

Full Length Research Paper

Analysis of volatility spillover in Indonesia, USA and Japan capital market

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Globalization and development in information technology makes easier for investor in obtaining global information. In this condition, volatility in domestic capital market could be affected by volatility from global stock markets. That concern will be answered in this research: volatility spillover in Indonesia, USA, and Japan capital market. This research using daily return data from each country from January 2004 until December 2008 employing econometric model generalized autoregressive conditional heteroscedasticity (GARCH) (1,1). The result shows that there is volatility spillover between Indonesia and USA (Indonesia affected by USA). Meanwhile, there is bidirectional volatility spillover between Indonesia and Japan (Indonesia affected by Japan, and vice versa).

Key words: Volatility, spillover, generalized autoregressive conditional heteroscedasticity (GARCH).

INTRODUCTION

Investment in capital market is one investment alternative for investor. Globalization and development in information technology means investor could invest in either domestic or global capital market.

Fact showed that crash in USA capital market caused by subprime mortgage followed by crash in other capital market. Another fact that can be captured is if USA capital market closed with positive return, there is a big probability that another capital market followed the same condition.

From those descriptions, we can conclude that what happened in USA capital market impacted to another capital market. Or in other words, there is a pretty high correlation between USA capital market with another.

Besides, Indonesia capital market has been suspended for several days started on October 8th, 2008 because its composite index down for more than 10% in a single day. The authority said that investors were panic and did not act rationally because of financial crisis in USA. It is interesting to find out if there is any relation of these or the downfall of Indonesia capital market caused by domestic matter, not by financial crisis in USA.

In 2008, Indonesian composite index (JKSE) recorded loss as of 50.64%. If compared with 2006 and 2007, JKSE give return respectively 55.10 and 52.10%. The top point of JKSE reached on second week in January 2008, when it hits 2,830.26 and in intraday have been reached to 2,838.48.

With financial crisis caused by subprime mortgage in USA, JKSE fall continuously. At the end of October 2008, JKSE down to 1,111.39. At the end of 2008, JKSE closed at 1,355.41. There are many researches about capital market volatility. Generally, it studies volatility in USA and Japan capital market. Meanwhile, there is no research for volatility spillover between Indonesia capital markets with some major capital markets in the world.

USA capital market is one of the most influential capital markets in the world. As we have discussed earlier, crash in USA capital market is followed by another capital markets in the world. And another influential capital market in Asia is Japan capital market.

Figure 1 show daily return variance data from Indonesia, USA, and Japan capital market that we can use as a proxy for volatility. This variance was calculated based on arithmetic return from JKSE (Indonesia), S & P 500 (USA), and Nikkei 225 (Japan).

We can see that variance of Indonesia capital market is the highest from 2004 to 2007.

But, when financial crisis in 2008 its variance is the lowest compared to USA and Japan. In total, variance of

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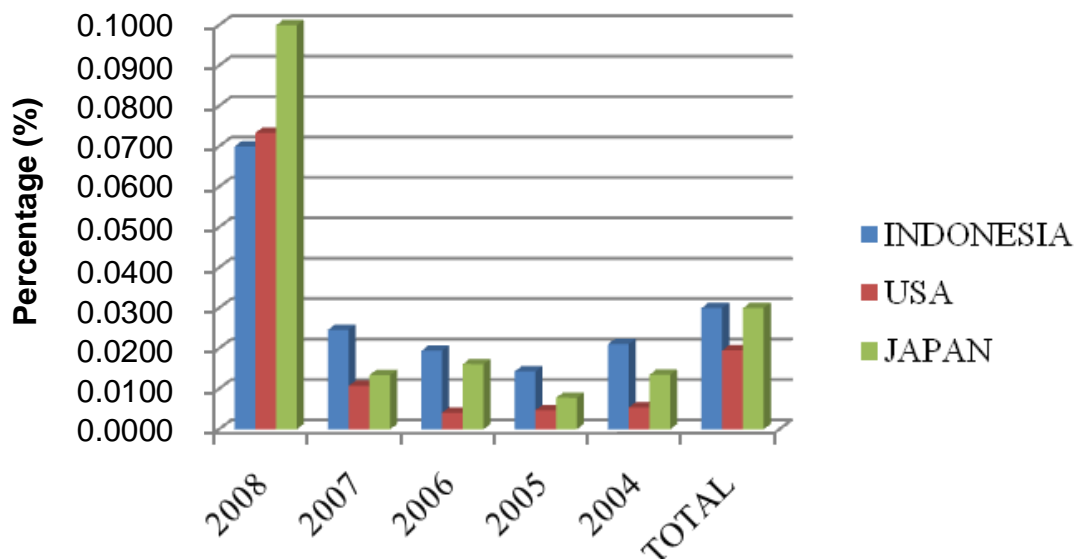


Figure 1. Variance of daily return Indonesia, USA, and Japan capital market. Source: Processed data; *total variance data calculated by using daily return from each capital market from 2004 to 2008.

