Examining Asymmetric Volatility and Spillovers of ASEAN-6 Stock Markets in Financial Crisis

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Abstract

This paper aims to study the asymmetric relation between stock returns and volatility in ASEAN-6 stock markets by applying EGARCH model to the daily ASEAN-6 returns stock markets over the period of July 31, 2000 to April 1, 2015. Our results also showed that conditional volatility react to good and bad news asymmetrically. That is, the positive shocks generate less volatility than the negative shocks in all ASEAN-6 stock markets. Moreover, this paper also investigated volatility spillovers in the ASEAN-6 stock market returns with three developed indices (S&P 500; Nikkei and Hang Seng) in this period 2000-2015 include Global Financial crisis 2008 through VAR model. We found the impulse responses of ASEAN-6 stock markets with US stock market are higher than with Japan; Hong Kong. We recommend given lag 1-day, the investors can predict the evolution of domestic stock markets when there have a shock from others. In addition, it is also advice for investors' decision of diversify portfolio in stock markets.

Keywords: ASEAN-6, asymmetric volatility, EGARCH model, VAR model, volatility spillovers

1. Introduction

Nowadays, financial market is the vital role in economic system of each country. One of key aspect of the financial markets is stock market. In this problem, many studies have attracted much attention about stock market volatility. Similarly, volatility reflects the change of stock return by time. It is related to, but not the same, as risk. Risk is associated with undesirable outcome, whereas volatility as a measure of strictly for uncertainty could be due to a positive outcome (Poon, 2005).

This study purposes to investigate the asymmetric relation between stock returns and volatility in ASEAN-6 stock markets (Note 1). The assumption of relation means that the negative (or positive) returns are identified with upward (or downward) adjustments of conditional volatility. Wu presented that the asymmetric volatility is most apparent in stock markets. This is a huge of theories consider the relationship between volatility and stock price (Black, 1976 and Christie, 1982). Many theories consider that the negative return increases financial leverage and its volatility.

Secondly, this paper proposes the alteration of developed stock market would reflect to emerging stock market, especially ASEAN-6 stock market. The hypothesis insists that the returns of ASEAN-6 stock markets are not only influenced by itself, but also by the volatility of other stock market return. This is called volatility spillovers. Definitely, volatility spillovers are the variable of stock market returns over time. Due to the similar cultural and policies of countries in the same region, we assume that the stock returns be more pronounce among this countries. Moreover, it is not denied that the influence of developed stock markets on other markets. Therefore, volatility spillover of ASEAN-6 countries is regarded to neighboring by major stock markets. In this paper, the authors use the data of 3 developed stock markets including the Standard and Poor 500 (S&P 500) in United States (U.S.), Hang Seng in Hong Kong stock market and Nikkei index in the Japanese market. The purpose of this study is to examine volatility transmission and spillovers in ASEAN financial markets during 2008 Global Financial crisis. Chan and Karim (2010) had also the same topic about volatility spillovers of ASEAN countries but there were not mention Vietnam financial market. Nguyen (2009) has also research the volatility transmissions between Vietnam stock market and other Asian stock markets but not compare with other ASEAN countries. The inclusion of the younger Vietnamese market in ASEAN in this study is extremely of interest news.

This paper aims to accomplish two main objectives. First, this study investigates the asymmetric volatility of ASEAN-6 stock market. Second, we examine how the financial crisis affected the interrelationship between developed stock markets and ASEAN-6 stock markets. This paper employs univariate EGARCH model to estimate the asymmetric volatility and leverage effect between positive and negative shocks. In addition, we based on VAR (1) model to identify the volatility spillover of the major stock markets in ASEAN-6 with three developed stock markets before, during and after financial crisis.

This paper seeks to investigate the relationship between stock indices of 6 emerging markets in ASEAN along with 3 developed stock markets (US, Japan and Hong Kong).). It has many previous papers which investigated about group 5-country in ASEAN include Thailand, Malaysia, Indonesia, Philippines and Singapore. However, in recent years, Vietnam is also one of emerging and potential market in ASEAN and Asia. So, this paper will investigate the effect group 6-country in ASEAN included Vietnam. In the other hand, we also stick the assessment of international stock markets to ASEAN-6. This paper chose 3-developed stock markets to interrogate include Hong Kong, Japan and US. Hong Kong and Japan are two main stock markets in Asian. Moreover, in many studies, Hong Kong and Japan stock markets are influenced with neighbor stock markets in area. The US market is regarded as so important because the US is the biggest economy in the world and America was also the first country began financial crisis in 2008. Hence, how is ASEAN-6 stock markets effected by asymmetric volatility and what happens to the US stock market tends to influence the performance of other market in the world. In detail, this paper will try to answer to the following research questions:

1). How is ASEAN-6 stock market exist asymmetric volatility from 2000 to 2015?

