VOLATILITY TRANSMISSION OF THE MAIN GLOBAL STOCK RETURN TOWARDS INDONESIA

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Abstract

Volatility of stock returns is a very interesting phenomenon as it impacts the existence of global financial markets. Indeed, the impact of shocks in a country can be transmitted to markets in other countries through the mechanism of transmission, leading to financial instability in related markets (Liu et al., 1998). The present paper aims to determine the best model in describing the volatility of stock returns, to identify the asymmetric effect, and also to explore the transmission of seven foreign stock return volatilities in Indonesia over the period of 1990-2016 (on daily basis). The stock return volatility modeling process uses symmetric GARCH and various asymmetric GARCH models. Whereas, the stock return volatility transmission analysis uses the Vector Autoregressive system. The result of fitting the right model for all of seven stock markets showed that the asymmetric model of GARCH had a better estimation in portraying the stock return volatility. Moreover, the model can also reveal the existence of asymmetric effects on the seven stock markets. The other findings demonstrated that Hong Kong and Singapore play a dominant role in influencing the volatility return of Indonesia. In addition, the degree of interdependence between Indonesia's stock market and foreign's stock market has increased substantially after the 2007 crisis. In the period after the crisis of 2007, the effects of return volatility of both the US and UK stock markets experienced a drastic increase in affecting return volatilities of the Indonesia stock market.

Keywords: GARCH asymmetric, modeling, the stock market, volatility return, volatility transmission.
JEL Classification: C01, C51, C58, G15

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I. INTRODUCTION

The Indonesian economic growth has strengthened over the last decade, after the Asian crisis (OECD, 2015). The Gross Domestic Product (GDP) of Indonesia is expected to grow by 5.3% in 2017, up from a forecast of 5.0% in 2016 (IDX, 2016). This brighter outlook has attracted considerable foreign investment in both real and financial assets through its investment portfolio on a stock exchange. It looks at the performance of the Indonesia Stock Exchange which became one of the largest stock exchanges in Asia, holding the 9th rank in the Asian stock exchanges through market capitalization size indicator (Pratiwi, 2015). The improved performance of the Indonesian capital market becomes a factor of interest and optimism for both foreign and domestic investors in choosing Indonesia as an investment destination not only in the present but also in the future.

Along with increased globalization, international finance become increasingly integrated, more opened, and market shares in several different countries are interconnected (King and Wadhwani, 1990). Associated with the fact that the international financial markets become increasingly integrated, the mobility of capital from one country to another country also grew. Most industrialized countries, nowadays, are not restricted in the control of foreign assets (Dornbusch et al., 2011). This condition occurs in the Indonesia Stock Exchange as the impact of globalization, which is about 65% of the public shares owned by foreign investors (Volatility Study Team and World Economy, 2010).

Another fact that must be faced, regarding the impact of increased globalization, is the world's financial markets without borders that leads to possibilities of increment in risks through shocks that happened on a certain market which become harder to isolate from the other markets. The impact of a shock in a country can be spilled over into another country through the mechanism of transmission which will result in financial instability on the related markets (Ajireswara, 2014). It makes the diversification gains from investing internationally might have to reduce significantly (Liu et al., 1998). In turn, the transmission process can weaken the stability of financial markets and invite the risk of investment that might significantly rise.

Financial globalization also contributed to the financial crisis. Indeed, almost all of the world financial markets, especially emerging markets, were traumatized since the onset of the global financial crisis that peaked in 2008. This crisis was triggered by the explosion of subprime mortgages in the United States. The development of the financial crisis has impacted the investment, commercial banking, insurance industry, which have been transmitted through the countries in Europe, Japan, and eventually spread to almost all developing countries. Tumbling world stock prices reached a very low level. The deteriorating condition of the US financial markets, as the pole of world's economy, brought significant impact on the weakening of other countries economies in the world, including Indonesia. Thus, poor conditions or a market failure in a country can be transmitted to other markets, which will result in the increase of volatility (King and Wadhwani, 1990).

In relation to the above description, the market risk is one thing that must be considered by traders, companies, and investors, while making investment decisions. The stock price index moves in seconds and minutes, then returns stock are also moving up and down within a relatively short period of time. This movement is known as the volatility of stock return, which will lead to risks and uncertainties faced by investors that could be increasingly large with the unstable interest of investors. The existence of volatility is closely related to the risk on the stock market. High volatility reflects uncommon characteristics of supply and demand. Thus, the volatility on the financial market, especially on the stock market, is an interesting phenomenon that attracts the interests of both researchers and the general public who care about the risks.

Market participants can control and reduce the market risk of the assets, that are traded such as shares, by estimating the volatility through the modeling process. The modeling volatility can be done with the initial generation of GARCH models such as ARCH of Engle (1982) and GARCH of Bollerslev (1986), which can reveal the presence of volatility clustering, for big shocks are followed by big shocks (Awartani and Corradi, 2005). However, the initial generation of GARCH models cannot capture the asymmetric effect, which refers to the fact that bad news significantly increases the volatility compared to good news. An explanation related to that fact was first emphasized by Black (1976) who stated that the fall in the value of stock return (negative return) usually display a tendency of negative correlation with the changes in volatility return, making the stocks riskier and thus, increasing its volatility. This phenomenon is called "leverage effect"; also known as the asymmetric effect. It is important to know that each state has differences in the performance, size, and characteristics in capturing the effects of leverage. Therefore, various types of specifications of asymmetric GARCH models need to be chosen to have accurately fix volatility model (Yalama and Sevil, 2008). A more precise model that is used to describe the volatility of stock return will make the appropriate decisions for companies and investors in forecasting the risk of an investment that would be close to the actual value. In turn, the information will be used by investors in taking proper precaution in investing such as whether investors should keep or remove their investments in a particular state.

Based on the background described, this research is divided into two sections. The first section is focused on choosing the appropriate model to illustrate the volatility of stock return and to identify the existence of asymmetric effect which refers to the difference in the response of a good news and a bad news on certain markets. The second section is analyzing the speed of response and the variance decomposition of stock return volatility in Indonesia towards the stock return volatility on foreign markets i.e. Singapore (Lestano and Sucito, 2010), Hong Kong (Chuang et al., 2007), Japan (Miyakoshi, 2003), United States; US (Dimpfl and Jung, 2011), United Kingdom (Veiga and McAleer, 2004), and Australia, which were deliberately chosen to observe the effects. These countries display some differences in terms of economic growth, capital size, and trade size (terms of trade). Another aspect that needs to be examined with regard to the impact of the crisis is the international transmission on the stock market that may change after the turbulence on world stock markets (King and Wadhwani, 1990). Thus, this study also attempts to identify the change in dynamic interaction structure of the Indonesian stock market after the crisis in 2007 (or the crisis of subprime mortgage).

The objective of this study are:

1. Determine the best model to describe the volatility return of a stock market.
2. Identify the asymmetric effects on volatility stock return of the world stock markets.
3. Examine the transmission of volatility return of another stock market towards that of the Indonesian markets in the period pre and post-crisis in 2007.

