INTERNATIONAL TRANSMISSION OF STOCK RETURNS: MEAN AND VOLATILITY SPILLOVER EFFECTS IN INDONESIA AND MALAYSIA

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ABSTRACT

This paper examines the mean return and volatility spillover effects from the three influential stock markets of the US, Japan, and China to the two emerging stock markets of Indonesia and Malaysia over the sample period from 2005 to 2007. By analyzing GARCH models, we verify that there are significant mean spillover effects from the three major markets to the two emerging markets. The magnitude of the mean spillover from the US market is the most significant compared to the Japanese and Chinese markets. This would be consistent with the conventional wisdom in which the US market is believed to be the most influential market in the world. In terms of the volatility spillover, the empirical results reveal that the US market is more influential to Indonesia, but less to Malaysia, and recently growing Chinese market has a significant influence to both of the two emerging markets.

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JEL: F36; G15

KEYWORDS: Indonesian and Malaysian stock markets; mean and volatility spillover effects

INTRODUCTION

The Association of South East Asian Nations (ASEAN) has recently made tremendous progress toward economic integration through forming a free trade area (ASEAN Free Trade Area – AFTA) and an investment zone (ASEAN Investment Area - AIA). Even though the 1997 Asian financial crisis might have discouraged some fast-growing economies in the region, it has been widely acknowledged that financial integration with rapidly growing stock markets in the area plays a crucial role in achieving more efficient allocation of capital, and thus promoting economic development.

The on-going liberalization of capital mobility along with technological progress of network systems has caused international financial markets to become highly integrated and interdependent. One important aspect of integration is international transmissions among stock markets, as anecdotes often emphasize co-movements associated with a significant impact of major markets. This paper provides some empirical evidences of international transmissions from major stock markets toward recently developing stock markets (Indonesia and Malaysia) in ASEAN. In particular, we examine the mean and volatility spillover effects of stock returns from the US and Japanese markets toward each of the two emerging markets, partly following the two-stage GARCH method as in Liu and Pan (1997).

As an extension, we also incorporate the transmission from the Chinese market into the model. The reason for this extension is that the Chinese market seems to affect other emerging markets because of its large economic scale and impressive economic growth, as well as its close relationship with ASEAN countries in terms of trade and FDI. Given the fact that the stock markets in the region are attracting many investors with global portfolio diversification, understanding the interdependence of the stock markets would be crucial to implement appropriate financial policies.

By using GARCH models, we first capture the residuals for the US, Japan, and China markets with the consideration of their interdependence. After that, the residuals are employed to analyze the international transmission from the three large markets to each emerging market of Indonesia and Malaysia. The results verify that there could be a significant mean spillover effect of the US market on the two emerging markets. The Japanese and Chinese markets also present the significant mean spillovers. The results further reveal that the magnitude of the mean spillover from the US market is the most significant compared to the Japanese and Chinese markets. This would be consistent with the findings in most previous studies in which the US market is believed to be the most influential market in the world. Concerning the volatility spillover effects, the empirical results reveal that the US market is more influential to Indonesia but less influential to Malaysia. It is also shown that recently growing Chinese market has clear transmission to both of the two emerging markets.

The rest of the paper is organized as follows. The next section reviews previous studies on international transmission of stock returns. The third section explains our empirical methodology of the ARMA-GARCH-in-mean, partly following the idea of Liu and Pan (1997), and then presents empirical results. The last section provides some conclusions of this paper.

LITERATURE REVIEW

Many studies have been done on international transmission of stock returns in the context of the mean and/or volatility spillover effects. Most of them show some evidences of international transmission from major markets, such as the US and Japanese markets, toward the other developed and emerging markets. For example, empirical works by Hamao, Masulis and Ng (1990), King, Sentana and Wadhwani (1994), Karolyi (1995), Becker, Finnerty and Friedman (1995), and Baur and Jung (2006) observe some spillovers in terms of both returns and their volatilities from the US to some developed equity markets like the U.K., Japan, Canada, Germany, and France. The transmission from developed markets to emerging markets in Asia is also detected by various studies, such as Park and Fatemi (1993), Kim and Rogers (1995), Hu, Chen, Fok, and Huang (1997), and He (2001).

As studies particularly focusing on the discussions related to emerging ASEAN markets, Park and Fatemi (1993) find a weak linkage between the stock markets of Pacific Basin countries (including two ASEAN countries – Thailand and Singapore) and those of the US, the UK, and Japan. Janakiramanan and Lamba (1998) examine the linkages between some developed markets and three ASEAN developing markets (Indonesia, Malaysia, and Thailand) and find that the US market influences all other markets except for Indonesia. Tan and Tse (2002) investigate the linkages among the US, Japan, and seven Asian stock markets. They find that while the US is the most influential one to Asian markets, Japan's influence is increasing. Moreover, many other papers focus on integration and linkages of ASEAN stock markets after the 1997 financial crisis (see Sharma and Wongbangpo, 2002; Wongbangpo and Sharma, 2002; Click and Plummer, 2005; and Abdul-Rahim and Nor, 2007).

To examine the relationships between short-term fluctuations in stock returns, some researches apply the VAR and/or the GARCH models. For example, Eun and Shim (1989), Janakiramanan and Lamba (1998), and Cha and Oh (2000) apply VAR models to explore the international transmission mechanism of stock market movements. While many other scholars rely on GARCH and some modification of GARCH models to investigate the international transmission effects among markets (see, e.g., Cheung and Mak, 1992; Kim and Rogers, 1995; Liu and Pan, 1997; Ng, 2000; and Kim, 2005), some studies like Antoniou, Pescetto and Violaris (2003) use the combination of VAR and GARCH models. Moreover, Lee (2002) develops a new testing technique based on the wavelet transform to explore returns and volatility spillover effects across markets.