2). Do volatility spillovers exist among ASEAN-6 and 3 developed stock markets and which is the direction of influence within those markets before, during and after financial crisis 2008?

2. Literature Review

One of the most remarkable topics in the current financial world is asymmetric volatility and volatility spillover across stock markets. On the one hand, many authors believe that there is a negative relationship between stock returns and volatility. Engle and Ng (1993) define that asymmetric volatility is the difference of good news and bad news effects to the stock price. Some early papers researching this topic like Black (1976) and Christie (1982), which defined asymmetric volatility of individual stock markets in the US and feedback the link between volatility and leverage. Black (1976) argue that volatility of the equity return rise when the companies' leverage increases. In the same idea, Nelson (1991) and Bekaret (2000) apply this concept and believe that the negative shocks increase conditional volatility more than positive shocks, hence there is asymmetry on the impact of good and bad news on the riskiness of the stock market. On the other hand, volatility spillover is a factor to mention the effect of developed stock markets to emerging stock markets through the stock price. In this paper, we use the empirical data to investigate volatility spillovers across ASEAN-6 with Hong Kong, Japan and US stock market because Asian region is influenced by similar economic expectations, technological innovations, financial regulations and trading conditions. These factors are lead to a long-run positive correlation between markets. Additionally, the effect of leader stock markets in the world such as US market to emerging stock market is evaluated very enormous. The dominance of the U.S market has been provided for the last few decades and has led to the spillover effects level of this market to other markets, especially to emerging markets, which has increased over time. There are various empirical studies that have addressed the volatility and spillover effects spread across countries such as the U.S and UK, the U.S and other markets. The level of correlations and co-integrations of countries' stock markets is normally used to evaluate the magnitude of volatility transmissions across markets (Ng, 2000, Worthington &Higgs, 2004)

2.1 Asymmetric Volatility and Univariate GARCH Model

Merton (1980) shows the realtionship between the volatility and stock returns. There are many papers using quantitative methods to examining this theory, most of them using GARCH model to identify the effect of asymmetric volatility to stock markets. Engle (1982) and Bollersley (1986) primarily presented Generalized autoregressive conditional heteroskedastic (GARCH) models to estimate volatility for time-series data of the financial assets. Hentschel (1994) summerises a parametric family of model of GARCH when examining the symmetric and asymmetric volatility. Evan and McMilan (2007) forecasted the performance of nine models for daily stock returns in 33 countries. They suggest that 70% case of GARCH model could explain either asymmetry or long-memory dynamic of stock markets. However, GARCH (1,1) only captured some of skewness and leptokurtosis in financial data. Moreover, the normal GARCH model could not explain the leptokurtosis in sample data which conditional variance did not follow the normal distribution. Alexander and Lazar (2006) apply the exponential GARCH model for difference distribution including non-normal, t-student and normal-lognormal distribution. Su

(2010) use Chinese stock market data and suggest that EGARCH model is fitter than GARCH model to model the volatility. In the same case, Chong et al. (1999) also suggested that exponential GARCH had best performing to describe the often-observed skewness in stock market indices.

Particularly, Bae and Karolyi (1994) examined the stock dynamics (both of overnight and daytime returns) of Japanese and US stock markets from 1988 to 1992. They also extend the GARCH model to allow for asymmetric effects of "bad news" from foreign market returns shocks. Their evidence demonstrates that if the asymmetric effect is ignored, there are reasonable and significant transmissions between the U.S. and Japan. In this study, authors choose EGARCH (1, 1) of Nelson (1991) to model the variance-covariance equation.

