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Capital Market Integration of Selected ASEAN Countries and its Investment Implications

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Abstract

This paper investigates the dynamic integration of ASEAN6 stock markets (Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam) with international stock markets (the US, the ASEAN bloc, and Asia) in an ARMA-EGARCH-M and a vector autoregression models (VAR) using weekly price returns from January 2000 to October 2015. The interaction channels between these markets provide valuable information to investors about possible investment gateways into these ASEAN6 countries. The dependence structure of unexpected returns between the US and ASEAN6 countries, and contagion of the Global Finance Crisis (GFC) are explored in the paper. The results indicate that investors from the US and Asia could gain diversification benefits by investing in the stock markets of Indonesia, Malaysia, the Philippines, Singapore and Thailand. At the same time, ASEAN investors might wish to invest in Vietnam for their investment diversification. However, the Vietnamese market is found to be highly dependent on the US and Asian markets.

Keywords: ARMA-EGARCH; ASEAN; capital market integration; investment; VAR.

1. Introduction

Over the last decade, more and more countries have liberalized their capital markets. If capital market liberalization is effective, it is expected to lead to capital market integration. However, capital market integration might also reduce the benefit of investment diversification. Thus, there is a paradox between the intention of the government to liberalize the domestic capital market and the aim of investors to diversify their investment portfolios on this market.

The recent developments of the ASEAN region raise the question whether it is beneficial for investors to diversify their investment portfolios by investing in ASEAN countries. To answer this question, this paper intends to investigate the integration of the ASEAN stock markets with international stock markets, the interaction channels, the dependence structure and contagion of unexpected returns between the local ASEAN and international markets.

ASEAN currently has ten member states. However, due to the underdevelopment of financial markets in Brunei Darussalam, Cambodia, Myanmar and Laos, we focus on the remaining six ASEAN countries - hereafter labeled as the ASEAN6: Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam. As for the international stock markets, we consider three stock markets: the ASEAN bloc, the Asian region, and the US.

We investigate capital market integration of the ASEAN6 markets with these three international markets by estimating ARMA-EGARCH-M models, and study the time-varying integration using a rolling regression of the mean model. The advantage of this approach is that it makes it possible to model and isolate the cross-market effects of returns and the conditional return volatilities. However, a shortcoming of the ARMA-EGARCH-M model is its limitation in showing causal effects between the local and international markets. To overcome this shortcoming we perform Granger causality tests in a VAR model, along with the "flow" and "stock" channels proposed by Phylaktis and Ravazzolo (2005) to infer possible investment options to investors.

Finally, the paper addresses the interdependence between the six ASEAN stock markets and the US market from contagion of the 2007-2008 Global Financial Crisis (GFC) by applying a modified version of the two-stage method of Samarakoon (2011).

The results indicate that Indonesia, Malaysia, the Philippines, Singapore and Thailand are highly integrated with the ASEAN bloc, implying an inefficient combination of assets among these ASEAN markets. However, ASEAN investors could invest in the Vietnamese stock market to exploit the segmentation between Vietnam and the ASEAN regional markets.

Furthermore, the findings show that investing in the stock markets of Indonesia, Malaysia, the Philippines and Thailand could bring potential investment diversification benefits to investors in the US and Asian region. Specific investment channels in these ASEAN markets are inferred from the VAR model. Among ASEAN6 markets, Singapore is highly integrated with the US and Asian markets, whereas the Vietnamese market is found highly dependent on these international markets. Investors targeting the Singaporean and Vietnamese markets should be aware of this difference between

them.

The rest of the paper is organized as follows. Section 2 briefly reviews the theories and models on capital market integration. Section 3 explains the model and methodology used in the paper. The data and empirical results are presented in sections 4 and 5. The last section summarizes the main findings.

2. Literature review

Up to date reviews of capital market integration including definitions, proxies, and models have been given in Do et al. (2016). Various proxies to examine integration/segmentation characteristics of capital markets over the world are applied. For example, Bekaert and Harvey (1995) use the regime probability, while Bekaert and Harvey (1997) use the ratio of equity market capitalization to Gross domestic product (GDP) and the ratio of trade to GDP. Carrieri et al. (2007) use the time varying R^2, Bekaert et al. (2011, 2013) use weighted aggregated difference between local and global industry earnings yields. De Nicolo and Juvenal (2014) use the distance measure of the country's excess return from the group average. Recent papers, Lehkonen (2015) and Bae and Zhang (2015), use cross-market correlation as a proxy for their integration.

Countless studies in the literature have investigated the integration of various markets and regions over the world using multiform models and methodologies, such as regime-switching models, factor models, generalized autoregressive conditional heteroskedasticity model (GARCH) and VAR models. Each model has its own advantages and shortcomings.

The advantage of a GARCH model (De Santis and Imrohoroglu, 1997; Carrieri et al., 2007; Tai, 2007b; Lau et al., 2010; Kenourgios and Samitas, 2011; Pasioura et al., 2013; Abid et al., 2014; Guesmi and Teulon, 2014; Narayan and Islam, 2014) is that it can expose the influence of conditional volatility on returns. However, it cannot reveal either the simultaneous interdependence of dependent variables in a system model or the causal effects between these variables.

The autoregressive conditional heteroskedasticity model (ARCH) of Engle (1982) and the GARCH model of Bollerslev (1986) are useful for non-normal and heteroscedastic series. Different variants of the basic GARCH model have been applied in the literature, for example the ARMA-EGARCH model (Karanasos and Kim, 2003; and Liu et al., 2011), the EGARCH-in-mean model (Kanas and Kouretas, 2002; Anyfantaki and Demos, 2015), the EGARCH model (Guo et al., 2014), the Beta-t-EGARCH(1,1) model (Harvey and Sucarrat, 2014; and Blazsek and Villatoro, 2015), and the AR-EGARCH-in-mean model (Van, 2015). These papers show that the EGARCH model is better than the GARCH model in capturing the asymmetric effect of positive and negative shocks on return conditional volatility. For this reason, this paper uses an ARMA-GARCH-in-mean model to investigate the integration of ASEAN6 stock markets.

The advantage of a VAR and error correction models is that they can disclose the simultaneous interdependence or comovement among dependent variables. However, these techniques cannot incorporate the influence of conditional return volatility on stock returns. Studies applying this technique include Phylaktis (1997), Jang and Sul (2002), Phylaktis and

Ravazzolo (2002) , Click and Plummer (2005), Phylaktis and Ravazzolo (2005), Shabri et al. (2008, 2009), Huyghebaert and Wang (2010), Lau et al. (2010), Umutlu et al. (2010), and Lin and Fu (2016).

Some papers focus on the integration of a specific ASEAN market, e.g. Teulon et al. (2014) and Lean and Teng (2013) use Dynamic Conditional Correlation models. There are also several applications of copula to describe the dependence structure of financial markets, including McNeil and Frey (2000), Di Clemente and Romano (2004), Fantazzini (2004), De Melo Mendes B.V., De Souza R.M. (2004), Junker and May (2005), Ane and Labidi (2006), Hu (2006), Rosenberg and Schuermann (2006), Nelsen (2007), Ozun and Cifter (2007), Rodriguez (2007), Miguel-Angel C., Eduardo P. (2012), and Bhatti and Nguyen (2012).

However, copulas are more useful in boom and crisis periods, or for downside regimes, where there might be more extreme values than in the normal periods. Moreover, the effects of shocks on stock returns in crisis periods have been investigated extensively in the literature by analyzing spill-over effects and contagions (see for example, Nagayasu, 2001; Forbes and Rigobon, 2002; Sander and Kleimeier, 2003; Tai, 2004; Bakaert et al., 2005; Baele and Inghelbrecht, 2010; and Tai, 2007a). Others investigate asymmetric effects of positive and negative shocks (Kroner and Ng, 1998; Bekaert and Wu, 2000). For these reasons, this paper does not apply copula to investigate the integration/segmentation of the ASEAN stock markets.

The literature on the GFC agrees that the start time of the crisis was around August 2007 (Helleiner, 2010; Didier et al., 2012) but there is disagreement about the time at which it ended (August 2008 in Didier et al., 2012; September 2008 in Erkens et al., 2012; early 2009 in Acharya et al., 2009; and Fratzscher, 2009). However, there is some degree of agreement in the literature that as far as the US is concerned, it was around the third quarter of 2008. Hence, in this study, the crisis period is based on the downward trends of the ASEAN stock market and international benchmark price indices from August 3rd 2007 to December 26th 2008.

3. Model and methodology

3.1. Tests for capital market integration

To investigate the integration of the ASEAN6 stock markets with the international markets, we use an ARMA(r,s)-EGARCH(1,1)-M model

$$r_{i,t} = \beta_{i,0} + \beta_{i,1} EXR_{i,t} + \beta_{i,2} CPI_{i,t} + \beta_{i,3} r_{ASEAN,t} + \beta_{i,4} r_{j,t} + \beta_{i,5} Dum_t + \xi_i h_{i,t} + \sum_{k=0}^{r} \phi_{i,k} r_{i,t-k} + \sum_{l=0}^{s} \theta_{i,l} \varepsilon_{i,t-l} + \varepsilon_{i,t} \quad (1)$$

where, $r_{i,t}$ is the stock market return for the ASEAN6 country i (i = Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam) in year t, $r_{j,t}$ is the return on the international market j (j = Asia and the US), $EXR_{i,t}$ is the return on nominal exchange rate per US dollar of country i at time t, $CPI_{i,t}$ is the inflation rate of country i at time t, and $r_{ASEAN,t}$ is the return of ASEAN stock price index at time t.[1] $EXR_{i,t}$, $CPI_{i,t}$ and $r_{ASEAN,t}$ are control variables accounting for country and ASEAN regional effects on stock market i at time t. Dum_t is a dummy variable for the GFC (i.e. Dum_t equals 1 in 2007-2008 and zero otherwise).

