DETERMINING THE BEST ARCH/GARCH MODEL AND COMPARING JKSE WITH STOCK INDEX IN DEVELOPED COUNTRIES

Kharisya Ayu Effendi

Faculty of Business and Management in Widyatama University, Bandung, Indonesia
kharisya.ayu@widyatama.ac.id

ABSTRACT

The slow movement of Indonesia economic growth in 2014 due to several factors, in internal factors; due to the high interest rates in Indonesia and external factors from the US which will raise the fed rate this year. However, JKSE shows a sharp increase trend from the beginning of 2014 until the second quarter of 2015 although it remains fluctuate but insignificant. The purpose of this research is to determine the best ARCH / GARCH model in JKSE and stock index in developed countries (FTSE, Nasdaq and STI) and then compare the JKSE with the stock index in developed countries (FTSE, Nasdaq and STI). The results obtained in this study is to determine the best model of ARCH / GARCH, it is obtained that JKSE is GARCH (1,2), while the FTSE obtains GARCH (2,2), NASDAQ produces the best model which is GARCH (1,1) and STI with GARCH (2,1), and the results of the comparison of JKSE with FTSE, NASDAQ and STI are that even though JKSE fluctuates with moderate levels but the trend shown upward trend. This is different with other stock indexes fluctuated highly and tends to have a downward trend.

Keywords: *ARCH/GARCH, return stock, stock price*

ABSTRAK

Pergerakan yang semakin melambat pada pertumbuhan ekonomi Indonesia pada 2014 disebabkan oleh beberapa faktor, faktor internal dikarenakan tingginya bunga di Indonesia dan faktor eksternal dari AS yang akan menaikkan suku federalnya tahun ini. Akan tetapi, JKSE menunjukkan tren peningkatan tajam dari awal 2014 hingga kuartal kedua 2015 meskipun masih berfluktuasi akan tetapi tidak signifikan. Tujuan dari penelitian ini adalah untuk menentukan model terbaik ARCH / GARCH pada JKSE dan saham indeks di negara-negara maju (FTSE, Nasdaq dan STI) dan kemudian membandingkan JKSE dengan indeks saham di negara-negara maju tersebut. Hasil yang diperoleh dalam penelitian ini adalah model ARCH / GARCH terbaik, diperoleh JKSE adalah GARCH (1,2), sementara FTSE mendapatkan GARCH (2,2), NASDAQ menghasilkan model terbaik adalah GARCH (1,1) dan STI dengan GARCH (2,1), dan hasil perbandingan JKSE dengan FTSE, NASDAQ dan STI adalah bahwa meskipun JKSE berfluktuasi dengan tingkat sedang, akan tapi tren yang ditunjukkan adalah kecenderungan meningkat. Hal ini berbeda dengan indeks saham lainnya yang berfluktuasi sangat tinggi dan cenderung mengalami tren penurunan.

Kata kunci: *ARCH/GARCH, retun saham, harga saham*

INTRODUCTION

The movement which is getting slowed in Indonesia economic growth in 2014 is due to several factors, namely internal and external factors. On internal factors, due to the high interest rates in Indonesia. In this case, the Bank of Indonesia as the central bank to prevent the high inflation caused by pruning subsidies of fuel oil, inhibits the release of capital, ahead of the US monetary tightening, limiting the current account deficit and strengthen of the rupiah by raising the BI rate several times in recent years.

Prevention efforts are not making the rupiah stronger, but depreciated to Rp 13,500/USD. It was also due to external factors from the US which will raise the fed rate this year. Slowing economic growth in Indonesia is also due to the unstable political and many natural disasters that occurred in the last few years. On the outer, this can lead to doubts or fears of investors to invest in Indonesia. But on JKSE figure 1, the trend shows a sharp increase from the beginning of 2014 until the second quarter of 2015, although it remains fluctuate, but insignificant.

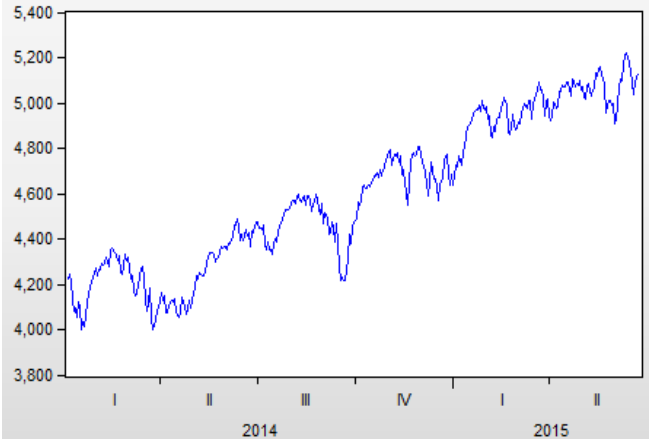

Figure 1 Movement JKSE Price
Source: Yahoo finance (www.yahoofinance.com)

Similar research has been done using the method of ARIMA or ARCH / GARCH, such as Jati (2014) by determining the best sugar prices using the method of ARMA and ARCH / GARCH. Then, Nastiti and Suharsono (2012) investigated Volatility Stocks Companies Go Public with ARCH-GARCH method, which focuses on the analysis of volatility return. McClain & Humphreys (1996), used ARCH in measuring the risks and the financial behavior of the mining sector. Al-Raimony and El-Nader (2012) examined the volatility of the stock market in Jordan, which discusses the same thing about stock volatility using ARCH / GARCH. Later in the same year they also use this model to test the impact of micro-economic factors on share price returns. Previously, Urooj, Zafar and Durrani (2009) have examined the same thing about stock returns using the same method on the KSE-100 index. Most of the above research analyze only on volatility spiked by using ARCH / GARCH. While in this study, in addition to determining the best model in the ARCH / GARCH, it also compares the JKSE stocks to shares in developed countries.

