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Macroeconomic Analysis of Mining Stock Index Volatility in Indonesia

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ABSTRACT

The purpose of this study is to analyze the influence of macroeconomic variables, such as, exchange rates, interest rates, inflation rates, and consumer price index on mining stock volatility. The unit of analysis is the mining stock index volatility in Indonesia from January 2010 to December 2019. The analytical method used in the study is the econometric model ARCH/GARCH using EViews software. The test results show the exchange rate of the dollar against the rupiah (USD/IDR) and the inflation rate has a negative and significant effect while the interest rate and the consumer price index have a positive and significant effect on mining stock index volatility in Indonesia. In addition, based on the ARCH/GARCH coefficient is found that the mining stock index in Indonesia is influenced by the volatility of the current and past stock indexes. The mining stock index volatility in Indonesia is persistent volatile, which is high volatility and occurs continuously.

Keywords: *Macroeconomic Analysis, Minix Stock Index, Index Volatility*

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INTRODUCTION

An investment is the current commitment of dollars for a period of time in order to derive future payments that will compensate the investor for: (1) the time the funds are committed, (2) the expected rate of inflation during this time period, and (3) the uncertainty of the future payments (Reilly & Brown, 2012: 4). As a financial instrument, stocks hold a significant role in a country's economy. The stocks can be used to generate cash, by the issuers, investors, or third parties (Toly, 2009).

Theories in finance related to stock price volatility are Signaling Theory (signal theory) and Efficient Market Hypothesis (EMH). Signaling theory is the information signals needed by investors to consider and determine whether investors will invest their shares or not in the company concerned (Khairudin; Wandita, 2017). The efficient market hypothesis by Fama (1970) has long been used by researchers to explain the influence between changes in macroeconomic variables and stock price volatility. The efficient market hypothesis states that stock prices adjust quickly to new and sensitive price information (Lucey & Dowling, 2005). Part of sensitive information that will be adjusted according to price according to the Efficient Market Hypothesis is information about changes in macroeconomic variables such as interest rates, inflation rates, and exchange rates.

Volatility in the stock market generally describes the level of risk faced by investors because it reflects fluctuations in stock price movements. Every day stock prices fluctuate and observers have confidence that various factors from outside the stock market will affect current stock price fluctuations and have a significant impact on the economy (Fitriyani, Ika & Herlambang, 2016). Understanding significant information on volatility in macroeconomic variables will help to predict stock market volatility (Olasunkanmi & Corresponding, 2011; Zakaria & Shamsuddin, 2012). Volatility can determine the uncertainty of future stock returns and what is very important is risk management, portfolio optimization and asset pricing (S. Z. S. Abdalla & Winker, 2012).

Empirical evidence has shown that there is an effect of exchange rates on stock prices is I.S.A. Abdalla and I. S. A. Abdalla and Murinde (1997) for Pakistan, Erbaykal and Okuyan (2007) for eight countries out of thirteen countries, Ardana (2016) for Indonesia, Onafowora and Owoye (2011) for Nigeria. However, there is some empirical evidence that shows that there is no effect of exchange rates on stock prices (Murwaningsari, 2008). The results of research found that the exchange rate does not have a significant effect on the Composite Stock Price Index (CSPI) but the exchange rate, trading volume, interest rates simultaneously have a significant effect on the Composite Stock Price Index.

Generalized Autoregressive Conditional Heteroscedasticity (GARCH) modeling was used to determine the effect of interest rates on stock prices on the Malaysian Stock Exchange from the period January 1997 to November 2009 and found that interest rates had a negative and not significant effect on stock price volatility (Hazlina *et al.*, 2011). Menike (2006), Kuwornu and Victor (2011), Husin *et al.* (2012), Damayanti (2014), Nasir *et al.* (2016), and Sudarsono (2018) found that interest rates have a negative effect on stock prices. Rising interest rates will make people tend to save funds in the form of deposits. If deposits are able to provide the expected benefits, people are less interested in saving in the form of investment in the capital market. This situation makes investment demand in the capital market tend to decrease, causing the stock price to decline.