EMPIRICAL ANALYSIS

Data employed in this paper are daily closing stock market indices for two developed stock markets (the

U.S. and Japan) and three emerging stock markets (China, Indonesia, and Malaysia). The indices used are Standard & Poor 500 Index (the U.S.), Nikkei 225 (Japan), Shanghai Stock Exchange Composite Index (China), Jakarta Composite Index (Indonesia), and Kuala Lumpur Stock Exchange Composite Index (Malaysia) over the sample period from January 2005 to December 2007.

The data are retrieved from Yahoo Finance. For each market, the daily market index is measured in local currency terms. The indices are transformed to a daily rate of return as $r_t = \ln(p_t) - \ln(p_{t-1}) = \ln(p_t / p_{t-1})$, where p_t and p_{t-1} are the price index value at time t and t-1.

Table 1 presents the summary statistics for the daily stock index returns of the five markets from January 2005 to December 2007. The mean return and the volatility are the highest for the Chinese stock market among all of five markets, and the Indonesian stock market follows. The characteristics of the two emerging markets seem to be consistent with the argument that distinguishing features are high risk and high returns (see, e.g., Harvey, 1995). In contrast, the Malaysian stock market is relatively stable and less volatile compared to the other markets. Furthermore, the results of Kurtosis test suggest that their daily return series would be "peaked" and have "fat tailed" distribution.

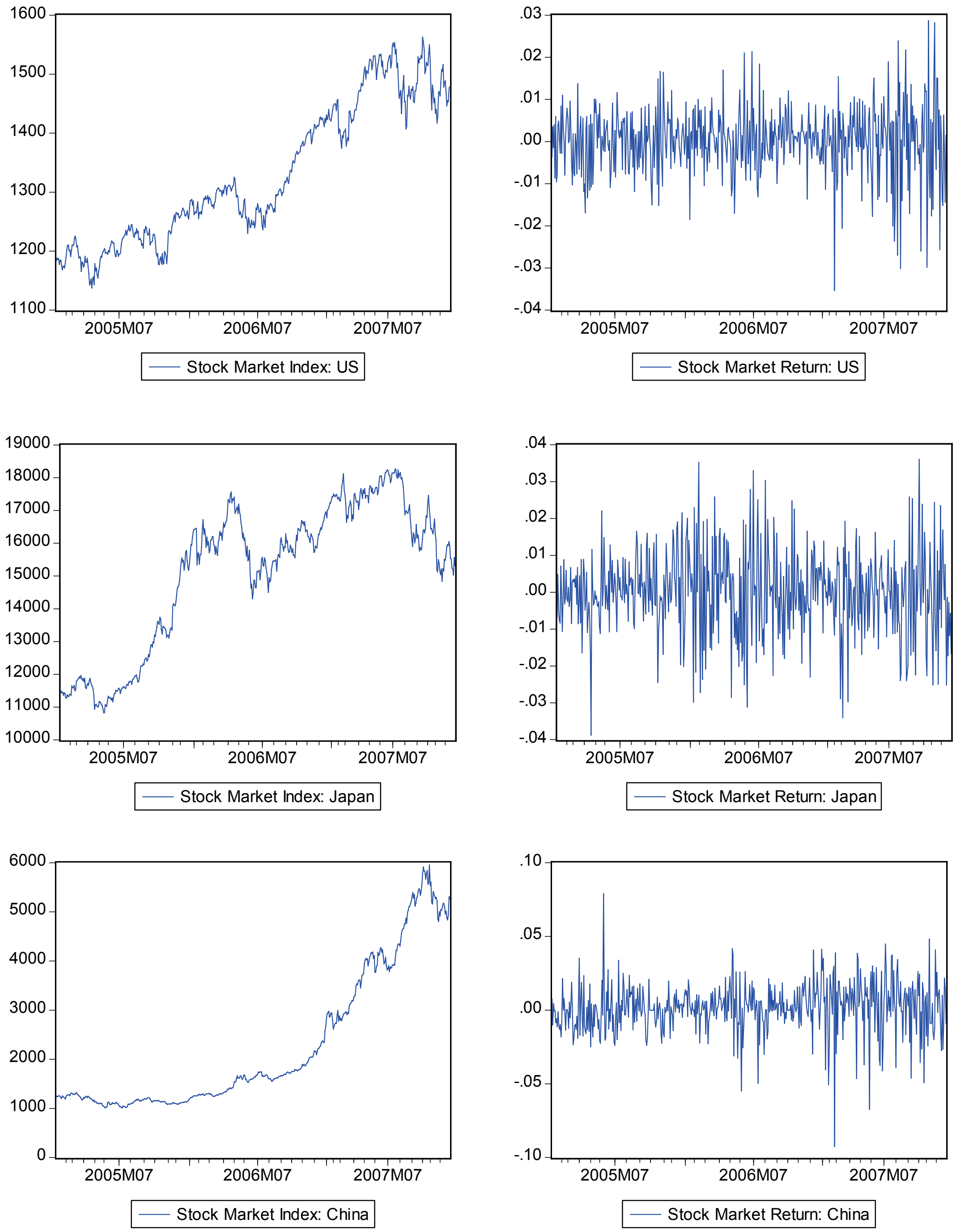
Table 1: Summary Statistics for Daily Stock Index Returns

	Indonesia	Malaysia	US	Japan	China
Mean	0.0010	0.0002	0.0002	0.0000	0.0016
Median	0.0021	0.0006	0.0009	0.0000	0.0019
Maximum	0.0532	0.0260	0.0287	0.0360	0.0789
Minimum	-0.0665	-0.0475	-0.0353	-0.0388	-0.0926
Std. Dev.	0.0135	0.0075	0.0080	0.0112	0.0167
Skewness	-0.9402	-1.2486	-0.4591	-0.0969	-0.5114
Kurtosis	7.3647	9.4273	5.1232	3.6703	6.4845
Ljung-Box Q-Statistics					
Daily Returns					
LB(12)	14.40	27.86*	19.04	16.33	4.57
LB(24)	37.50*	45.76*	33.62	34.69	18.37
Squared Daily Returns					
LB(12)	120.68*	307.39*	168.45*	70.18*	33.95*
LB(24)	134.15*	312.21*	184.95*	96.04*	57.23*