The definition of stock prices according to Martono (2007) is “a reflection of asset management, investment decisions and financing”. According to Sawidji (2005), "stock price are the price of one investor to another investor after the stock in put on the exchange, both major exchanges or OTC (Over the counter market) ". Supply and demand are the determinant of the price of stocks

listed on the stock exchange. In times of rising prices, the tendency of investors to sell their stocks led to excess supply, so the price can go back down. When prices go back down, investors tend to buy shares which can lead to excess demand to increase the price again. If the demand for stocks increases, the share price will tend to rise. According to Nastiti (2012), stock price movements consist of three kinds: the first is Bullish, which stock prices continue to go up over time. This can occur due to global financial circumstances or management policies of the company. Second, Bearish, which is a state in which stock prices fell and continued investor detriment. Investors who own shares can be sold at a low price and get a loss, or can be bought back if there is accurate information about the rise in stock prices in the future. Third, sideways, which is a state in which stock prices stable. It is said to be stable because stock prices moves up or down to form a horizontal chart from time to time.

This is the main attraction of researchers in conducting this research. Amid the global economy that has not been conducive to the issue of the increase in fed rate, unstable political issues, natural disasters that frequently occur, JKSE still shows the green trend. This means that the level of investor confidence is still high on the Indonesian stock index. Based on it, the researcher wrote a research, entitled " Determining The Best ARCH/GARCH Model and Comparing JKSE with Stock Index in Developed Countries ", with the purpose of this research is to determine the best ARCH / GARCH model on JKSE and stock index in developed countries (FTSE, Nasdaq and STI). Then compare JKSE with the stock index in developed countries (FTSE, Nasdaq and STI). This was done in an effort to show the world, that the stock index in Indonesia still the rising trend although hit by the economic and political instability in the country as well as the global economy has not been conducive.

METHOD

The data used in this research is secondary data time series for the data stock index in Indonesia, JKSE and several stock index in developed countries like the US (NASDAQ), London (FTSE), Singapore (STI). The data used in this study is the return of stock prices taken from the date of 02 January 2014 to 24 June 2015. This taken data are meant to see volatility JKSE price, which in range of time rupiah / usd was weakened compared to stock indexes in developed countries like US, London and Singapore (www.idx.co.id). The data was taken in the form of closing stock prices. Data is processed using software reviews and use the instructions of Winarno (2009).

The ARMA/ARIMA Model

Before explaining models of ARCH and GARCH, the first discussed variable that affect stock prices. The model used is the technique of Box-Jenkins. Box-Jenkins models is commonly called as Autoregressive Integrated Moving Average model (ARIMA). Box and Jenkins popularize the method which consists of three stages in selecting a suitable model for estimating and forecasting univariate time series data, the model identification, parameter estimation, and forecasting (Enders, 1995). ARIMA model is a combination of autoregressive models (AR) and moving average (MA). Both models require the data to be analyzed and moves along a constant average (stationary). If the data is not stationary, then the stationary process data using the differentiation process. ARIMA is a combination of AR and MA models through different processes. ARIMA models have time slackness. Inaction first time period in a process called autoregressive first order autoregressive or abbreviated AR (1). The symbol to denote the number of inaction at the time of the autoregressive process is p. Inaction first time period in a process called a moving average moving average of first-order or abbreviated MA (1). The symbol for the number of inaction when the moving average process is q. The value of p and q values can be more than 1. Different process on ARIMA models aimed at obtaining data stationary. Different process can be performed once or may be done more than once

until the data is stationary. Usually, different process is not more than 2 times. Different process the data symbol is d. Writing ARIMA models for AR (p), MA (q), and different times as much d is ARIMA (p, d, q). For example in an ARIMA process using a first-order autoregressive, moving average first-order, and differentiate once to obtain data stationary, then the writing is ARIMA (1,1,1). Gujarati (2003) described the Box-Jenkins methodology into four steps, namely: identification, estimation, diagnostic examinations, and forecasting. For instance, in creating a model to predict the value of Y. The general form of autoregressive model order of p or AR (p) is:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \ldots + \alpha_p Y_{t-p} + \varepsilon_t \quad (1)$$

Y_t : observed variables
α_0: constant autoregressive
$\alpha_1 \ldots \alpha_p$: parameter $Y_{t-1} \ldots Y_{t-p}$