Coleman and Tettey (2008) examined how the influence of macroeconomic variables on stock prices in Ghana with time series data found that inflation rates had a negative and significant effect on stock prices. Yaya and Shittu (2010) examined the effect of inflation on stock prices. Using monthly stock price data from 1991 to 2008 and the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model, it was found that the inflation rate had a significant effect on stock prices in Nigeria. Evbayiro-Osagie and Emeni (2015) found that the inflation rate had a negative and significant effect on stock price volatility. Secondary data research in the form of a stock price index listed on the Nigerian Stock Exchange from 1985 to 2012 and data processed using the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model.

Heriyanto and Chen (2014) examined the effect of the consumer price index on the composite stock price index on the Indonesia Stock Exchange in the long run. Using monthly data from January 2005 to December 2013 and data analyzed with the Vector Error Correction Model (VECM), it was found that the consumer price index significantly affected the combined price index in the long run. Alfuadi (2019) conducted a study on the effect of the consumer price index on the Jakarta Islamic Index (JII). Secondary data were analyzed using Vector Autoregression (VAR) which if cointegration occurs it will proceed with the Vector Error Correction Model (VECM) and it is found that the consumer price index has a significant effect on the Jakarta Islamic Index.

Over the past four years, mining stock index in Indonesia experienced intense fluctuations or movements from January 2016 to December 2019. Stock index in January 2016 to December 2017 experienced fluctuations in the stock index range of 800-1600 per share. The highest stock index in October 2017 but then declined in November 2017. The stock index in January 2017 to December 2018 experienced fluctuations in the stock index range of 1400-2200 per share. The highest stock index in May 2018 but then declined quite dramatically in June 2018. The stock index in December 2018 to February 2019 experienced fluctuations in the price range 1800-1900 per share. In April 2019 to December 2019 stock index fluctuations occurred from the price range of 1500-1600 per share with the ups and downs of the price per sheet intensely. The lowest stock index occurred in November 2019, namely 1300 per share and gradually rose to 1600 per share in December 2019.

METHOD

Data is processed with Eviews software. The first step is to test classic assumptions. The classic assumption test consists of four tests, namely the classic assumption test, multicollinearity test, autocorrelation test, and heteroscedasticity test. Furthermore, a data behavior test can be performed through a stationary test and a degree of integration test. Data behavior test is carried out to determine time series data to be used was stationary. However, various studies on time series data often produce non-stationary data at normal degrees (data level). If the unit root test is apparently not stationary, a degree of integration testing is performed. One of the way to see whether the data stationary is to look at the probability of the Augmented Dickey-Fuller test statistic output.

Time series data, especially data in the financial sector, is highly volatile. One approach to this is the ARCH-GARCH model developed by Engle (1982) and Bollerslev (1986). Engle was the first to analyze the heteroscedasticity problem of residual variants in the time series. The GARCH model is a developmental model of the ARCH model. ARCH (Autoregressive Conditional Heteroscedasticity) was developed by Robert Engle (1982) and modified by Mills (1999), then Team Bollerslev (1986 and 1994) also introduced an ARCH generalization model called GARCH. This GARCH is intended to improve ARCH (Ghozali & Ratmono, 2018: 422).

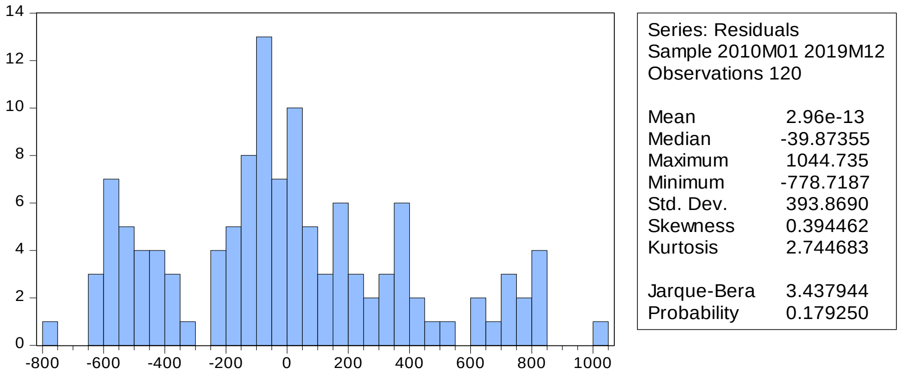
In estimating the ARCH / GARCH model, it can be done with the method of maximum likehood estimation. The selection of the best ARCH / GARCH model is chosen based on all the constants and coefficients on the significant ARCH / GARCH model, has the highest adjusted R-squared value, which means the model is able to explain the relationship between the independent variable (dependent) to the dependent variable, and see the lowest AIC (Akaike Info Criterion) and SIC (Schwarz Info Criterion) coefficients.