Sample period is January 2005 to December 2007. LB(k) is the Ljung-Box Q statistic for k order serial correlation.
** indicates significance at the 5 percent level.*

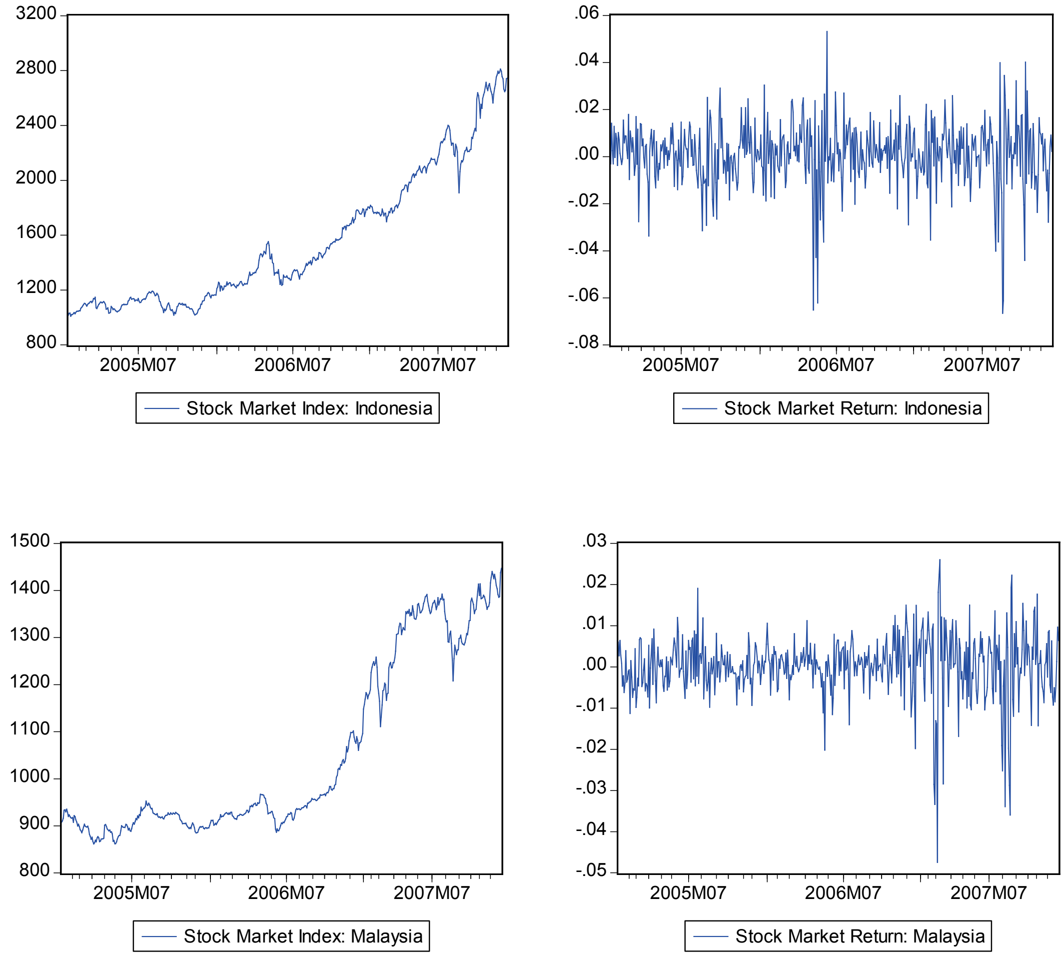
Figures 1 and 2 show the stock market index series p_t and the corresponding returns series r_t of the five stock markets. Each national stock market operates in different time zones with different opening and closing times, so that the daily rates of return represent the returns in different real time periods. All the Asian stock markets are closed when the US market opens, and vice versa.

Figure 1: Stock Market Indices and Daily Returns in the U.S., Japan, and China



The figures in the left-hand side show the stock market index, and the figures in the right-hand side show the daily returns of the stock market index. Sample period is from January 2005 to December 2007.

Figure 2: Stock Market Indices and Daily Returns in Indonesia and Malaysia



The figures in the left-hand side show the stock market index, and the figures in the right-hand side show the daily returns of the stock market index. Sample period is from January 2005 to December 2007.

Table 2 reports the correlations of stock index returns. Notice that the correlations between returns of Asian countries and the previous day's returns of the US are higher than the corresponding correlations with the same-day US returns. Moreover, as expected, the correlations between returns of Asian markets and that of previous day of the US are all positive. These could support the conjecture that the U.S. market is influential to other markets.

Since the introduction of the work of Engle (1982) on the Autoregressive Conditional Heteroskedasticity (ARCH) model, there has been a large body of literature on volatility forecast (see Bollerslev, Chou, and Kroner, 1992, for summaries of this family's models). Although empirical evidences are rather mixed as to which volatility model performs best, the ARCH models are widely applied to capture the fat-tailed nature of the stock return distribution with time-dependent volatility. For example, the work of Akgiray (1989) on the U.S. stock markets finds that the GARCH (1,1) model outperforms more traditional technical analysis. Brailsford and Faff (1996) suggest that the ARCH class of models provide superior forecasts of volatility. However, the various model rankings are shown to be sensitive to the error statistic used to assess the accuracy of the forecasts.

