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Comparative Analysis of the Volatility Structures of the Stock Prices of Energy Companies Traded on the Kazakhstan Stock Exchange and International Gold and Oil Prices

Zamzagul Sultanova[1], Galimzhan A. Pazilov[2], Lyailya Baibulekova[3], Gulzhakhan Kassymbekova[4], Gulnar Lukhmanova[5]*, Gulmira Issayeva[2], Kundyz Myrzabekkyzy[6]

[1]Zhangir Khan West Kazakhstan Agrarian-Technical University, Uralsk, Kazakhstan, [2]M. Auezov South Kazakhstan University, Shymkent, Kazakhstan, [3]Kenzhegali Sagadiyev University of International Business, Almaty, Kazakhstan, [4]Turan University, Almaty, Kazakhstan, [5]Zhetysu University named after I. Zhansugurov, Taldykorgan, Kazakhstan, [6]Khoja Akhmet Yassawi International Kazakh-Turkish University, Turkestan, Kazakhstan. *Email: g.k.lukhmanova@gmail.com

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ABSTRACT

The return of its stock exchange and the companies traded within are one of the important indicators for a national economy. Due to the global structure of stock markets, returns are closely related to both national and international market variables. This study makes a comparative analysis of the volatility structures of the energy companies traded in the Kazakhstan Stock Exchange (KASE) and the combined stock market index and gold and oil prices in international markets for the period between January 01, 2021 and June 31, 2023. The research focused on two issues. The first is the analysis of the volatility structure of the six series examined. For this purpose, four different models were examined. The second focus is to determine whether the returns in international indices have a causal effect on the Kazakhstan stock market (composite stock market index) and the returns of oil and energy companies traded in the stock market. The results revealed that other indices and returns have a similar variable variance structure, except for the KASE. The relevant coefficient estimation was found to be significant in both conditional standard deviation models for the KASE index. The coefficient estimate of the GARCH-M(1,1) model in the OIL index was significant, whereas conditional standard deviation models and the relevant coefficients of both conditional standard deviation models were found to be statistically insignificant in the other returns. This is an indication of the structural compatibility of Kazakhstan's stock market composite index and energy and oil companies with international markets. Furthermore, the causality analysis results showing that international indices have a causal effect on KASE and KZAP is another indicator that the Kazakhstan market works in harmony with the international markets.

Keywords: Kazakhstan, Kazakhstan Stock Exchange, Renewable Energy, Gold, Oil, Autoregressive Conditional Heteroskedasticity, Generalized Autoregressive Conditional Heteroskedasticity, Granger Causality
JEL Classifications: C13, C20, C22

1. INTRODUCTION

Kazakhstan gained its independence in 1991 with the disintegration of the USSR. Kazakhstan has carried out a series of structural reforms to integrate with world markets with a focus on developing its economy and ensuring the development and welfare of the country. Small and medium-sized enterprises were privatized and the banking sector was reformed during the transition to the free market economy (Oskenbayev et al., 2011). Although these structural changes in the economy caused many problems at first, Kazakhstan's economy started to recover and rise as of 2000. In addition to the success of structural reforms, Kazakhstan's natural energy resources (approximately 3% of the global oil reserves, 1.1% of the natural gas reserves, and 3% of the coal reserves) have also had a great impact (Xiong et al., 2015; Myrzabekkyzy et al., 2022; Bolganbayev et al., 2022; Bolganbayev et al., 2021; Kelesbayev et al., 2022b).

This process, in which countries such as Kazakhstan went through important structural reforms to integrate into world trade, is called the transition period or transition economy in the literature (Mashirova et al., 2023). One of the important steps Kazakhstan took in this transition period was the introduction of the Kazakhstan national currency, the Tenge, on November 15, 1993. The establishment of the Kazakhstan Stock Exchange (KASE) on 17 November 1993 is another important step in the transition to a free market economy (Zhussipova et al., 2023). KASE was established with the participation of 23 leading Kazakh banks under the leadership of the National Bank of the Republic of Kazakhstan and is the only exchange operating the stock and foreign exchange markets, which are an integral part of Kazakhstan's financial market infrastructure (https://kase.kz/en/history/). The largest shareholder of KASE, which is responsible for the organization of the national money market in Kazakhstan, is the National Bank of Kazakhstan with a 50.1% share. As in other developing country stock markets, KASE differs from developed country stock markets in terms of risk, return, and volatility (Bekaert and Harvey, 1997). For example, investors trading in KASE achieved the highest profit among emerging market stock markets in 2016, even though they lost 44% in 2015 (Syzdykova, 2018; Kelesbayev et al., 2022a; Bekzhanova et al., 2023).

The concept of volatility, which is defined as the range of all possible values of a variable, that is, the statistical measurement of changes in the price of an asset, was first introduced in Markowitz's (1952) portfolio theory study and has been used in many models since then. Mandelbrot (1963) introduced the concept of volatility clustering to the literature. Accordingly, large fluctuations in financial series are followed by large waves and small fluctuations are followed by small waves. Poon (2005) defined the concept of volatility as the range of all possible outcomes of an uncertain variable (Ayça, 2021; Sabenova et al., 2023).