Indonesia and Japan is equal, both are higher than USA.

Research by Hamao et al. (1990) found that there is significant spillover effect from USA and UK capital markets to Japan. Balasubramanyan and Premaratne (2003) concluded there is small but significant volatility spillover from Singapore capital market to USA, Hong Kong, and Japan. Their research is interesting because many of previous researches tend to conclude spillover effect would be significant from dominant market to smaller, and the effect would be unidirectional.

Based on their research, the objective of our research is to find out the relation between Indonesia stock market with USA and Japan stock market. Previous research have not included Indonesia, while Indonesia is one of emerging market it is interesting to find out relation between emerging capital market and well-developed capital market.

We also distinguish contemporaneous and dynamic volatility spillover in our research. This is important due to difference in trading time. We should also analyze if the volatility spillover is contemporaneous (directly in the very same day) or dynamic/lagged (with one day lag).

LITERATURE REVIEW

Globalization and its impact to capital market

Increasingly regional economic activity and financial market liberalization since 1980s result in integration of regional economy all over the world. Globalization also allows an enterprise in a country selling its stock in another country as new source for raising its capital needs for its expansion.

This expansion showed latest development in communication technology. With very high pace of communication technology development and information making possible of local financial markets became an international scale.

With those conditions, globalization and expansion of financial markets result in growth of financial market integration. Integration of financial market, especially in capital market, will make a correlation between return and volatility of every capital market. This could happen because speaking of globalization is not only about trading, but also dealing with investment. So, news about fundamental economy in a country mostly has impact for another country.

Another reason for change of price stock correlation between one and another country is contagion. Contagion is change of stock's price in a country because of impact from another country that is not caused from fundamental economy of that another country. The classic example of this market contagion is downfall of New York Stock Exchange in October 1987, famously known as Black Monday, causing stock price turmoil in the world.

Volatility

Globalization and multi-directional flow of capital between financial markets increase market interdependency. There are many empirical studies concluding co-movements and interdependency between capital markets in some country. There are two approaches used to research it.

First approach is researching many aspects of market

interdependency using cointegration and causality. One research using this first approach is research by Eun and Shim (1989) Mougoue and Bond (1991) and Febrian and Herwany (2009). Second approach is researching interdependency concerning in volatility spillover. Hamao et al. (1990) Bekaert and Wu (2000), Ng (2000), Balasubramanyan (2004), Veiga and McAleer (2004) and Mukherjee and Mishra (2008) using this approach.

According to King and Wadhvani (1990), an investor in capital market used announcement or information that accumulated from last closing of domestic capital market for estimating its impact on opening price. Otherwise, they can use change of price from global capital market which opens early than domestic capital market to estimating its impact probability to domestic capital market.

According to Calvet et al. (2006), main objective in research of volatility spillover is for understanding how volatility can affect return of portfolio. Return of portfolio has implication on daily risk management, portfolio selection, and derivative price. Movement of volatility could help in understanding shock transmission in global financial system. There is effect that affect volatility of financial market and assets, which is volatility spillover.

Price of assets intertwined each other (Rigobon and Sack, 2003). Analyzing a single market without paying attention to another aspect would mean ignoring important information of market behaviour. Change of asset's price in its market not only impacted by volatility shock, but also by its reaction to shock on asset's price in different country.

In this research there will be two terminologies on volatility, contemporaneous volatility spillover and dynamic volatility spillover. Contemporaneous volatility spillover is volatility spillover in the very same day. Contemporaneous volatility spillover generally happen on stock markets in a same region.

This can be explained by capital market in a same region having overlapping trading time. So, information from one capital market could be transmitted to another capital market on the same day where trading still take place. Based on this information, investor could make a decision that will impact that capital market.