Common forms of moving average models order to q or MA (q) is:

$$Y_t = \beta_0 + \beta_1 \varepsilon_t + \beta_2 \varepsilon_{t-1} + \beta_3 \varepsilon_{t-2} + \ldots \beta_q \varepsilon_{t-q} \quad (2)$$

Y_t : observed variables
β_0 : Constant moving average
$\beta_1 \ldots \beta_q$: Parameter $\varepsilon_t \ldots \varepsilon_{t-q}$

Common form of ARIMA model with autoregressive order for p and q as moving average order are:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \ldots + \alpha_p Y_{t-p} + \varepsilon_t + \beta_0 \varepsilon_t + \beta_1 \varepsilon_{t-1} + \ldots + \beta_q \varepsilon_{t-q} \quad (3)$$

There are four steps in determining the best ARIMA. The first step in the process is the identification of ARIMA. This step is performed to determine whether the observed data is stationary. If not stationary, do different process until the data is stationary. After that, makes correlogram distribution data to determine the order of the autoregressive and moving average order. Order selected is inaction time coefficient autoregressive and partial autoregressive coefficients are significant. The determination of the order of (inaction time) for AR and MA is done by trial and error. Identification tool used is the autocorrelation function (ACF) and partial autocorrelation function (PACF) on the table correlogram. The concept of partial autocorrelation analogous to the concept of partial regression coefficients in the k-variable regression, regression coefficient βk measures changes in the average value regression and on changes in the unit k regression Xk .. Partial autocorrelation ρkk measures the correlation between observations (time series) in the period of time k after controlling for correlations at intermediate lag. In addition to the saw table correlogram, the formal stationary test can be applied by using the Dickey-Fuller unit root test (Gujarati, 2003).

The second step is to estimate the parameters of the autoregressive and moving average parameters based order (p and q) obtained at the stage of identification. The third step is to perform a diagnostic test. After getting estimator of ARIMA model, then choose a model which explains the data well. The third step is iterative and requires a special expertise to choose the right ARIMA model, so the ARIMA modeling is more to art than scientific (Gujarati, 2003). A good model is a model that has randomly distributed residuals (White Noise). The test is performed by comparing the magnitude of the coefficient autoregressive (ACF) and partial autoregressive coefficient (PACF) residual obtained from residual correlogram. If the coefficient of ACF and PACF coefficients were not significant (the coefficient value is smaller than the critical value), then the model obtained is white noise (residual randomly distributed).

The fourth step is to forecast the value of observed variables. One reason for its popularity is the ARIMA model in forecasting success. In some cases the predictions obtained from this method is better than traditional econometric forecast models, especially in the short term.

The ARCH/ GARCH Model

Assuming a constant residual variance or homoskedasticity which are generally used in modeling of time series data. But in fact, the residual variance is not constant or heteroskedastisity occurred in many time series data, especially in the the financial sector time series data. This led to the assumption that homoskedasticity modeling cannot be used. Engle (1982) introduced the ARCH models or Autoregressive Conditional Heteroskedasticity that can be used to analyze the time series data contained heteroskedasticity. However, this model can be used after the proven data auto regression is stated to be heteroskedasticity. ARCH models can be formulated as follows:

$$h_t = k + \alpha_1 \varepsilon_{t-1}^2 + \cdots + \alpha_q \varepsilon_{t-q}^2 + v_t \quad (4)$$

Then in 1986, Bollerslev develop ARCH models, became a model GARCH or Generalized Autoregressive Conditional Heteroskedasticity used to avoid ARCH a large and gives results more practical than the previous model, similar to the conditions in which the ARMA model is preferred over the AR model. Parameter ARCH / GARCH can be predicted with maximum likelihood method and if the data distribution abnormal, GARCH specifications can still provide a decent model parameters a consistent and forecasting based on linear quadratic v, the Quasi Maximum Likelihood method that is by maximizing the log likelihood function. GARCH models can be formulated as follows:

$$h_t = k + \alpha_1 \varepsilon_{t-1}^2 + \cdots + \alpha_q \varepsilon_{t-q}^2 + \beta_1 \sigma_{t-1}^2 + \cdots + \beta_p \sigma_{t-p}^2 + v_t \quad (5)$$

Many economists explain that economic agents are not only providing a response to the mean, but also economic events which are very volatile. With conditions such variants are likely to be high, the traditional econometric models cannot explain validly in estimating and perform forecasting time series data. In this case the stock price that has high volatility which is certainly a variant of such data cannot be constant (homoskedasticity) that violates the classical assumptions. Engle (1982) proposed a model called the Conditional Autoregressive Heteroscedasticity (ARCH). The model was applied to analyze the behavior of inflation in the United Kingdom in the period 1958: 2-1977: 2. The equation used is first order auto regression and was estimated using ARCH models. In his paper, Engle explained that the model with time series data with high volatility tended to contain the problem of heteroscedasticity. The valuation method used by Engle is Maximum Likelihood (ML) with ARCH models and compared it to the estimated OLS models. The result indicates that the model ARCH-ML was able to deliver results in a more realistic prediction of the variant compared with OLS. Bollerslev (1986) enhanced ARCH models developed by Engle (1982), but within the framework of the same analysis. This was done by incorporating elements of past residuals and residual variance in the equation Autoregressive. The model is called as the Generalized Autoregressive Conditional Heteroscedasticity (GARCH). By using the inflation data in the U.S. with autoregressive equation, Bollerslev tried to re-evaluate inflation ARCH model by Engle. The results showed that by incorporating elements of the residual variance in the regression equation produces better than ARCH models. In this study the data used is stock index data.

