

Comparison of ARCH and GARCH Model Performance in Estimating LQ45 Stock Return Volatility

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ABSTRACT

Volatility is a crucial indicator in capital market analysis because it reflects the risk level of an investment instrument. Accurate volatility estimation is essential for investors, portfolio managers, and regulators to support informed decision-making. This study aims to compare the performance of the Autoregressive Conditional Heteroskedasticity (ARCH) and Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models in estimating the return volatility of stocks included in the LQ45 index on the Indonesia Stock Exchange. The LQ45 index was chosen because it comprises stocks with high liquidity and market capitalization, making it a key representative of stock market movements in Indonesia. The data used are daily LQ45 returns over a specific research period. The analysis begins with a heteroscedasticity test using the Breusch-Pagan test to ensure the presence of non-constant variance. Next, ARCH and GARCH model estimations are performed, as well as model performance evaluations based on the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). The results show that the GARCH model tends to provide more stable volatility estimates and better fits the characteristics of the financial data compared to the ARCH model. This finding indicates that GARCH can be used as a more reliable model for measuring LQ45 stock return volatility.

Keywords: Volatilitas, Return Saham, ARCH, GARCH, LQ45

1. INTRODUCTION

Volatility is a key indicator in financial market analysis because it reflects the level of uncertainty in an asset's price movements. For investors and portfolio managers, an accurate understanding of volatility is crucial for investment decision-making, risk management, and hedging strategies. One market that frequently receives attention is the Indonesia Stock Exchange, specifically the LQ45 index, which comprises stocks with large capitalizations, high liquidity, and strong fundamental performance. The movement of LQ45 stock returns is inextricably linked to global and domestic market dynamics, which can lead to sharp fluctuations, making accurate volatility estimates increasingly relevant.

In the financial literature, the Autoregressive Conditional Heteroskedasticity (ARCH) model introduced by Engle (1982) is one of the initial approaches to capturing the phenomenon of volatility clustering, namely the condition where periods of high volatility tend to be followed by periods of low volatility, and vice versa. Subsequently, Bollerslev (1986) developed the Generalized ARCH (GARCH) model, which extends the ARCH framework by incorporating lags of conditional variance, making it more flexible in capturing complex volatility dynamics. Both models are widely used in research and practice to predict market risk.

The LQ45 index was chosen as the research object for several reasons. First, the LQ45 index represents blue-chip stocks in Indonesia, boasting large market capitalization and high liquidity. Therefore, it is often used as a primary reference by both domestic and foreign investors in assessing the performance of the Indonesian capital market. Second, the index's movements tend to reflect overall macroeconomic

conditions and investor sentiment, so its volatility estimates have broad implications for market stability and investment strategies. Third, due to its liquid and diversified nature, the LQ45 is often used as an underlying in various derivative instruments and investment products, making its volatility measurement crucial for risk management.

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Numerous previous studies have discussed volatility modeling using ARCH and GARCH models on various financial instruments. Engle (1982) first introduced the ARCH model to estimate inflation volatility in the UK and successfully demonstrated the phenomenon of volatility clustering [1]. Furthermore, Bollerslev (1986) developed the GARCH model, which proved more flexible in capturing the dynamics of conditional variance in financial data [2]. In Indonesia, several studies have also tested the effectiveness of ARCH/GARCH models in modeling stock returns. For example, Muhammad Arifin et al. modeled stock portfolio returns using the asymmetric GARCH method [3]. Another study by Leoni Fransisca et al. used the GARCH method to predict the technology sector stock index (IDXTECHNO) listed on the Indonesia Stock Exchange for the 2021-2022 period [4]. Meanwhile, ETTY Puji Lestari et al. estimated the price volatility of red chili peppers using the ARCH-GARCH approach [5].

Based on these studies, it can be concluded that GARCH is generally superior to ARCH in volatility estimation, but empirical evidence is still needed in different contexts. Therefore, this study re-examines and compares the performance of ARCH and GARCH, focusing on the LQ45 index, as this index is the primary representation of liquid stocks on the Indonesia Stock Exchange and serves as an important reference for investors and regulators in making investment decisions.