Even though the whole world has turned to alternative energy sources due to environmental problems, oil continues to be the most important energy source for all countries although it is near depletion. Therefore, increases and decreases in oil prices can affect all economies and even lead to recession or expansion (Basher and Sadorsky, 2006). These rises and falls affect oil exporting and oil importing countries in different ways. This necessitates the oil prices in the world markets to be followed closely. Although sharp increases and decreases have been observed in the oil market since the 19th century, when oil began to be used as an energy source, the general trend is in the direction of increase. The underlying reason for these fluctuations is primarily the increase in demand and the problems in supply. Among the causes of supply shortages are political crises and wars (such as the 1973-1974 Arab-Israeli war, the 1979 Iranian revolution and the Iran-Iraq war that started after it, the 1990 Gulf war, the recent turmoil in Syria and the Ukraine War) (Nandha and Faff, 2008; Lee and Ni, 2002). Oil prices, which have been in a constant upward trend since the end of 1999, experience sudden increases and decreases due to the increase or decrease in oil supply due to global economic and political events (İşcan, 2010; Niyetalina, et al., 2023). The changes in crude oil prices in the last ten years are given in Table 1.

Gold has always been "the" precious metal throughout the known history of mankind. So it is regarded as one of the most important macroeconomic indicators and has continued to be the most reliable investment tool for centuries. The underlying reason is that it is used both as a reserve and a means of exchange. Therefore gold is an alternative to stock investment, especially in times of crisis (Ocakli, 2020). The gold price changes in the world markets in the last 10 years are given in Table 2.

2. LITERATURE REVIEW

The literature contains many studies on the price changes in oil and gold in the global markets, as well as stock markets. Although the number of studies on Kazakhstan, which has drawn attention with its rising economy after its independence, has increased, it is still limited. Here we will only give brief information about the relevant ones.

Oskenbayev et al. (2011) analyzed the causality between macroeconomic indicators and the KASE index in the 2001-2009 period. Their findings were not only compatible with theory but also with practice. They determined that the main determinants of KASE are per capita income, inflation, and the exchange rate

Table 1: Changes in the crude oil price in the last 10 years

Crude oil prices - Historical annual data						
Year	Average closing price ($)	Annual range ($)	Annual high ($)	Annual low ($)	Annual closing ($)	Annual change as %
2023	74.80	80.26	83.13	66.74	77.07	−4.27
2022	94.53	76.08	123.70	71.59	80.51	7.05
2021	68.17	47.62	84.65	47.62	75.21	55.01
2020	39.68	61.17	63.27	11.26	48.52	−20.64
2019	56.99	46.31	66.24	46.31	61.14	35.42
2018	65.23	60.37	77.41	44.48	45.15	−25.32
2017	50.80	52.36	60.46	42.48	60.46	12.48
2016	43.29	36.81	54.01	26.19	53.75	44.76
2015	48.66	52.72	61.36	34.55	37.13	−30.53
2014	93.17	95.14	107.95	53.45	53.45	−45.55
2013	97.98	93.14	110.62	86.65	98.17	6.90

Source: http://www.macrotrends.net/1369/crude-oil-price-history-chart (Access date: May 23, 2023)

Table 2: Changes in the gold price in the last 10 years

Gold prices - historical annual data						
Year	Average closing price ($)	Annual range ($)	Annual high ($)	Annual low ($)	Annual closing ($)	Annual change as %
2023	1935.50	1824.16	2053.13	1811.27	1960.84	7.48
2022	1801.87	1800.10	2043.30	1626.65	1824.32	−0.23
2021	1798.89	1946.60	1954.40	1678.00	1828.60	−3.51
2020	1773.73	1520.55	2058.40	1472.35	1895.10	24.43
2019	1393.34	1287.20	1542.60	1270.05	1523.00	18.83
2018	1268.93	1312.80	1360.25	1176.70	1281.65	−1.15
2017	1260.39	1162.00	1351.20	1162.00	1296.50	12.57
2016	1251.92	1075.20	1372.60	1073.60	1151.70	8.63
2015	1158.86	1184.25	1298.00	1049.60	1060.20	−11.59
2014	1266.06	1219.75	1379.00	1144.50	1199.25	−0.19
2013	1409.51	1681.50	1692.50	1192.75	1201.50	−27.79

Source: https://www.macrotrends.net/1333/historical-gold-prices-100-year-chart (Access date: May 23, 2023)

and dummy variables that explain the impact of the worldwide crisis by applying the Johansen Co-integration test, the Engel-Granger two-step approach, and the Granger causality tests. They also observed that fluctuations in oil prices affect the stock index.

Syzdykova (2017) analyzed the effect of oil prices on stocks traded in KASE for the period from January 2000 to March 2017. The study determined a long-run relationship between the variables using the Johansen co-integration test and a unidirectional relationship from oil prices to stock returns using the Granger causality test.