RESULTS AND DISCUSSION

Classic Assumption Test

Normality Test

Normality test aims to test whether in the regression model, confounding or residual variables have a normal distribution (Ghozali & Ratmono, 2018: 145).



Picture 1. Jarque-Bera Normality Test Result
Source: Data processed by researcher (2020)

Based on Figure 2 it can be concluded that the data are normally distributed at a significance level of 5% because they meet two conditions, the value of Jarque-Bera (3.437944) is smaller than the value of chi square with degree of freedom = 2 (5.99147) and the probability value (0.179250) is greater than the alpha value of 0.05.

Multicollinearity Test

Multicollinearity test aims to test whether the regression model found a high or perfect correlation between independent variables (Ghozali & Ratmono, 2018: 71).

Table 1. *Correlation Matrix* Multicollinearity Test Result

	EXCHANGERATE	INTERESTRATE	INFLATION	CPI
EXCHANGERATE	1.000000	-0.254644	-0.341639	0.081483
INTERESTRATE	-0.254644	1.000000	0.704837	-0.456623
INFLATION	-0.341639	0.704837	1.000000	-0.191835
CPI	0.081483	-0.456623	-0.191835	1.000000

Source: Data processed by researcher (2020)

From table 1 it can be seen that the correlation coefficient is not above 0.8 so it can be concluded that in the model there is no multicollinearity problem, which means that in the data there is no high correlation between the independent variables.

Autocorrelation Test

The autocorrelation test aims to test whether in a linear regression model there is a correlation between residual errors in the t-period and the disruption in the t-1 (previous) period. If there is a correlation, it is called an autocorrelation problem (Ghozali & Ratmono, 2018: 121).

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	447.5005	Prob. F(2,113)	0.0000
Obs*R-squared	106.5476	Prob. Chi-Square(2)	0.0000

Table 2. *Lagrange Multiplier* (*LM Test*) Autocorrelation Test Result

Source: Data processed by researcher (2020)

From table 2 it is known that the Obs*R-squared probability value of 0.0000 is smaller than α = 0.05. Because the probability value Obs*R-squared is smaller than α = 0.05, H_0 is rejected so it can be concluded that the rest of the model has an autocorrelation problem.

Heteroscedasticity Test

Heteroscedasticity test aims to test whether in the regression model there is an inequality of residual variance from one observation to another (Ghozali & Ratmono, 2018: 85).

Table 3. Heteroscedasticity (White) Test Result

Heteroskedasticity Test: White

F-statistic	11.74327	Prob. F(14,105)	0.0000
Obs*R-squared	73.23040	Prob. Chi-Square(14)	0.0000

Source: Data processed by researcher (2020)

From table 3 it is known that the Obs*R-squared probability value of 0.0000 is smaller than α = 0.05. Because the probability value Obs*R-squared is smaller than α = 0.05, H_0 is rejected so that it can be concluded that the rest of the model has a heteroscedasticity problem which means that the variance of the residuals is not constant and changeable.

Based on the results of the classic assumption test conducted, the data used by using the ordinary least squares (OLS) regression method only passed the normality and multicollinearity tests. Thus the OLS regression method contains autocorrelation and heteroscedasticity problems. The inconsistency of research data which results in non-constant residual variance between observations (heteroscedasticity) can be said to be a phenomenon of volatility in the movement of data.

Data Behavior Test

Stationary Test

Stationary testing is done by conducting a Unit Root Test to find out whether the time series data contains unit roots. Unit root testing for all variables used in time series analysis needs to be done to meet the validity of the ARCH-GARCH model. In this case the data must be stationary in other words the behavior of stationary data has a variance that is not too large and has a tendency to approach the average value.

Based on Augmented Dickey-Fuller Test, all variables in the study are not stationary. This is due to the variables having the calculated ADF value greater than the Critical Value (CV) of 5% and the probability value greater than the alpha value of 0.05. In this case all variables must be stationary in the same order or degree so it needs to be continued with the first degree integration test.