2. METHODS

This study uses a quantitative approach with time series analysis. The Autoregressive Conditional Heteroskedasticity (ARCH) and Generalized ARCH (GARCH) models are used to estimate stock return volatility. The main objective of this study is to compare the performance of the two models in describing the dynamics of LQ45 stock return volatility. The data used in this study is secondary data in the form of daily closing prices of stocks included in the LQ45 index on the Indonesia Stock Exchange. The observation period was determined from January 1, 2020, to January 1, 2025, as this period encompasses both normal market conditions and periods of high volatility, such as during the COVID-19 pandemic. Data was obtained from the official website of Investing.com.

Stock returns are calculated using the equation

$$R_t = \ln \left(\frac{P_t}{P_{t-1}} \right)$$

Where R_t is the stock return on day t , P_t is the closing price on day t and P_{t-1} is the closing price on the previous day [4][3].

2.1 Stationarity Test

Prior to estimation, stock return data were tested for stationarity using the Augmented Dickey-Fuller (ADF) Test. Non-stationary data were transformed to meet the stationarity criteria.

The following model was used to test the ADF in this study [6] [5][7]:

$$\Delta Y_t = \beta + \delta Y_{t-1} + e_t$$

The hypothesis for the unit root test is as follows:

H_0 : There is no stationarity in the data

H_1 : There is stationarity in the data

2.2 Heteroscedasticity Test

This test is conducted to determine whether or not there is a deviation from the classical assumption of heteroscedasticity, namely the unequal variance of the residuals for all observations. This test uses the Breusch-Pagan test; if the Chi-square probability value is > 0.05 , it means there are no heteroscedasticity symptoms [8].

2.3 ARCH and GARCH Model Estimation

After the data is tested for heteroscedasticity, the ARCH/GARCH model is estimated. The ARCH model equation (p) is [9]

$$\sigma_t^2 = \alpha_0 + \alpha_1 \epsilon_{t-1}^2 + \alpha_2 \epsilon_{t-2}^2 + \dots + \alpha_p \epsilon_{t-p}^2$$

while the GARCH (p,q) model is [3]

$$\sigma_t^2 = \alpha_0 + \alpha_1 \epsilon_{t-1}^2 + \alpha_2 \epsilon_{t-2}^2 + \dots + \alpha_p \epsilon_{t-p}^2 + \beta_1 \sigma_{t-1}^2 + \beta_2 \sigma_{t-2}^2 + \dots + \beta_q \sigma_{t-q}^2.$$

2.4 Selection of the Best Model

The performance of the ARCH and GARCH models was evaluated and compared using two commonly used model selection criteria, namely the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). Both criteria are designed to assess the goodness of fit of the models while penalizing model complexity, ensuring that overfitting is minimized. A lower AIC or BIC value indicates that the model provides a better balance between accuracy and parsimony in capturing the volatility dynamics of stock returns. In this study, the model with the lowest AIC and BIC values was considered superior in explaining the time-varying behavior of return volatility. These criteria are particularly important in financial time series analysis, as volatility in stock returns often exhibits heteroskedasticity and volatility clustering, requiring models that can capture such dynamics effectively. By using AIC and BIC as the primary selection benchmarks, the comparison between ARCH and GARCH provides a robust assessment of which model performs better in modeling the volatility of LQ45 stock returns [10].