Syzdykova (2019) also examined the effects of oil prices on the stock markets of developed and developing countries for the January 2010-August 2018 period using the panel data analysis method in a doctoral thesis. They comparatively analyzed the relationship between the stock market index and oil price changes in 23 developed and developing countries. They found that oil price changes have a significant effect on the country's stock markets, that the effects in oil-importing countries differ from those in exporting countries, and that the stock markets of developing countries are affected more by the changes in oil prices compared to those of developed countries.

Sabenova et al. (2023) made a comparative analysis of the KASE composite index returns and the volatility structures of the returns of oil and energy companies traded in the Kazakhstan stock exchange for the period between January 05, 2021 and January 04, 2023. They determined that the past period volatility structure is effective in the current period, oil and energy companies and the stock market compound index are in the same volatility structure, which is an important finding for investors to decide, and that any financial shock or volatility fluctuation in the past has an effect on the current return.

Levin and Wright (2006) examined in detail the relationship between stock prices and gold prices in the USA between 1976 and 2005 and found a positive relationship between them.

Hussin et al. (2013) analyzed the effects of oil and gold prices on Islamic stock markets. They used the monthly data of the Malaysian Sharia Exchange from the period 2007 to 2011. They determined no long-term relationship between oil and gold prices and the stock market.

Basit (2013) analyzed stock returns, oil and gold prices using monthly data for the Pakistan Karachi Stock Exchange (KSE) from the period 2005 to 2011. He determined that oil prices and gold prices do not affect stock returns.

Bhunia (2013) analyzed the relationship between the Indian Stock Exchange stock index and oil and gold prices using monthly data for the period 1991-2012 and found a long-term and positive relationship between the variables. Using the causality test, he found a bidirectional relationship between oil prices and the stock index and a unidirectional relationship between the stock index and gold prices, but no causality relationship between oil and gold prices.

On the other hand, Khan et al. (2016) analyzed the relationship between oil prices, gold prices, and the KSE 100 stock index using monthly data from the Pakistani Karachi Stock Exchange (KSE) for the period 2000-2013. This research found a significant relationship between the variables, a positive relationship between oil prices and BSI 100, and a negative one between gold prices and BSI 100.

3. DATA AND ECONOMETRIC METHOD

This study comparatively analyses the volatility structures of energy companies traded in KASE and international gold and oil prices for the period between January 01, 2021 and June 31, 2023. Research data were retrieved from the website https://tr.investing.com/indices/(Accessed on August 10, 2023).

One of the basic assumptions in regression-based analyzes for the relationship or effect analysis between the variables is that the variance is constant. However, variance does not remain constant in financial time series due to local or global economic shocks. This problem disrupts the statistical properties of estimators such as unbiasedness and efficiency (Güriş and Çağlayan, 2013). Therefore, modeling of varying variance and volatility has become an important application area 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 adding the effect of variance.

The mathematical expression of the models is as follows:

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

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

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

The ARCH(1) model is expressed by the following equation (Engle, 1982):

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

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

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

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.

So ARCH-M(1) model is expressed by the following equation (Merton, 1980):

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

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

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

So GARCH-M(1,1) model is expressed by the following equation (Tsay, 2010):

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

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

LL (Log Likelihood), SIC (Schwarz information criterion), and AIC (Akaike info criterion) criteria were taken into consideration in evaluating the goodness of both ARMA (p,q) and autoregressive models. First the model with the highest LL value, then the model with the lowest AIC and SIC value was selected.

Causality analysis for econometric time series is an important research problem both for application and theoretical studies. Whether any variable has a causal effect on the other is examined by Granger causality analysis. Following the models used in this study, the matrix representation of the VAR model for bivariate and p-lagged Granger causality analysis is expressed as follows:

$$\begin{bmatrix} r_t^y \\ r_t^z \end{bmatrix} = \begin{bmatrix} \alpha_{10} \\ \alpha_{20} \end{bmatrix} + \begin{bmatrix} \alpha_{11}^1 & \alpha_{12}^1 \\ \alpha_{21}^1 & \alpha_{22}^1 \end{bmatrix} \begin{bmatrix} r_{t-1}^y \\ r_{t-1}^z \end{bmatrix} + \ldots + \begin{bmatrix} \alpha_{11}^p & \alpha_{12}^p \\ \alpha_{21}^p & \alpha_{22}^p \end{bmatrix} \begin{bmatrix} r_{t-p}^y \\ r_{t-p}^z \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \tag{11}$$

If all coefficients on the right are equal to zero, the lagged values of the variables are not the cause of Granger in the variable on the left (Sevüktekin and Nargeleçekenler, 2007).

4. FINDINGS

This study analyzes the returns of oil and energy companies traded in the Kazakhstan stock exchange, the stock market index, and the gold and oil indices. Brief descriptions of the series used in the study are given in Table 3. Data analysis focused on two issues. The first is the analysis of the volatility structure of the six series studied. For this purpose, four different models were examined. The second focus was to determine whether the returns in international indices have a causal effect on the Kazakhstan stock market (composite stock market index) and the returns of oil and energy companies traded in the stock market.