II. THEORY

2.1. Modeling of the Stock Market Volatility

The volatility on financial markets illustrates the fluctuations in the value of an instrument within a certain period. In statistical term, the volatility is defined as the changes in the value of the average fluctuation of a financial time series, which will lead to greater risks and uncertainties faced by the market players, so that the interest of market participants to invest become unstable. Moreover, the existence of volatility also impacted on the existence of global financial markets as it relates to the notion of risk.

Stock price volatility is very important to observe for investors, as it is the basis for calculating the volatility of stock return. The volatility of stock return describes a fluctuation of differences in daily price observations within a specified observation period. Financial time series has given rise to time-varying volatility or "heteroscedasticity" of the data. The Linear Model trend, exponential smoother, or ARIMA models have failed to observe the phenomenon of their high volatilities (increased variance), because the models assume a constant residual variance (Montgomery et al., 2007). Over the past three decades, many studies were conducted to model volatility, especially on the financial markets.

Bollerslev (1986) proposed a model generalized autoregressive conditional heteroscedasticity (GARCH) with order k and l; GARCH(l,k). GARCH represents the current conditional variance which is also dependent on the previous conditional variances and residual squared lag. The GARCH models indicate that the volatility of returns asset depicts clustering volatility views from the lagged variances. The classical ARCH and GARCH models work within the assumption that all of the effects of shocks on volatility have a symmetric distribution. But in fact, returns asset does not always have a symmetrical distribution, but asymmetrical distribution as well, represented in the asymmetric GARCH models.

The characteristics that often appear in the observation volatility data in the financial sector is the existence of asymmetric volatility. The classical model of GARCH ignores the phenomena of asymmetric volatility that better suits the volatility modeling of stock return, because it captures the leverage effect; the negative correlation between volatility and return at the last period. The asymmetrical conditions generally arise where the stock market is in a crash condition i.e. when a drop in stock price bring further effects and significantly increase the volatility of the stock (Wu, 2001). Thus, causing negative events with greater effects than the positive ones towards the volatility of the asset. Engle and Ng (1993) also explain that the positive and negative information has a different impact on volatility; where bad news is likely to have a higher impact on volatility than the good news.

It is important to know that one country towards other countries has different performance in capturing the leverage effect so that the various specifications of asymmetric GARCH models should be chosen to make the models more accurate (Yalama and Sevil, 2008). Specifications for asymmetric GARCH models among others are *Exponential*-GARCH (EGARCH) proposed by Nelson (1991), *Threshold*-GARCH (TGARCH) proposed by Zakoian (1994), GJR proposed by Glosten et al. (1993), *Integrated*-GARCH (IGARCH) by Engle and Bollerslev (1986), *Component*-GARCH by Engle and Lee (1993), *Asymmetric power ARCH (APARCH)* by Ding et al. (1993).

The study of the data, that contain the effects of asymmetric volatility, has a lot to do with the studies of researcher such as Engle and Ng (1993), Nelson (1991), Zakoian (1994), Glosten et al. (1993), Engle and Bollerslev (1986), Ding et al. (1993), Engle and Lee (1993), and several other related research. Whereas the volatility in the stock market, both at the corporate level, local or global, has a lot to do with the studies of researcher such as Gokbulut and Pekkaya (2014), Wu (2001), Awartani and Corradi (2005), Yalama and Sevil (2008), Mishra et al. (2007), Booth et al. (1997), Lestano and Sucito (2010), and Miran and Tudor (2010).

Gokbulut and Pekkaya (2014) examined the ability of symmetric and asymmetric GARCH to estimate and forecast the volatility of the stock market, the exchange rate, and the interest rate on the Turkish financial market. The main results obtained from these study indicated that there are asymmetric effects on each market. The asymmetric GARCH models used in the current estimation and forecasting time series data of the financial markets showed a better performance in describing the volatility compared to the classical model.

Research conducted by Awartani and Corradi (2005) used stock index S&P-500 to test the predictive ability of GARCH samples of 10 different models. They found that the asymmetric GARCH plays a crucial role in predicting volatility. GARCH model is weak when compared to the asymmetric GARCH model in describing volatility. In addition, the stock return combines the leverage effect, so that the asymmetric behavior of volatility can provide more accurate predictions. Yalama and Sevil (2008) also studied the 7 different GARCH to perform forecasting on daily data of 10 different countries. Based on the research results, the GARCH models have different performances from one country to another country and the performance of EGARCH, PARCH, TARCH, IGARCH, GARCH, and GARCH-M is better in estimating the volatility.

Engle and Ng (1993) define the news impact curve which measures how new information is incorporated into the estimation of volatility. The specifications of the models are used in modeling unpredictable returns (residual) such as GARCH, EGARCH, *Asymmetric*-GARCH, VGARCH, *Nonlinear-Asymmetric-GARCH,* GJR-GARCH, and *Partial nonparametric* (PNP) ARCH. The selection model is made to find a model that fits in the daily modeling of stock return of the Japanese stock market from 1980 to 1988. The results of the model tests indicated that there were types of asymmetric effects of news on volatility. All of the models were tested to find results proving that negative shocks are more volatile than the positive ones.

2.2. Stock Market Volatility Transmission

The increasingly sophisticated technology and the increase of information processing throughout the world make international transactions, especially in the field of finance, easier and cheaper than ever before. Meanwhile, the liberalization of capital movements and securities on the stock market has increased very sharply, so that the national stock market can react quickly to new information from the international market. The movement in the stock market allows for a transmission between markets in terms of volatility. King and Wadhwani (1990) investigated on what happened in October 1987, nearly all of the stock markets fell simultaneously and widespread, despite being in different economic circumstances that varied. The investigation was constructing a model of the "contagion" across the market as a result of the efforts of rational agents towards price changes in other markets. This leads to a signal that the "mistake" on a market can be transmitted to other markets through a process called "contagion effect". Some of the reasons that support the transmission of shocks on a market that can affect the other stock markets include:

a) Dominant economic power: in the period after the World War, the United States became the most influential economy, as the US currency (US dollars) has been dominant in international trade. Achsani and Strohe (2005) also found that the US stock market has a very strong influence on all stock markets, including Europe and Asia stock markets.

b) Common investor groups: countries that are geographically adjacent have normally a similar group of investors on their markets. Therefore, these markets will affect each other.

c) Multiple stock listings: when a stock is traded on multiple markets, the shock on one market can be transmitted to the other market.

Liu et al. (1998), examined the structure of the international transmission on six national stock markets through their daily return, including the United States, Japan, Hong Kong, Singapore, Taiwan, and Thailand. The analysis of the structure of the interactions among the 6 stock markets was based on the vector-autoregressive analysis (VAR) introduced by Sims (1980). The VAR is used to test the dynamic structure of the international transmission on the stock market for the six countries. The results showed that there are facts that the US market plays a dominant role in influencing the markets in the Pacific-Basin, Japan, and Singapore, with a significant persistent influence on the Asian market.