2.2 Volatility Spillovers and VAR Model

In the period of globalization, the transmission mechanism in international finance markets is popular and have more recent studies investigate stock market interactions. It has many recent literatures that have considered the linkages between mature markets and emerging markets in the normal and crisis times. Goetzmann et al. (2005) said that economists and financial analysts pointed out that benefits of international diversification rely increasingly on investment in emerging markets. Bernier et al. (2009) use tri-variate GARCH-BEKK model to test the volatility spillover of 41 emerging market economies. Li (2007) also use the same model to find the linkage between stock exchange in mainland China and other mature stock markets and find the volatility spillover of Hong Kong, Shanghai and Shenzhen to mainland Chinese stock market. Additionally, Li (2007) argue that there is no evidence for the linkage between US stock market and China. However, many paper show that there are the volatility spillover effects from US and Japan stock markets to Asian markets. Hsin (2004) believes that the main stock markets in ther world such as US, UK and Canada have contagion effect to other stock markets outside its region. This paper also shows that Japanese stock market become more influence toward other market during Asian financial crisis. In the same case, Fernández-Izquierdo and Lafuente (2004) found significant leverage effects in all the markets in the Asian financial crisis. They found that the financial crisis had resulted in negative shock among these markets and volatility spillover is responsible for the noisy transmission of the negative information.

Diebold and Yilmaz (2009) introduce a volatility spillover measure based on forecast error variance decompositions from vector autoregressive (VAR). It can be used to measure spillovers in returns or return volatilities across individual assets, asset portfolios, asset markets, etc., both within and across countries, revealing spillover trends, cycles, bursts, etc. Some studies consider contagion effects as a function of stock returns across markets and focus on the vulnerability of a country to shocks from other countries using a vector autoregressive (VAR) framework. Eun and Shim (1989) investigate the international transmission mechanism of stock market movements by estimating a nine-market VAR system. They find that a substantial amount of interdependence exists among national stock markets, and that the U.S. stock market is the most influential market in the world. Thus, any changes in the New York stock exchanges would cause fluctuations of stock markets across countries. Ratanapakorn and Rivas (2002) use counteraction analysis and a VAR model to examine the long-term and short term relationships among stock indices of the US, Europe, Asia, Latin America, and Eastern Europe–Middle East. In this paper, we use VAR model to measure spillovers in returns from developed markets (US, Japan and Hong Kong) to ASEAN-6 stock markets.

3. Methodology and Data

3.1 Methodology

3.1.1 EGARCH Model

Let Ri,t is known as the return of a market index at the time t, where subscript i={1;2;..;9}. Ri,t denotes the continuously compounded daily returns at the time t:

$$R_{i,t} = \delta R_{i,t-1} + \varepsilon_{i,t}$$

$$\varepsilon_{i,t} = \sigma_{i,t} z_{i,t}$$

$$\ln(\sigma_t^2) = \omega + \beta \ln(\sigma_{t-1}^2) + \alpha \left[\frac{|\varepsilon_{t-1}|}{\sigma_{t-1}} - E\left(\frac{|\varepsilon_{t-1}|}{\sigma_{t-1}} \right) \right] + \gamma \left(\frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right)$$

Forecast by EGARCH (1,1)

$$\ln(\sigma_{t+1}^2) = \hat{\omega} + \hat{\beta} \ln(\sigma_t^2) + \hat{\alpha} \left[\frac{|\varepsilon_t|}{\sigma_t} - \sqrt{\frac{2}{\pi}} \right] + \hat{\gamma} \left(\frac{\varepsilon_t}{\sigma_t} \right)$$

where $\sigma_{i,t}^2$ is represented the conditional variance since it is a one period ahead estimate for the variance calculate on past information. $z_{i,t}$ is the standardized residual. The first equation is defined a variance ω, α, β, γ are parameters to be estimated. If the parameters ω, α, β, γ are negative, $\sigma_{i,t}^2$ will be positive since $\ln\sigma_{i,t}^2$ is created.

The α parameter is measured a magnitude effect or the symmetric effect of the model, the "GARCH" effect. β is represented the persistence in conditional volatility inattentive of market. When β seems large, it means volatility takes a long time to become extinct following the crisis in the market. The coefficient γ presents the different impact on good news and bad news, this is very important so that the EGARCH model allows for testing of asymmetries.

If γ=0, then the model is symmetric. When γ<0, then positive innovations (good news) spawn less volatility than negative innovations (bad news). When γ>0, it implies that positive shocks are more destabilizing than negative shocks.