Table 2: Correlation Matrix of Daily Stock Index Returns

	China	Indonesia	Japan	Malaysia	US	US (-1)[b]
China	1.0000	0.1514	0.1687	0.2298	0.0580	0.0878
Indonesia	0.1514	1.0000	0.4960	0.5425	0.0872	0.3684
Japan	0.1687	0.4960	1.0000	0.4398	0.1190	0.3951
Malaysia	0.2298	0.5425	0.4340	1.0000	0.0344	0.3772
The U.S	0.0580	0.0872	0.1190	0.0344	1.0000	-0.0875
The U.S (-1)[b]	0.0878	0.3684	0.3951	0.3772	-0.0875	1.0000

Sample period is January 2005 to December 2007. b indicates the one-day lagged return in the U.S. market

Empirical Models

This subsection employs the idea of the two-stage GARCH model in Liu and Pan (1997) to examine the international transmissions of the mean and volatility from the major stock markets (the US, Japan, and China) to each of the two emerging stock markets (Indonesia and Malaysia). The GARCH models allow us to observe the "conditional" volatility of the stock return, once the influence of various factors is controlled. They provide information to explain the factors underlying the movements of the stock return.

At the first stage, the short-run fluctuations of the stock returns of three major markets of the US, Japan, and China are derived through estimating the residual series of the GARCH model. At the second stage, the international transmission of the stock returns from the major markets to the two emerging markets is estimated by incorporating the residuals derived at the first stage into the GARCH model. Notice that our model specification assumes that the major markets could influence the emerging markets, but the emerging markets never influence the major markets (see, e.g., Janakiramanan and Lamba, 1998, for the case of Pacific-Basin stock markets). Moreover, we also assume that there is no transmission within the emerging countries. Ideally, these assumptions should be examined carefully by appropriate empirical analysis. However, given the conventional argument that small markets do not affect other markets significantly, it would be reasonable to make the above assumptions for the purpose of our analysis on the international transmission.

Major Markets: the US, Japan, and China

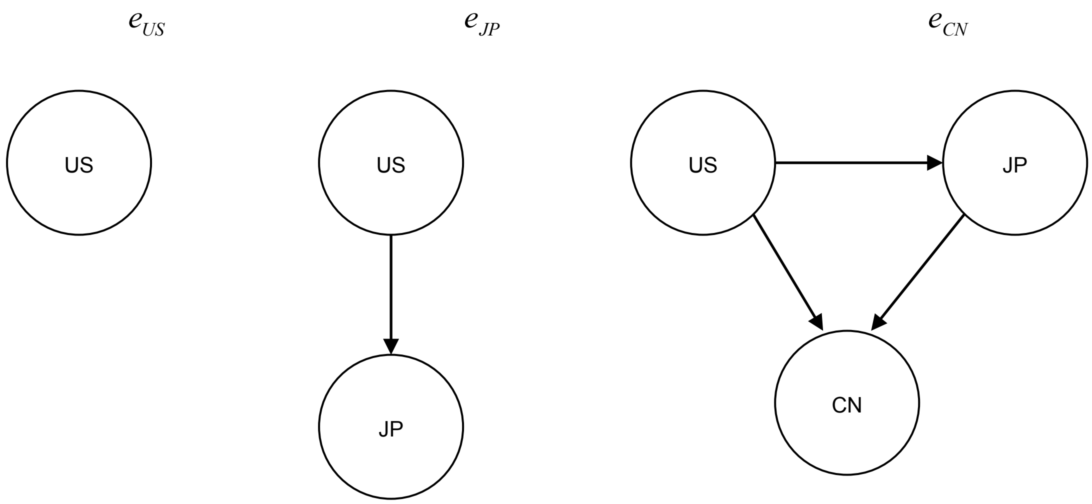
To obtain the short-term fluctuations of the stock returns of three major markets (the US, Japan, and China), the ARMA-GARCH-type of the model is applied (see Figure 3 for the general process). The US stock market returns are estimated through the following ARMA-GARCH model with the mean and variance equations:

$$r_t = \varphi_0 + \varphi_1 r_{t-1} + \varphi_2 v_t + \varphi_3 \varepsilon_{t-1} + \sum_{j=1}^{4} d_j D_{j,t} + \varepsilon_t \quad (1)$$

$$v_t = \alpha_0 + \alpha_1 v_{t-1} + \alpha_2 \varepsilon_{t-1}^2, \quad (2)$$

where r_t is the daily stock index return; $D_{j,t}$s are dummy variable for Monday, Tuesday, Wednesday and Thursday, respectively; and ε_t is the residual which has standard properties with mean zero and variance v_t ($\varepsilon_t = \sqrt{v_t}\eta_t, \eta_t \sim N(0,1)$). The stock returns series for the US market is modeled as the MA(1) model ($\varphi_1 = 0$) according to the Akaike Information Criterion (AIC) with the adjustment for possible serial correlation. The model specification assumes that the US market is never affected by other markets, i.e., no international transmission exists. The residual series captures the short-term fluctuations of the stock returns of the US market.

Figure 3: First Stage



For the Japanese market, we consider the case where the international transmission from the US market could exist in terms of the mean and volatility effects. To capture this, we estimate the following ARMA-GARCH model:

$$r_t = \varphi_0 + \varphi_1 r_{t-1} + \varphi_2 v_t + \varphi_3 \varepsilon_{t-1} + \sum_{j=1}^{4} d_j D_{j,t} + \lambda_{US} e_{US,t-1} + \varepsilon_t , \quad (3)$$

$$v_t = \alpha_0 + \alpha_1 v_{t-1} + \alpha_2 \varepsilon_{t-1}^2 + \gamma_{US} e_{US,t-1}^2 , \quad (4)$$

where $e_{US,t-1}$ and $e_{US,t-1}^2$ are the residual and the square of the residual for the US market estimated in equations (1) and (2). The coefficient λ_{US} captures the mean spillover effect from the US, and the coefficient γ_{US} captures the volatility spillover effect. Notice that the lag of the residuals is used since the US stock returns in current date could influence the Japanese market in next date, due to different time zones between the US and Japan. Similar to the residuals of the US, the residual series derived from the model captures the short-term fluctuations of the stock returns of the Japanese market. The stock return series for the Japanese market is also modeled as the MA(1) model ($\varphi_1 = 0$) according to the AIC with the adjustment for possible serial correlation.