In equation (1), the stock market of country i is segmented from international market j if

$\beta_{i,4}$ is zero, or is integrated with international market *j* if $\beta_{i,4}$ is different from zero. $\beta_{i,5}$ is the coefficient of the intercept dummy variable for the GFC and it measures the immediate effect this crisis had on the ASEAN industry market returns. $\phi_{i,k}$ and $\theta_{i,l}$ are ARMA(r,s) terms in the mean equation (1), and k=0 and/or l=0 mean there is no AR and/or MA terms in the equation.

The error term at time t, $\varepsilon_{i,t}$, is assumed to be a time stochastic process,

$$\varepsilon_{i,t} = \sqrt{h_{i,t}}\, z_{i,t} \quad (2)$$

in which, $z_{i,t}$ is a white noise term with mean 0 and variance 1. $h_{i,t}$ denotes the conditional variance of the errors $\varepsilon_{i,t}$ ($\varepsilon_{i,t|\Sigma_{t-1}} \sim (0, h_{i,t})$ and it is assumed to follow an EGARCH(1,1) process,

$$\ln(h_{i,t}) = \alpha_{i,0} + \delta_i[|z_{i,t-1}| - E(|z_{i,t-1}|)] + \zeta_{i,1} z_{i,t-1} + \alpha_{i,1}\ln(h_{i,t-1}) + \lambda_i r_{j,i} \quad (3)$$

Thus, ξ_i in equation (1) indicates the effect of conditional volatility on the return in stock market *i*. The EGARCH(1,1) model, i.e. equation (3), does not impose any restriction on δ_i, $\zeta_{i,1}$ and $\alpha_{i,1}$. $\zeta_{i,1}$ measures the asymmetric effects of positive and negative shocks on the return conditional volatility of market *i*. If $\zeta_{i,1} = 0$, the effects of positive and negative shocks are symmetric; if $\zeta_{i,1}>0$, the return conditional volatility is worse with a positive information than with a negative information; and if $\zeta_{i,1}<0$, a positive shock (or good news) produces less volatility than a negative shock (bad news), indicating the existence of a leverage effect. Moreover, λ_i in equation (3) implies whether price return of international market *j* influences the conditional return volatility of local market *i*.

To examine the integration of the US and Asian stock markets on the ASEAN6 markets, we use a model similar to equations (1)-(3) above. However, $r_{US,t}$ and $r_{Asia,t}$ are considered simultaneously in the following ARMA(r,s)-EGARCH(1,1)-M model:

$$r_{i,t} = \beta_{i,0} + \beta_{i,1} EXR_{i,t} + \beta_{i,2} CPI_{i,t} + \beta_{i,3} r_{ASEAN,t} + \beta_{i,4} r_{Asia,t} + \beta_{i,5} r_{US,t} + \beta_{i,6} Dum_t + \xi_i h_{i,t} + \sum_{k=1}^{r} \phi_{i,k} r_{i,t-k} + \sum_{l=1}^{s} \theta_{i,l} \varepsilon_{i,t-l} + \varepsilon_{i,t} \quad (4)$$

$$\ln\left(h_{i,t}\right) = \alpha_{i,0} + \delta_i\left[\left|z_{i,t-1}\right| - E\left(\left|z_{i,t-1}\right|\right)\right] + \zeta_{i,1} z_{i,t-1} + \alpha_{i,1}\ln(h_{i,t-1}) + \lambda_{i,1} r_{Asia,t} + \lambda_{i,2} r_{US,t} \quad (5)$$

In addition, this paper examines time-varying integration/segmentation between ASEAN6 stock markets and those of the US and Asia by estimating equation (1) using rolling regressions with a window of 52 observations (i.e. equivalent to a trading year). At this stage, similar to Phylaktis and Ravazzolo (2005), we assume that there is no GARCH term in equation (1) and that the error term follows a normal distribution. However, our model surpasses that of Phylaktis and Ravazzolo (2005) as it includes control variables for the economic condition of the ASEAN6 market and the ASEAN regional market, as well as taking into account serial correlation.[2]

3.2. Multivariate Granger causality tests

We investigate the impact of international stock markets on the ASEAN6 stock markets by performing Granger causality tests in VAR models. We apply the idea of Phylaktis and Ravazzolo (2005) about the interaction mechanism between variables in the "flow" and "stock" approaches to exchange rate determination.

The "flow" channel approach describes the

link between two relationships, namely the relationship between the real exchange rate of a country and its economic activity (see e.g., Phylaktis K., 1997; Oh et al., 2010) and the relationship between economic activity and the stock markets of that country (Schwert, 1990; Roll, 1992; and Canova and De Nicolo, 1995). The first relationship describes the influence of international factors on domestic economic activity, while the second specifies the influence of economic situation on stock markets. According to the first relationship, if the currency of a country depreciates, its domestic goods become more competitive in the global marketplace, and the domestic aggregate demand and output level increase. In accordance with the second relationship, the expected future cash flows are reflected in the stock prices so that stock prices incorporate present and expected future economic activities, such as industrial production, economic growth, corporate profits and employment rates.

In terms of the "flow" approach, if there are significant trade links between the ASEAN6 countries and the US (or the ASEAN bloc, the Asian, or the world) market, an increase in the US (or the ASEAN bloc or Asia) market conveys information about the improved performance of these economies and implies increased exports by the ASEAN6 countries. More exports by the ASEAN6 countries lead to an appreciation of the ASEAN6 currencies and an increase in the ASEAN6 output, which causes the ASEAN6 stock prices to increase. Hence, exchange rate depreciation may increase the stock price through its effect on economic activity.

The "stock" approach is based on the portfolio approach to exchange rate determination. In this approach agents adjust their portfolios amongst different assets such as domestic currency, domestic bonds and equities, and foreign assets, and the exchange rate plays the role of balancing the asset demands and supplies. If the demand and supply of these assets change, the equilibrium exchange rate also changes. For instance, if the ASEAN6 markets are integrated with the world market, then an increase in the world index will cause the ASEAN6 markets to rise and the demand for assets on the ASEAN6 markets to increase. In turn, this increases the demand for the ASEAN6 currencies and leads to higher interest rates in these countries. The ASEAN6 currencies also increase since investors substitute domestic assets for foreign assets. In short, the demand for foreign securities and the exchange rate drop simultaneously. The disadvantage of this approach is that it is not suitable for investors who cannot access foreign assets.

We estimate the following VAR model:

$$\begin{bmatrix} r_{i,t} \\ r_{exri,t} \\ r_{j,t} \end{bmatrix} = \begin{bmatrix} A_{10} \\ A_{20} \\ A_{30} \end{bmatrix} + \begin{bmatrix} A_{11}(L)\, A_{12}(L)\, A_{13}(L) \\ A_{21}(L)\, A_{22}(L)\, A_{23}(L) \\ A_{31}(L)\, A_{32}(L)\, A_{33}(L) \end{bmatrix} \begin{bmatrix} r_{i,t-1} \\ r_{exri,t-1} \\ r_{j,t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{i,t} \\ \varepsilon_{exri,t} \\ \varepsilon_{j,t} \end{bmatrix} \quad (6)$$

where $r_{i,t}$ is the same as in Eq. (1), $r_{j,t}$ is the international stock returns, and j = US, Asia and ASEAN, $r_{exri,t}$ is the exchange rate return for the ASEAN6 country i, all in year t. In addition, A_{i0} are the intercept terms and $A_{ij}(L)$ are polynomials in the lag operator. Following Phylaktis and Ravazzolo (2005), we perform Wald tests on the following hypotheses concerning the two link channels between the stock and foreign exchange markets:

(i) "Flow" channel if: $A_{12}(L) \neq 0$, $A_{13}(L) \neq$

0, and $A_{23}(L) \neq 0$;

(ii) "Stock" channel if: $A_{13}(L) \neq 0$, $A_{21}(L) \neq 0$, and $A_{23}(L) \neq 0$;

(iii) "Flow" and "stock" channels if: $A_{12}(L) \neq 0$, $A_{13}(L) \neq 0$, $A_{21}(L) \neq 0$, and $A_{23}(L) \neq 0$.

Beside testing $A_{12}(L) = 0$ and $A_{13}(L) = 0$ separately like Phylaktis and Ravazzolo (2005), we also apply a Wald test for all these restrictions simultaneously. Similarly, the hypotheses $A_{21}(L) = 0$ and $A_{23}(L) = 0$ are tested both individually and jointly. The conclusion about "flow" channel or "stock" channel is based on the significance of the joint restrictions. We also test the restriction $A_{31}(L) = 0$ to find out whether there is an impact from the ASEAN6 stock markets to the international markets.

We choose the lag length for the VAR model on the basis of the likelihood ratio tests (LR), the final prediction error (FPE), the Akaike information criterion (AIC), the Schwarz information criterion (SIC) and the Hannan-Quinn information criterion (HQ). However, if the residuals from the selected VAR model fail the LM test for autocorrelation of orders 1-5 then we gradually increase the lag length up to 12 in order to whiten the residuals.