Before estimated parameters, this paper calculated log-likelihood value for EGARCH model estimated for each market based on the Student-t distribution and the Gaussian distribution. After that, we use likelihood ratio statistics based on the definition of likelihood ratio (LR) test:

$$LR = -2(L_S - L_G) \sim \chi^2(1)$$

L_G measures given maximized log likelihood value of Gaussian model while L_S denotes for the Student-t model.

Essentially LR test statistic is following Chi-square distribution.

3.1.2 VAR Model

This paper is using the short-run dynamic relationships between stock markets, we use following Vector Autoregressive (VAR) model. This model is easily to use for calculating and analyzing the time series because we do not indicate the variables which are endogenous or exogenous.

$$R_{i,t} = \beta_{i,0} + \sum_{j=1}^{n} \beta_{i,j} R_{j,t-1} + \varepsilon_{i,t}$$

The conditional mean in each market (Ri,t) is a function of own past returns and cross-market past returns (Rj,t). βi,j is captured the lead-lag relationship between returns in different markets, for i # j. Market j leads market i when βi,j is significant. Because VAR models required the variables must be stationary, so the authors must determines the lag lengths of all stock returns data by Akaike's (AIC) test. After apply VAR model, basically, the authors used VAR's impulse responses function to estimate how long the volatility reacts to each markets.

3.2 Data and Preliminary Statistics

The data is consisted of daily prices recorded when closing price in GMT +8 time (pseudo-closing prices) of ASEAN-6, S&P 500 (USA), Nikkei (Japan) and Hang Seng (Hong Kong) indices. It is mean that S&P 500 is recorded after 1-day than other indices. The period is from July 31, 2000 to April 1, 2015. The authors choose daily data based on some following advantage:

- Efficiency market hypothesis would suggest that news is quickly and efficiently related to stock prices. Therefore, information generated yesterday is more important in explaining prices today than the information set up last week or before.
- Profit forecasts, changes in interest rates, changes in oil prices, declarable of war have different impact on investors' behavior. Using daily stock data permits an analysis of how a market reacts to news and how the market's "psychology" can be transmitted from one market to another.
- International stock markets have different trading hours, so the usage of closing prices leads to an underestimation of the true correlation between stock markets. Using pseudo-closing prices, we avoid this correlation.

We calculated the returns of these markets as follows:

$$R_{i,t} = \log\left(\frac{P_t}{P_{t-1}}\right)$$

where P_t is the price level of an index at time t

Since the data comes from different countries, it has a problem of different holidays for each market. We tackle this problem by taking the holiday (pseudo) closing price as being the same as the previous day. Hence the sample for each country contains all days of the week except weekends.

Table 1. Preliminary statistic daily closing stock returns

	Min	Max	Mean	Std. Dev	Kurtosis	Skewness
Thailand	-.06976	.04593	.000188	.0058026	13.886**	-.72313**
Singapore	-.31589	.31859	.0000596	.008807	882.2**	.26341**
Malaysia	-.06531	.06162	.0000939	.0037495	54.069**	-.96101**
Indonesia	-.11196	.08282	.000272	.0063711	40.474**	-1.4429**
Philippines	-.07668	.08384	.0001949	.0059645	33.868**	.51917**
Vietnam	-.03324	.02890	.0001913	.0067257	6.0539**	-.25229**
US	-.09469	.10957	.0000973	.0124587	11.910**	-.18414**
Japan	-.24038	.29671	.0000481	.0162888	48.462**	.40704**
Hong Kong	-.15528	.20284	.0000989	.0153275	21.285**	.32976**

** denotes significance at the 5% level; ** denotes significance at the 1% level*

We practiced the skewness and kurtosis tests to test the normality of sample data. The Ho and H_1 hypothesis was that:

H_0= the sample data are normal distribution

H_1= the sample data are not normal distribution

The result of this test is illustrated in Table 1. We reject the null hypothesis that the sample is normally distributed at 5% significant level. The skewness parameters are highly significant, indicating that the stock market returns were not symmetrically distributed. Coefficients of kurtosis are all significant in all equity markets, referring that stock market return volatility exist in all exchanges.

The Augmented Dicky-Fuller (ADF) statistic indicates that the stock return series is stationary. The ADF test statistics rejected the hypothesis of the existence of a unit root in the returns series at 1% level of significance. The absolute value of the ADF statistic 30.786 exceeds the MacKinnon critical value of 3.430. Therefore, this data is suitable for two bellow model.