Concerning the short-run fluctuation of the stock returns of the Chinese market, we assume that the Chinese market could be affected by both the US and Japanese markets, i.e., the international transmission from the US and Japanese markets to the Chinese market. The mean and volatility effects are estimated through substituting the residual and its square of the US market derived from equations (1) and (2) and the residual and its square of the Japanese market derived from equations (3) and (4) into the following ARMA-GARCH model:

$$r_t = \varphi_0 + \varphi_1 r_{t-1} + \varphi_2 v_t + \varphi_3 \varepsilon_{t-1} + \sum_{j=1}^{4} d_j D_{j,t} + \lambda_{US} e_{US,t-1} + \lambda_{JP} e_{JP,t} + \varepsilon_t \quad , \quad (5)$$

$$v_t = \alpha_0 + \alpha_1 v_{t-1} + \alpha_2 \varepsilon_{t-1}^2 + \gamma_{US} e_{US,t-1}^2 + \gamma_{JP} e_{JP,t}^2 . \quad (6)$$

where $e_{JP,t}$ and $e_{JP,t}^2$ are the residual and the square of the residual for the Japanese market estimated in equations (3) and (4). The coefficients, λ_{US} and λ_{JP}, capture the mean spillover effect from the US and Japan, and the coefficients, γ_{US} and γ_{CN}, capture the volatility spillover effect from the US and Japan. The stock returns series of the Chinese market is modeled as MA(1). Similar to the residuals for the US and Japan, the residual series, denoted by $e_{CN,t}$, captures the short-term fluctuations of the stock returns of the Chinese market.

The estimation results from the ARMA-GARCH models on the stock returns of the US, Japan, and China markets are shown in Table 3. The Ljung Box (LB) Q-statistics at lag *k* is a test statistic for the null hypothesis that there is no autocorrelation among residuals up to order *k*. The LB Q-statistics at lags 12 and 24 is not significant at the 5% level, which could mean no serial correlation. The result suggests that the model has taken care of most of the fat-tails and time-varying volatility in the data.

Furthermore, Table 3 presents some results of the international transmission. In terms of the mean spillover effects, the coefficient of $e_{US,t-1}$ (λ_{US}) is significantly positive for the Japanese and Chinese markets. This implies that the international transmission of stock returns could exist from the US market to the Japanese and Chinese markets. The coefficient of $e_{JP,t}$ (λ_{JP}) is significantly positive for the Chinese markets, which implies that the significant mean spillover effect could exist from the Japanese market to the Chinese market. On the other hand, in terms of the volatility spillover, the coefficient of $e^2_{US,t-1}$ (γ_{US}) in the variance equations is significantly positive for the Japanese market, but the coefficients, γ_{US} and γ_{JP}, are insignificant for the Chinese market. These results demonstrate that there could be the volatility spillover effect from the US market to the Japanese market. However, the results do not support the evidence of the volatility spillover effects from the US and Japanese markets to the Chinese market.

<u>Emerging Markets: Indonesia and Malaysia</u>

We attempt to examine the international transmission from the three major markets to the two emerging markets through using the ARMA-GARCH models with the short-run fluctuations of the major markets estimated in the previous discussion. Formally, to find the impact of the international transmission, we estimate the following ARCH-GARCH model with the mean and variance equations:

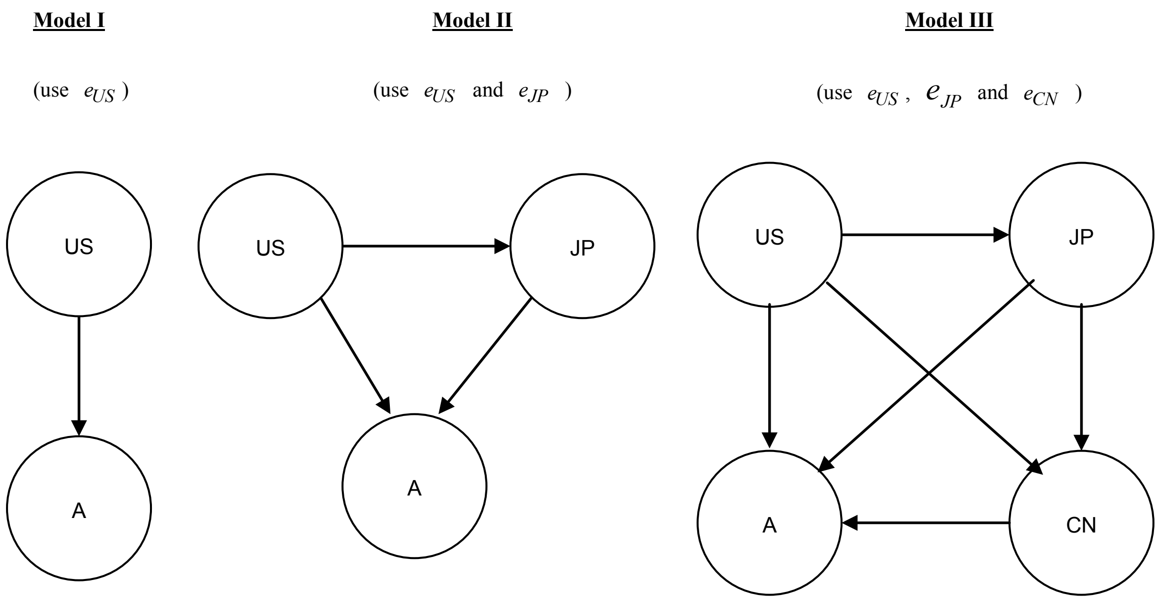
$$r_t = \varphi_0 + \varphi_1 r_{t-1} + \varphi_2 v_t + \varphi_3 \varepsilon_{t-1} + \sum_{j=1}^{4} d_j D_{j,t} + \lambda_{US} e_{US,t-1} + \lambda_{JP} e_{JP,t} + \lambda_{CN} e_{CN,t} + \varepsilon_t, \qquad (7)$$