3.3. Interdependence and contagion of the 2007-2008 financial crisis shock

We follow the methodology of Samarakoon (2011) to investigate the effect of the 2007-2008 US financial crisis on the ASEAN6 stock markets. However, different from Samarakoon (2011) who uses daily data and 3 lags in the autoregressive (AR) regressions, we estimate the following AR regressions of order up to 5 (corresponding to 5 trading weeks) to capture unexpected returns or return shocks:

$$r_{i,t} = c_i + \sum_{k=1}^{l} \beta_{i,k}(r_{i,t-k}) + \varepsilon_{i,t}, \quad \text{where } l \leq 5 \qquad (7)$$

$$r_{US,t} = c_{US} + \sum_{k=1}^{l} \beta_{US,k}(r_{i,t-k}) + \varepsilon_{US,t}, \quad \text{where } l \leq 5 \qquad (8)$$

where, $r_{i,t}$ is the same as in Eq. (1), $r_{US,t}$ is the stock market return of the US, $\varepsilon_{i,t}$ and $\varepsilon_{US,t}$ are the disturbance terms, and the estimates of these disturbance terms are the unexpected returns or return shocks. In each equation, the actual lag length is allowed to vary between 1 and 5 and is chosen to whiten the residuals.

In the second step, the interdependence and contagion of shocks between an ASEAN6 stock market and the US stock market are studied by using the following pair of equations:

$$e_{i,t} = A_{i,t} + \sum_{m}^{n} B_{i,t-m}(e_{i,t-m}) + D_{i,t-1}(CD_{t-1}) + C_{i,t-k}(e_{US,t-k}) + F_{i,t}(e_{US,t} \times CD_t) + F_{i,t-1}(e_{US,t-1} \times CD_{t-1}) + V_{i,t}, 1 \leq n \leq 5, 0 \leq l \leq 5 \qquad (9)$$

$$e_{US,t} = a_{i,t} + \sum_{r}^{s} b_{US,t-r}(e_{US,t-r}) + d_{i,t-1}(CD_{t-1}) c_{i,t}(e_{i,t}) + c_{i,t-1}(e_{i,t-1}) + f_{i,t}(e_{i,t} \times CD_t) + f_{i,t-1}(e_{i,t-1} \times CD_{t-1}) + v_{i,t}, 1 \leq s \leq 5 \qquad (10)$$

where $e_{i,t}$ is the estimate of $\varepsilon_{i,t}$ and $e_{US,t}$ is the estimate of $\varepsilon_{US,t}$. *CD* is the crisis dummy variable that takes the value of one from August 3rd 2007 to December 26th 2008 and zero otherwise.[3]

In Eq. (9) the estimate of $C_{i,t-k}$ is a measure of the impact of the US unexpected shocks at lag *k* on ASEAN6 stock market *i*, and $F_{i,t}$, $F_{i,t-1}$ imply the contagion of the 2007-2008 financial crisis shock from the US market to the related ASEAN6 market at time *t* and *t*-1, respectively.

In Eq. (10), $c_{i,t}$, $c_{i,t-1}$ and $f_{i,t-1}$ are the impact and contagion of unexpected shocks from the ASEAN6 markets to the US market.

4. Data

We use weekly observations from January 2000 to October 2015. The indices of the ASEAN6 stock markets and of the three international stock markets, and the nominal exchange rates of the ASEAN6 countries are from *DataStream*. The rates of returns had been calculated by the formula: $R_t = 100x(P_t - P_{t-1})/P_{t-1}$, where R_t is the return and P_t is the stock market price or nominal bilateral exchange rate or CPI in period *t*.

We measure the trade openness of the ASEAN6 countries by the usual trade openness index; [(export + import) / GDP] x 100. The total exports and total imports of the ASEAN countries are from the UNComtrade Database and the GDP series, all in current US dollars, are from the World Bank World Development Indicators.

The descriptive statistics of stock market returns are summarized in Table 1.[4]

Although Vietnam and Indonesia have the highest market mean return (0.316 percent and 0.292 percent, respectively), they are relatively the least volatile as attested by their small coefficients of variation (CV) (13.323 and 13.412, respectively). Whereas, the Singaporean market return is relatively the most volatile (CV is 56.355) among the ASEAN6 markets. Among the regional and international markets, the ASEAN region has the highest return with the lowest relative volatility (23.556), whereas Asia has the lowest return with the highest relative volatility (68.698). Hence, investing in the ASEAN regional stock market may bring beneficial opportunities for international and domestic investors alike.

To see whether the returns of the ASEAN6 security markets are related to each other and to the ASEAN bloc, Asia and the US, we calculated their pairwise correlation coefficients and found that they are all significant even at the 1 percent level (Table 2).

Apparently, the Singapore market return has the strongest correlation with the international market returns (0.551 with the US, 0.878 with the ASEAN bloc, and 0.714 with Asia), while the weakest relation is between the Vietnamese market and these international markets (0.162

Table 1: Descriptive statistics of stock market returns

	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam	ASEAN	Asia	US
Mean	0.2919	0.1072	0.1894	0.0468	0.1752	0.3156	0.1086	0.0374	0.0740
Median	0.3826	0.1420	0.2504	0.0999	0.4050	0.0096	0.2539	0.1633	0.1652
Std. Dev.	3.9150	2.0120	2.9558	2.6374	3.0186	4.2056	2.5582	2.5693	2.5170
CV	13.4121	18.7687	15.6061	56.3547	17.2295	13.3257	23.5562	68.6979	34.0135
Skewness	-0.1952	-0.1766	0.0152	-0.1420	-0.8683	-0.0754	-0.5620	-0.5350	-0.5340
Kurtosis	5.3953	7.7132	7.7132	9.3563	8.6438	6.2616	8.0249	6.2578	8.6697
Jarque-Bera	202.717	804.286	764.566	1393.308	1197.672	353.573	912.513	404.670	1145.585
Observations	826	826	826	826	826	796	826	826	826

Table 2: Correlation of returns of ASEAN6 and international stock markets

	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam	ASEAN	Asia	US
Indonesia	1.0000								

Malaysia	0.4045	1.0000							
	(0.000)	-----							
Philippines	0.4625	0.3883	1.0000						
	(0.000)	(0.000)	-----						
Singapore	0.4954	0.5116	0.4647	1.0000					
	(0.000)	(0.000)	(0.000)	-----					
Thailand	0.4432	0.4388	0.4592	0.5361	1.0000				
	(0.000)	(0.000)	(0.000)	(0.000)	-----				
Vietnam	0.1319	0.1253	0.1473	0.1734	0.1501	1.0000			
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	-----			
ASEAN bloc	0.6889	0.6959	0.5691	0.8777	0.6877	0.1826	1.0000		
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	-----		
Asia	0.4659	0.4339	0.4555	0.7136	0.5213	0.1598	0.7373	1.0000	
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	-----	
US	0.2938	0.2871	0.3279	0.5506	0.3502	0.1615	0.5230	0.5907	1.0000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	-----

with the US, 0.183 with the ASEAN bloc and 0.160 with Asia). Among the ASEAN6 countries, the strongest correlation of stock returns is between the Thai and Malaysian markets (0.536) and the weakest relation of stock returns is between the Vietnam and Malaysian markets (0.125).

In this paper, we apply the methodology of Phylaktis and Ravazzolo (2005) to justify 'stock' and 'flow' channels. However, while Phylaktis and Ravazzolo (2005) use 'logs of price indexes', we employ 'returns of nominal exchange rates' and 'returns of market price indexes' in our regression model. Since the return series are dimensionless, and the monthly nominal and real exchange rates are strongly correlated (see Table 3), we can use weekly nominal exchange rate returns instead of real exchange rate returns in our regressions.

In equation (1), we use the CPI growth rate instead of the GDP growth rate to account for local economic factors for two reasons. First, weekly GDP is not available. Second, there are strong and significant correlations between the quarterly series of these two variables in the ASEAN6 countries from 2000-2015 (see Table 3).

Table 3: Pair wise correlations of economic variables in ASEAN6 countries during 2000-2015

Correlation	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam
Quarterly CPI-GDP	0.9707 (0.0000)	0.9657 (0.0000)	0.9662 (0.0000)	0.9635 (0.0000)	0.9837 (0.0000)	0.9698 (0.0000)
Monthly nominal-real exchange rates	-0.0311 (0.6713)	-0.9807 (0.0000)	-0.9106 (0.0000)	-0.9554 (0.0000)	-0.9934 (0.0000)	0.9072 (0.0000)
Returns of monthly nominal-real exchange rates	0.9617 (0.0000)	0.9626 (0.0000)	0.9709 (0.0000)	0.9370 (0.0000)	0.9717 (0.0000)	0.7417 (0.0000)

We investigate the time-series characteristics of the series by performing five unit-root/stationary tests, namely the Augmented Dickey-Fuller (ADF) test, the Dickey-Fuller GLS (DF-GLS) test, the Phillips-Perron (PP) test, the Elliot-Richardson-Stock (ERS) test, and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test, both on the level and first differenced series. Since there is no apparent long-run trend in the time series of stock returns, exchange rate returns, and inflation rates, we use only a constant term in the test regressions. The unit root test results indicate that the returns of the ASEAN6 markets and the three international markets, the exchange rate returns, and the inflation rates are all stationary.[5]

5. Estimation results

5.1. Capital market integration

The estimation results of Eqs. (1)-(3) with $r_{US,t}$ in the model are summarized in Table 4. The regressions are justified by the Ljung-Box statistics of orders 4 and 8 on the standardized residuals (Q statistic) and on their squares (Q^2 statistic), and by the ARCH LM test of order 4 for conditional heteroskedasticity.