Veiga and McAleer (2004) examined the effect of volatility between mature markets in the world and the relation between the stock market in the United States, UK, and Japan. They found that these markets are related as they influence the volatility of each other, although the three countries have different economic performances. The US stock market is a stock market that has the greatest influence in the transmission of the volatility among the three markets. The relevance to this study is justified through the selection of US, UK, and Japan as samples of international stock markets that affect other markets. In addition, Japan, Hong Kong, and Singapore, that were the subjects of the study of Liu et al. (1998), revealed that the three countries and the US have mutual influence, as well as significant impact on the Asian market. Based on previous research, the stock markets have an influence on both global and regional markets. Thus, the present study used seven sample stock markets, including the United States, UK, Japan, Hong Kong, Singapore, Australia, and Indonesia.

The spillover of the return asset volatility on the Asian stock markets is a major concern in the economic literature since the Asian financial crisis of 1997-1998. In et al. (2001) investigated the transmission of volatility return on the three stock markets of Asia, namely Hong Kong, South Korea, and Thailand by using multivariate models of GARCH and VAR. The results revealed that Hong Kong plays an important role in the transmission of volatility with the reciprocal effects on other Asian stock markets, while the volatility transmission from Thailand to South Korea is a one-way direction.

III. METHODOLOGY

3.1. Data

The data used in this study are daily closing stock market indices for Indonesia, US, Australia, UK, Japan, Hong Kong, and Singapore. The data were retrieved from Financial Services Authority (OJK). Table 1 shows the stock market index and the period of data used on each market.

Table 1.
Data Period Stock Market Index

Country	Index Stock Market	Data Period
Indonesia	Jakarta Stock Exchange Composite Index (JKSE)	03/01/1990 - 06/15/2016
United States	Standard and Poors 500 Index (S&P 500)	02/01/1990 - 06/15/2016
Australia	Australian Stock Exchange All Ordinaries Index (AS30)	02/01/1990 - 15/06/2016
United Kingdom	Financial Times-Stock Exchange 100 Index (FTSE)	02/01/1990 - 15/06/2016
Japan	Nikkei 225 Index (Nikkei 225)	04/01/1990 - 15/06/2016
Hong Kong	Hang Seng Index (HSI)	02/01/1990 - 06/15/2016
Singapore	Strait Times Index (STI)	08/31/1999 - 15/06/2016

3.2. Procedure for Data Analysis

3.2.1. Return of Stock Price Measurement

This study does not use the stock price index of input variables that make up the econometric model but replace it with a value of the stock price return. Awartani and Corradi (2005) define stock prices return as follows:

$$r_t = \ln\left(\frac{S_t}{S_{t-1}}\right) \tag{1}$$

where, r_t is the return of stock price on day t; continuously compounded return, S_t is the opening stock price on day t, and S_{t-1} is the closing stock price on day $t-1$.

3.2.2. Identification of econometric models

Identification of econometric models was carried out to determine the best model that could describe the volatility return of a stock market. The best models, which was selected in this process, were the best symmetric and asymmetric models. The estimation of the best asymmetric model could be used to identify the presence of an asymmetric effect on the volatility of stock return. Thus, the best model can provide information on the existence and symmetric shapes of the stock return volatility.

We compare the relative predictive ability of the following model, such as GARCH, EGARCH, GJR-GARCH, TGARCH, IGARCH, APARCH, and CGARCH. GARCH *(l,k)* proposed by Bollerslev (1986), process is as follows (Montgomery et al., 2007),

$$\sigma_t^2 = \beta_0 + \sum_{i=1}^{k} \beta_i \sigma_{t-i}^2 + \sum_{j=1}^{l} \alpha_j e_{t-j}^2 \tag{2}$$

where σ_t^2 is the conditional variance, e_{t-j}^2 is a lag squared residual, and σ_{t-i}^2 is lag conditional variance that represents the difference between GARCH and ARCH. Then, α_j and e_{t-j}^2 are known as ARCH component, β_i and σ_{t-i}^2 are known as GARCH component and β_0, β_i, and α_j are positive.

Nelson (1991) introduced one of several models of asymmetric GARCH as EGARCH by arranging Exponential ARCH. The EGARCH model can be expressed in Equation (3) as follows (Awartani and Corradi, 2005):

$$\log \sigma_t^2 = \omega + \sum_{i=1}^{k} \beta_i log \sigma_{t-i}^2 + \sum_{j=1}^{l} \left\{ \alpha_j \frac{e_{t-j}}{\sigma_{t-j}} + \gamma_j \left(\left| \frac{e_{t-j}}{\sigma_{t-j}} \right| - E \left| \frac{e_{t-j}}{\sigma_{t-j}} \right| \right) \right\} \tag{3}$$

The presence of leverage effect can be seen from the value γ_j. If $\gamma_j \neq 0$ then there is an asymmetric influence if $\gamma_j=0$ then there is no asymmetric effect.

GJR-GARCH models proposed by Glosten et al. (1993) as cited by (Lee, 2009) in Equation (4) below:

$$\sigma_t^2 = \omega + \sum_{i=1}^{k} \beta_i \sigma_{t-i}^2 + \sum_{j=1}^{l} \left[\alpha_j + \gamma_j I_{e_{t-j}<0}\right] e_{t-j}^2 \tag{4}$$

$$I_{e_{t-j}} \begin{Bmatrix} 1;\ e_{t-j} \leq 0 \\ 0;\ e_{t-j} > 0 \end{Bmatrix}$$

When e_{t-j} is positive, the total effect on conditional variance is given by $\alpha_j\, e_{t-j}^2$, when e_{t-j} is negative, the total effect on conditional variance is given by $[\alpha_j+\gamma_j]\, e_{t-j}^2$.

TGARCH is similar to the GJR model in using dummy variables but the TGARCH model proposed by Zakoian (1994) used standard deviation, expressed in Equation (5) as follows (Gokbulut and Pekkaya, 2014):

$$\sigma_t = \omega + \sum_{i=1}^{k} \beta_i \sigma_{t-i} + \sum_{j=1}^{l} \left[\alpha_j |e_{t-j}| + \gamma_j I_{e_{t-j}<0} e_{t-j}\right] \tag{5}$$

The IGARCH model was proposed by Engle and Bollerslev (1986). This model is similar to GARCH model in Equation (1), the difference is that there is a restriction in the IGARCH model of the total estimated value parameter which is equal to one. The IGARCH model is expressed in Equation (6) below (Awartani and Corradi, 2005):

$$\sigma_t^2 = \omega + \sum_{i=1}^{k} \beta_i \sigma_{t-i}^2 + \sum_{j=1}^{l} \alpha_j e_{t-j}^2\,;\ 1 - \sum_{i>1}^{k} \beta_i - \sum_{i=1}^{l} \alpha_i = 0 \tag{6}$$

APARCH modeled by Ding *et al.*(1993), the model is expressed in Equation (7) as follows:

$$(\sigma_t)^\delta = \omega + \sum_{i=1}^{k} \beta_i (\sigma_{t-i})^\delta + \sum_{j=1}^{l} \alpha_j \left(|e_{t-j}| - \gamma_j e_{t-j}\right)^\delta \tag{7}$$

The APARCH model is a key model and can be adopted by some ARCH models, such as ARCH (when δ=2, β_i=0, and γ_j=0), GARCH (when δ=2 and γ_j=0), GJR (when δ=2), TARCH (when δ=1), Taylor Schwert's (when δ=1 and γ_j=0), and so on (Peters, 2001).