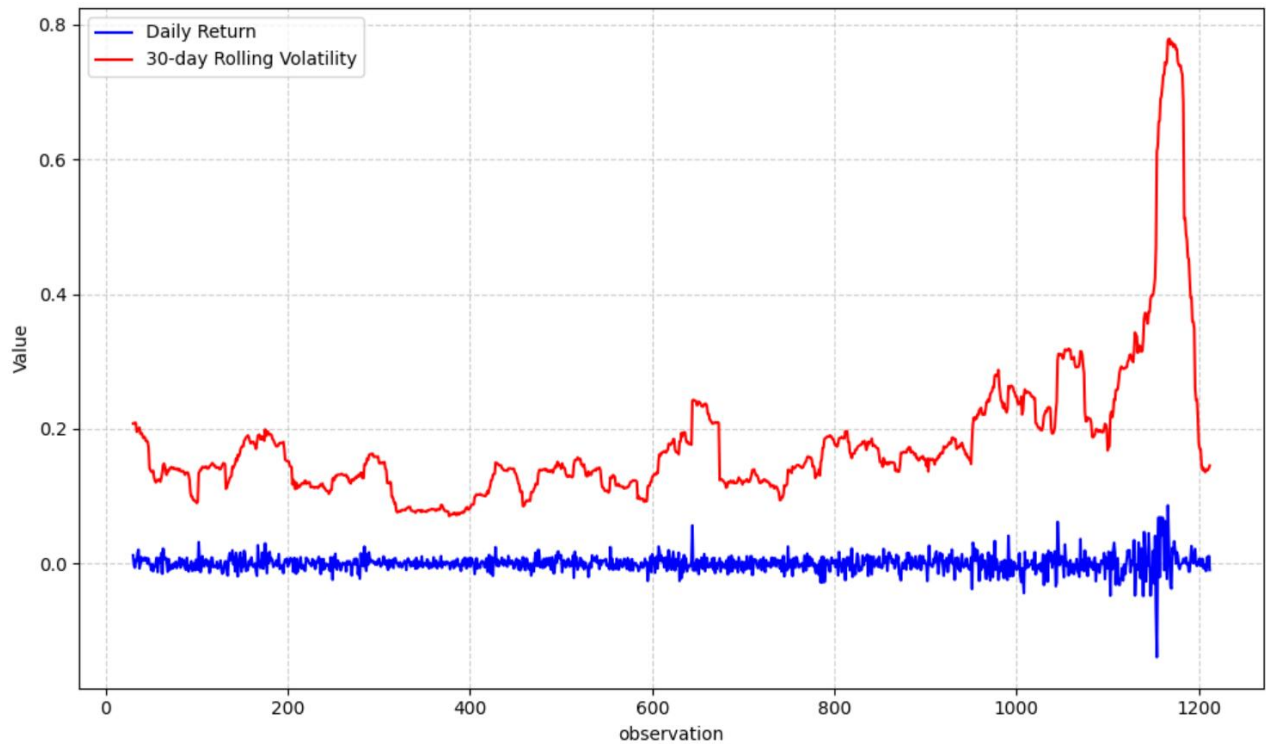
3. RESULTS AND DISCUSSION

The research data uses the daily closing prices of LQ45 shares for the period January 1, 2020 to January 1, 2025. Based on the processing results, stock returns calculated using the logarithmic return method show quite high fluctuations, especially in the 2024 period. This indicates non-constant volatility (heteroscedasticity), so the ARCH and GARCH methods are relevant to use.

Table 1. Descriptive statistics of LQ45 stock returns

	Mean	Min	Q1	Q2	Q3	Max	Std
Return	0.0001	-0.1391	-0.0061	-0.0001	0.0066	0.0862	0.0133

Based on Table 1, the LQ45 stock return has an average value of 0.0001, indicating that daily returns generally tend to be stable and close to zero. A minimum value of -0.1391 and a maximum of 0.0862 indicate extreme fluctuations, either price increases or decreases, within a given period. Most returns are concentrated around zero, indicated by a median of -0.0001 and a quartile distribution between -0.0061 and 0.0066 . Meanwhile, the standard deviation of 0.0133 , or 1.33% reflects moderate volatility, despite some days with sharp fluctuations. These findings demonstrate that LQ45 stock returns are relatively stable, while still exhibiting financial market characteristics such as volatility clustering.