$$v_t = \alpha_0 + \alpha_1 v_{t-1} + \alpha_2 \varepsilon^2_{t-1} + \gamma_{US} e^2_{US,t-1} + \gamma_{JP} e^2_{JP,t} + \gamma_{CN} e^2_{CN,t} \qquad (8)$$

where $e_{US,t}$, $e_{JP,t}$, and $e_{CN,t}$ are respectively the residuals for the US, Japanese and Chinese markets estimated in equations (1) to (6). In particular, we focus on the coefficients, λ_{US}, λ_{JP}, and λ_{CN}, in the mean equations to examine the mean spillover effects and on the coefficients, γ_{US}, γ_{JP}, and γ_{CN}, in the variance equations to examine the volatility spillover effects.

We consider three models depending on the transmission patterns: the first is the case where the emerging markets (Indonesia and Malaysia) are influenced by only the US market (Model I); the second is the case where the emerging markets are influenced by the US and Japanese markets (Model II); and the third is the case where the emerging markets are influenced by the US, Japanese, and Chinese markets (Model III). The three specific models are depicted in Figure 4. Notice that Model I corresponds to the case where no international transmission from the Japan and China markets exists in terms of the mean and volatility ($\lambda_{JP} = \lambda_{CN} = \gamma_{JP} = \gamma_{CN} = 0$ in equations (7) and (8)); Model II to the case where no international transmission from the China market exists ($\lambda_{CN} = \gamma_{CN} = 0$); and Model III to the case where international transmission from all major markets could exist without any restrictions on λ s and γ s. The model specification of the mean equation is decided according the AIC.

Figure 4: Second Stage



Note: A represents each stock market of ASEAN countries

Table 3: ARMA-GARCH Model for the U.S., Japan, China Markets

	US	Japan		China	
φ_0	-0.0001	0.0008		0.0009	
	(0.0010)	(0.0012)		(0.0018)	
φ_2	2.4525	-2.5670		6.3419	
	(12.5349)	(8.7635)		(5.1902)	
φ_3	-0.0826	-0.0638		0.0033	
	(0.0503)	(0.0479)		(0.0480)	
d_1	0.0006	-0.0019		-0.0003	
	(0.0013)	(0.0013)		(0.0022)	
d_2	-0.0001	-0.0005		-0.0028	
	(0.0010)	(0.0014)		(0.0021)	
d_3	0.0008	-0.0011		-0.0005	
	(0.0010)	(0.0013)		(0.0018)	
d_4	-0.0004	0.0007		-0.0040	*
	(0.0010)	(0.0013)		(0.0019)	
λ_{US}		0.5548	*	0.2384	*
		(0.0603)		(0.0894)	
λ_{JP}				0.1422	*
				(0.0609)	

	US		Japan		China	
α_0	0.0000	*	0.0000		0.0000	*
	(0.0000)		(0.0000)		(0.0000)	
α_1	0.8964	*	0.9035	*	0.8972	*
	(0.0265)		(0.0334)		(0.0227)	
α_2	0.0664	*	0.0743	*	0.0858	*
	(0.0188)		(0.0292)		(0.0211)	
γ_{US}			0.0354	*	-0.0054	
			(0.0151)		(0.0387)	
γ_{JP}					-0.0352	
					(0.0183)	
Ljung Box Q-Statistics						
Standardized Residuals						
LB(12)	10.87		13.44		5.33	
LB(24)	22.87		23.87		21.86	
Squared Standardized Residuals						
LB(12)	15.96		11.98		5.85	
LB(24)	20.41		20.37		20.00	

The estimated coefficients are shown for the following models over the sample period from January 2005 to December 2007. The model for the US is: $r_t = \varphi_0 + \varphi_2 v_t + \varphi_3 \varepsilon_{t-1} + \sum d_j D_{j,t} + \varepsilon_t$

$v_t = \alpha_0 + \alpha_1 v_{t-1} + \alpha_2 \varepsilon_{t-1}^2$.

The model for Japan is: $r_t = \varphi_0 + \varphi_2 v_t + \varphi_3 \varepsilon_{t-1} + \sum d_j D_{j,t} + \lambda_{US} e_{US,t-1} + \varepsilon_t$,

$v_t = \alpha_0 + \alpha_1 v_{t-1} + \alpha_2 \varepsilon_{t-1}^2 + \gamma_{US} e_{US,t-1}^2$.

The model for China is: $r_t = \varphi_0 + \varphi_2 v_t + \varphi_3 \varepsilon_{t-1} + \sum d_j D_{j,t} + \lambda_{US} e_{US,t-1} + \lambda_{JP} e_{JP,t} + \varepsilon_t$

$v_t = \alpha_0 + \alpha_1 v_{t-1} + \alpha_2 \varepsilon_{t-1}^2 + \gamma_{US} e_{US,t-1}^2 + \gamma_{JP} e_{JP,t}^2$.

$D_{j,t}$ *is the dummy variable for Monday through Thursday.*

*LB(k) is the Ljung-Box Q statistic for k order serial correlation. Standard error is in parentheses. * indicates significance at the 5 percent level.*

RESULTS FOR EMERGING MARKETS

We estimate the modified ARMA-GARCH models to find the international transmission with the mean and volatility spillover effects. Tables 4 to 5 present our estimations of the three models, Model I, II, and III, for each of the two emerging markets, Indonesia and Malaysia. The main results of each emerging market are as follows.