RESULTS AND DISCUSSION

Figure 2-4 below are stick indexes in several countries, namely: Indonesia, London, USA, and Singapore from January 2, 2014 until July 25, 2015, at which time range the Indonesian stock index was fluctuate but still experiencing upward trend.

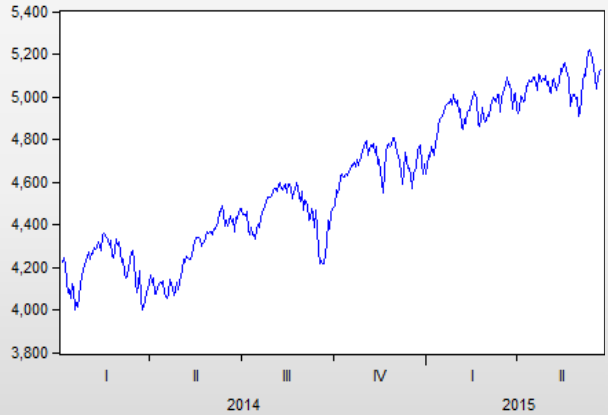

Figure 2 JKSE

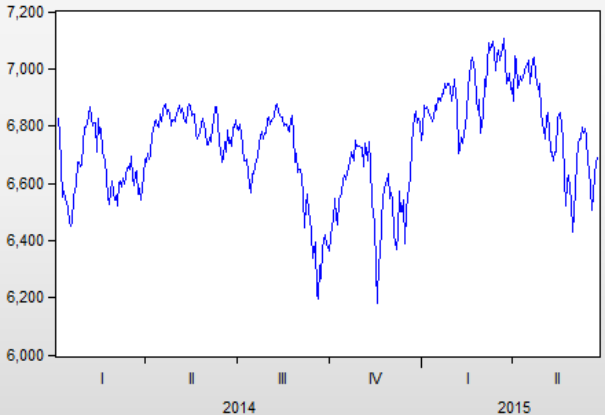

Figure 3 FTSE

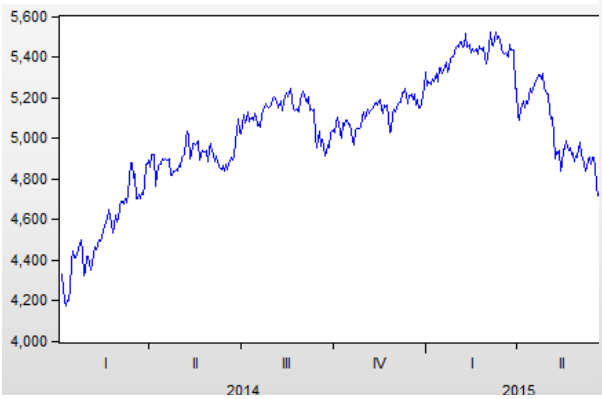

Figure 4 Nasdaq

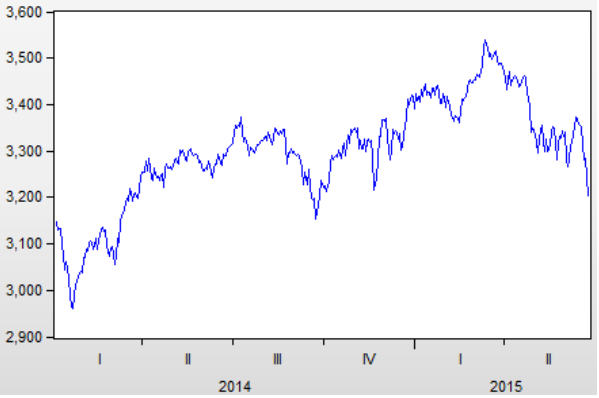

Figure 4 STI

(Sources: Yahoo finance (www.yahoofinance.com))

Another case with Indonesia, stock indexes in developed countries such as London, USA and Singapore fluctuate very high, and tend experiencing downward trend. Stock indexes above shows a sharp decline in the 3rd quarter and 4th in 2014 and 2nd quarter of 2015, which led to high fluctuations. Unlike the Indonesian stock indexes, even though it was fluctuating, but it still showed upward trend until the second quarter of 2015. This indicates the risk of the stock index in Indonesia was lower than developed countries, as represented in this paper, namely London, USA and Singapore. It is tempting for investors to avoid risk and prefer to invest in stocks that tend to be more stable. Indonesia is currently experiencing instability of the rupiah and stock index caused by several factors, but in developed countries, Indonesia stock index tends to be more stable with upward trend.

Stationarity Test

To determine whether the data used has a stable deployment or not, testing stationary as a preliminary step is required, prior to the determination of the model. This study used Unit Root Test with Augmented Dickey-Fuller test (ADF). In the ADF test, to determine the data is stationary or not visible from p-values should be less than α (5%).