Picture 1. Illustration of return and rolling volatility

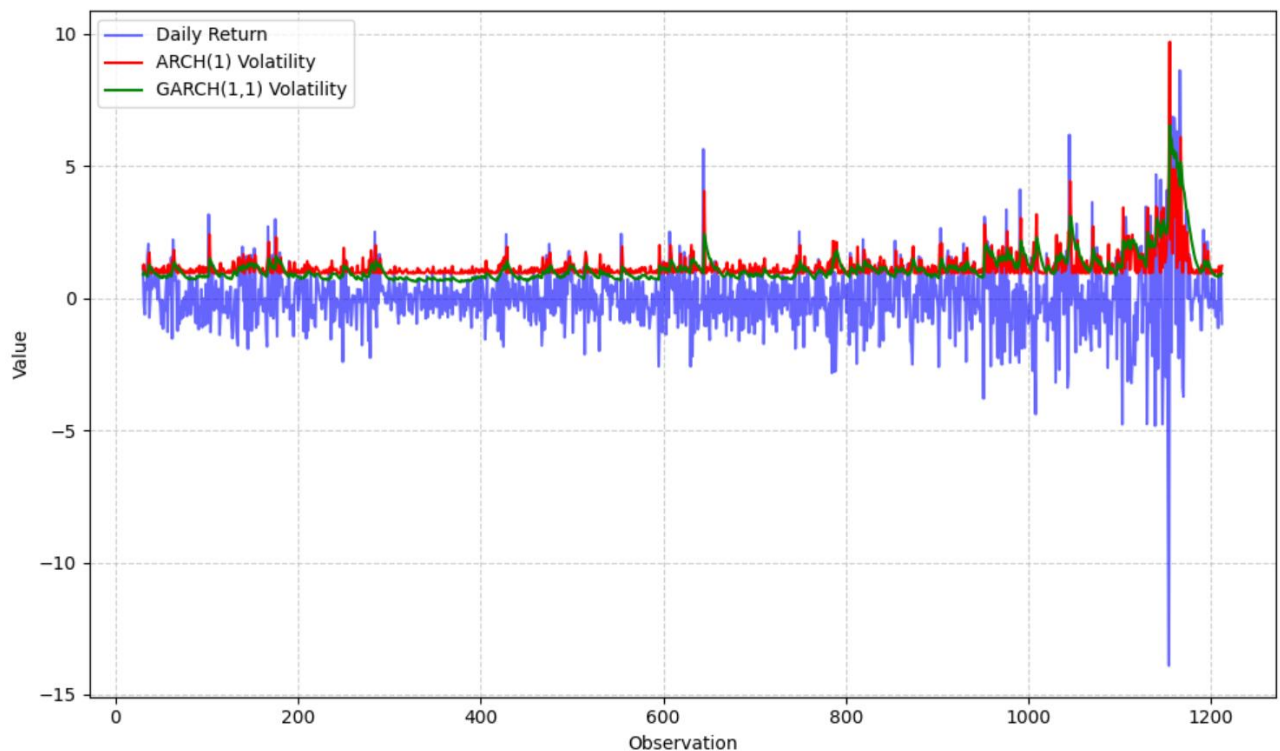
The Augmented Dickey-Fuller (ADF) test for stationarity indicates that the return data is stationary at the level, as evidenced by a p-value < 0.05 . This result implies that the mean and variance of the return series remain constant over time, making the data suitable for time series modeling. Furthermore, the Breusch-Pagan test reveals the presence of significant heteroskedasticity, confirming the existence of an ARCH effect in the residuals. This finding suggests that the variance of the residuals is not constant but rather depends on past squared errors, a common phenomenon observed in financial time series where periods of high volatility tend to cluster together. Consequently, applying volatility modeling techniques such as the Autoregressive Conditional Heteroskedasticity (ARCH) and Generalized ARCH (GARCH) frameworks becomes appropriate. These models are specifically designed to capture time-varying volatility and provide a more accurate representation of the dynamic behavior of stock return fluctuations, thereby improving the reliability of risk measurement and forecasting.

Estimation was performed using the arch package in Python. The estimation results for the ARCH(1) and GARCH(1,1) models are summarized in Table 2 below:

Table 2. ARCH(1) and GARCH(1,1) Model Estimation Results

	AIC	BIC
ARCH (1)	3666.91	3682.13
GARCH (1,1)	3479.29	3499.58

Based on Table 2, it can be seen that the GARCH(1,1) model has smaller AIC and BIC values compared to the ARCH(1) model. Thus, the GARCH(1,1) model is considered better at explaining the volatility of LQ45 stock returns.



Picture 2. Illustration of daily return, ARCH(1) and GARCH(1,1)

This finding is consistent with the literature suggesting that GARCH models are generally superior to ARCH because they incorporate past volatility into the calculation of conditional variance. Thus, GARCH models are able to capture the volatility clustering common in financial data, where periods of high volatility tend to be followed by periods of low volatility, and vice versa.