Indonesia

Table 4 reports the results of the estimation for Indonesia. The LB Q-statistics confirms that the three models fit the data well since there is no serial correlation in the residual series. It is observed that since the coefficients, λ_{US}, λ_{JP}, and λ_{CN}, are positive and significant at the 5% level for all three models, there are significant mean spillover effects from the three major markets to Indonesia. Evaluating the magnitude of the mean spillover effect implies that the transmission from the US is the most influential. In terms of the volatility spillover, the coefficient γ_{US} is significant for all models, so that there are significant volatility spillover effects from the US market to Indonesia. In contrast, the coefficient γ_{JP} is insignificant for Models II and III, so that the Japanese market might not affect the Indonesian market in terms of the volatility spillover. Furthermore, since the coefficient γ_{CN} is significant for Model III, the Chinese market could induce the volatility spillover to the Indonesian market, although its magnitude is not so large compared to that of the US market. Our result of the spillover effect from the US is in contrast with the argument of Janakiramanan and Lamba (1998) in their VAR approach that the US market had been less influential over the sample period from 1988 to 1996. The disagreement might be not only due to the different method and data sample, but due to the recent trend of financial integration of the world capital markets.

Malaysia

Table 5 reports the results of the estimation for Malaysia, where the LB Q-statistics present that all models fit the data well. Similar to the results of the Indonesian market, it can be shown that there exist mean spillover effects from the three major markets to Malaysia, since the coefficients, λ_{US}, λ_{JP}, and λ_{CN}, are significant for all three models. In addition, the magnitude of the mean spillover effect from the US is the most evident, as in conventional arguments.

Our empirical analysis also presents that the volatility spillover from the US market to the Malaysian market is less clear, since the coefficient γ_{US} is significant for Model I but insignificant for Models II and III. These results are different from those for Indonesia in that all models are supportive of clear evidences of the volatility spillover from the US. In contrast, the analysis on the volatility spillover effect from Japan and China shows the similar results as in the case of Indonesia. The Japanese market would not affect the Malaysian market through the volatility spillover, since the coefficient γ_{JP} is not significant for Models II and III. However, the coefficient γ_{CN} is significant for Model III, which implies that the Chinese market could induce the volatility spillover to the Malaysian market.

Table 4: ARMA-GARCH Model for Indonesia

	Model I		Model II		Model III	
φ_0	0.0031	*	0.0027	*	0.0031	*
	(0.0015)		(0.0013)		(0.0012)	
φ_1	0.0376		0.9456	*	0.0223	
	(0.0514)		(0.0446)		(0.0520)	
φ_2	-2.5966		-2.6462		-1.6309	
	(7.5640)		(7.7399)		(8.1992)	
φ_3			-0.9582	*		
			(0.0397)			
d_1	-0.0030		-0.0031	*	-0.0035	*
	(0.0016)		(0.0014)		(0.0014)	
d_2	-0.0013		-0.0011		-0.0015	
	(0.0016)		(0.0014)		(0.0014)	
d_3	-0.0013		-0.0011		-0.0010	
	(0.0015)		(0.0014)		(0.0014)	
d_4	-0.0006		-0.0005		-0.0008	
	(0.0015)		(0.0014)		(0.0013)	
λ_{US}	0.5341	*	0.5337	*	0.5372	*
	(0.0742)		(0.0667)		(0.0640)	
λ_{JP}			0.4208	*	0.4193	*

Table 4: ARMA-GARCH Model for Indonesia (continued)

	Model I		Model II		Model III	
			(0.0488)		(0.0407)	
λ_{CN}					0.0826	*
					(0.0269)	
α_0	0.0000	*	0.0000	*	0.0000	*
	(0.0000)		(0.0000)		(0.0000)	
α_1	0.5662	*	0.5516	*	0.5859	*
	(0.0685)		(0.0999)		(0.0954)	
α_2	0.1949	*	0.2023	*	0.2004	*
	(0.0513)		(0.0667)		(0.0676)	
γ_{US}	0.2796	*	0.1556	*	0.1471	*
	(0.0811)		(0.0604)		(0.0642)	
γ_{JP}			0.0892		-0.0002	
			(0.0478)		(0.0005)	
γ_{CN}					0.0005	*
					(0.0002)	
Ljung Box Q-Statistics						
Standardized Residuals						
LB(12)	11.47		12.71		13.20	
LB(24)	26.52		23.28		26.19	
Squared Standardized Residuals						
LB(12)	14.70		14.43		12.80	
LB(24)	35.14		24.66		27.67	

The estimated coefficients are shown for the following three models over the sample period from January 2005 to December 2007.

Model I is: $r_t = \varphi_0 + \varphi_1 r_{t-1} + \varphi_2 v_t + \sum d_j D_{j,t} + \lambda_{US} e_{US,t-1} + \varepsilon_t$

$$v_t = \alpha_0 + \alpha_1 v_{t-1} + \alpha_2 \varepsilon_{t-1}^2 + \gamma_{US} e_{US,t-1}^2 .$$

Model II is: $r_t = \varphi_0 + \varphi_1 r_{t-1} + \varphi_2 v_t + \varphi_3 \varepsilon_{t-1} + \sum d_j D_{j,t} + \lambda_{US} e_{US,t-1} + \lambda_{JP} e_{JP,t} + \varepsilon_t$

$$v_t = \alpha_0 + \alpha_1 v_{t-1} + \alpha_2 \varepsilon_{t-1}^2 + \gamma_{US} e_{US,t-1}^2 + \gamma_{JP} e_{JP,t}^2 .$$

Model III is: $r_t = \varphi_0 + \varphi_1 r_{t-1} + \varphi_2 v_t + \sum d_j D_{j,t} + \lambda_{US} e_{US,t-1} + \lambda_{JP} e_{JP,t} + \lambda_{CN} e_{CN,t} + \varepsilon_t$

$$v_t = \alpha_0 + \alpha_1 v_{t-1} + \alpha_2 \varepsilon_{t-1}^2 + \gamma_{US} e_{US,t-1}^2 + \gamma_{JP} e_{JP,t}^2 + \gamma_{CN} e_{CN,t}^2 .$$