There are a few interesting details. For Indonesia, Malaysia, the Philippines, Singapore and Thailand, the R^2 statistics vary between 0.3728 and 0.8245, and the exchange rates are significant and the ASEAN bloc return are both significant.

For the ASEAN bloc return, the coefficients indicate that the market of Indonesia, Malaysia, the Philippines, Singapore and Thailand are positively integrated with the ASEAN region, and that on average a one percent increase in the return of the ASEAN bloc leads to a 0.6043 percent (Philippines) to a 1.0842 percent (Indonesia) increase of the market price return.

From Table 4, the US market return is significantly negative both in the mean and the variance equations in the regressions for Indonesia and Malaysia, implying great potential benefits of diversification between these markets and the US stock markets. In particular, a one percent reduction in the US price return is expected to lead to a 0.1412 percent and a 0.0817 percent increase in the price returns of Indonesia and Malaysia, respectively.

The regression on the Vietnamese market price return appears to be somewhat peculiar. Specifically, its R^2 is rather low (0.0674) and the exchange rate, CPI and the ASEAN bloc return are all insignificant, but the coefficient of the US returns is significantly positive at the 5 percent level. Hence, the Vietnam stock market return appears to be segmented from the ASEAN regional market return but integrated with the US market return.

The GARCH effect is only significant in the mean equation of Singapore and the GFC dummy variable is insignificant in every equation except the one for Vietnam. One could argue that the GFC originated from the US and the slope estimate of the US return is significant in the regression of the Vietnamese stock return. However, why does the GFC not affect the returns of Indonesia and Malaysia although the slope estimates of the US are significant in those equations as well?

The answer is provided by the variance equations (3), which are reported in the second part of Table 4. Apparently, $z_{i,t-1}$ is insignificant in the variance equations of Malaysia, the Philippines, Thailand and Vietnam, implying the symmetric effect of positive and negative

Table 4: Arma-Egarch-M model with the US return

	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam
Mean equation						
Constant	0.1321	0.1144	0.4455***	-0.1847***	0.1812	-0.1593
	(0.3540)	(0.1082)	(0.0081)	(0.0095)	(0.2144)	(0.3394)
Exchange rate	-0.1871***	0.2275***	-0.4952***	0.7382***	-0.3672***	-0.2778
	(0.0042)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.1025)
CPI	0.0678	-0.7535	-1.0860	-0.3038	-0.5719	0.1543
	(0.8661)	(0.1407)	(0.2179)	(0.1540)	(0.2675)	(0.8116)
ASEAN	1.0842***	0.6244***	0.6043***	0.9130***	0.7242***	0.0688
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.1605)
US	-0.1412***	-0.0817***	-0.0016	0.1066***	0.0291	0.1284**
	(0.0023)	(0.0004)	(0.9698)	(0.0000)	(0.4173)	(0.0100)
Dum	0.4123*	-0.1036	-0.2794	-0.1309	-0.1981	-1.4772***
	(0.0885)	(0.5269)	(0.2740)	(0.1359)	(0.4164)	(0.0047)
GARCH	0.0058	-0.0284	-0.0350	0.1483**	-0.0080	0.0143
	(0.7839)	(0.5058)	(0.2990)	(0.0320)	(0.8163)	(0.2841)
AR(1)	-0.1897***		-0.1095***	-0.1084***	-0.0947**	0.5625***
	(0.0000)		(0.0012)	(0.0019)	(0.0162)	(0.0003)
MA(1)						-0.4299**
						(0.0143)
Variance equation						
Constant $\alpha_{i,0}$	-0.0287	-0.0869***	-0.0151	-0.1567***	-0.0837	-0.1593
	(0.1009)	(0.0000)	(0.4001)	(0.0000)	(0.0412)	(0.0000)
$\lvert z_{i,t-1}\rvert - E(\lvert z_{i,t-1}\rvert)$	0.0726***	0.1201***	0.0558***	0.2054***	0.2931***	0.4934***
	(0.0003)	(0.0000)	(0.0079)	(0.0000)	(0.0000)	(0.0000)
$z_{i,t-1}$	-0.0570***	0.0244	-0.0031	-0.1016***	0.0050	0.0372
	(0.0019)	(0.1103)	(0.8368)	(0.0000)	(0.8352)	(0.1721)
Ln(GARCH $_{t-1}$)	0.9843***	0.9831***	0.9825***	0.9485***	0.8993***	0.9160***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
US	-0.0212***	-0.0163**	-0.0300***	0.0065	-0.0317***	-0.0233*
	(0.0065)	(0.0543)	(0.0006)	(0.4113)	(0.0013)	(0.0993)
R^2	0.5022	0.5120	0.3728	0.8245	0.4853	0.0674
Q(4)		2.1216	1.5610	4.2206	4.1550	3.4579
		(0.713)	(0.668)	(0.239)	(0.245)	(0.177)
Q(8)		3.7274	9.2463	8.4149	5.8322	4.5834
		(0.881)	(0.235)	(0.297)	(0.559)	(0.598)
$Q^2(4)$		1.3694	4.6789	3.7069	0.0634	0.6148
		(0.849)	(0.322)	(0.295)	(0.996)	(0.735)
$Q^2(8)$		2.6991	4.8373	8.2121	1.6611	4.7201
		(0.952)	(0.680)	(0.314)	(0.976)	(0.580)
Convergence iterations	28	23	33	92	18	21
ARCH LM test	3.3887	1.3670	3.9644	3.9068	0.0516	0.5948
Obs×R^2	(0.4950)	(0.8499)	(0.4108)	(0.4188)	0.9997	(0.9636)

shocks on the conditional return volatilities in these countries. However, the coefficient of $z_{i,t-1}$ is significantly negative for Indonesia and Singapore, so a positive shock (or good news) from the US market produces less volatility than a negative shock of the same size in the Indonesian and Singaporean stock markets, hence there is a leverage effect.

Table 5: Arma-Egarch-M model with the Asian return

	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam
Mean equation						
Constant	0.1120	0.0825	0.3426**	-0.1516**	0.1864	-0.1124
	(0.4217)	(0.2593)	(0.0292)	(0.0246)	(0.2136)	(0.4886)
Exchange rate	-0.2203***	0.2438***	-0.4302***	0.7878***	-0.3263***	-0.2310
	(0.0007)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.2110)
CPI	0.0315	-0.6301	-0.7740	-0.2896	-0.5541	0.6361
	(0.9368)	(0.2258)	(0.3649)	(0.1873)	(0.3209)	(0.2919)
ASEAN	1.1521***	0.6784***	0.5402***	0.8518***	0.7342***	0.0054
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.3827)
Asia	-0.1787***	-0.1191***	0.1094**	0.1607***	0.0048	0.1138**
	(0.0008)	(0.0000)	(0.0193)	(0.0000)	(0.9055)	(0.0432)
Dum	0.4310*	-0.0802	-0.3233	-0.1046	-0.2210	-1.3941***
	(0.0750)	(0.6136)	(0.2242)	(0.2549)	(0.4125)	(0.0041)
GARCH	0.0078	-0.0162	-0.0195	0.1197*	-0.0111	0.0076
	(0.7095)	(0.7147)	(0.5424)	(0.0665)	(0.7526)	(0.5405)
AR(1)	-0.1873***		-0.0918***			0.4852***
	(0.0000)		(0.0089)			(0.0055)
AR(2)				-0.0866**		
				(0.0301)		
MA (1)						-0.3414*
						(0.0747)
Variance equation						
Constant $\alpha_{i,0}$	-0.0407**	-0.0973***	-0.0364**	-0.1317***	-0.0798*	-0.1617***
	(0.0107)	(0.0000)	(0.0415)	(0.0000)	(0.0841)	(0.0001)
$\lvert z_{i,t-1}\rvert - E(\lvert z_{i,t-1}\rvert)$	0.0827***	0.1330***	0.0754***	0.1715***	0.3129***	0.5307***
	(0.0000)	(0.0000)	(0.0006)	(0.0000)	(0.0000)	(0.0000)
$z_{i,\,t-1}$	-0.0538***	0.0270*	-0.0175	-0.0947***	0.0021	0.0305
	(0.0026)	(0.0985)	(0.3040)	(0.0001)	(0.9361)	(0.2974)
Ln($GARCH_{t-1}$)	0.9862***	0.9807***	0.9855***	0.9593***	0.8851***	0.9044***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Asia	-0.0126***	-0.0137**	-0.0212***	-0.0040	-0.0360***	-0.0385***
	(0.0065)	(0.0481)	(0.0001)	(0.4666)	(0.0000)	(0.0004)
R^2	0.4988	0.5174	0.3713	0.8262	0.4797	0.0634
Q(4)	1.0316	1.7199	0.8547	5.4741	7.2922	4.7976
	(0.794)	(0.787)	(0.836)	(0.140)	(0.121)	(0.091)
Q(8)	9.0345	3.8352	6.0558	8.0782	9.0752	6.4625
	(0.250)	(0.0872)	(0.533)	(0.326)	(0.336)	(0.373)
$Q^2(4)$	5.0148	0.5796	2.3894	2.0952	0.4630	0.9727
	(0.171)	(0.965)	(0.496)	(0.553)	(0.977)	(0.615)
$Q^2(8)$	8.7737	1.7581	4.2034	5.8919	2.5210	4.4376
	(0.269)	(0.988)	(0.756)	(0.552)	(0.961)	(0.618)
Convergence iterations	26	23	24	71	18	30
ARCH LM test	4.8762	0.5856	2.4152	2.1245	0.4487	0.9313
Obs*R^2	(0.3002)	(0.9647)	(0.6599)	(0.7129)	(0.9783)	(0.9200)

In addition, the coefficients of the US return are significantly negative in the variance equations of Indonesia, Malaysia, the Philippines and Thailand. This implies that changes in the US market return negatively affect conditional return volatility of these four ASEAN markets. However, the US return is insignificant in the regressions for Singapore and Vietnam.