4. Results

4.1 Asymmetric Volatility through EGARCH Model

Table 2 is presented the log-likelihood values in EGARCH model estimated of single markets. Models based on the Student-t distribution generally produce the largest LLH value, where the log-likelihood values in EGARCH model that assume the Gaussian distribution are consistently much worse than Student-t distributions.

Table 2. The Log-Likelihood value for EGARCH model

	Gaussian	**Student-t**
Thailand	14501.59	14748.83
Singapore	13849.24	15367.76
Malaysia	16302.25	16849.69
Indonesia	14308.9	14702.05
Philippines	14414.32	14890.85
Vietnam	14189.17	14425.83

Likelihood ratio test between EGARCH models and theirs conventional Gaussian counterparts is reported in Table 3. It illustrates that an EGARCH model with Student-t distribution specification is more fit in the sample data than EGARCH model with Gaussian distribution in all markets. Hence, the EGARCH model with Student-t distributions is the best fit in this case.

Table 3. The LR test of EGARCH model between Gaussian and Student-t distribution

	LR test
Thailand	494.50**
Singapore	3037.04**
Malaysia	1094.89**
Indonesia	786.30**
Philippines	953.07**
Vietnam	473.33**

** denotes significance at the 5% level; ** denotes significance at the 1% level*

We estimated the volatility parameters in six stock markets along with evaluating the effects of financial crisis based on Student-t EGARCH (1,1) model. The time-series divided into three periods:

- Pre-crisis: Jul 31,2000 to Dec 29,2006
- During-crisis: Jan 1,2007 to Dec 31,2009
- Post-crisis: Jan 1, 2010 to Apr 1,2015

The parameter estimation for the EGARCH (1,1) model is showed in Table 4. Most of estimated coefficients are significant in all models. To analyze asymmetric volatility, according to the results we can find that the leverage effect γ are almost negative It means that the positive shocks (good news) cause less volatility than the negative shocks (bad news) in all stock markets. The hypothesis, that there is existed asymmetric volatility in all ASEAN-6 stock markets, is confirmed. In others, there is an existence of the 'down market effect' or the 'leverage effect'. Extending on this outcome, it might indicate that bad news creates speculative bubbles, particularly when the socioeconomic and political circumstances are very unpredictable (Ogum et. al., 2008).

Furthermore, the absolute value of γ is larger than it when compares with the period before the crisis during the financial crisis. Thus, we are not surprising to say that the investors of ASEAN-6 preferred to hear positive information than negative information when they endure the crisis. Basically in the crisis, shareholders feel scarier for bad news, because bad investment will go bankrupt. It is reliable to claim that stock markets are more sensitive for negative information. In addition, in the past-crisis period, we can see a bigness difference of γ with the post-crisis period. This can explain that the investors are still cautious with the market information after crisis.

To all indices during financial crisis, the symmetric effect α which is different than it in the other periods in EGARCH model, it however is relatively large than 0.1 too, so it means that the volatility is sensitive to market changes in the period. On the other hand, during the crisis α is the largest, represented that volatility was very sensitive in the bad time.

The parameter β is represented the persistence in conditional volatility irrespective. Almost β are positive and relatively large (above 1) in all period. It is mean that the volatility persistence can be strong. During crisis, almost markets (exception Malaysia) show dramatic decrease of β. It might explain that the markets are more sensitive with information. Special, after crisis, with emerging markets ASEAN-6, Philippines and Vietnam are stock markets which have increase of β. It is mean that Philippines and Vietnam are effected long time volatility than others.

Table 4. Parameters estimate of nine stock markets

	Thailand	Singapore	Malaysia	Indonesia	Philippines	Vietnam
2000-2015						
ω	1.7703*	2.6565**	-.1722	-1.2885*	-.5172	.4905
β	1.1759**	1.2703**	.9842**	.8764**	.9519**	1.0456**
α	.2877**	.5423**	.4421**	.4326**	.3516**	.8769**
γ	-.0929**	-.1609**	-.0874**	-.1412**	-.0794**	-.0049
2000-2006						
ω	4.0913**	2.6667	-.1555	-.7365	.8031	1.5196**
β	1.4008**	1.252**	.9883**	.9301**	1.0805**	1.1108**
α	.1954**	.2313**	.3853**	.2524**	.1626**	1.2314**
γ	-.05522*	-.0910**	-.07	-.0884*	-.03639	.0331
2007-2009						
ω	.6747	-12.104**	.3262	-.9002	-2.5328*	-7.0303
β	1.0750**	-.3456	1.0322**	.9152**	.736**	.2663**
α	.3635**	.4148*	.3061**	.4607**	.5071**	.6395
γ	-.1438**	-.1418	-.1176*	-.2201**	-.0817	.0845
2010-2015						
ω	.0889	-10.025**	-2.6842	-1.9708	.7	-.2656
β	1.012**	.1081*	.7756**	.8154**	1.0644**	.9769**
α	.2809**	.2426*	.3942**	.4275**	.3189**	.4374**
γ	-.1245**	-.1340*	-.1429**	-.1793**	-.1005*	-.024