The results of this study indicate that the GARCH model is more suitable for estimating LQ45 stock return volatility. This is consistent with research by Engle (1982) and Bollerslev (1986), which introduced ARCH and GARCH. The importance of these results is that investors, portfolio managers, and regulators can use GARCH as a primary approach for risk calculation and investment decision-making in the Indonesian capital market.

CONCLUSION

Based on the results of the analysis and discussion, several conclusions can be drawn as follows:

- LQ45 stock returns during the study period exhibited fluctuating volatility characteristics and formed a volatility clustering pattern. This indicates that the use of conditional variance-based models such as ARCH and GARCH is relevant for describing market volatility dynamics.
- The results of the stationarity test and the ARCH effect test confirm that the return data is suitable for modeling with the ARCH/GARCH approach.
- Comparison of estimation results shows that the GARCH(1,1) model is superior to the ARCH(1) model. This is indicated by the smaller AIC and BIC values. Thus, GARCH(1,1) is more appropriate for modeling LQ45 stock return volatility.

REFERENCES

- [1] R. F. Engle, "Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation," *Arch*, vol. 50, no. 4, pp. 1–23, 2023, doi:

- 10.1093/oso/9780198774310.003.0001.
- [2] T. Bollerslev, "Reprint of: Generalized Autoregressive Conditional Heteroskedasticity," *J. Econom.*, vol. 234, pp. 25–37, 2023, doi: 10.1016/j.jeconom.2023.02.001.
- [3] M. Arifin, Tarno, and B. Warsito, "Pemodelan Return Portofolio Saham Menggunakan Metode GARCH Asimetris," *J. Gaussian*, vol. 6, no. 1, pp. 51–60, 2017.
- [4] L. Fransisca and Y. D. Hapsari, "Penggunaan Metode Garch Dalam Memprediksi Indeks Saham Sektor Teknologi (Idxtechno) Yang Terdaftar Di Bursa Efek Indonesia Periode 2021-2022," *J. Soc. Econ. Res.*, vol. 5, no. 1, pp. 231–246, 2023, doi: 10.54783/jser.v5i1.88.
- [5] E. P. Lestari, S. D. W. Prajanti, W. Wibawanto, and F. Adzim, "ARCH-GARCH Analysis: An Approach to Determine The Price Volatility of Red Chili," *Agraris*, vol. 8, no. 1, pp. 90–105, 2022, doi: 10.18196/agraris.v8i1.12060.
- [6] S. Sumiyati, B. D. A. Arisandi, and P. R. Wilujeng, "Metode Arch/Garch Untuk Memprediksi Hubungan Economic Uncertainty Akibat Pandemi Covid 19 Dan Volatilitas Saham," *J. Bisnis dan Akunt.*, vol. 24, no. 1, pp. 117–130, 2022, doi: 10.34208/jba.v24i1.1152.
- [7] L. M. W. Mufaridho, P. Jalaludin, and R. Amigo, "Analisis Respon Indeks Dolar Terhadap Pasar Saham Amerika Menggunakan Model Vector Auto Regressive," *J. Gaussian*, vol. 14, no. 1, pp. 236–246, 2025, doi: 10.14710/j.gauss.14.1.236-246.
- [8] M. N. Sari, "HEDGING CRYPTOCURRENCY SEBAGAI ALTERNATIF DALAM INVESTASI," *Accid. Anal. Prev.*, vol. 10, no. 1, pp. 348–368, 2023.
- [9] T. Hutapea, "Analysis of Volatility of the Return of Composite Stock Price Index Using ARCH/GARCH Model, January 2015 - September 2024," *J. Kewirausahaan, Akunt. Dan Manaj. Tri Bisnis*, vol. 7, no. 1, pp. 81–99, 2025, doi: 10.59806/jkamtb.v7i1.498.
- [10] J. Antika, A. Mugayat, and M. Sukartini, "Analisis Volatilitas Saham Dengan Metode Arch-Garch Pada Bank Rakyat Indonesia Tahun 2019-2022," *J. Ilmu Ekon.*, vol. 4, no. 1, pp. 323–341, 2025, doi: 10.59827/jie.v4i1.227.