For the problem of varying variance, first, the ARMA structures of the series were analyzed and it was tested for a varying variance according to the obtained ARMA model. Following the test result, the variance problem was examined with four different models. For the causality analysis, first, the vector autoregressive (VAR) structure of the variable set consisting of six series was examined and Granger causality analysis was performed following this structure.

The explanatory statistics of the research series are given in Table 4. The mean is positive for all series and the median is negative only for the CRAP series. This shows that the shares of Kazakhstan energy companies move positively in line with the global oil and gold indices. In addition, the fact that the skewness coefficient for all series is in the range of $(-1,1)$ indicates that the series has a symmetrical structure.

The time path plots of the series are given in Graph 1. It shows that the volatility of the KZAP series has partially decreased in the 2023 period. In other series, volatility remained "similar" over the entire period.

The stationarity of the series was examined with the ADF unit root test and the results are given in Table 5. Results proved that all

Table 3: Research variables and definitions

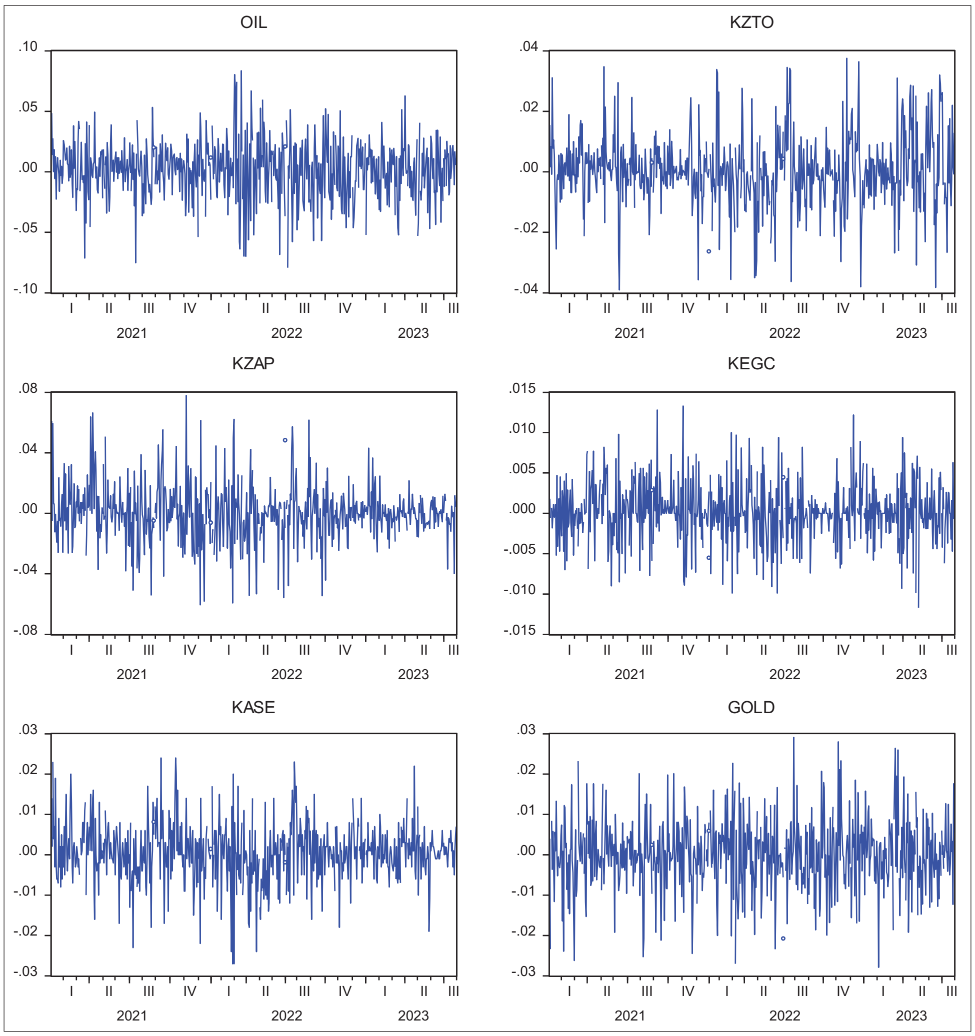
Variable	Definition
KZTO	KazTransOil JSC
KZAP	KazAtomProm Kazakhstan National Atomic Organization
KEGC	Kazakhstan Electricity Grid Operating Company
KASE	Kazakhstan Stock Exchange Composite Index
GOLD	Gold Price Index
OIL	Oil Price Index

Table 4: Descriptive statistical findings for research series

Statistics	OIL	KZTO	KZAP	KEGC	KASE	GOLD
Mean	0.001550	0.000396	0.000196	0.000183	0.000654	0.000108
Median	0.003250	0.000000	−0.0001	0.000000	0.001000	0.000200
Maximum	0.083500	0.037500	0.077800	0.013300	0.024000	0.029100
Minimum	−0.0793	−0.039	−0.0605	−0.0117	−0.027	−0.0279
SD	0.023822	0.011861	0.018717	0.003696	0.007293	0.008833
Skewness	−0.22298	0.054308	0.274290	0.035850	−0.21276	−0.06587
Kurtosis	3.831812	4.522746	5.194494	3.772143	4.478863	3.844530
Observations	610	610	610	610	610	610

OIL: Oil Price Index, KZTO: KazTransOil JSC, KZAP: KazAtomProm Kazakhstan National Atomic Organization, KEGC: Kazakhstan Electricity Grid Operating Company, KASE: Kazakhstan Stock Exchange Composite Index, GOLD: Gold Price Index

Graph 1: Time path plot for research variables



series are stationary at level. In line with the findings, the series are used without taking the difference in the analysis.