Meanwhile, dynamic volatility spillover generally happens between capital markets in different region. Time-trading difference because of one capital market starts trading when the other has been closed or almost in closing time of trading. In this circumstance information from one capital market will make an impact to the other on next trading day, so volatility spillover happen on the next day. These condition what we called dynamic volatility spillover.

Previous research

Some previous research showed the existence of

volatility spillover. Eun and Shim (1989) analyzed daily return in Australia, Hong Kong, Japan, France, Canada, Switzerland, Germany, USA, and UK capital market. They found a substantial interdependence between each market with USA capital market is the most influential. On innovation in USA, all European and Asia Pacific markets highly responsive with one day lag. Most of this response to the shock will take place within two days.

Hamao et al. (1990) used daily and intraday data from Japan (Nikkei 225), UK (FTSE 100), and USA (S and P 500) for three years (from April 1985 to March 1988). They research price interdependency and volatility between three capital markets.

In that research, calculation of return used by comparing closing price with opening price, and opening price with closing price. Their research used GARCH-M (1,1) model. The result concludes that there is significant spillover effect from USA and UK capital market to Japan, but there is no significant spillover effect from Japan capital market to USA and UK.

Park and Fatemi (1993) research relation between capital market of Basin Pacific countries with USA, UK, and Japan. USA capital market is the most influential compared to UK and Japan. From their research found that Australia is the most sensitive to USA market. Singapore, Hong Kong, and New Zealand are next group showing moderate relation to those markets. Meanwhile, Korea, Taiwan, and Thailand showing little impact from those markets. Basin Pacific economy has unique structure that different to country have emerging market and its stock fluctuation mostly affected by domestic factors.

Lin et al. (1994) researching how return and volatility of Japan and USA indices correlated one another. Data used in that research is intraday data from Nikkei 225 and S and P 500. From those data, daytime return was calculated (opening price to closing price) and overtime return (closing price from previous day to opening price). Research employed GARCH-M model, as Hamao et al. (1990) also used, found that foreign daytime return affected domestic overnight return significantly.

Most research conclude that USA capital market impacted to Japan, not vice versa. Otherwise, research by Lin et al. (1994) showed that return and volatility market interdependency is bidirectional between Japan and USA.

Janakiraman and Lamba (1998) research empirically relation between Basin Pacific capital markets. Their result showed USA capital market influent to all capital markets but Indonesia, the isolated one. Markets with similar geographic and economic showing significant impact one another. Overall, impact from USA market to Australia-Asia market decline significantly nowadays, and Indonesia being more integrated to these markets.

Indrawati (2002) used value at risk (VAR) and vector error correction (VEC) model with GNC to testing dynamic relation of macro monetary economic variable

and capital market indices. Her research showed Indonesian capital market integrated to USA capital market. 1% increased in USA capital market will affected increase of Indonesian Composite Index as 0.32%.

That research also concluded that there is Granger cause bidirectional relation between Indonesia capital market with Thailand, Taiwan, and South Korea capital market. Besides, all stock markets in her research (Indonesia, Thailand, Taiwan, and South Korea) integrated with USA capital market.

Balasubramanyan and Premaratne (2003) research by using daily return data from January 1992 to August 2002 to investigate volatility spillover and comovement between Singapore stock exchange with USA, UK, Hong Kong, and Japan. One interesting result from their research is that there is significant volatility spillover from Singapore capital market to Hong Kong, Japan, and USA.

We know in case of influence and market dominance, Hong Kong, Japan, and USA capital markets are far more influential and dominant to Singapore capital market. Many researches tend to conclude that spillover effect will be significant from dominant market to smaller market, in a unidirectional way. This could be interesting noting that from their research there is little but significant volatility spillover from Singapore to Hong Kong, Japan, and USA.

Hypothesis development

From what we have earlier discussed, we can develop the following hypothesis:

First hypothesis: There is volatility spillover between Indonesia capital market with USA and Japan capital market.

Second hypothesis: There is bidirectional volatility spillover between Indonesia capital market with USA and Japan capital market.

METHODOLOGY

Data used

Data used in this research is closing price of indices. Daily return data y_t calculated using following formula:

$$R_t = 100 \times \log(P_t / P_{t-1})$$

Data of indices obtained from Yahoo! Finance from period January 1st, 2004 to December 31st, 2008. Usage of daily data cause of daily return can capture all possible interaction. Meanwhile, using weekly or monthly data could delete possible interaction that taking place only for several days. Data used are indices of each country, Jakarta Composite Index for Indonesia, S and P 500 index for USA, and Nikkei 225 for Japan.