Table 1 Unit Root Test on Level

	JKSE	FTSE	NASDAQ	STI
ADF test	-18.90221	-18.25458	-19.02186	-18.2951
Critical Value 1%	-3.447169	-3.447169	-3.447169	-3.447169
Critical Value 5%	-2.868848	-2.868848	-2.868848	-2.868848
Critical Value 10%	-2.57073	-2.57073	-2.57073	-2.57073
P-Value	0.0000	0.0000	0.0000	0.0000

(Sources: Yahoo finance (www.yahoofinance.com) and Calculate)

Table 1 show that the test unit root at the level of p-values in the entire index <0.05 (5%), which means that all the data is stationary. After all, the data are certainly stationary at further level (which means not necessary first difference) in determining the best model of ARMA (ARIMA will be used if the data is experiencing first difference when the unit root test).

The Best ARMA Model

The best ARMA models derived from trial and error is described in Table 2 below:

Table 2 The Best ARMA Model

No	Description	Best ARMA Model	Min Sum Squared Resid	Minimum AIC
1	JKSE	ARMA (1,2)	643674.2	10.28564
2	FTSE	ARMA (1,1)	1036120	10.28564
3	NASDAQ	ARMA (0,1)	605028	10.21325
4	STI	ARMA (1,1)	129751.3	8.678827

(Sources: Yahoo finance (www.yahoofinance.com) and Calculate)

From table 2, it is obtained the best model of ARMA. At JKSE, best ARMA model be obtained ARMA (1,2). On the FTSE, best ARMA model be obtained ARMA (1,1). On the NASDAQ, best ARMA model be obtained (0.1). And the STI, the best model obtained ARMA (1,1). Things that become the best model on the ARMA determination of results trial and error, determine the value of the smallest sum squared residuals, Akaike information criterion value the smallest, can also see the value of Schwarz Criterion (SC) and Adjusted R-Squared smallest. In this case, the researchers also assessed the probability of each variable is less than 0.05.

The Best ARCH/GARCH Model

Table 3 Descriptive Statistics Data JKSE, FTSE, NASDAQ and STI

Series: JKSE	
Sample 1/02/2014 6/25/2015	
Observations 385	
Mean	-1.234451
Median	-4.573243
Maximum	189.9092
Minimum	-152.4761
Std. Dev.	41.14630
Skewness	0.654877
Kurtosis	5.487028
Jarque-Bera	126.7414
Probability	0.000000

Series: FTSE	
Sample 1/02/2014 6/25/2015	
Observations 385	
Mean	0.337662
Median	-3.800293
Maximum	181.1001
Minimum	-159.7998
Std. Dev.	52.24873
Skewness	0.214684
Kurtosis	3.989826
Jarque-Bera	18.67429
Probability	0.000088

Series: NASDAQ	
Sample 1/02/2014 6/25/2015	
Observations 385	
Mean	-2.344208
Median	-6.449707
Maximum	129.7898
Minimum	-104.0898
Std. Dev.	39.71005
Skewness	0.445964
Kurtosis	3.546306
Jarque-Bera	17.54935
Probability	0.000155

Series: STI	
Sample 1/02/2014 6/25/2015	
Observations 385	
Mean	-0.143298
Median	-0.440186
Maximum	79.04981
Minimum	-51.42993
Std. Dev.	18.44801
Skewness	0.395809
Kurtosis	3.794599
Jarque-Bera	20.18115
Probability	0.000041

(Sources: Yahoo finance (www.yahoofinance.com) and Calculate)

In the descriptive analysis of the statistics above describe a positive Skewness value on the each composite index. The value of skewness is an asymmetry measurements distribution data. The value of 0.654877 on the JKSE, 0.214684 on the FTSE, 0.445964 on the NASDAQ, and 0.395809 on the STI, indicate that the data distribution has a longer tail to the right hand. Furthermore, Kurtosis value is greater than three for each stock index, which means that, the value of kurtosis over the three showed early symptoms of heteroscedasticity. It also appears on the Jarque-Bera test with a probability value of <0.05 which means that the data distribution is abnormal, as seen in Table 3.

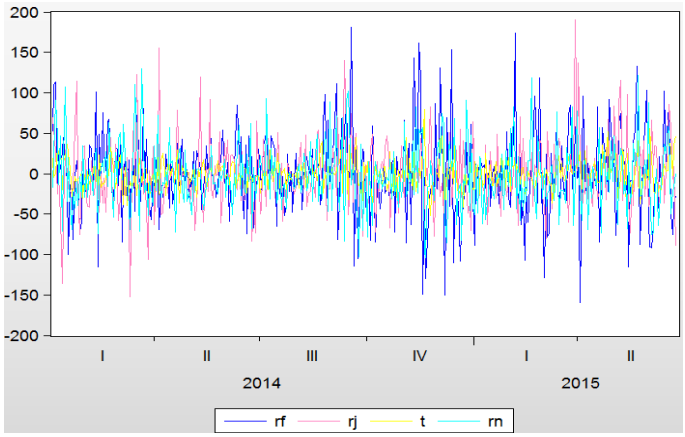

Figure 5 Changes in the level of daily return on all stock index
(Sources: Yahoo finance (www.yahoofinance.com) and Calculate)