Integration Test

The result of stationary test is not stationary data at level. Therefore, a first degree integration test must be performed. Based on the results of the Augmented Dickey-Fuller test at the first difference level, the value of the Augmented Dickey-Fuller test (ADF test) is smaller than the Critical Value (CV) of 5% and the probability value is smaller than the alpha value of 0.05 meaning that all variables are stationary in the first integration (first difference). From the results of the stationarity test it can be concluded that all variables are stationary in the same order, namely at the first degree integration.

ARCH Effect Test

The ARCH effect in the data indicates that the estimation results are exposed to symptoms of volatility. The presence of ARCH symptoms can be proven by the significance of the LM ARCH test results. The ARCH effect can be seen in the F-statistic probability value. If the F-statistic probability value is smaller than the significance value α = 0.05, there is an ARCH effect and then the variables will be made ARCH / GARCH modeling for further identification.

Tabel 4. ARCH Effect Test Result

Heteroskedasticity Test: ARCH

F-statistic	342.5936	Prob. F(1,117)	0.0000
Obs*R-squared	88.70584	Prob. Chi-Square(1)	0.0000

Source: Data processed by researcher (2020)

From table 4 it is known that the F-statistic probability value of 0.0000 is smaller than the significance value α = 0.05 so it can be concluded that the estimation results of the OLS model have an ARCH effect. Thus the estimation can be done using the ARCH/GARCH model.

The Best Model Selection Test

To choose the most feasible model, do the trial and error process or try a number of possible models to produce the best model. There are several ways that can be used to choose the best model, namely all constants and coefficients in the ARCH / GARCH model are significant, have the highest adjusted R-squared value, which means the model is able to explain the relationship between independent variables to the dependent variable, and see the coefficient values AIC (Akaike Info Criterion) and SIC (Schwarz Info Criterion) are the lowest.

Table 5. ARCH/GARCH Model Alternative Test Result

Variable \ Modeling		ARCH (1,0)	ARCH (2,0)	GARCH (1,1)	GARCH (2,1)	GARCH (2,2)
Exchange rate		Significant	Significant	Significant	Significant	Significant
Interest rate		Significant	Significant	No Sig.	Significant	No Sig.
Inflation rate		Significant	Significant	Significant	Significant	Significant
Consumer price index		Significant	Significant	Significant	Significant	Significant
C coefficient		No Sig.	No Sig.	Significant	Significant	Significant
ARCH coefficient	RESID(-1)	Significant	Significant	Significant	Significant	Significant
	RESID(-2)	-	No Sig.	-	-	Significant
GARCH coefficient	GARCH(-1)	-	-	No Sig.	Significant	Significant
	GARCH(-2)	-	-	-	Significant	No Sig.
Adjusted R-squared		0.47	0.47	0.34	0.55	0.56
AIC		14.01	14,20	13.89	14.00	14.26
SIC		14.17	14,21	14.08	14.21	14.50

Source: Data processed by researcher (2020)

Based on table 5, the best model is GARCH (2,1). This can be seen in the GARCH model (2.1) having significant C, ARCH, and GARCH coefficient values (probability values smaller than alpha values 0.05), relatively large adjusted R-squared values, and AIC and SIC values that are relatively small. From the GARCH model (2.1), the results are obtained that all independent variables affect the dependent variable.

Model Verification

Model verification is done to determine whether the best model, namely GARCH (2,1) has no heterocedasticity effect using the ARCH-LM test.

Table 6. ARCH-LM Test Result (Model Verification)

Heteroskedasticity Test: ARCH

F-statistic	2.127102	Prob. F(1,117)	0.1474
Obs*R-squared	2.124833	Prob. Chi-Square(1)	0.1449

Source: Data processed by researcher (2020)

Based on table 6, it can be seen that the F-statistic probability value (0.1474) is greater than the alpha value of 0.05 so it can be concluded that there is no heteroscedasticity effect in residuals.

DISCUSSION

The results of the study are based on the results of tests on ARCH/GARCH modeling and the best model, the GARCH model (2.1) was chosen.