** denotes significance at the 5% level; ** denotes significance at the 1% level*

4.2 Volatility Spillover through VAR Model

The optimal lag length for a VAR model is usually based on some information criteria and/or residual tests. After considering the parsimony principle and the residuals' white-noise property, a one-period lag or VAR (1) model is selected. The test stability condition of VAR (1) model is available in appendix 2. It said that VAR (1) model are suitable.

Table 5. Result of VAR (1) model

Thailand (i=1)		**Singapore (i=2)**		**Malaysia (i=3)**	
i=1	-.0810078**	*i=1*	.0789191**	*i=1*	.023372
i=2	-.0025006	*i=2*	-.7406387**	*i=2*	.0139241
i=3	.0435834	*i=3*	.1044473*	*i=3*	-.0783982**
i=4	.0467012*	*i=4*	.0535344*	*i=4*	.0703936**
i=5	.0602378**	*i=5*	.0550198*	*i=5*	.0094104
i=6	.0116496	*i=6*	-.035372	*i=6*	.0203731*
i=7	.1070982**	*i=7*	.1703581**	*i=7*	.077264**
i=8	-.0067604	*i=8*	.0443803**	*i=8*	-.0062431
i=9	-.0223301*	*i=9*	.0621348**	*i=9*	-.0007118

R^2	0.0631	R^2	0.3150	R^2	0.1052
Indonesia (i=4)		**Philippines (i=5)**		**Vietnam (i=6)**	
i=1	.0427403*	*i=1*	.0659789**	*i=1*	-.003232
i=2	.0245811	*i=2*	.0176191	*i=2*	.0035013
i=3	.0053406	*i=3*	.0749813**	*i=3*	.1645993**
i=4	-.0028217	*i=4*	.1081283**	*i=4*	.0293014
i=5	.0639774**	*i=5*	-.0495048**	*i=5*	-.0245837
i=6	-.0062141	*i=6*	-.0222525	*i=6*	.1782778**
i=7	.1254668**	*i=7*	.166055**	*i=7*	.0866246**
i=8	.0121677	*i=8*	-.0064909	*i=8*	-.0015117
i=9	-.0429245**	*i=9*	.0023497	*i=9*	.0128881
R^2	0.0787	R^2	0.2097	R^2	0.0844
US (i=7)		**Japan (i=8)**		**Hong Kong (i=9)**	

** denotes significance at the 5% level; ** denotes significance at the 1% level*

Table 5 presents the estimates of VAR (1) model coefficients. An inside view of estimations results brings out that the VAR system allows to satisfactorily explain the dependency of stock market volatility indices. Taking a close look to the R2 statistic, we acknowledge that the volatilities in Singapore (38.5%); Philippines (20.97%) and Malaysia (10.52%) are well explained by volatilities in foreign markets. For these markets, the explanatory power is generally medium and ranges from 6.31% (Thailand) to 38.5% (Singapore). In ASEAN stock markets, four couple market include Thailand – Indonesia; Thailand – Philippines; Indonesia – Philippines and Malaysia – Vietnam are interaction during all sample time series. Compare between pre, post and after crisis, it is simply find that a strong interaction of ASEAN-6 stock markets during crisis and less interdependence after crisis. It is mean that ASEAN-6 stock markets are recovering after crisis.

It has been found that both of six ASEAN markets are leaded by US market. Hong Kong is also a market that effect to Thailand, Singapore and Indonesia. Japan stock market leads only Singapore stock market. The influence of US stock market in the emerging stock markets in ASEAN has been demonstrated in studies such as R.C.Royfaizal; C.Lee; M.Azali (2009) and M.Z.A. Karim (2010). Although we do not find shock spillovers from Japan to ASEAN-6 in the long run, the volatility spillovers between them are more significant after crisis (appear spillovers from Japan to Thailand, Malaysia, Indonesia and Philippines). Particularly, during the recent five years, the linkages between the Japanese market and the ASEAN-6 have become stronger. Beside that, the leadership of Hong Kong stock market is decrease after crisis. The geographical proximity might be not a highly explanation with Hong Kong in this case.