Figure 5 illustrates the differences between the top point with the bottom is very large. This indicates visually for heteroscedasticity. The existence of heteroscedasticity can also be assessed from the probability value (p-value) on the trial and error of ARMA <0.05 which means that the ARMA (1,2) on the JKSE, ARMA (1,1) on the FTSE, ARMA (0,1) on the NASDAQ and ARMA (1.1) on the STI contained ARCH effects. If an analysis has to determine the existence of heteroscedasticity on all that exist in stock index data, the next step is to test the models of ARCH / GARCH to determine the

best model. In determining the model ARCH / GARCH best through trial and error, and by looking at either one of values AIC and SC its lowest and has a significant coefficient values <0.05.

Table 4 Testing ARCH/GARCH JKSE ARMA (1,2)

Coefficient	ARCH (1)	ARCH(2)	GARCH (1,1)	GARCH (1,2)	GARCH (2,1)	GARCH (2,2)
C	0.0000	0.0000	0.4897	0.0000	0.3539	0.4741
A1	0.0001	0.1014	0.3261	0.0328	0.1786	0.0004
A2		0.1643			0.0855	0.1907
G1			0.1187	0.0000	0.4034	0.6256
G2				0.0000		0.4817
AIC	10.26014	10.27770	10.28477	10.25719	10.28406	10.26178
SC	10.32187	10.34971	10.35679	10.3395	10.36636	10.35437
SSR	637515.4	637169.3	637102	638022.2	637096.3	637430.8
ARS	0.003937	0.004478	0.004583	0.003145	0.004592	0.004069

(Sources: Yahoo finance (www.yahoofinance.com) and Calculate)

C = Coefficient
A1 = ARCH 1
A2 = ARCH 2
G1 = GARCH 1
G2 = GARCH 2
AIC = Akaike Info Criterion
SC = Schwarz Criterion
SSR = Sum Squared Residual, ARS is Adjusted R-Square.

In some sources, it is said that in determining the best model of ARCH / GARCH than to see the value of AIC and SC the lowest, can also see the value of SSR and ARS lowest. In 4 it can be found the best model of JKSE is GARCH (1, 2). Preliminary analysis can be seen from the coefficient values of <0.05, then it can be seen from AIC and ARS with the first lowest value, after that, the value of the SC with the second lowest value. These can strengthen the results of alleged ARCH / GARCH as the best models on JKSE.

Table 5 Testing ARCH/GARCH FTSE ARMA (1,1)

Coefficient	ARCH (1)	ARCH(2)	GARCH (1,1)	GARCH (1,2)	GARCH (2,1)	GARCH (2,2)
C	0.0000	0.0000	0.0222	0.0012	0.0386	0.0001
A1	0.0986	0.1515	0.0018	0.0095	0.1027	0.0865
A2		0.1494			0.6514	0.3416
G1			0.0000	0.0000	0.0000	0.0000
G2				0.0000		0.0000
AIC	10.74405	10.73772	10.67395	10.67383	10.67869	10.66961
SC	10.79549	10.79945	10.73568	10.74585	10.75071	10.75192
SSR	1028210	1029602	1028624	1028337	1028480	1028905
ARS	0.011387	0.010049	0.010989	0.011264	0.011128	0.010719

(Sources: Yahoo finance (www.yahoofinance.com) and Calculate)

Table 5 shows the results where the best models of ARCH / GARCH on the FTSE is GARCH (2,2). This analysis indicated from coefficient values of <0.05, the lowest AIC value with 10.66961. It can strengthen the results of alleged ARCH / GARCH the best models in the FTSE in the period January 2014 - June 2015.

Table 6 Testing ARCH/GARCH NASDAQ ARMA (0,1)

Coefficient	ARCH (1)	ARCH(2)	GARCH (1,1)	GARCH (1,2)	GARCH (2,1)	GARCH (2,2)
C	0	0.0000	0.1704	0.1835	0.2112	0.1972
A1	0.0555	0.0606	0.0306	0.05	0.4026	0.0149
A2		0.8870			0.6784	0.1226
G1			0.0000	0.475	0.0000	0.0737
G2				0.5149		0.0000
AIC	10.20503	10.21018	10.19059	10.19599	10.19526	10.19353
SC	10.24610	10.26152	10.24193	10.25760	10.25687	10.26541
SSR	605098.3	605092.7	605617.9	605527.5	605796.4	605815.9
ARS	-0.001904	-0.001895	-0.002765	-0.002615	-0.00306	-0.003092

(Sources: Yahoo finance (www.yahoofinance.com) and Calculate)

Results obtained from table 6 above shows the best model of NASDAQ, which is the GARCH (1,1). Obtaining the results of the best model through analysis alleged lowest value of AIC and SC. It can strengthen the results of alleged ARCH / GARCH as the best models of NASDAQ stock index in the period of January 2014 - June 2015.