In summary, we can infer that the Singaporean and Vietnamese stock markets are positively integrated with the US market, while the conditional return volatilities of the Philippines and Thailand are negatively integrated with the US market return and a one percent increase of the US price return will lead to a reduction of about 0.03 percent in conditional return volatilities of these stock markets.

Table 5 reports estimates of Eqs. (1) - (3) with the Asian market return in the model. The GARCH term is insignificant in every mean equation at the 5 percent level, and the GFC dummy variable is significant only in the regression for Vietnam.

The slope estimate of the Asian price return is insignificant in the mean equation for Thailand but it is significantly negative in the corresponding variance equation. These results imply that the Thai stock market is segmented from the Asian stock market in terms of price returns, but an increase in the Asian price return reduces the Thai conditional return volatility. Consequently, a combination of assets from the Asian and Thai markets would bring potential diversification benefits to investors.

The coefficients of the Asian market returns in the mean equations for the Philippines, Singapore and Vietnam are significantly positive at the 5 percent level, implying the integration of these ASEAN markets with the Asian regional stock market. The significantly negative coefficients of the Asian market return in the variance equations of the Philippines and Vietnam imply that a one percent increase in the Asian price return leads to a reduction of 0.0212 and 0.0385 percent in conditional return volatility in the markets of Philippines and Vietnam, respectively. However, the Asian market return does not have a significant effect on the conditional return volatility in the Singaporean market.

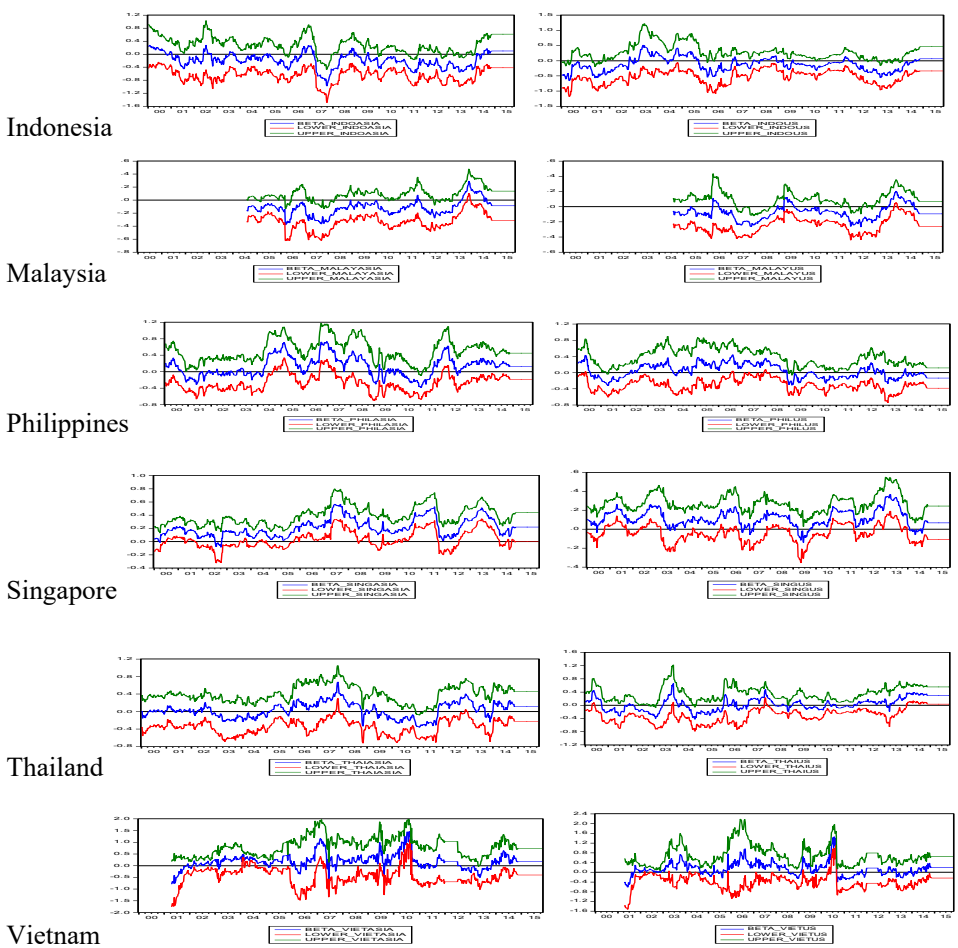
The results for Indonesia and Malaysia in Table 5 suggest that the Indonesian and Malaysian stock market returns are negatively integrated with that of the Asian market, and that the increase of the Asian return is expected to reduce conditional return volatility in the Indonesian and Malaysian stock markets. Only the regressions for Indonesia and Singapore show a leverage effect (the coefficients of $z_{i,t-1}$ are significantly negative). This means that in the Indonesian and Singaporean stock markets, good news from the Asian market results in less volatility than bad news. In the other four ASEAN markets, the effect of good and bad news are symmetric.

To capture the integration/segmentation of the ASEAN6 markets with the Asian region and the US simultaneously, we also estimated Eqs. (1) - (3) which include the returns of the US and the Asian region simultaneously. The results are summarized in Table 6. [6]

The results for Indonesia in Table 6 confirm that the stock market is negatively integrated with the Asian market and the spillover effects are asymmetric. These results imply potential benefits of investment diversification between the stock markets of Indonesia and Asia.

The slope estimates of the US and Asia returns in the mean equation for Malaysia are significantly negative at the 5 percent level, which is consistent with the findings in Tables 4 and 5, implying great beneficial investment diversification in the Malaysian stock markets. In addition, findings in Tables 4-6 consistent-

Figure 1: Rolling regressions from Eq. (1)



ly reveal that there is no asymmetric effect of positive and negative shocks on the Malaysian conditional volatility.

In the case of the Philippines, the US return is insignificant while the Asian return is significantly positive at the 5 percent level, implying that the market return of the Philippines is segmented from that of the US but it is integrated with that of Asia. Therefore, investors might find investments in the Philippines and Asian markets beneficial. As for Singapore, the significant positive slope estimates of the US and Asian returns imply that the Singaporean market is positively integrated with those of the US and Asia. In addition, the variance equation attests a significant leverage effect.

Table 6: Arma-Egarch-M model with the US and Asian returns

	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam
Mean equation						
Constant	0.1128	0.1069	0.3767**	-0.2260***	0.1906	-0.0556
	(0.4153)	(0.1414)	(0.0186)	(0.0021)	(0.2079)	(0.7431)
EXR	-0.1705***	0.2434***	-0.4336***	0.7758***	-0.3363***	-0.2205
	(0.0078)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.2851)
CPI	0.0620	-0.6374	-0.8960	-0.3199	-0.5735	0.3332
	(0.8744)	(0.2162)	(0.3039)	(0.1391)	(0.3053)	(0.6141)
ASEAN	1.1682***	0.6864***	0.5447***	0.8568***	0.7310***	0.0208
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.7462)
Asia	-0.1322**	-0.0942***	0.1198**	0.1276***	-0.0031	0.0855
	(0.0269)	(0.0004)	(0.0148)	(0.0000)	(0.9432)	(0.1689)
US	-0.0920*	-0.0525**	-0.0316	0.0550***	0.0295	0.1045**
	(0.0716)	(0.0350)	(0.4807)	(0.0016)	(0.4256)	(0.0481)
Dum	0.3901	-0.0888	-0.3013	-0.1736**	-0.2213	-1.6140***
	(0.1135)	(0.5681)	(0.2539)	(0.0449)	(0.4143)	(0.0025)
Ln($GARCH_{t-1}$)	0.0081	-0.0286	-0.0243	0.1967***	-0.0111	0.0066
	(0.7026)	(0.5242)	(0.4553)	(0.0086)	(0.7513)	(0.6178)
AR(1)	-0.1889***		-0.0954***			0.6012***
	(0.0000)		(0.0064)			(0.0000)
AR(2)				-0.0802**		
				(0.0453)		
MA(1)				-0.0844**		-0.4646***
				(0.0215)		(0.0037)
Variance equation						
Constant $\alpha_{i,0}$	-0.0295*	-0.0937***	-0.0246	-0.1960***	-0.0859*	-0.1507***
	(0.0979)	(0.0000)	(0.1859)	(0.0000)	(0.0617)	(0.0002)
$\lvert z_{i,t-1}\rvert - E(\lvert z_{i,t-1}\rvert)$	0.0737***	0.1287***	0.0652***	0.2520***	0.3116***	0.5045***
	(0.0003)	(0.0000)	(0.0032)	(0.0000)	(0.0000)	(0.0000)
$z_{i,\,t-1}$	-0.0553***	0.0320*	-0.0107	-0.0958***	0.0037	0.0377
	(0.0025)	(0.0582)	(0.5362)	(0.0003)	(0.8842)	(0.1941)
Ln($GARCH_{t-1}$)	0.9841***	0.9812***	0.9835***	0.9270***	0.8898***	0.9079***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Asia	-0.0013	-0.0047	-0.0112	-0.0159	-0.0357**	-0.0481***
	(0.8719)	(0.6303)	(0.1205)	(0.2691)	(0.0202)	(0.0094)
US	-0.0192	-0.0124	-0.0172	0.0310*	0.0011	0.0139
	(0.1320)	(0.3031)	(0.1869)	(0.0965)	(0.9519)	(0.5595)
R^2	0.5014	0.5208	0.3713	0.8346	0.4793	0.0702
Q(4)	1.2708	1.6657	0.9643	0.7157	7.4649	3.4614
	(0.736)	(0.797)	(0.810)	(0.699)	(0.113)	(0.177)
Q(8)	10.042	3.6230	7.1284	4.0291	9.1343	4.9245
	(0.186)	(0.889)	(0.416)	(0.673)	(0.331)	(0.554)
$Q^2(4)$	3.6784	0.7343	2.4950	2.8413	0.3705	0.7751
	(0.298)	(0.947)	(0.476)	(0.242)	(0.985)	(0.679)
$Q^2(8)$	7.5627	1.8895	4.2296	7.4363	2.5344	4.3989
	(0.373)	(0.984)	(0.753)	(0.282)	(0.960)	(0.623)
ARCH LM test	3.5878	0.7394	2.5261	2.9224	0.3544	0.7404
Obs*R^2	(0.4647)	(0.9464)	(0.6400)	(0.5709)	(0.9860)	(0.9463)