Econometric model

With objective to obtain information about volatility spillover from time series data, we used GARCH (1,1) model in this research. Firstly, we use basic GARCH model for proxy volatility. Following model estimated using Maximum Likelihood Procedure applying BHHH algorithm. The following are models were used to test contemporaneous spillover:

$$R_{i,t} = \gamma_0 + \gamma_1 R_{i,t-1} + \gamma_2 R_{j,t} + \gamma_3 h_{j,t} + \varepsilon_{i,t} \quad (1)$$

$$h_{i,t} = \alpha_0 + \alpha_1 \varepsilon_{i,t-1}^2 + \alpha_2 h_{i,t-1} + \delta_1 h_{j,t} \quad (2)$$

$$R_{j,t} = \theta_0 + \theta_1 R_{j,t-1} + \theta_2 R_{i,t} + \theta_3 h_{i,t} + \varepsilon_{j,t} \quad (3)$$

$$h_{j,t} = \beta_0 + \beta_1 \varepsilon_{j,t-1}^2 + \beta_2 h_{j,t-1} + \varphi_1 h_{i,t} \quad (4)$$

where:

$R_{i,t}$ = return of domestic capital market at t period,

$R_{i,t-1}$ = return of domestic capital market at t-1 period,

$R_{j,t}$ = return of foreign capital market at t period,

$h_{i,t}$ = volatility of domestic capital market at t period,

$h_{i,t-1}$ = volatility of domestic capital market at t-1 period,

$h_{j,t}$ = volatility of foreign capital market at t period,

$\varepsilon_{i,t}$ = error of domestic capital market at t period,

$\varepsilon_{j,t}$ = error of foreign capital market at t period.

From above model we can see that $R_{j,t}$ and $h_{j,t}$ are contemporaneous spillover variable from foreign capital market (another country). Meanwhile, models used to test dynamic spillover are:

$$R_{i,t} = \eta_0 + \eta_1 R_{i,t-1} + \eta_2 R_{j,t-1} + \eta_3 h_{j,t-1} + \varepsilon_{i,t} \quad (5)$$

$$h_{i,t} = \chi_0 + \chi_1 \varepsilon_{i,t-1}^2 + \chi_2 h_{i,t-1} + \omega_1 h_{j,t-1} \quad (6)$$

$$R_{j,t} = \psi_0 + \psi_1 R_{j,t-1} + \psi_2 R_{i,t-1} + \psi_3 h_{i,t-1} + \varepsilon_{j,t} \quad (7)$$

$$h_{j,t} = \xi_0 + \xi_1 \varepsilon_{j,t-1}^2 + \xi_2 h_{j,t-1} + \rho_1 h_{i,t-1} \quad (8)$$

where:

$R_{i,t}$ = return of domestic capital market at t period,

$R_{i,t-1}$ = return of domestic capital market at t-1 period,

$R_{j,t-1}$ = return of foreign capital market at t-1 period,

$h_{i,t}$ = volatility of domestic capital market at t period,

Table 1. Result of processed data from Equations 1 and 2, Indonesia and USA.

γ_0	γ_1	γ_2	γ_3	α_0	α_1	α_2	δ_1
0.0814*	0.1741*	0.1383*	-0.1220	0.0395*	0.2209*	0.5551*	0.3089*
(4.1351)	(5.2229)	(3.5160)	(-1.4747)	(4.7600)	(6.7072)	(10.3606)	(4.7826)

Source: Processed data using Eviews 6. * Significant in 1%, ** significant in 5%, *** SIGNIFICANT in 10%. Numbers in parenthesis are z-statistic.

Table 2. Result of processed data from Equations 3 and 4, Indonesia and USA.

θ_0	θ_1	θ_2	θ_3	β_0	β_1	β_2	φ_1
0.0044	-0.1149*	0.0657*	0.0125	0.0020**	0.0722*	0.9160*	0.0018
(0.2777)	(-3.3662)	(3.5361)	(0.4658)	(2.2283)	(6.1035)	(61.8465)	(0.8030)

Source: Processed data using Eviews 6. * Significant in 1%, ** significant in 5%, *** significant in 10%. Numbers in parenthesis are z-statistic.