The CGARCH is modeled by Engle and Lee (1993) to decompose the components of variance into a temporary or permanent component. CGARCH models were written in Equation (8) as follows:

$$\sigma_t^2 = q_t + \sum_{i=1}^{k} \beta_i \left(\sigma_{t-i}^2 - q_{t-j}\right) + \sum_{j=1}^{l} \alpha_j \left(e_{t-j}^2 - q_{t-j}\right) \tag{8}$$

$$q_t = \omega + \rho q_{t-1} + \emptyset\left(e_{t-1}^2 - v_{t-1}\right)$$

where q_t is a permanent component of conditional variance.

The software used to identify the econometric models in this study is R 3.1.2. The steps that must be taken in the identification of econometric model are as follows:

1. Stationary test

   The stationary condition of series are conditions where the data series do not have any particular movement patterns, in other words, the series does not contain pattern like trends. The series are stationary when they have a constant mean, constant variance and constant covariance for each lag. The Augmented Dickey-Fuller (ADF) unit root test has been applied to check whether the series is stationary or not. The stationary condition of series has been tested by using the ADF (Gujarati, 2003).

2. GARCH model (Equation (2))

   Stock return modeling in this study was carried out simultaneously, meaning that the overall GARCH process was running and the best model selected with certain criteria. Unlike the case of Gokbulut and Pekkaya (2014), the modeling of stock return was carried out by optimizing the ARIMA process in order to obtain the best ARIMA model and proceed with the GARCH model with the mean model, obtained in the previous ARIMA optimization process. The ARIMA model identification, conducted in this study, is a combination of order p =0, 1, 2, and 3 and q =0, 1, 2, and 3, and the identification of models of ARCH / GARCH is a combination of the order k =0, 1, 2, and 3 for GARCH and l =0, 1, 2, and 3 to ARCH. The ARIMA model was used as a mean model to compose the GARCH model. The fitting model of any ARIMA model was followed by GARCH process with a combination of its order. So that, in each of the ARIMA model with a specific order, the fifteen selection of models ARCH / GARCH will be obtained. Thus, this modeling process will result in 225 model options.

3. Asymmetric GARCH Model

   The specifications for the asymmetric GARCH models are EGARCH as shown in Equation (3), GJR-GARCH is shown in Equation (4), TGARCH shown in Equation (5), IGARCH shown in Equation (6), APARCH shown in Equation (7), and CGARCH shown in Equation (8). The best asymmetrical model criteria are all the independent variables that are significant, both mean model coefficient and ARCH-GARCH coefficient, then proceed with the selection of the smallest AIC value.

3.2.3. Vector Autoregressive (VAR) system

The VAR analysis permits us to assess the volatility transmission of stock return of Indonesia towards shocks emanating from some of the world's stock markets, both prior and post the crisis of 2007. The software used in the identification of the VAR model is *EViews6*. The steps taken when estimating the data with VAR included:

1. Stationary test

   Stationary test needed to determine the shape of the VAR model that will be used in this study. The existence of variables that are not stationary in the VAR system is important to observe, for it can be a cointegration relationship. For example, if the variables used in the VAR system was stationary at a level, then the form of the VAR model to be used is unrestricted VAR.

2. Determination of optimal lag

   Optimal lag is required in order to capture the effect of each variable towards another variable in the VAR system.

3. Volatility dynamic relationship of the return Stock

   The model used in this study to modify the model written by Veiga and McAleer (2004). The specifications of the model are as follows (Equation 9):

$$\boldsymbol{V_t = A_0 + A_1V_{t-1} + A_2V_{t-2} + A_3V_{t-3} + \cdots + A_pV_{t-p} + e_t} \tag{9}$$

   where,

   V_t = 7 × 1 column vector that contains seven variables, namely volatility of stock returning the country *j*; *j*= 1, 2, 3, ..., 7

   p = length of the lag (order) VAR

   A_0 = *7* × 1 column vector of interception

   A_i = 7 × 7 matrix coefficients or parameters measurement for every *i*= 1 , 2, ...,*p*

   e_t = measurement error 7 × 1 vector

4. Analysis of Impulse Response to shocks

   The speed of response to the volatility of Indonesian stock return market towards shock of the volatility return of other stock markets can be observed by using the analysis of impulse response function (IRF). This analysis permits to observe the fast or slow response to the volatility of the Indonesian stock return market towards the volatility shocks of other stock markets.

5. Analysis of Forecast Error Variance Decomposition (FEVD)

   The analysis of how the volatility returns of foreign stock markets influences the Indonesian stock market volatility will be determined by predicting the decomposition variance; which is called FEVD analysis. In addition, the volatility returns of foreign stock that mostly influence the volatility of the Indonesian stock return market can be also determined.

IV. RESULT AND ANALYSIS

4.1. Descriptive Analysis of Return Stock

The volatility on the capital markets is generally observed by looking for variations in the return of certain capital markets. The return stocks are those given by a share on the relevant market. In the daily observations, the stock return is defined as the difference between the opening price and the closing price. Therefore, the input variable, that will be used in the process of