Table 7 Testing ARCH/GARCH STI ARMA (1,1)

Coefficient	ARCH (1)	ARCH(2)	GARCH (1,1)	GARCH (1,2)	GARCH (2,1)	GARCH (2,2)
C	0.0000	0	0.2344	0.2311	0.3812	0.4144
A1	0.0036	0.0034	0.0303	0.0099	0.0048	0.0063
A2		0.8464			0.0408	0.1201
G1			0.0000	0.4810	0.0000	0.0810
G2				0.0881		0.3344
AIC	8.655204	8.660314	8.634561	8.631372	8.625552	8.626556
SC	8.706645	8.722043	8.696290	8.703389	8.697569	8.708862
SSR	129781.0	129784.7	129661.4	129681.7	129762.6	129721.6
ARS	-0.000966	-0.000994	-0.000043	-0.000199	-0.000824	-0.000507

(Sources: Yahoo finance (www.yahoofinance.com) and Calculate)

In the table 7 it can be concluded that ARCH / GARCH the best model on the STI is GARCH (2, 1). The above results are the analysis results taken from its lowest value of AIC and SC. It can strengthen the results of alleged ARCH / GARCH as the best model on the STI in the period of January 2014 - June 2015. The Model of GARCH (1,2) on the JKSE, GARCH (2,2) on the FTSE, GARCH (1,1) on the NASDAQ and GARCH (2,1) on the STI is alleged as the best models. Further analysis the above Jarque Berra (on descriptive statistics) shows that the probability value of <0.05, shows that the distribution of the data abnormal. This method is an abnormality prediction of GARCH model used is the Quasi Maximum Likelihood. Further examination test the raw residual ACF. There is no heteroscedasticity in the expected raw residual. Assessment models free from heteroscedasticity is the probability value > 0.05. Table 8 shows the results of Ljung Box are used.

Tabel 8 JKSE Heteroskedasticity Test

Heteroskedasticity Test: ARCH

F-statistic	0.225553	Prob. F(1,381)	0.6351
Obs*R-squared	0.226603	Prob. Chi-Square(1)	0.6341

(Sources: Calculate)

Table 8 shows the probability that has been > 0.05, which is 0.6351, which means that the model GARCH (1,2) has been free from the heteroscedasticity. Thus it can be said that JKSE have heteroskedastic volatility movement which is significant. Thus GARCH (1,2) on JKSE is a good model.

Tabel 9 FTSE Heteroskedasticity Test

Heteroskedasticity Test: ARCH

F-statistic	0.986790	Prob. F(1,381)	0.3212
Obs*R-squared	0.989407	Prob. Chi-Square(1)	0.3199

(Sources: Calculate)

Table 9 shows the probability > 0.05, which is 0.3212, which means that the model GARCH (2,2) has been free from the heteroscedasticity. Thus, it can be said that FTSE have heteroskedastic volatility movement which is significant. Thus, GARCH (2,2) on FTSE is a good model.

Tabel 10 NASDAQ Heteroskedasticity Test

Heteroskedasticity Test: ARCH

F-statistic	0.188843	Prob. F(1,382)	0.6641
Obs*R-squared	0.189738	Prob. Chi-Square(1)	0.6631

(Sources: Calculate)

Table 10 shows the probability > 0.05, which is 0.6641, which means that the model GARCH (1,1) has been free from the heteroscedasticity. Thus, it can be said that NASDAQ have heteroskedastic volatility movement which is significant. Thus GARCH (1,1) on NASDAQ is a good model.

Tabel 11 STI Heteroskedasticity Test

Heteroskedasticity Test: ARCH

F-statistic	0.040927	Prob. F(1,381)	0.8398
Obs*R-squared	0.041137	Prob. Chi-Square(1)	0.8393

(Sources: Calculate)

Table 11 above shows the probability that is > 0.05, which is 0.8398, which means that the model GARCH (2,1) has been free from the heteroscedasticity. Thus it can be said that STI have heteroskedastic volatility movement which is significant. Thus GARCH (2,1) on STI is a good model.

Forcasting

The model of GARCH (1,2) on JKSE, GARCH (2,2) on the FTSE, GARCH (1,1) on the NASDAQ and GARCH (2,1) on the STI is the best variety of models used in forecasting.

Forecast: J_KSEF	
Actual: J_KSE	
Forecast sample: 1/02/2014 6/25/2015	
Adjusted sample: 1/03/2014 6/25/2015	
Included observations: 385	
Root Mean Squared Error	49.20228
Mean Absolute Error	37.55681
Mean Abs. Percent Error	0.819351
Theil Inequality Coefficient	0.005335
Bias Proportion	0.004430
Variance Proportion	0.033971
Covariance Proportion	0.961600

Figure 6 Forecast JKSE
(Sources: Calculate)

Forecast data showed that the Mean Absolute Percent Error (MAPE) on JKSE with Model GARCH (1,2) is 0.82%, which means that the error rate in predicting future stock prices is small, only about 0.82%. However MAPE in stock index is the second largest after the NASDAQ by 2.63%

Forecast: F_TSEF	
Actual: F_TSE	
Forecast sample: 1/02/2014 6/25/2015	
Adjusted sample: 1/03/2014 6/25/2015	
Included observations: 385	
Root Mean Squared Error	51.57125
Mean Absolute Error	38.46624
Mean Abs. Percent Error	0.575646
Theil Inequality Coefficient	0.003828
Bias Proportion	0.005941
Variance Proportion	0.029656
Covariance Proportion	0.964402

Figure 7 Forecast FTSE
(Sources: Calculate)

Forecast data showed that the Mean Absolute Percent Error (MAPE) on FTSE with GARCH model (2.2) is 0.57%, which means that the error rate in predicting future stock prices is small, only

about 0.57%. In this prediction indicates the level of error in predicting smaller than JKSE and larger when compared with the STI just 0.43%.