$h_{i,t-1}$ = volatility of domestic capital market at t-1 period,

$h_{j,t-1}$ = volatility of foreign capital market at t-1 period,

$\varepsilon_{i,t}$ = error of domestic capital market at t period,

$\varepsilon_{j,t}$ = error of foreign capital market at t period.

This research tests both contemporaneous and dynamic volatility spillover. Testing of dynamic volatility spillover was because there is one day lag between USA and either Indonesia or Japan.

RESULTS AND ANALYSIS

Test of contemporaneous spillover between Indonesia and USA

Here, we analyzed contemporaneous volatility spillover between Indonesia and USA. From Table 1 we can see that δ_1 coefficient shows that there is volatility spillover from USA. Volatility in Indonesia capital market affected from USA, which is significant in 1%.

However, as we have discussed earlier that there is one day lag between Indonesia and USA. So, the existence of volatility spillover from USA capital market which affected Indonesia capital market should be subject to advance research by employing dynamic model.

Meanwhile, from Table 2 we can extract that volatility of USA capital market is not affected from volatility spillover of Indonesia capital market.

From testing of first model, we can conclude that there is volatility spillover between USA and Indonesia capital market. Nature of volatility spillover is in one direction/unidirectional, volatility from USA capital market affected Indonesia but volatility from Indonesia does

not affected USA otherwise.

Test of contemporaneous spillover between Indonesia and Japan

Following are the result of processed daily return data between Indonesia and Japan using Equations 1 to 4. From Table 3, we can see that there is volatility spillover from Japan capital market to Indonesia capital market which is significant in 1%. So, volatility in Indonesia capital market is clearly affected by Japan capital market. Meanwhile from Table 4, we can see there is also contemporaneous volatility spillover from Indonesia capital market to Japan capital market. Therefore, from these testing we can conclude that there is bidirectional volatility spillover between Indonesia and Japan capital market.

Test of dynamic spillover between Indonesia and USA

Testing of dynamic spillover between Indonesia and USA capital market is important to do because we have known there is one day lag between two markets. From testing of dynamic spillover, we will know whether these have the same result as contemporaneous spillover or have the different one. Recall that testing of contemporaneous spillover showing that there is unidirectional volatility spillover from USA to Indonesia.

Processing result shown in Table 5 showed that there is dynamic volatility spillover from USA capital market to Indonesia, significant in 1%. The result shows that volatility of Indonesia capital market influenced by volatility spillover from USA capital market with one day lag.

Table 3. Result of processed data from Equations 1 and 2, Indonesia and Japan.

γ_0	γ_1	γ_2	γ_3	α_0	α_1	α_2	δ_1
0.0613*	0.1239*	0.5064*	-0.0232	0.0499*	0.2746*	0.4924*	0.0950*
(3.5099)	(4.3928)	(24.2686)	(-0.7380)	(4.4237)	(6.8642)	(7.1204)	(3.4826)

Source: Processed data using Eviews 6. * Significant in 1%, ** significant in 5%, *** significant in 10%. Numbers in parenthesis are z-statistic.

Table 4. Result of processed data from Equations 3 and 4, Indonesia and Japan.

θ_0	θ_1	θ_2	θ_3	β_0	β_1	β_2	ϕ_1
0.0073	-0.0286	0.3725*	-0.0393	-0.0006*	0.0708*	0.8960*	0.0240*
(0.4008)	(-0.9700)	(22.2092)	(-1.1680)	(-0.3780)	(5.2354)	(54.4718)	(4.2994)

Source: Processed data using Eviews 6. * Significant in 1%, ** significant in 5%, *** significant in 10%. Numbers in parenthesis are z-statistic.

Table 5. Result of processed data from Equations 5 and 6, Indonesia and USA.

η_0	η_1	η_2	η_3	χ_0	χ_1	χ_2	ω_1
0.0680*	0.1423*	0.4670*	-0.0652	0.0418*	0.2711*	0.5296*	0.2223*
(3.6642)	(4.4960)	(15.0117)	(-0.9361)	(6.2097)	(6.7972)	(11.0624)	(4.3871)

Source: Processed data using Eviews 6. * Significant in 1%, ** Significant in 5%, *** Significant in 10%. Numbers in parenthesis are z-Statistic.

Table 6. Result of processed data from Equations 7 and 8, Indonesia and USA.