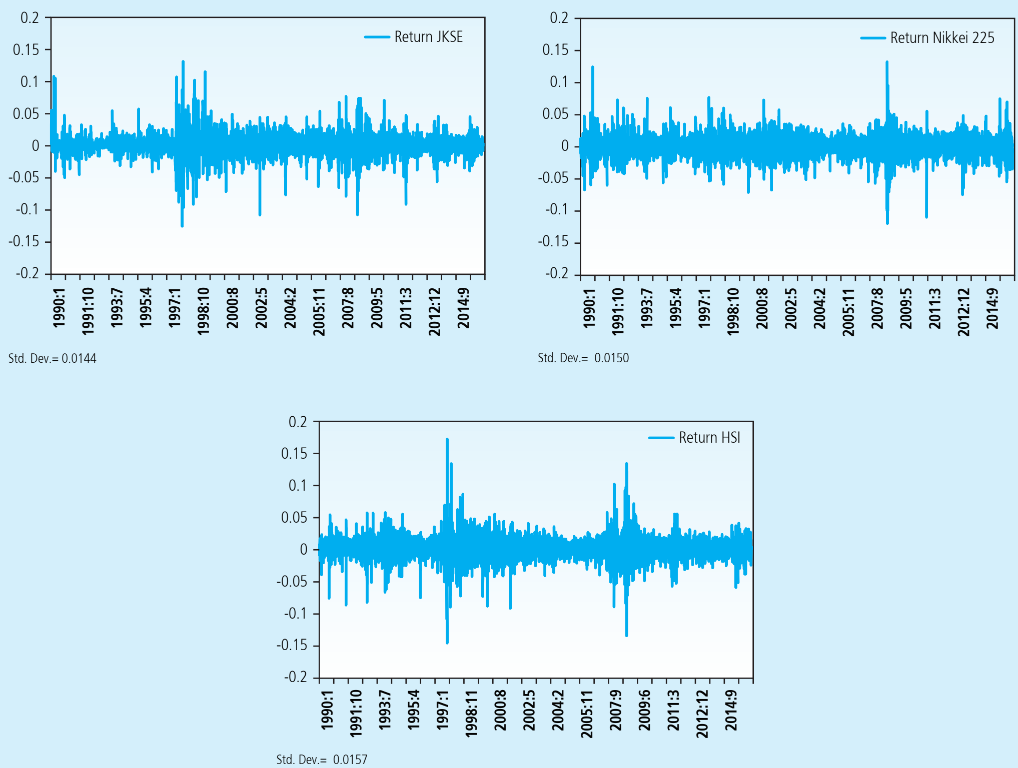

Figure 1.
Plot time series of JKSE, Nikkei 225, and HSI stock returns

modeling the volatility of a stock in this study, is no longer a closing stock price, but the return stock. Thus, prior to the modeling process, there is a need to transform the closing price of stock in the form of using continuous return (Awartani and Corradi, 2005).

Figure 1 and 2 present a chart pattern of returns for stock market indices. The stock markets have been grouped into two i.e. the market group with a relatively high deviation and the market group with a relatively low deviation. The group division was based on the standard deviation of return of a stock, if the value of the standard deviation is more than the average value of the standard deviation of the market (0.0126), then the market is categorized as a market with a relatively high fluctuation. Meanwhile, if the returns of a stock with a deviation of less than the average value of the standard deviation of the market, then the market is categorized as a market with a relatively low fluctuation.

Figure 1 shows the movement of stock return of three countries, namely Indonesia (JKSE), Japan (Nikkei 225), and Hong Kong (HSI). The three markets have relatively high fluctuations of return compared to other country samples. The value of the standard deviation of the return

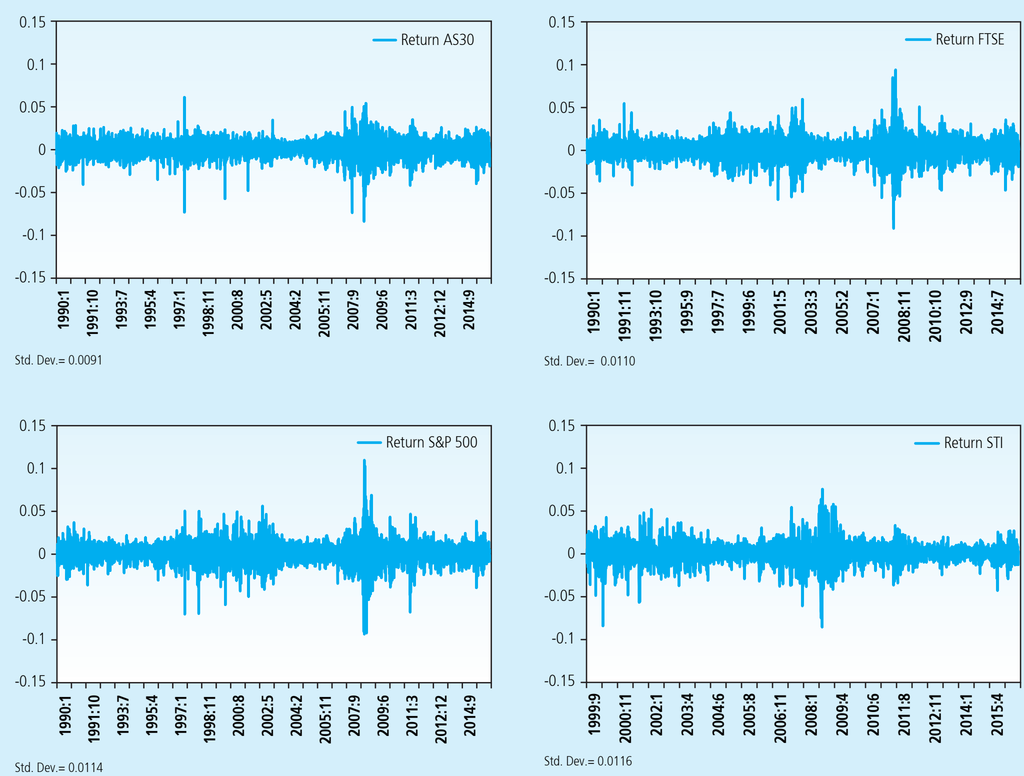

Figure 2.
Plot time series of stock returns AS30, FTSE, S & P 500, and the STI

is observed during the period of 26 years, showing that the Indonesian stock market (0.0144) has the lowest fluctuation of return stock, followed by the Japanese stock market (0.0150), and Hong Kong's stock market (0.0157) which has the highest fluctuation of stock return the group.

Australia (AS30), UK (FTSE), United States (S&P 500), and Singapore (STI) are categorized as a group market with relatively low fluctuations (Figure 2). The values of the standard deviations for the UK and the US were observed during the period of 26 years, while that of Singapore was observed for over 16 years. The comparisons were made on three stock markets i.e. Australian, UK, and the US, and since the three stock markets were observed in the same period, the results showed that the Australian stock market (0.0091) had the lowest fluctuation of return stock, followed by the UK stock market (0.0110), and the US stock market (0.0111) which had the highest fluctuation of stock return the group.

Figures 1 and 2 revealed that the movement of return varies with time changes. Both of these figures demonstrated positive serial correlation or volatility clustering which may imply that large changes tend to be followed by large changes and small changes are also likely to be followed by small changes, which means that the volatility clustering observed on data return stock.

4.2. Best GARCH Model

After the returns of all of the used stock markets have been ascertained at a stationary level, the next step is selecting the best model by using the variable stock return as a variable input. Fitting the best model is needed to describe the volatility of the seventh stock return indices observed. The fitting model of the return series is not suitable if using the ARIMA process because the return series have volatility; with a variance of residual which is not constant, leading to heteroscedasticity. Thus, the volatility of stock return is modeled using the GARCH process.

This stage focuses on the selection of the best model to describe the volatility of each stock market using the symmetric GARCH models. The best model criteria are the model with all significant estimated coefficients (real impact on response), both coefficients in the mean model and ARCH-GARCH model. Afterwards, the selection process of the smallest AIC values could be carried out. The process of selecting the best symmetric GARCH model in this study is through the optimization process (simultaneously). The simultaneous optimization is done as a whole, which means every ARIMA model is used as a mean model in the GARCH process without going through the optimization process of the ARIMA. The process of selecting the best model is carried out at the end of the simulations with a combination of orders that have been determined, both the order for ARIMA models and orders for symmetric GARCH models. The candidates of the model will choose the best symmetric model with the given criteria. The simultaneous optimization is done with the intention to obtain a global optimization level.