To determine the ARCH effect, ARMA (p, q) models of the series were estimated and the results are given in Table 6. The appropriate model was selected according to LL, AIC, and SIC criteria. In the second step, the ARCH effect was examined with the ARCH-LM test. There was an ARCH effect at the 5% significance level for all six series. Thus, conditional variable variance models (ARCH and GARCH) were applied.

The varying variance findings obtained with four different models for the OIL index return series are given in Table 7. The comparative examination of LL, AIC, and SIC criteria proved GARCH-M(1,1) to be the best model. Furthermore, there was no autocorrelation problem with varying variance in the models according to the ARCH-LM test, and according to the Ljung-Box-Q (LBQ) and Ljung-Box-Q2 (LB-Q2) tests applied to the residuals. The findings showed that the estimation values are statistically significant, except for the conditional standard deviation ARCH-M(1,1) model, and the estimation values met the positivity condition. The insignificance of the conditional standard deviation value indicates that the ARCH-M(1) model is not suitable for the OIL index. Therefore the GARCH-M(1,1) model was not appropriate for the OIL 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 effects (ARCH effect and GARCH effect) in the OIL index. In other words, the shocks experienced by the KASE index and the volatility of the previous period affect the current period.

The heteroscedasticity findings obtained with four different models for the GOLD index return series are given in Table 8. The comparative examination of LL, AIC, and SIC criteria proved GARCH-M(1,1) to be the best model. Also, there was no autocorrelation problem with varying variance in the models according to the ARCH-LM test and no autocorrelation problem according to the Ljung-Box-Q (LBQ) and Ljung-Box-Q2 (LB-Q2) tests applied to the residuals. Findings showed that the estimation values are statistically significant, except for the conditional standard deviation, and the estimation values met the condition of positivity. The insignificance of the conditional standard deviation value indicates that the ARCH-M(1) and GARCH-M(1,1) models are not suitable for the GOLD index. For this reason, the GARCH(1,1) model is appropriate for the GOLD index according to the LL criterion. Both ARCH (α) and GARCH (β) parameters are positive and significant, this indicates the presence of both effects (ARCH effect and GARCH effect) in the GOLD index. In other words, the shocks experienced by the GOLD index and the volatility of the previous period affect the current period.

The heteroscedasticity findings of four different models for the KASE index return series are given in Table 9. The comparative examination of LL, AIC, and SIC criteria proved GARCH-M(1,1) to be the best model. In addition, there was no autocorrelation problem with varying variance in the models according to the ARCH-LM test and no autocorrelation problem according to the Ljung-Box-Q (LBQ) and Ljung-Box-Q2 (LB-Q2) tests applied to the residuals. Findings showed that the estimation values are statistically significant, and the estimation values met the condition of positivity. Therefore, according to the LL criterion, the GARCH-M(1,1) model is appropriate for the KASE index. Both ARCH (α) and GARCH (β) parameters are positive and significant, this indicates the presence of both effects (ARCH effect and GARCH effect) in the KASE index. In other words, the shocks experienced by the KASE index and the volatility of the previous period affect the current period.

The heteroscedasticity findings of four different models for the KEGC index return series are given in Table 10. The comparative examination of LL, AIC, and SIC criteria proved GARCH-M(1,1) to be the best model. In addition, there was no autocorrelation problem with varying variance in the models according to the ARCH-LM test and no autocorrelation problem according to the Ljung-Box-Q (LBQ) and Ljung-Box-Q2 (LB-Q2) tests applied to the residuals. Findings showed that the estimation values are statistically significant, except for the conditional standard deviation, and the estimation values met the condition of positivity. The insignificance of conditional standard deviation value indicates that the ARCH-M(1) and GARCH-M(1,1) models are inappropriate for the KEGC index. Therefore, according to the LL criterion, the GARCH-M(1,1) model is appropriate for the KEGC

Table 5: ADF unit root test findings for research series

Variable code	t-statistics	P-value
GOLD	−24.93251	0.0000
OIL	−24.15516	0.0000
KASE	−15.07341	0.0000
KEGC	−32.04023	0.0000
KZAP	−23.72581	0.0000
KZTO	−13.67478	0.0000
Test critical values		
1% level		−3.440876
5% level		−2.866075
10% level		−2.569244

