0.508317	0.476	0.187669	0.665
LL	1670.588		1672.722		1671.033		1673.776	
AIC	−6.83609		−6.84075		−6.83381		−6.84097	
SIC	−6.78449		−6.78055		−6.77361		−6.77217	

ARCH: Autoregressive conditional heteroskedasticity, GARCH: Generalized autoregressive conditional heteroskedasticity, LL: Log likelihood, AIC: Akaike ınfo criterion, SIC: Schwarz ınfo criterion

Table 6: Autoregressive conditional heteroskedasticity and generalized autoregressive conditional heteroskedasticity model estimation findings for Kazakhstan Electricity Grid Operating Company Return

Coefficients	ARCH (1)		GARCH (1, 1)		ARCH-M (1)		GARCH-M (1, 1)	
	Estimate	Probability	Estimate	Probability	Estimate	Probability	Estimate	Probability
Phi					0.319626	0.6102	−0.0157	0.9652
Alpha 0	9.27E-06	0.000	9.95E-07	0.0525	1.19E-05	0.000	1.00E-06	0.0519
Alpha	0.171429	0.0043	0.053174	0.0382	0.122963	0.0555	0.053259	0.0386
Beta			0.875262	0.000			0.874725	0.000
ARCH-LM (F)	1.567555	0.2112	0.34402	0.5578	0.144452	0.7041	0.327772	0.5672
LL	2037.79		2048.12		2043.192		2048.122	
AIC	−8.34411		−8.38242		−8.36218		−8.37832	
SIC	−8.2925		−8.32222		−8.30198		−8.30952	

ARCH: Autoregressive conditional heteroskedasticity, GARCH: Generalized autoregressive conditional heteroskedasticity, LL: Log likelihood, AIC: Akaike ınfo criterion, SIC: Schwarz ınfo criterion

Table 7: Autoregressive conditional heteroskedasticity and generalized autoregressive conditional heteroskedasticity model estimation findings for KazAtomProm Kazakhstan National Atomic Company return

Coefficients	ARCH (1)		GARCH (1, 1)		ARCH-M (1)		GARCH-M (1, 1)	
	Estimate	Probability	Estimate	Probability	Estimate	Probability	Estimate	Probability
Phi					−0.02817	0.9605	0.315788	0.5655
Alpha 0	5.65E-04	0.000	2.45E-04	0.0134	4.83E-04	0.000	2.37E-04	0.0122
Alpha	0.171637	0.0195	0.09991	0.0105	0.101643	0.014	0.099993	0.0121
Beta			0.443856	0.0302			0.457501	0.0208
ARCH-LM (F)	0.262044	0.609	1.36E-05	0.9971	0.00303	0.9561	0.002812	0.9577
LL	1143.409		1149.247		1147.827		1149.423	
AIC	−4.66561		−4.68544		−4.67962		−4.68206	
SIC	−4.62268		−4.63392		−4.6281		−4.62195	

ARCH: Autoregressive conditional heteroskedasticity, GARCH: Generalized autoregressive conditional heteroskedasticity, LL: Log likelihood, AIC: Akaike ınfo criterion, SIC: Schwarz ınfo criterion

Table 8: Autoregressive conditional heteroskedasticity and generalized autoregressive conditional heteroskedasticity model estimation findings for KazTransOil JSC return

Coefficients	ARCH (1)		GARCH (1, 1)		ARCH-M (1)		GARCH-M (1, 1)	
	Estimate	Probability	Estimate	Probability	Estimate	Probability	Estimate	Probability
Phi					−0.23269	0.241	−0.36589	0.1824
Alpha 0	9.88E-05	0.000	3.61E-05	0.000	9.55E-05	0.000	3.72E-05	0.000
Alpha	0.171433	0.000	0.265136	0.000	0.336846	0.000	0.254008	0.000
Beta			0.491654	0.000			0.486157	0.000
ARCH-LM (F)	0.356021	0.551	0.038561	0.8444	0.451073	0.5021	0.00217	0.9629
LL	1484.849		1499.399		1495.105		1503.002	
AIC	−6.08152		−6.13716		−6.11542		−6.14374	
SIC	−6.04712		−6.09416		−6.06382		−6.08354	

ARCH: Autoregressive conditional heteroskedasticity, GARCH: Generalized autoregressive conditional heteroskedasticity, LL: Log likelihood, AIC: Akaike ınfo criterion, SIC: Schwarz ınfo criterion

The heteroscedasticity findings of four different models for the KZTO return series are given in Table 8. LL, AIC, and SIC criteria were compared and GARCH-M (1, 1) was selected as the best model. ARCH-LM test did not show any variable variance autocorrelation problem in the models, and Ljung-Box-Q (LBQ) and Ljung-Box-Q2 (LB-Q2) tests applied to its residuals did not show autocorrelation problem. The estimation values were statistically significant except for the conditional standard deviation, and the positivity condition is met. The insignificant conditional standard deviation value indicates that the GARCH (1, 1) model is not suitable for the KZTO return. Therefore, GARCH (1, 1) model is deemed suitable for the KZTO return according to the LL criterion. The fact that both ARCH (α) and GARCH (β) parameter estimates are positive and significant indicates the presence of both (the ARCH effect and GARCH effect) in the KZTO return. This means that the shocks in the KZTO return and the volatility of the previous period affect the current period.

5. CONCLUSION AND RECOMMENDATIONS

This study examines the volatility structure of the returns of oil and energy companies traded on the Kazakhstan stock exchange and the return of the stock market composite index (KASE). The preliminary test (ARCH LM) showed that the volatility structure of the previous period affects the current period in all four returns. Based on this finding, the structure of the series was evaluated through four different models. Accordingly, it was concluded that all four return series conform with the GARCH-M (1, 1) model. The fact that oil and energy companies and the stock market composite index are in the same volatility structure is considered an important finding for investor decisions. In addition, knowing that any past financial shock or volatility fluctuation affects the current return will positively affect the estimation of the future value of the financial asset. According to the models in this study, the estimation of the future values of these assets can be taken as the subject of a future study.

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