Table 2.
AIC Value of The Best Symmetric and Asymmetric GARCH Model

No	Return	Type of Model	AIC of Best Model	Selected Asymmetric Model
1	JKSE	Symmetric	-6.0510	APARCH (1,2)
		Asymmetric	**-6.0550**	
2	S&P 500	Symmetric	-6.5658	TGARCH (2,2)
		Asymmetric	**-6.6011**	
3	FTSE	Symmetric	-6.5196	TGARCH (1,1)
		Asymmetric	**-6.5460**	
4	Nikkei 225	Symmetric	-5.7767	TGARCH (2,1)
		Asymmetric	**-5.8088**	
5	HSI	Symmetric	-5.8201	APARCH (1,1)
		Asymmetric	**-5.8413**	
6	STI	Symmetric	-6.4345	TGARCH (2,2)
		Asymmetric	**-6.4440**	
7	AS30	Symmetric	-6.8057	TGARCH (1,1)
		Asymmetric	**-6.8332**	

Bold text indicates the smallest AIC value in the group

The GARCH symmetric model assumes that the volatility is symmetric, meaning that there is no difference in the effect of the volatility when a negative or positive shock occurred. There are indications that the volatility of stock return has asymmetric behavior. So, to detect the presence of an asymmetric effect on the behavior of the volatility of return stock, this study will specify several asymmetric GARCH models by orders of the best models that have been obtained in a symmetric model. These models are EGARCH, GJR-GARCH, TGARCH, IGARCH, and APARCH. Table 2 shows the results of model estimation that were obtained for each country (with differences), which is in accordance with research conducted by Yalama and Sevil (2008), stating that the performance and the size of one state against another state is different, so the model obtained in describing the volatility stock return also vary.

Based on the obtained results, the overall model of asymmetric GARCH presents a better model than that of the symmetric GARCH model. It can be seen in the best asymmetric GARCH models which have smaller AIC values compared to those of the symmetric model for each stock market, as shown in Table 2. Thus, it indicates that the result estimated in asymmetric GARCH models for each market stock is better than that of the volatility stock return of symmetric GARCH model. These results are consistent with the results of research conducted by Awartani and Corradi (2005) which states that the asymmetric GARCH models play an important role in predicting volatility. Symmetric GARCH process weakens when compared to the asymmetric GARCH models in describing the volatility return of a stock market.

Table 3.
Coefficient Parameters for Best Model of Asymmetric GARCH for Each Stock Return

	JKSE	S&P 500	FTSE	Nikkei 225	HSI	STI	AS30
Model	**APARCH**	**TGARCH**	**TGARCH**	**TGARCH**	**APARCH**	**TGARCH**	**TGARCH**
ARMA	**(3,2)**	**(2,3)**	**(3,3)**	**(3,3)**	**(2,3)**	**(3,2)**	**(3,2)**
GARCH	**(1,2)**	**(2,2)**	**(1,1)**	**(2,1)**	**(1,1)**	**(2,2)**	**(1,1)**
ω	0.0000*	0.0002*	0.0002*	0.0005*	0.0001*	0.0002*	0.0002*
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0310)	(0.0000)	(0.0000)
α_1	0.1577*	0.0641*	0.0632*	0.0574*	0.0761*	0.0545*	0.0668*
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
α_2		0.0229*		0.0709*		0.0718*	
		(0.0006)		(0.0000)		(0.0000)	
β_1	0.4144*	0.8336*	0.9350*	0.8862*	0.9210*	0.7500*	0.9258*
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
β_2	0.4369*	0.0757*				0.1482*	
	(0.0000)	(0.0000)				(0.0000)	
γ_1	0.1106*	1.0000*	0.8130*	1.0000*	0.4367*	0.7987*	0.8455*
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0197)	(0.0000)
γ_2		-0.1149		-0.6093*		-0.5427*	
		(0.7615)		(0.0000)		(0.0000)	
δ	1.7212*				1.2139*		
	(0.0000)				(0.0000)		
AIC	**-6.0550**	**-6.6011**	**-6.5460**	**-5.8088**	**-5.8413**	**-6.4440**	**-6.8332**

*Significant at the 5% significance level

Table 3 shows the results of model estimation in describing the best asymmetric volatility stock return of seven stock markets, namely: Indonesia (JKSE), US (S&P 500), UK (FTSE), Japan (Nikkei 225), Hong Kong (HSI), Singapore (STI), and Australia (AS30). The result of estimation parameters of ARCH (α) and GARCH (β) on the seventh stock markets is positive and statistically significant at the 5% (significance level). The positive value of ARCH and statistical significance can be interpreted as the mean effects of any shocks at this point (e_t), depending on the size of the shocks in the past. Thus, the great shocks in the current period *(t)* will increase the effect of the shock in the next period *(t+1, t+2,* and so on). Meanwhile, the positive value of GARCH and statistical significance can be interpreted as the mean volatility at this time depends on the volatility of some of the previous period. Based on these results, it can be stated that the volatility return of a stock market is not only affected by shock and volatility at this time, but also by shocks and volatilities in the previous period. Thus, investors need to observe fluctuations (volatilities) of stock return and shock that occurred in early periods, before taking steps for investment. This is necessary so as the investors are able to control and reduce the market risk of the asset being traded.

The coefficient $\gamma_{i,i=1,2}$ indicates the presence of an asymmetric effect on the seven stock markets. If the estimated value of $\gamma_{i,i=1,2} \neq 0$, then there is an asymmetric effect on a stock market, meaning that there is a difference between the effects of bad news or good news on the volatility return of a stock market (current). Table 3 showed that the coefficient $\gamma_1 \neq 0$ is positive and significant at the 5%. This means the volatility return of the Indonesian stock market, US stock market, UK stock market, Japanese stock market, Hong Kong stock market, Singapore stock market, and Australian stock market has the asymmetrical effect, which means that bad news that occurred in a previous period *(t-1)* will further increase the volatility of returns in the current period *(t)* than when there is good news in the previous period *(t-1).* Meanwhile, the coefficient of γ_2 is negative and significant at the 5%, that means the effect of bad news at this point *(t)* of the volatility return will be corrected two days later *(t*+2). In other words, volatility will begin to decline at $t + 2$. The decline in volatility occurs as a result of the correction of overreaction or mispriced on the bad news in the previous period. Overreaction occurs because of pessimistic response towards bad news in the previous period. This attitude accelerates the increment of volatility, so there is an element of mispriced*,* the result would counter the current to correct these mispriced.