$D_{j,t}$ *is the dummy variable for Monday through Thursday. LB(k) is the Ljung-Box Q statistic for k order serial correlation. Standard error is in parentheses. * indicates significance at the 5 percent level.*

Table 5: ARMA-GARCH Model for Malaysia

	Model I		Model II		Model III	
φ_0	0.0009		0.0008		0.0004	
	(0.0006)		(0.0006)		(0.0006)	
φ_1						
φ_2	2.9617		4.5622		10.4018	
	(10.7826)		(11.3789)		(11.9232)	
φ_3	0.1770	*	0.1821	*	0.1688	*
	Model I		**Model II**		**Model III**	
	(0.0506)		(0.0501)		(0.0486)	
d_1	-0.0016	*	-0.0015	*	-0.0012	
	(-0.0007)		(0.0007)		(0.0007)	
d_2	-0.0010		-0.0011		-0.0006	
	(0.0008)		(0.0007)		(0.0007)	
d_3	-0.0009		-0.0008		-0.0004	
	(0.0007)		(0.0006)		(0.0006)	
d_4	-0.0001		-0.0002		0.0000	
	(0.0006)		(0.0006)		(0.0006)	
λ_{US}	0.1907	*	0.2030	*	0.2145	*
	(0.0311)		(0.0300)		(0.0302)	
λ_{JP}			0.1282	*	0.1257	*
			(0.0192)		(0.0182)	
λ_{CN}					0.0610	*
					(0.0175)	
α_0	0.0000	*	0.0000	*	0.0000	*
	(0.0000)		(0.0000)		(0.0000)	
α_1	0.7690	*	0.7666	*	0.7533	*
	(0.0384)		(0.0437)		(0.0622)	
α_2	0.1771	*	0.1692	*	0.1155	*
	(0.0365)		(0.0389)		(0.0383)	
γ_{US}	0.0188	*	0.0170		0.0044	
	(0.0094)		(0.0089)		(0.0101)	
γ_{JP}			-0.0055		-0.0042	
			(0.0030)		(0.0029)	

Table 6: ARMA-GARCH Model for Malaysia (continued)

	Model I	Model II	Model III	
γ_{CN}			0.0120	*
			(0.0037)	
Ljung Box Q-Statistics				
Standardized Residuals				
LB(12)		6.37	4.84	
LB(24)	21.62	18.82	18.95	
Squared Standardized Residuals				
LB(12)		8.31	5.94	
LB(24)	23.37	21.63	15.28	

The estimated coefficients are shown for the following three models over the sample period from January 2005 to December 2007.

Model I is: $r_t = \varphi_0 + \varphi_2 v_t + \varphi_3 \varepsilon_{t-1} + \sum d_j D_{j,t} + \lambda_{US} e_{US,t-1} + \varepsilon_t$

$$v_t = \alpha_0 + \alpha_1 v_{t-1} + \alpha_2 \varepsilon_{t-1}^2 + \gamma_{US} e_{US,t-1}^2 .$$

Model II is: $r_t = \varphi_0 + \varphi_2 v_t + \varphi_3 \varepsilon_{t-1} + \sum d_j D_{j,t} + \lambda_{US} e_{US,t-1} + \lambda_{JP} e_{JP,t} + \varepsilon_t$

$$v_t = \alpha_0 + \alpha_1 v_{t-1} + \alpha_2 \varepsilon_{t-1}^2 + \gamma_{US} e_{US,t-1}^2 + \gamma_{JP} e_{JP,t}^2 .$$

Model III is: $r_t = \varphi_0 + \varphi_2 v_t + \varphi_3 \varepsilon_{t-1} + \sum d_j D_{j,t} + \lambda_{US} e_{US,t-1} + \lambda_{JP} e_{JP,t} + \lambda_{CN} e_{CN,t} + \varepsilon_t$

$$v_t = \alpha_0 + \alpha_1 v_{t-1} + \alpha_2 \varepsilon_{t-1}^2 + \gamma_{US} e_{US,t-1}^2 + \gamma_{JP} e_{JP,t}^2 + \gamma_{CN} e_{CN,t}^2 .$$

$D_{j,t}$ *is the dummy variable for Monday through Thursday.*

*LB(k) is the Ljung-Box Q statistic for k order serial correlation. Standard error is in parentheses. * indicates significance at the 5 percent level.*

In summary, the three major markets (the US, Japan, and China) have significant mean spillover effects on the Indonesian and Malaysian stock markets. In particular, the US market is the most influential in terms of the mean spillover. On the other hand, the evidences of the volatility spillover effects are less clear. The US and Chinese markets have the international transmission in terms of the volatility spillover to Indonesia, while only the Chinese market has the international transmission in terms of the volatility spillover to Malaysia. More interestingly, our analysis shows clearly that the Chinese market has significant international transmissions in terms of both mean and volatility spillovers.

CONCLUSION

This paper has investigated the transmission of mean return and volatility from the US, Japan, and China to the Indonesian and Malaysian markets, using daily data from January 2005 to December 2007. These emerging countries have increased their economic integration in recent years, and their stock markets have achieved remarkable development. By adopting a GARCH model based on the concept of Liu and Pan (1997), we construct mean return and volatility spillover models to discuss whether regional (China and Japan) and global (the US) impacts are crucial for the determination of stock returns in Indonesia and Malaysia.

The findings of this paper show that, as expected, the US market influences the Indonesian and Malaysian markets. The results also support significant feedback relationships in mean return between Japan and Indonesia and between Japan and Malaysia. More importantly, the empirical results suggest significant levels of mean and volatility spillover effects between China and its neighbors, Indonesia and Malaysia. It coincides with the recent argument that the Chinese market has gradually played more important roles in the international stock market transmission.

In this paper, we consider a model specification with a one-way transmission from developed markets to emerging markets. However, recent trends of international capital integration, including the existence of multinational financial institutions, could intensify the other way from emerging markets to developed markets. Thus, careful examination on such mutual interdependence among capital markets must be needed in future research.

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