ADF: Augmented Dickey Fuller, GOLD: Gold Price Index, OIL: Oil Price Index, KASE: Kazakhstan Stock Exchange Composite Index, KEGC: Kazakhstan Electricity Grid Operating Company, KZAP: KazAtomProm Kazakhstan National Atomic Organization, KZTO: KazTransOil JSC

Table 6: ARMA (p, q) and ARCH effect test results for research variables

Variable code	Structure of time series	ARCH LM test results F (Prob.)
GOLD	ARMA (2,2)	6.499 (0.011)
OIL	ARMA (2,2)	6.866 (0)
KASE	ARMA (1,1)	2.181 (0.043)
KEGC	ARMA (2,2)	5.442 (0.005)
KZAP	ARMA (1,1)	2.67 (0.015)
KZTO	ARMA (0,0)	3.655 (0.001)

ARCH: Autoregressive Conditional Heteroskedasticity, GOLD: Gold Price Index, OIL: Oil Price Index, KASE: Kazakhstan Stock Exchange Composite Index, KEGC: Kazakhstan Electricity Grid Operating Company, KZAP: KazAtomProm Kazakhstan National Atomic Organization, KZTO: KazTransOil JSC

Table 7: OIL index return estimations of ARCH and GARCH models

Coefficients	ARCH (1)		GARCH (1,1)		ARCH-M (1)		GARCH-M (1,1)	
	Estimate	Prob.	Estimate	Prob.	Estimate	Prob.	Estimate	Prob.
Phi					0.0648	0.1041	0.0903	0.0295
Alpha 0	0.0005	0.0000	0.0000	0.0243	0.0005	0.0000	0.0000	0.0193
Alpha	0.0955	0.0423	0.0957	0.0015	0.0955	0.0430	0.0988	0.0014
Beta			0.8388	0.0000			0.8399	0.0000
LL	1417.6150		1435.3710		1418.9120		1437.9630	
AIC	−4.6338		−4.6886		−4.6347		−4.6938	
SIC	−4.6193		−4.6669		−4.6131		−4.6649	

OIL: Oil Price Index, ARCH: Autoregressive Conditional Heteroskedasticity, GARCH: Generalized Autoregressive Conditional Heteroskedasticity, ARCH-M: Autoregressive Conditional Heteroskedasticity in Mean, GARCH-M: Generalized Autoregressive Conditional Heteroskedasticity in Mean, LL: Log Likelihood, AIC: Akaike info criterion, SIC: Schwarz information criterion index. Both ARCH (α) and GARCH (β) parameters are positive and significant, this indicates the presence of both effects (ARCH effect and GARCH effect) in the KEGC index. In other words, the shocks experienced by the KEGC index and the volatility of the previous period affect the current period.

The heteroscedasticity findings of four different models for the KZAP index return series are given in Table 11. The comparative examination of LL, AIC, and SIC criteria proved GARCH-M(1,1) to be the best model. In addition, there was no autocorrelation problem with varying variance in the models according to the ARCH-LM test and no autocorrelation problem according to the Ljung-Box-Q (LBQ) and Ljung-Box-Q2 (LB-Q2) tests applied to the residuals. Findings showed that the estimation values are statistically significant, except for the conditional standard deviation, and the estimation values met the condition of positivity.

Table 8: GOLD index return estimations of ARCH and GARCH models

Coefficients	ARCH (1)		GARCH (1,1)		ARCH-M (1)		GARCH-M (1,1)	
	Estimate	Prob.	Estimate	Prob.	Estimate	Prob.	Estimate	Prob.
Phi					0.0100	0.8043	0.0105	0.7973
Alpha 0	0.0001	0.0000	0.0000	0.4114	0.0001	0.0000	0.0000	0.4099
Alpha	−0.0112	0.7029	0.0269	0.2723	−0.0106	0.7202	0.0269	0.2760
Beta			0.7780	0.0022			0.7762	0.0024
LL	2023.2500		2024.5600		2023.2810		2024.5940	
AIC	−6.6162		−6.6172		−6.6130		−6.6141	
SIC	−6.6018		−6.5955		−6.5914		−6.5852	

ARCH: Autoregressive Conditional Heteroskedasticity, GARCH: Generalized Autoregressive Conditional Heteroskedasticity, ARCH-M: Autoregressive Conditional Heteroskedasticity in Mean, GARCH-M: Generalized Autoregressive Conditional Heteroskedasticity in Mean, LL: Log Likelihood, AIC: Akaike info criterion, SIC: Schwarz information criterion

Table 9: KASE index return estimations of ARCH and GARCH models

Coefficients	ARCH (1)		GARCH (1,1)		ARCH-M (1)		GARCH-M (1,1)	
	Estimate	Prob.	Estimate	Prob.	Estimate	Prob.	Estimate	Prob.
Phi					0.0810	0.0364	0.0920	0.0355
Alpha 0	0.0000	0.0000	0.0000	0.0112	0.0000	0.0000	0.0000	0.0127
Alpha	0.2148	0.0001	0.1156	0.0004	0.2136	0.0001	0.1130	0.0004
Beta			0.7485	0.0000			0.7584	0.0000
LL	2146.8030		2154.2790		2148.9010		2156.8790	
AIC	−7.0206		−7.0418		−7.0242		−7.0471	
SIC	−7.0062		−7.0202		−7.0025		−7.0182	