*Note: *, ** and *** denote significance at 10%, 5% and 1%, respectively. P values are in brackets.*

Meanwhile, as shown in Table 6, slope estimates of the US and Asian returns in mean equation and asymmetric coefficient $z_{i,t-1}$ in the variance equation are insignificant, implying a segmentation of the Thai market and the international benchmark markets as well as symmetric spillover effects. These findings are consistent with the corresponding ones in

Tables 4-5. Finally, in the regression for Vietnam, in the mean equation, the estimate of the US coefficient is significantly positive at the 5 percent level while in the variance equation the Asian market return is significantly negative at the 1 percent level. Thus, it can be inferred from Tables 4-6 that the Vietnamese stock market is segmented from the ASEAN bloc but is integrated with the US market, and an increase of the Asian market return tends to reduce the conditional volatility of the return on the Vietnamese stock market.

In order to get a better understanding of the integration and segmentation periods of the ASEAN6 stock markets, we re-estimated Eq. (1) by using rolling regression with a 52-week sample window. The point estimates and the corresponding 95 percent confidence interval limits of β_4 are illustrated in Figure 1. If a confidence interval for some ASEAN6 market includes zero in a given time period then we can conclude that in that time period, this ASEAN6 market is not integrated. However, in general, the confidence intervals do include zero, with a few exceptions, for example around the GFC, implying some degree of contagion effect.

5.2. Multivariate Granger causality tests

To investigate the channels through which the exchange rate has an impact on the price index, we implement Granger causality tests on the VAR model (6). Since according to the unit-root/stationarity tests, each time series is likely stationary, we estimate these models in the levels of the variables. The lag selections for this VAR model and the Granger causality test results are summarized in Table 7. Unfortunately, although the selected lag lengths ensure serially uncorrelated residuals, each VAR model suffers from heteroskedasticity.[7] This is a disadvantage of the VAR model in a comparison with a GARCH model. Therefore, our conclusions are based on the agreements rather

Table 7: Granger causality tests, the VAR model, Eq. (6)

ASEAN6	International market	Lags chosen	$A_{12}(L)=0$	$A_{13}(L)=0$	$A_{12}(L)=0$ $A_{13}(L)=0$	$A_{21}(L)=0$	$A_{23}(L)=0$	$A_{21}(L)=0$ $A_{23}(L)=0$	$A_{31}(L)=0$
Indonesia	US	10	19.095**	50.524***	73.316***	43.355***	22.091***	64.681***	10.133
	ASEAN	7	14.718***	24.795***	42.972***	23.378***	4.973	43.686***	15.940**
	Asia	6	14.248**	33.930***	49.147***	32.843***	5.921	44.395***	6.904
Malaysia	US	2	1.22	28.663***	29.274***	0.131	0.914	0.994	6.843**
	ASEAN	2	2.789	11.208***	11.807**	1.352	4.226	4.307	0.858
	Asia	2	0.538	5.660*	6.255	0.164	2.235	2.316	2.108
Philippines	US	2	7.925**	38.727***	44.568***	8.377**	11.640***	20.688***	5.421*
	ASEAN	5	17.398***	44.236***	52.085***	16.910***	34.117***	46.743***	3.057
	Asia	2	9.568***	24.459***	30.202***	11.152***	22.951***	32.122***	5.740*
Singapore	US	4	6.368	55.707***	68.367***	9.081*	2.020	11.469	15.045***
	ASEAN	3	7.068*	1.492	10.269	8.218**	10.880**	18.745***	10.416**
	Asia	2	4.055	4.071	12.696**	7.261**	3.506	10.720**	2.587
Thailand	US	4	4.245	38.298***	41.320***	15.926***	2.492	26.252***	2.211
	ASEAN	5	2.194	13.958**	18.253*	12.132**	10.962*	35.831***	12.780**
	Asia	4	2.897	10.351**	13.272	12.698**	4.368	28.184***	4.728
Vietnam	US	4	16.390***	24.986***	38.879***	1.750	3.260	4.266	5.350
	ASEAN	2	3.479	12.519***	15.788***	1.103	1.270	2.005	0.252
	Asia	4	15.604***	14.353***	28.053***	1.355	4.212	5.220	5.183

*Notes: *, ** and *** denote significance at the 10%, 5% and 1%, respectively.*

than on the contradictions between these models. We discuss the VAR models country by country.

Indonesia. The Indonesian stock market connects to the ASEAN bloc and Asia through the "stock" channel, and the US market through both the "flow" and "stock" channels. The results also imply that there is a feedback between the Indonesian and ASEAN bloc markets, and a one-way direct effect from the US and Asian markets.

Malaysia. There is no influence channel between the Malaysian stock market and the international benchmark markets. However, there is a feedback relationship between the markets of Malaysia and the US at the 5 percent level. This result contradicts the findings of Phylaktis and Ravazzolo (2005) that the Malaysian and US markets are connected through the "stock" channel and that the Malaysian market does not influence the US market. However, the different conclusions can be due to the different sample periods: December 1987 - December 1998 in Phylaktis and Ravazzolo (2005) and January 2000 - October 2015 in the current study. The Asian market does not directly affect the Malaysian market but the ASEAN bloc market does at the 1 percent level.

The Philippines. Our results indicate that the Philippine stock market connects to all three international markets through both "flow" and "stock" channels, confirming the finding of Phylaktis and Ravazzolo (2005) that during 1986-1998, the Philippine stock market connected to the US stock market through the "stock" channel and that there was a feedback. However, there are one-way relationships from the international markets to the Philippines market.

Singapore. Our findings suggest that the Singaporean market does not have any channel connection to these international markets, and a feedback relationship is found between markets of Singapore and the US. This finding is in contrast with those of Phylaktis and Ravazzolo (2005) that the Singapore stock and exchange markets are connected through the "flow" channel and that the Singapore stock market does not have an impact on the US stock market. The reason might be due to the different time frames. With regards to the ASEAN bloc and the Asian markets, no channel has been detected between these markets and the Singapore stock market. Interestingly, the results from the model in Eq. (6) imply that the ASEAN bloc does not affect the Singapore stock market but the Singapore market influences the ASEAN bloc.

Thailand. We find that the Thailand stock market connects to the US stock market through the "stock" channel and that the US stock market drives the Thailand stock market, which is consistent with Phylaktis and Ravazzolo (2005). The Thailand stock market also connects to the ASEAN bloc and Asian markets through the "stock" channel. In addition, there is a feedback relationship between Thailand and the ASEAN bloc.

Vietnam. "Stock" and "Flow" channels between the Vietnam stock market and three international markets are not found from the model. However, our findings imply that the international markets drive the Vietnamese market.