Table 7. GARCH (2,1) Model

Dependent Variable: VOLATILITAS
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 06/17/20 Time: 19:05
Sample: 2010M01 2019M12
Included observations: 120
Convergence achieved after 140 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(6) + C(7)*RESID(-1)^2 + C(8)*GARCH(-1) + C(9)*GARCH(-2)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	1793.137	382.3400	4.689901	0.0000
NILAITUKAR	-0.222542	0.006496	-34.25906	0.0000
SUKUBUNGA	77.55381	21.90934	3.539760	0.0004
INFLASI	-97.51063	12.40652	-7.859625	0.0000
IHK	20.77374	2.375579	8.744708	0.0000
Variance Equation				
C	3295.257	1650.656	1.996331	0.0459
RESID(-1)^2	0.975039	0.332513	2.932334	0.0034
GARCH(-1)	0.337462	0.148453	2.273196	0.0230
GARCH(-2)	-0.109353	0.048830	-2.239477	0.0251

R-squared	0.566535	Mean dependent var	1799.832
Adjusted R-squared	0.551457	S.D. dependent var	623.8234
S.E. of regression	417.7952	Akaike info criterion	14.00962
Sum squared resid	20073574	Schwarz criterion	14.21868
Log likelihood	-831.5771	Hannan-Quinn criter.	14.09452

Durbin-Watson stat	0.130975

Source: Data processed by researcher (2020)

Based on the GARCH (2,1) model can be obtained as follows:

1. Mining stock index in Indonesia are influenced by the volatility of the current stock index so that the stock index has an error variant that is not constant from time to time. This can be seen from probability coefficient of ARCH (1) is 0.034 < alpha value 0.05 meaning that there is an ARCH effect on the mining stock index in Indonesia
2. Mining stock index in Indonesia are persistent volatile, they are high volatility and occur continuously. This can be seen from the coefficient of ARCH (1) is 0.975039 or more than 0.7.
3. Mining stock index in Indonesia are influenced by the stock index volatility last period. This can be seen from each probability coefficient of GARCH (1) and GARCH (2) < alpha value 0.05.
4. H_1 influence of the exchange rate (X_1) on mining stock index volatility in Indonesia. From table 7, the probability of a currency exchange rate variable is 0.0000 or smaller than 0.05 so it can be concluded that H_1 is accepted. Thus, there is a significant influence between the currency exchange rate and the mining stock index volatility in Indonesia.
5. H_2 influence of interest rates (X_2) on mining stock index volatility in Indonesia. From table 7, the probability of the interest rate variable is 0.0004 or smaller than 0.05 so it can be concluded that H_2 is accepted. Thus, there is a significant influence between interest rates and the mining stock index volatility in Indonesia.
6. H_3 influence of interest rates (X_3) on mining stock index volatility in Indonesia. From table 7, the probability of the inflation rate is 0.0000 or smaller than 0.05 so it can be concluded that H_3 is accepted. Thus, there is a significant influence between the inflation rate and the mining stock index volatility in Indonesia.
7. H_4 influence of the consumer price index (X_4) on mining stock index volatility in Indonesia. From table 7, the probability of the interest rate variable is 0.0000 or smaller than 0.05 so it can be concluded that H_4 is accepted. Thus, there is a significant influence between the consumer price index and the mining stock index volatility in Indonesia.
8. The adjusted R-squared value or the coefficient of determination is 0.55. This means that 55% of the variation in the mining stock index volatility in Indonesia can be explained by variations of four macroeconomic variables, for example the exchange rate, interest rates, inflation rates, and the consumer price index while the rest (45%) is explained by other causes in outside the model or research.

CONCLUSION

Based on the results of research and discussion, the following conclusions can be drawn Exchange rate has a significant effect on the mining stock index volatility in Indonesia. Interest rate has a significantly effect on the mining stock index volatility in Indonesia. Inflation rate has a significantly effect on the mining stock index volatility in Indonesia. Inflation rate has a significantly effect on the mining stock index volatility in Indonesia. Mining stock index in Indonesia has ARCH and GARCH effect, which means that the movement of stock index is influenced by the volatility of the current and previous stock index.

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AUTHOR CONTRIBUTION STATEMENTS

The authors had participated in the research. The authors processing the finding, evaluation of research, and finishing review process.

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