Forecast: N_ASDAQF	
Actual: N_ASDAQ	
Forecast sample: 1/02/2014 6/25/2015	
Included observations: 386	
Root Mean Squared Error	171.4157
Mean Absolute Error	127.4393
Mean Abs. Percent Error	2.633940
Theil Inequality Coefficient	0.016959
Bias Proportion	0.094790
Variance Proportion	0.771160
Covariance Proportion	0.134050

Figure 8 Forecast NASDAQ
(Sources: Calculate)

Figure 8 forecast data showed that the Mean Absolute Percent Error (MAPE) on the NASDAQ with the model GARCH (1,1) is 2.63%, which means that the error rate in predicting future stock prices is small, only about 2.63%. However, compares to other stock indexes, NASDAQ is the highest MAPE.

Forecast: S_TIF	
Actual: S_TI	
Forecast sample: 1/02/2014 6/25/2015	
Adjusted sample: 1/03/2014 6/25/2015	
Included observations: 385	
Root Mean Squared Error	18.32061
Mean Absolute Error	14.09594
Mean Abs. Percent Error	0.429079
Theil Inequality Coefficient	0.002774
Bias Proportion	0.000726
Variance Proportion	0.009722
Covariance Proportion	0.989552

Figure 9 Forecast FTSE
(Sources: Calculate)

Forecast data in figure 9 that the Mean Absolute Percent Error (MAPE) on STI with GARCH model (2.1) is 0,43%, which means that the error rate in predicting future stock price is the smallest, only about 0,43% compared to other stocks. It can also provide input to the investors to buy the stock. However, MAPE is not the only indicator in determining investment. From the trend and movement of stocks above, it is showed that JKSE is a stock index in developing countries which shows a rising trend amid weak exchange rate and the increasing issue of the fed rate.

CONCLUSION

It can be concluded that the best model that has been determined ARCH / GARCH on JKSE, FTSE, NASDAQ and each STI is GARCH (1,2), GARCH (2,2) GARCH (1,1) and GARCH (2,1), alleged model have been tested for feasibility with Ljung box test and get the maximum result that the model has been free from heteroscedasticity. Furthermore, a comparison obtained from the results above is, JKSE is a stock with an upward trend even though the economic and political instability in the country was also a problem that the fed rate issue to rise this year, but it has no effect on the stock price on JKSE. Another case with the stock in developed countries such as the FTSE, NASDAQ and STI are experiencing high volatility and tend to downward trend. Other than to the issue fed rate to rise, the Greece crisis also greatly impact on its stock price movements.

REFERENCES

Al-Raimony, A. D., & El-Nader, H. M. (2012). The Sources of Stock Market Volatility in Jordan. *International Journal of Economics and Finance*, *4*(11).

Al-Raimony, A. D., & El-Nader, H. M. (2012). The Impact of Macroeconomic Factors on Amman Stock Market Returns. *International Journal of Economics and Finance, 4*(12).

Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics*, *31*(3), 307-327.

Enders, W. (1995). *Applied Econometrics Time Series*. New York: John Wiley and Sons.

Engle, R. F (1982), Autoregressive Conditional Heteroskedasticity with Estimates of the Variance of UK Inflation. *Econometrica, 50*(4), 987-1008.

Gujarati. (2003), *Econometría*, México: McGraw Hill.

Jati, K. (2014). Analysis of Sugar Prices Volatility Using ARMA and ARCH/GARCH. *International Journal of Trade, Economics and Finance, 5*(2), 136-141.

McClain, K. T., Humphreys, H. B. (1996), Measuring Risk in The Mining Sector with ARCH Model with Important Observations on Sample Size. *Journal of Empirical Finance*, *3*(4), 369-39.

Martono, Harjito. (2007), *Management in Finance*. Djogjakarta: Ekonisia.

Nastiti, S. (2012). Volatility Analysis of Stocks Companies Go Public with ARCH - GARCH method. *Jurnal Sains dan Seni ITS, 1(1).*

Sawidji, W. (2005). *Healthy Ways to Invest in Stock Market*. Jakarta: PT. Elex Media Komputindo.

Urooj, S.F., Zafar, N., & Durrani, T.K. (2009). Finding the Stock Return Volatility: A Case od KSE-100 Index. *Interdisciplinary Journal of Contemporary Research in Business*, *1*(4), 65-80.

Website Yahoo Finance http://finance.yahoo.com

Winarno, W.W. (2009). *Analisis Ekonometrika dan Statistika dengan EViews*. Yogyakarta: UPP STIM YKPN.