From VAR model (6), we estimated the impulse responses of ASEAN6 stock market returns to innovations at the US, Asia and ASE-

Figure 2: Impulse responses of ASEAN6 market returns to an innovation from international markets

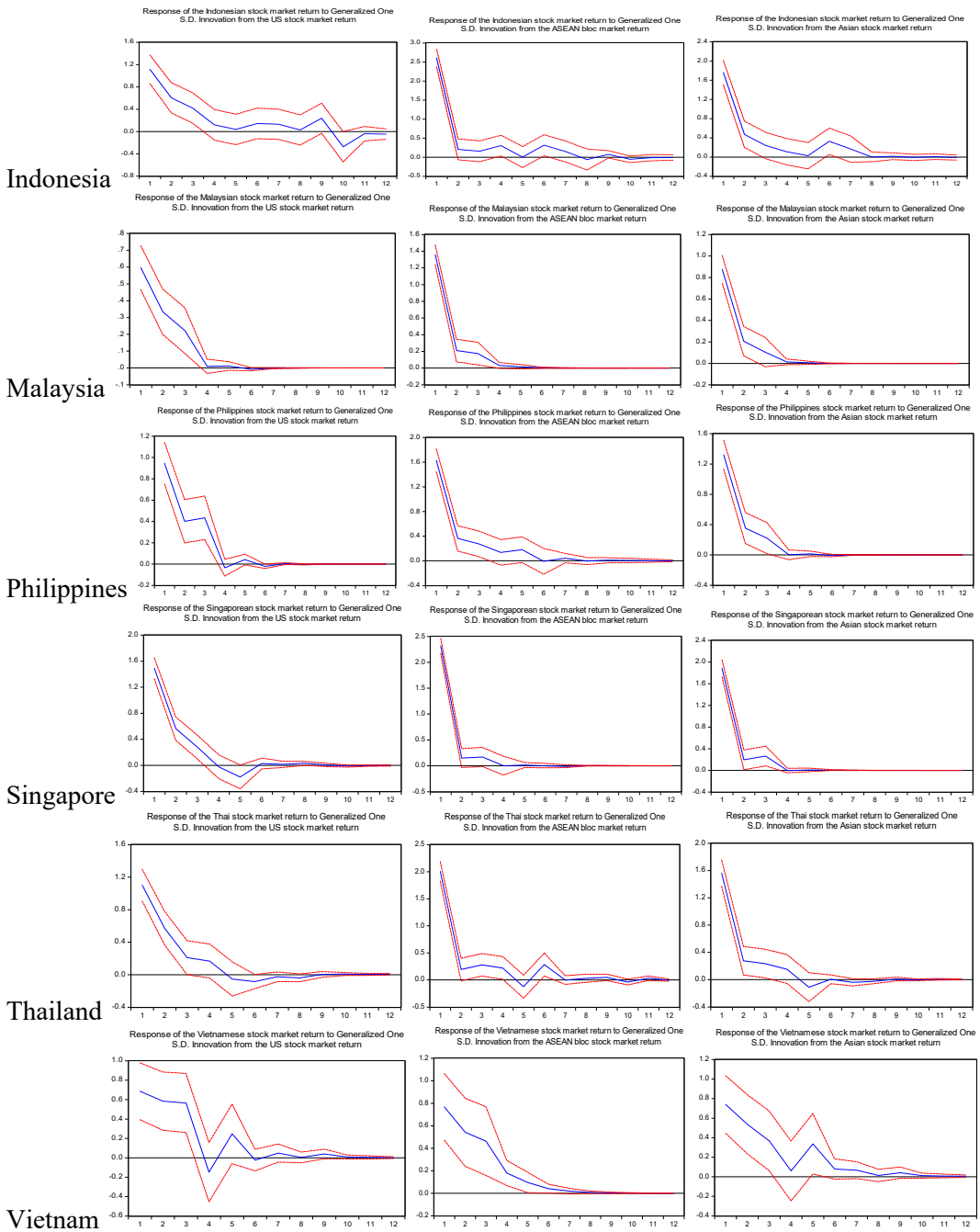
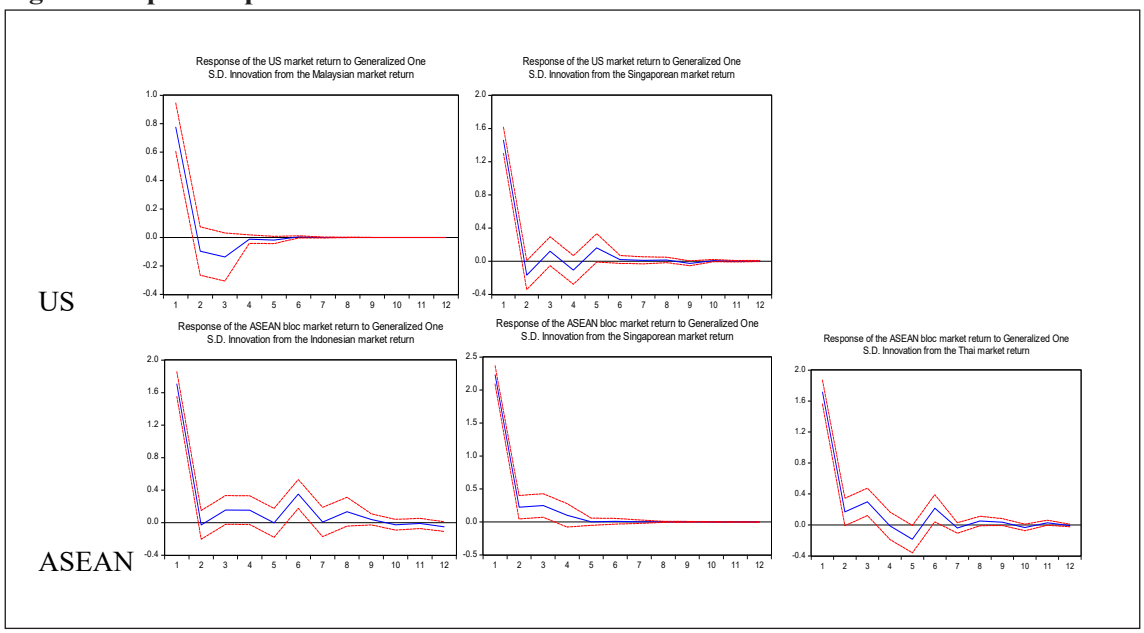


Figure 3: Impulse responses of international market returns to an innovation from ASEAN6 markets



AN bloc (Figure 2), and the impulse responses of international market returns to innovations at ASEAN6 markets (Figure 3).

From Figure 2, the effects of a shock on the US market to the ASEAN6 markets die out after 3 weeks, while the effects of shocks on the ASEAN bloc and Asia markets disappear after 2 weeks in the markets of Indonesia, Malaysia, the Philippines, Singapore and Thailand. However, the Vietnamese stock market takes a longer time, 4 weeks, to absorb these effects. In addition, most of the effects are positive before vanishing.

Table 7 shows that the Asian stock market is not statistically affected by ASEAN6 markets. Therefore, only impulse responses of the US and ASEAN bloc to innovations on the ASEAN6 markets are shown in Figure 3. Specifically, for the US, we show only two countries (Malaysia and Singapore); and for the ASEAN bloc we show three (Indonesia, Singapore and Thailand). From Figure 3a, the US stock market takes only one period to absorb the shocks from the Malaysian and Singaporean markets. Besides, the US has a negative response to a shock from Malaysia but positive and negative responses to a shock from Singapore. Similarly, Figure 3b demonstrates that effects of shocks from Indonesia, Singapore and Thailand on the market return of ASEAN bloc die out after 1 period.

5.3. Interdependence and contagion of 2007-2008 financial crisis shocks

The results for the impacts of US shocks on the ASEAN6 stock markets and those of ASEAN6 markets on the US market are reported in Tables 8 (from Eq. 9) and 9 (from Eq. 10), respectively.

Table 8 shows that the estimate of $e_{US,t}$, which

Table 8: Impact of US shocks on the ASEAN6 stock markets

	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam
Constant	0.0131	0.0165	0.0434	0.0496	0.0598	0.0829
	(0.9206)	(0.8052)	(0.6619)	(0.5137)	(0.5428)	(0.5789)
$e_{i,t-1}$	-0.0750**	-0.0803**	-0.0682*	-0.1654***	-0.0701**	-0.0109
	(0.0321)	(0.0210)	(0.0524)	(0.0000)	(0.0407)	(0.7606)
$e_{i,t-4}$				-0.0745***		
				(0.0082)		
$CD_{i,t-1}$	0.4691	-0.1737	-0.0785	-0.2836	-0.1848	-0.5841
	(0.3039)	(0.4561)	(0.8206)	(0.2858)	(0.5881)	(0.2545)
$e_{US,t}$	0.3664***	0.2385***	0.3038***	0.5611***	0.3804***	0.1828***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0066)
$e_{US,t-1}$	0.2894***	0.1052***	0.1829***	0.2768***	0.1937***	0.1638**
	(0.0000)	(0.0006)	(0.0000)	(0.0000)	(0.0000)	(0.0152)
$e_{US,t-2}$	0.1842***	0.0862***	0.1254***	0.0905***		
	(0.0004)	(0.0010)	(0.0012)	(0.0025)		
$e_{US,t-3}$						-0.1256**
						(0.0323)
$e_{US,t}\times CD_t$	0.4587***	-0.0159	0.3333***	0.1619**	0.2527	0.3020**
	(0.0002)	(0.7952)	(0.0003)	(0.0214)	(0.0053)	(0.0272)
$e_{US,t-1}\times CD_{t-1}$	0.1699	0.0699	0.0282	-0.0086	0.2394	-0.0007
	(0.1617)	(0.2548)	(0.7592)	(0.9017)	(0.0083)	(0.9961)
R^2	0.1567	0.1241	0.1554	0.3814	0.1863	0.0416
Serial Correlation test	6.3781	5.4747	4.9546	10.8885*	6.1176	3.2676
Obs*R^2	(0.2712)	(0.3607)	(0.4215)	(0.0536)	(0.2949)	(0.6588)

*Note: *, ** and *** denote significance at 10%, 5% and 1%, respectively. P values are in brackets.*

was not included in Samarakoon (2011), is significant at the 1 percent level in all countries, implying a misspecification in the model of Samarakoon (2011). In addition, the lagged interdependent coefficients, $e_{US,t-k}$, are always significantly positive at the 5 percent level (except the 5 percent significantly negative estimate at lag 3 in Vietnam). This information implies that ASEAN6 stock market returns positively response to a shock from the US, which is consistent with the finding in the VAR model as well as with visual evidence in Figure 2.