KASE: Kazakhstan Stock Exchange, ARCH: Autoregressive Conditional Heteroskedasticity, GARCH: Generalized Autoregressive Conditional Heteroskedasticity, ARCH-M: Autoregressive Conditional Heteroskedasticity in Mean, GARCH-M: Generalized autoregressive conditional heteroskedasticity in mean, LL: Log Likelihood, AIC: Akaike info criterion, SIC: Schwarz information criterion

Table 10: KEGC index return estimations of ARCH and GARCH models

Coefficients	ARCH (1)		GARCH (1,1)		ARCH-M (1)		GARCH-M (1,1)	
	Estimate	Prob.	Estimate	Prob.	Estimate	Prob.	Estimate	Prob.
Phi					0.0407	0.2829	0.0390	0.3213
Alpha 0	0.0000	0.0000	0.0000	0.0016	0.0000	0.0000	0.0000	0.0019
Alpha	0.2299	0.0012	0.1380	0.0001	0.2254	0.0015	0.1351	0.0001
Beta			0.7820	0.0000			0.7847	0.0000
LL	2564.9290		2572.5800		2565.4950		2573.0840	
AIC	−8.3893		−8.4111		−8.3879		−8.4094	
SIC	−8.3748		−8.3894		−8.3662		−8.3805	

KEGC: Kazakhstan Electricity Grid Operating Company, ARCH: Autoregressive Conditional Heteroskedasticity, GARCH: Generalized Autoregressive Conditional Heteroskedasticity, ARCH-M: Autoregressive Conditional Heteroskedasticity in Mean, GARCH-M: Generalized Autoregressive Conditional Heteroskedasticity in Mean, LL: Log Likelihood, AIC: Akaike info criterion, SIC: Schwarz information criterion

Table 11: KZAP index return estimations of ARCH and GARCH models

Coefficients	ARCH (1)		GARCH (1,1)		ARCH-M (1)		GARCH-M (1,1)	
	Estimate	Prob.	Estimate	Prob.	Estimate	Prob.	Estimate	Prob.
Phi					−0.0032	0.9382	0.0110	0.7899
Alpha 0	0.0003	0.0000	0.0000	0.0001	0.0003	0.0000	0.0000	0.0001
Alpha	0.1404	0.0006	0.0817	0.0000	0.1406	0.0006	0.0821	0.0000
Beta			0.8939	0.0000			0.8931	0.0000
LL	1568.8030		1595.7680		1568.8060		1595.8060	
AIC	−5.1287		−5.2136		−5.1254		−5.2105	
SIC	−5.1142		−5.1920		−5.1037		−5.1816	

KZAP: KazAtomProm Kazakhstan National Atomic Organization, ARCH: Autoregressive Conditional Heteroskedasticity, GARCH: Generalized Autoregressive Conditional Heteroskedasticity, ARCH-M: Autoregressive Conditional Heteroskedasticity in Mean, GARCH-M: Generalized Autoregressive Conditional Heteroskedasticity in Mean, LL: Log Likelihood, AIC: Akaike info criterion, SIC: Schwarz information criterion

Table 12: KZTO index return estimations of ARCH and GARCH models

Coefficients	ARCH (1)		GARCH (1,1)		ARCH-M (1)		GARCH-M (1,1)	
	Estimate	Prob.	Estimate	Prob.	Estimate	Prob.	Estimate	Prob.
Phi					0.0443	0.2931	0.0297	0.4811
Alpha 0	0.0001	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000
Alpha	0.2466	0.0001	0.2002	0.0000	0.2558	0.0001	0.2068	0.0000
Beta	1862.7620		0.6511	0.0000			0.6424	0.0000
LL			1874.7300		1863.3330		1875.0000	
AIC	−6.0909		−6.1268		−6.0895		−6.1244	
SIC	−6.0764		−6.1051		−6.0678		−6.0955	

KZTO: KazTransOil JSC, ARCH: Autoregressive Conditional Heteroskedasticity, GARCH: Generalized Autoregressive Conditional Heteroskedasticity, ARCH-M: Autoregressive Conditional Heteroskedasticity in Mean, GARCH-M: Generalized Autoregressive Conditional Heteroskedasticity in Mean, LL: Log Likelihood, AIC: Akaike info criterion, SIC: Schwarz information criterion

Table 13: Lag length criterion values for models related to the VAR model of research variables

Lag	LogL	LR: sequential modified LR test statistic (each test at 5% level)	FPE: Final prediction error	AIC: Akaike ınformation criterion	SC: Schwarz ınformation criterion	HQ: Hannan-Quinn ınformation criterion
0	11520.85	NA	1.04e-24	−38.1919	−38.14807*	−38.17483*
1	11579.98	116.8797	9.67e-25*	−38.26858*	−37.962	−38.1493
2	11608.89	56.58706*	9.90e-25	−38.2451	−37.6757	−38.0235
3	11621.32	24.07060	1.07e-24	−38.1669	−37.3347	−37.843
4	11640.09	35.98038	1.13e-24	−38.1097	−37.0147	−37.6836