The results of the best models of each of the stock market as a whole showed that the effects of bad news on the volatility of return are greater than the good news because of the leverage effect. These phenomena do indeed occur on the financial markets. Bad news will result in a huge drop in stock prices. This decrease, in turn, will increase the debt to equity ratio; the ratio which measures the extent to which the company is financed by debt. Improved debt to equity ratio causes an increased risk of asset ownership, thus leading to the increase in the volatility of the asset. Therefore, the existence of asymmetric effect appears when the condition of the stock market is experiencing a crash (Wu, 2001). Thus, the bad news at this time will further increase the volatility of return on the following day *(t*+1) compared to good news. Seven stock market used in this study indicated that there are asymmetric effects and statistical significance at the 5%. This proves that the presence of asymmetric effects on the stock market is indeed true.

In connection with the fact that the volatility of the return on a stock market showed a different response when there is bad news and good news, the volatility modeling of stock returns using symmetric GARCH model becomes less relevant in describing the actual state of the stock market. The usage symmetric GARCH models in describing the volatility of returns stock will lead to a result in forecasting the risk of a lack of proper investment. This, In turn, will lead to market participants, in this case, the company and any investor making a wrong decision in response to market conditions.

4.3. Analysis Vector Autoregressive (VAR) System

The period of sample data used in analyzing the VAR system ranged from September 1st, 1999 to June 15th, 2016. The reason for choosing this period of sampling is because the sets of intersection data period were used in the study. It is intended that all of the criteria in the process of selecting optimal lag can be compared to various lag so that the number of observations used in the VAR model system should be the same (Juanda and Junaidi, 2012). In addition, the period of sample data is divided into two sub-periods, namely the period before the crisis in 2007 (September 1st, 1999 and December 29th, 2006) and the period after the crisis of 2007 (January 1st, 2007 until June 15th, 2016). The input variables used in the VAR system analysis was the volatility return of the stock market of Indonesia, US, UK, Japan, Hong Kong, Singapore, and Australia. The volatility of stock return of each stock market gained from the best model estimation that has been done in the previous stage.

The objective of VAR systems analysis is to explore whether the transmission structure changed after the 2007 crisis (subprime mortgage crisis), because the international transmission on volatility return may change after a turbulence on the world market (King and Wadhwani in 1990). The results of VAR analysis are an analysis of impulse response (IRF) and analysis of forecast error variance decomposition (FEVD). It is important to remember that, before conducting a VAR analysis, the necessary stages are a stationary test, selection of the optimal lag, and the stability test of the VAR.

4.4. Analysis of the Impulse Response Function (IRF)

The aim of the IRF analysis is to test the response of volatility return on the Indonesian stock market toward shocks on volatility return on other stock markets i.e. US, UK, Japan, Hong Kong, Singapore, and Australia stock markets. The dynamics of the volatility response on the Indonesian stock market and the dynamics of the international markets are divided into two periods, which are the period before and after the crisis of 2007.

Figure 3 shows the behavior of impulse response on volatility return of Indonesian stock market toward shocks emanating from volatility on US, UK, Singapore, Hong Kong, Australia, and Japan stock markets, both in the period before and after the crisis of 2007. If observed in the first 15 days (equivalent to three weeks) at the commencement of a volatility shock of a stock market was observed an Indonesian stock market volatility, suggesting that volatility shocks emanating from the Hong Kong market is relatively providing the most impact on the Indonesian market volatility for both in the period before and after the crisis of 2007. The volatility shock derived from the Singaporean stock market also provides a relatively large influence on the Indonesian market volatility at the beginning of the observation period, although not as much as the transmission of volatility due to shocks on the Hong Kong stock market.

Figure 3. Impulse Response of the Indonesian Stock Market Volatility Return towards shock on Volatility of Foreign Stock Market; prior and post Crisis (2007)

Different thing with the effect of volatility shock is coming from the US and UK markets, both provide a relatively large influence on the second day after the shocks and the next, not on the first day of shocks, such as the effect of volatility shocks originating from Hong Kong, Singapore, Australia, and Japan (Figure 3). This can be understood as the impact of differences in transaction time. The US and UK markets have a relatively large time difference (in hours) to Indonesia, thus giving rise to differences in the operating hours of the exchange. Thus, shocks originating from Hong Kong, Singapore, Australia, and Japan will be faster in responding by the Indonesian stock market because it has a relatively small time difference compared to the US and UK markets. This also caused volatility shocks coming from the US and UK markets to last longer.

Figure 3 also showed that the period after the crisis indicates that interactions of the foreign stock market that were observed with the Indonesian stock market substantially increased. This increase is characterized by an increased in values of impulse response on the Indonesian stock market to volatility shocks emanating from foreign stock markets. These results are consistent with research conducted by Liu et al. (1998), stating that the degree of interdependence of national stock markets rises substantially after the crisis. This leads to an increase in transmission to the stock market, which in turn may increase the effect of volatility return on a market against the volatility return of other markets, or in the context of this study, the Indonesian market (Trihadmini, 2011).

Volatility transmission can be triggered by the liberalization of international capital movements, portfolio diversification across countries, as well as an increased transaction as a result of developments in the electronic telecommunications system (Lau and Ivaschenko, 2003). The liberalization of international financial markets, especially related to the flow of foreign investment to emerging markets will make the market more volatile in response to changes in economic conditions (Santis and Imrohoroglu, 1997). The consequences of volatile investment flow will have an impact on the high volatility in stock prices, particularly in emerging markets.Figure 3 shows that the Indonesian market is more exposed to the impact of volatility transmission compared to other stock markets in the period after the crisis. This indicates that the Indonesian stock market has increased interdependency relationship due to the influence of globalization of financial markets. As stated by Santis and Imrohoroglu (1997), an increase in market interdependency relationship on the Indonesian stock market which in fact belong to the emerging markets will lead to the Indonesian market more volatile than before, in response to the change of the state of the economy. Thus, in turn, will increase the impact of foreign stock market volatility transmission to the Indonesian stock market volatility, as shown in Figure 3.

4.5. Analysis Forecast Error Variance Decomposition (FEVD)

The FEVD analysis is used to analyze the contribution of the foreign stock market volatility observed in a study of the diversity of volatility *return* in Indonesia. Based on the decomposition of diversity shown in Table 4, the influence of the volatility of stock market can be identified and observed. In this study, the Indonesian stock market volatility was observed both before and after the crisis. Table 4 shows that an important source of variance on volatility return of Indonesia stock market is volatility of the stock market of Indonesia itself. However, when

Table 4.
Decomposition of Variance (%) Volatility Return of the Indonesian Stock Market

Periode	Volatility of Return						
	JKSE	FTSE	S&P 500	STI	HSI	AS30	Nikkei 225
Before Crisis							
1	91.8431	0.3494	0.2026	1.0562	4.6212	1.7925	0.1351
2	90.3885	1.1114	0.9754	1.1696	4.3596	1.8411	0.1545
5	89.2492	1.2946	2.0044	0.9674	4.4467	1.8947	0.1429
10	87.6422	1.5851	3.2640	0.6629	4.7876	1.9414	0.1169
15	86.0744	1.8131	4.3734	0.5795	5.1109	1.9485	0.1001
After Crisis							
1	84.5767	4.3349	0.6716	8.4980	0.0000	1.9188	0.0000
2	80.7807	4.0527	3.8920	9.3377	0.0168	1.8795	0.0407
5	75.8722	5.7491	5.9981	10.2490	0.2625	1.8297	0.0393
10	69.1925	8.2096	8.4197	10.9915	1.0706	1.8674	0.2487
15	63.2820	10.3072	10.4221	11.3302	2.0744	1.9162	0.6679

compared to the period before the crisis and after the crisis, the contribution of the Indonesian stock market in the period after the crisis is relatively small compared to the period before the crisis in the 15 days of observation. This indicates that there is a strong interaction between the stock market in the period after the crisis.