ψ_0	ψ_1	ψ_2	ψ_3	ξ_0	ξ_1	ξ_2	ρ_1
0.0123	-0.0737**	-0.0405**	0.0120***	0.0023**	0.0769*	0.9116*	0.0010
(0.7820)	(-2.7142)	(-2.2067)	(0.4442)	(2.5450)	(6.0854)	(60.3325)	(0.4280)

Source: Processed data using Eviews 6. * Significant in 1%, ** Significant in 5%, *** Significant in 10%. Numbers in parenthesis are z-statistic.

Meanwhile, from Table 6 we can see that there is no volatility spillover from Indonesia to USA capital market. Therefore, from result testing of contemporaneous and dynamic volatility spillover which show same result we can conclude that there is unidirectional volatility spillover between Indonesia and USA, which USA capital market influenced Indonesia capital market.

Test of dynamic spillover between Indonesia and Japan

If dynamic spillover testing between Indonesia and USA made based on one day lag of trading time between two capital markets, this testing is done for another reason. Indonesia and Japan have nearby geographical location, both capital markets operate in almost same trading day.

However, imperfect market made it possible for foreign volatility to have one day lag before influencing domestic market. So, we could test if there is dynamic volatility spillover between Indonesia and Japan. The following are the result of those testing.

From Table 7, we can see the existence of volatility spillover with one day lag (dynamic volatility spillover) from Japan capital market to Indonesia which significant in 1%. This showed that there is still spillover in one day difference.

In Table 8, we can see that Indonesia capital market also influenced Japan capital market which significant in 5%. In testing of contemporaneous spillover, volatility from Indonesia affected Japan significant in 1%. We can see there is declining significant value from 1 to 5%, but overall we can still conclude that there is bidirectional volatility spillover between Indonesia and Japan.

Table 7. Result of processed data from Equations 5 and 6, Indonesia and Japan.

η_0	η_1	η_2	η_3	χ_0	χ_1	χ_2	ω_1
0.0777*	0.1579*	0.0017	-0.0418	0.0290*	0.2140*	0.6545*	0.1000*
(3.4986)	(4.4452)	(0.0491)	(-0.8466)	(5.0350)	(8.3856)	(17.8872)	(3.4700)

Source: Processed data using Eviews 6. *Significant in 1%, ** Significant in 5%, *** Significant in 10%. Numbers in parenthesis are z-Statistic.

Table 8. Result of processed data from Equations 7 and 8, Indonesia and Japan.

ψ_0	ψ_1	ψ_2	ψ_3	ξ_0	ξ_1	ξ_2	ρ_1
0.0243	-0.0382	0.0414	-0.0065	0.0005	0.0911*	0.8915*	0.0178**
(1.1705)	(-1.1227)	(1.5948)	(-0.1560)	(0.2700)	(6.8934)	(56.0130)	(1.9814)

Source: Processed data using Eviews 6. * Significant in 1%, ** significant in 5%, *** significant in 10%. Numbers in parenthesis are z-Statistic.

From result testing of Indonesia and Japan, it means that there is bidirectional volatility spillover, informing us that volatility spillover is not just from developed market to emerging market. This research shows that there is volatility spillover from Indonesia to Japan. The result is in line with research of Balasubramanian and Premaratne (2003). They found little but significant volatility from Singapore to some developed markets.

Conclusion

Volatility of Indonesia capital market influenced from either USA or Japan capital markets. This result is in line with first hypothesis; there is volatility spillover between Indonesia, USA and Japan capital markets. Volatility spillover which influenced Indonesia capital market is contemporaneous and dynamic volatility spillover.

Both contemporaneous volatility spillover and dynamic volatility spillover from USA capital market are significant in 1%. Dynamic volatility spillover can be understandable as there is one day lag of trading time between two countries. With Japan capital market, there is also 1% significance for either contemporaneous or dynamic volatility spillover from Japan to Indonesia. Dynamic volatility spillover between Indonesia and Japan can be explain as there is market imperfection so information from foreign capital market impacted domestic capital market on the next day.

On testing of second hypothesis (existence of bidirectional volatility spillover) resulting in different result. With USA capital market shown that there is no bidirectional volatility spillover. Meanwhile, with Japan capital market there is bidirectional volatility spillover which is significant in 1% (contemporaneous) and 5% (dynamic).

This result shown the same as research of Balasubramanian and Premaratne (2003) where they found significant volatility spillover from Singapore to developed market (Hong Kong, Japan, USA).

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