*Indicates lag order selected by the criterion. AIC: Akaike info criterion

The insignificance of conditional standard deviation value indicates that the ARCH-M(1) and GARCH-M(1,1) models are inappropriate for the KZAP index. Therefore, according to the LL criterion, the GARCH-M(1,1) model is appropriate for the KZAP index. Both ARCH (α) and GARCH (β) parameters are positive and significant, this indicates the presence of both effects (ARCH effect and GARCH effect) in the KZAP index. In other words, the shocks experienced by the KZAP index and the volatility of the previous period affect the current period.

The heteroscedasticity findings of four different models for the KZTO index return series are given in Table 12. The comparative examination of LL, AIC, and SIC criteria proved GARCH-M(1,1) to be the best model. In addition, there was no autocorrelation problem with varying variance in the models according to the ARCH-LM test and no autocorrelation problem according to the Ljung-Box-Q (LBQ) and Ljung-Box-Q2 (LB-Q2) tests applied to the residuals. Findings showed that the estimation values are statistically significant, except for the conditional standard deviation, and the estimation values met the condition of positivity. The insignificance of conditional standard deviation value indicates that the ARCH-M(1) and GARCH-M(1,1) models are inappropriate for the KZTO index. Therefore, according to the LL criterion, the GARCH-M(1,1) model is appropriate for the KZTO index. Both ARCH (α) and GARCH (β) parameters are positive and significant, this indicates the presence of both effects (ARCH effect and GARCH effect) in the KZTO index. In other words, the shocks experienced by the KZTO index and the volatility of the previous period affect the current period.

The findings of the lag length criterion test, which was performed to determine the model that best expresses the relationship structure between the variables, are in Table 13. The maximum calculated lag length value is 2 (according to LR criteria). These findings showed that VAR(2) was the most appropriate model.

Table 14: Granger causality analysis findings

Excluded	Chi-square	df	Prob.
Dependent variable: KASE			
KEGC	0.395962	2	0.8204
KZAP	0.779194	2	0.6773
KZTO	2.809654	2	0.2454
GOLD	2.431903	2	0.2964
OIL	10.64755	2	0.0049
All	17.56914	10	0.0627
Dependent variable: KEGC			
KASE	2.936775	2	0.2303
KZAP	4.934877	2	0.0848
KZTO	5.843062	2	0.0539
GOLD	0.526094	2	0.7687
OIL	0.822238	2	0.6629
All	13.51017	10	0.1965
Dependent variable: KZAP			
KASE	0.210823	2	0.9000
KEGC	2.480918	2	0.2893
KZTO	1.522153	2	0.4672
GOLD	5.689009	2	0.0582
OIL	6.669982	2	0.0356
All	18.84023	10	0.0423
Dependent variable: KZTO			
KASE	0.184725	2	0.9118
KEGC	1.947491	2	0.3777
KZAP	0.895596	2	0.6390
GOLD	1.121473	2	0.5708
OIL	4.005951	2	0.1349
All	8.047481	10	0.6242

KASE: Kazakhstan Stock Exchange Composite Index, KEGC: Kazakhstan Electricity Grid Operating Company, KZAP: KazAtomProm Kazakhstan National Atomic Organization, KZTO: KazTransOil JSC, GOLD: Gold Price Index, OIL: Oil Price Index

Using this result, VAR(2) model estimation and Granger causality analysis were performed under the model.

The possible causal relationship between the international gold and oil return indices, the Kazakhstan stock market composite index, and the returns of energy companies was examined with the

Granger causality test, and the findings are presented in Table 14. The causal effects of OIL returns on KASE, KZAP, and KZTO returns on KEGC, and OIL and GOLD returns on KZAP were statistically significant at the 0.10 significance level.

5. CONCLUSION AND RECOMMENDATIONS

The return of its stock exchange and the companies traded within are one of the important indicators for a national economy. Due to the global structure of stock markets, returns are closely related to both national and international market variables. This study examined the variance characteristics of the Kazakhstan stock market composite index, the energy and oil companies traded on the stock exchange, and the return indices of oil and gold in the international market. It also investigated the possible causal effect of the international market indices on the Kazakhstan stock exchange and the companies traded there. The analysis showed that other indices and returns have similar variance structures except for the KASE index. The relevant coefficient estimation was significant in both conditional standard deviation models for the KASE index. On the other hand, the coefficient estimate of the GARCH-M(1,1) model in the OIL index was significant, whereas conditional standard deviation models and the relevant coefficients of both conditional standard deviation models were found to be statistically insignificant in the other returns. This is an indication of the structural compatibility of Kazakhstan's stock market composite index and energy and oil companies with international markets. Furthermore, the causality analysis results showing that international indices have a causal effect on KASE and KZAP is another indicator that the Kazakhstan market works in harmony with the international markets.

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