It can be seen, in more detail, that in the period before the crisis, the volatility return of Indonesian stock market observed in the 15-days observation period was influenced by the volatility of returns stock itself with an average value of 88.40%. The rest is the effect of volatility return of foreign stock markets, the volatility of *return* the market of Hong Kong (HSI; 4.69%), US (S&P 500; 2.66%), Australia (AS30; 1.91%), the UK (FTSE; 1.41%), Singapore (STI ; 0.81%), and Japan (Nikkei 225; 0.31%). Based on the estimates of the variance of decomposition, the volatility of return of the stock market of Hong Kong turned out to be the most contributing country towards the volatility return of Indonesian stock market compared to other stock market volatility. These results are supported by research conducted by Chuang et al. (2007) which states that the Hong Kong stock market is a stock market that has a considerable influence on the regional stock markets of Asia, particularly Indonesia stock market.

In the period after the crisis, the percentage decomposition of the variance of the volatility return of Indonesian stock market over a period of 15 days of observation is affected by the volatility of stock return itself with an average value of 72.30%. The rest is the effect of volatility return of foreign stock markets, the volatility return of Singapore (10.50%), UK (7.19%), US (7.08%), Australia (1.87%), Hong Kong (0.83%), and Japan (12:22%). The volatility return of Singapore stock market has a dominant influence on the period after the crisis. Ajireswara (2014) also found that the Singapore stock market has a dominant influence on the decomposition of the Indonesian stock market volatility compared to the effect of the decomposition of the stock market of Hong Kong, Japan, the US, and the UK.

As noted earlier, the average percentage contribution of volatility returns of the foreign stock market to the volatility return of the Indonesian stock market has increased in the period after the crisis of 2007. The average contribution of the Indonesian stock market volatility also decreased after the crisis period of 2007. In addition, the influence of mature markets such as the US and the UK also experienced a significant increase in the period after the crisis of 2007 and resulted in the average effect within 15 days of observation time. So, a strong influence shows that there is a greater interaction in the period after the crisis of 2007. The results of this FEVD supports the results of the analysis of IRF noted previously (Figure 3).

In general, the role of a mature market is proxied by the volatility return of the US and UK stock markets, which increased dramatically the influence on the volatility return of the Indonesian stock market in the period after the crisis. This suggests a volatility transmission due to the role of dominant economic power, such as US and UK markets. The US and UK are countries with great influence in the economy because the currencies of both countries have been widely used in international trade. Meanwhile, the growing influence of the volatility return of Singaporean stock market towards the volatility returns of the Indonesian stock market in the period after the crisis indicated that the volatility return transmission is a reason for the common investor groups. This refers to the fact that the countries are geographically adjacent groups with the same investment objectives (Achsani and Strohe, 2005). Kartika et al. (2012) also state that countries which have close economic and geographical basis would indicate a strong relationship. So that, in turn, these markets will affect each other. Thus, the interaction between Indonesia, the mature market and the stock market which is geographically closer to Indonesia should be observed as a reference of vigilance of the financial stability.

V. CONCLUSION

The objective of this study was to determine the best model to describe the volatility return of stock and identify their asymmetric effects on returns stock on several stock markets including the Indonesian stock market. In addition, this study also aimed to analyze the structure of volatility transmission return of the Indonesian stock within periods before and after the crisis of 2007. Based on the results of the analysis conducted in this study, the following points could be summarized:

1. The asymmetric GARCH models better present the estimates of volatility return compared to GARCH symmetric model for the entire stock market used in this study. The volatility return of the Indonesian and Hong Kong stock markets was described by the APARCH model. In addition, the volatility of the stock return markets of United States, UK, Japan, Singapore, and Australia was described by the TGARCH model TGARCH. Every country has different volatility characteristics so that the results of the established model were different.
2. The entire observed market indicated the presence of an asymmetric effect on stock return with a statistical significance. This means that there is a difference between the effects of

bad news or good news on the current volatility return. Thus, modeling the volatility of the stock return using symmetric GARCH models become less relevant in describing the actual state of the financial markets.

3. The results of the analysis of the impulse response of volatility return of the Indonesian stock market shocking other volatility return on the stock market showed that the biggest volatility transmission both in the period before and after the crisis of 2007, mainly came from Hong Kong stock market, followed by the Singaporean stock market. When compared to the results of impulse response volatility return the Indonesian stock market before and after the crisis, it suggests that the Indonesian stock market is more exposed to shocks within the period after the crisis. This indicates that the Indonesian stock market has increased the interdependency relationship of financial markets as a result of globalization.
4. The results of the variance decomposition of volatility return of the Indonesian stock market showed that in the period before and after the crisis of 2007, the volatility return of the Indonesian stock was predominantly influenced by itself. As for the external influences, the Hong Kong stock market has the biggest influence in the period before the crisis. Within the period after the crisis, the Singaporean stock market has the most impact. The analysis of variance decomposition also showed that the influence of the mature market was proxied by stock market of the US and UK which have increased drastically, affecting the volatility on the Indonesian stock return market in the period after the crisis of 2007.

Based on the results of the analysis conducted in this study, some recommendations that can be can be put forward for the policy perpetration authorities and investment actors on the stock market are as follows:

1. For the investment actors, especially for those in need to observe the fluctuations of stock returns and shocks that occurred in early periods, before taking steps for current investment. This is necessary so that the investors are able to control and reduce the market risk of the asset being traded. As such, the investors may be cautious in determining the decisions of investment, such as whether an investor has to release or hold his assets.
2. For the policy perpetration authority, once it is known that the perpetrator of investment is very easily influenced by negative sentiment on the market, the implications of policy perpetration authority is needed to maintain the condition of the market in case of negative sentiments, for example: macroeconomic factors and their negative issues that develop on the market. This is necessary because the negative sentiment can cause fluctuations in returns, an excessive stock which in turn will affect a factor of interest for investors.
3. For the policy perpetration authority, having in mind the increase in volatility transmission of foreign stock return towards the Indonesian market in the period after the crisis of 2007, the implications for the policy perpetration authority is the need of vigilance in addressing foreign stock market volatility, so that the reversal impact of capital outflow could be drastically anticipated.

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