Once the VAR systems for the returns are estimate, we then conduct the dynamic analyses of IRFs. The results of IRFs in three difference periods are showed in appendix 3. While we have set the impulse responses from 1 to 10, only the first three impulse responses are reported in the appendix. In effect, ASEAN-6 stock markets start to apparently respond to volatility shock in US stock market exactly (after 1 day). For example, an increase shock of the US returns of about 1% implies a reaction from ASEAN market such as Vietnam (0.09%), Indonesia (0.13%), Malaysia (0.08%), Philippines (0.17%), Singapore (0.17%) and Thailand (0.11%). Except Singapore, other ASEAN-5 returns seem to be not persistent until 3rd period. An obvious tendency is that the impulse responses are higher between US stock market and ASEAN-6, than between Japan; Hong Kong and ASEAN-6 because of the influence of the US stock market to Global financial. Special, during crisis, the impulse responses of US to ASEAN-6 are exactly and maximum in six countries. In crisis, when S&P 500 returns increased 1%, PSE index (Philippines) increased 0.2% after 1 day. The lower increase in this period was SET index (Thailand) with increased 0.1% when S&P 500 increased 1%. After crisis, the impulse responses of US returns to ASEAN are not change. With only Singapore, it prolonged with rhythm descending during 10 periods. As can be observed, shock to the volatility of Japanese and Hong Kong stock markets seem result in not significant responses of ASEAN-6 market. This typical spillover effect is only more important that to Singapore stock market after crisis with fluctuation the same with US market.

5. Conclusion

The volatility of ASEAN-6 stock returns has been investigated and modeled using nonlinear asymmetric EGARCH (1,1) model. We found that all ASEAN-6 returns series exhibit leverage effects. It means that the positive shocks cause less effect than the negative shocks in all stock markets. This model is also proved that the investors of ASEAN-6 preferred to hear good information than bad information when they suffer the crisis time. Basically in the crisis, shareholders feel scarier for bad news. It is reliable to declare that stock market is more sensitive for information special with bad news. It obviously explains because the investor confidence is always decline during crisis. After crisis, they are still cautious with inside and outside stock market information. ASEAN-6 investors are more sensitive until now with market volatility.

The VAR model results show that the relationships between ASEAN-6 stock markets occur all periods. This model is also prove that exist a big effect of US stock market to ASEAN-6 stock market from 2000 to 2015. Hence, authorities in the ASEAN-6 countries should be more alert to stock price movements, volatility, and any policies related to U.S. stock market. There are existed a reverse fluctuation between Japanese and Hong Kong stock market before and after the crisis. While the Japanese stock market demonstrates its influence to ASEAN-6 returns, Hong Kong stock market is plunged. This is also implied that the ASEAN-6 system is more interdependence during crisis and less after crisis. It is mean that ASEAN-6 stock markets are recovering after crisis.

After VAR model, we then conduct the dynamic analyses of IRFs. An obvious tendency is that the impulse responses are higher between US stock market and ASEAN-6, than between Japan; Hong Kong and ASEAN-6 because of the influence of the US stock market to Global financial. Special, during crisis, the impulse responses of US to ASEAN-6 are exactly after first period and maximum in six countries. It is mean that ASEAN-6 stock markets more sensitive with shocks from US and the change will be appeared into ASEAN-6 returns after one day. It will be helpful with investors can predict the evolution of domestic stock markets when there have a shock from others. In addition, it also advice for investors' decision of diversify portfolio in stock markets.

In this study, we only analyze the volatility spillovers through VAR model, but some literature suggests that we can also examine its through multivariate GARCH model (BEKK model; M-EGARCH model). Some paper usually use VAR model with volatility spillover index. Moreover, this paper only analysis the change of stock returns in short time (daily). It is impossible when remain some conclusions in the long periods for researchers and investors. This remains topics for further researches with the fixed about econometrics model and updated data.

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Note

Note 1. Six stock markets includes Thailand, Vietnam, Malaysia, Singapore, Indonesia and Phillipins.