During pre and post crisis, Vietnam and Malaysia exhibit the lowest degrees of dependence in the concurrent period (0.1828 percent and 0.2385 percent, respectively), whereas Singapore shows the strongest degrees of dependence (0.5611 percent and 0.3804 percent, respectively). However, Indonesia displays the strongest dependence in the first lag (0.2894 percent), followed by Singapore (0.2768 percent). Malaysia and Vietnam still have the lowest one-period lag dependences with respect to the US return shocks (0.1052 percent and 0.1638 percent, respectively).

The concurrent parameter of contagion of unexpected shocks from the US stock market to the ASEAN6 stock markets, $e_{US,t}\times CD_t$, was not included in Samarakoon (2011). However, the estimates of these coefficients in the equations of Indonesia (0.4587 percent), the Philippines (0.3333 percent), Singapore (0.1619 percent) and Vietnam (0.3020 percent) justifies the inclusion of this parameter in Eq. (9). The insignificance of $e_{US,t-1}\times CD_{t-1}$ in Table 8 is consistent with the findings of Samarakoon (2011) that there is no evidence of one-period lag contagion of unexpected shocks from the US stock

Table 9: Impact of ASEAN6 shocks on the US market

	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam
Constant	0.0612	0.0534	0.0535	0.0208	0.0453	0.0539
	(0.4745)	(0.5381)	(0.5291)	(0.7795)	(0.5883)	(0.5476)
$e_{US,t\text{-}1}$	-0.0463	-0.0463	-0.0177	-0.1310***	-0.0810**	0.0141
	(0.1940)	(0.1910)	(0.6160)	(0.0002)	(0.0236)	(0.6928)
$CD_{t\text{-}1}$	-0.6713**	-0.6590**	-0.5696*	-0.3257	-0.4431	-0.7155**
	(0.0202)	(0.0276)	(0.0510)	(0.2071)	(0.1270)	(0.0173)
$e_{i,t}$	0.1572***	0.3835***	0.2237***	0.5509***	0.2649***	0.0626***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0080)
$e_{i,t\text{-}1}$	0.0277	0.0682	-0.0159	0.0642*	0.0487	0.0325
	(0.2612)	(0.1664)	(0.6231)	(0.0794)	(0.1220)	(0.1679)
$e_{i,t}\times CD_t$	0.1889***	0.0609	0.2339***	0.0404	0.2613***	0.1541***
	(0.0002)	(0.5700)	(0.0004)	(0.5198)	(0.0001)	(0.0033)
$e_{i,t\text{-}1}\times CD_{t\text{-}1}$	-0.1249**	-0.1658	-0.1230*	-0.0270	-0.1260*	-0.1703***
	(0.0131)	(0.1225)	(0.0675)	(0.6676)	(0.0656)	(0.0013)
Adjusted R^2	0.1207	0.0984	0.1341	0.3365	0.1591	0.0494
LM test	2.7710	3.6017	5.1531	4.3869	4.5130	2.1166
Obs*R^2	(0.7352)	(0.6081)	(0.3975)	(0.4952)	(0.4781)	(0.8328)

market to the ASEAN6 stock markets.

Samarakoon (2011) does not include concurrent variables $e_{i,t}$ and $e_{i,t}\times CD_t$ in Eq (10) since the author claims that the US and these ASEAN countries are non-overlapping markets. However, Table 9 shows that the estimates of $e_{i,t}$s are significantly positive at the 1 percent level in all ASEAN6 markets, implying a significant concurrent effect of unexpected shocks from these ASEAN6 markets to the US market return. Furthermore, the lagged interdependent variable, $e_{i,t\text{-}1}$, is always insignificant, implying that there is no lagged impact of unexpected shocks from the ASEAN6 stock markets on the US stock market during pre and post crisis.

Table 9 also exhibits clear evidence of positive concurrent contagion of the return shocks in Indonesia, the Philippines, Thailand and Vietnam to the US stock market. However, the one-lag contagion coefficients are all negative, but only significant at the 5 percent level in regressions of Indonesia and Vietnam. The largest contagion effects are from Thailand (0.2613 percent) and the Philippines (0.2339 percent), and the smallest is from Vietnam (0.1541 percent). Meanwhile, one-lag contagion effects on the US market are found significantly negative from Indonesia (-0.1249 percent) and Vietnam (-0.1703 percent). In the crisis period, the US stock market is not affected by the unexpected return from Malaysia and Singapore.

5.4. Investment policy implication

Understanding integration/segmentation of the ASEAN6 stock markets and the interaction channels ("flow" or "stock" or both) between these markets and the international markets can help investors decide whether and how to invest in the ASEAN6 markets in order to diversify their portfolios. Our results imply the following.

Indonesia. Estimates from the AR-MA-EGARCH-M model in Tables 5-6 suggest negative integration of Indonesian and the US/Asian markets as well as the leverage effect of shocks from these international markets. Similarly, the VAR model and Eq. (9) also imply the

influence of the shocks from the US/Asian market to the Indonesian market. Thus, investors can consider both "flow" and "stock" channels to diversify their portfolios by holding assets from the US market, and focus on the "stock" channel if the portfolios include ASEAN/Asian assets.

The Indonesian stock market is negatively integrated with the US/Asian stock market and there is one-way influence from the US/Asian market to the Indonesian market, so investors can reduce their risk by having the US/Asian and Indonesian assets in their portfolios. Since the Indonesian stock market is highly integrated with the ASEAN bloc, combining assets from the Indonesian markets and the ASEAN bloc market does not help reduce potential risk. The investors should also be aware of the feedback relationships between the Indonesian stock market and ASEAN bloc. As shown in Appendix 1, in the last ten years Indonesia's total trade with the US relative to its GDP is relatively low, at less than 5 percent; however, its trade openness with the world is quite high, somewhere between 40 and 80 percent. Thus, investors are better off to consider the "stock" channel when investing in Indonesia if they have US assets.

Malaysia. Estimates from Tables 4-6 for the ARMA-EGARCH-M model suggest negative integration of the Indonesian and the US/Asian markets as well as the leverage effect of shocks from these international markets. Hence, potential risk can be reduced by combining assets from Malaysia and the US/Asia. In other words, there are potential benefits of investment diversification by combining assets from the Malaysian markets and the US/Asian market. Furthermore, no influence channel between the Malaysian stock market and the international benchmark markets is found in the VAR model, but there is a feedback relationship between the markets of Malaysia and the US. In addition, the impulse response analysis and Eq. (9) reveal contagion effect from the US/Asia market to the Malaysian market. The Malaysian market positively integrates with the ASEAN bloc market and the ASEAN bloc market directly affects the Malaysian market, so investors should not diversify their portfolios by holding both Malaysian and ASEAN assets.

Appendix 1 shows that the trade openness of Malaysia to the US is relatively high. In spite of its steady decline since 1998, it is still more than 10 percent of the GDP. In addition, the trade openness of Malaysia to the world is also quite high, reaching a peak at 191 percent in the year 2000 (Appendix 2). This suggests that investors with US assets in their investment portfolios could invest in Malaysia.

The Philippines. Estimates from Tables 4-6 imply a segmentation of the Philippines and the US/Asian markets, and the leverage effect of shocks from these international markets. So it is beneficial to diversify assets from the Philippines and the US. Investors with US/Asian assets can rely on both "flow" and "stock" channels to invest in the Philippines stock markets and they should be aware of the contagion effect of these international markets to the Philippines stock market. Diversifying portfolios among the Philippines and ASEAN bloc assets will not reduce the potential risk since these markets are highly integrated. Appendices 1 and 2 show that the trade openness of the Philippines to the US and the world has reduced

significantly since 2005. The trade openness of the Philippines to the US was particularly high in the period 1991-2007, but in 2013 it was only about 5 percent. Hence, the "flow" channel was relevant before 2008, but in current times it does not seem to be as beneficial to invest in the Philippines for investors with US assets.

Singapore. The Singaporean and the US/Asian markets are shown positively integrated by the ARMA-EGARCH-M model in Tables 5-6. In addition, findings from the VAR model in Table 7 suggest that the Singaporean market does not have any channel connection to ASEAN bloc and Asian markets, thus, investors with assets from these international markets should not invest in the Singapore stock market. With assets from the US market, a feedback relationship between Singapore and the US is found in the VAR model, whereas estimates from Eqs. (9) and (10) reveal a dependence relationship and contagion effect between them. Therefore, investing in the Singaporean market might not reduce potential risk for US investors.

As shown in Appendix 1, although the trade openness of Singapore to the US has gradually reduced from 60 percent in 1989 to 21 percent in 2013, it is still relatively high in comparison with those of other ASEAN countries. Moreover, its trade openness to the world is extremely high, which is always above 250 percent and reaches a peak of 354 percent in 2006 (Appendix 2). However, investors cannot apply any channel to invest in the Singapore stock market due to its insignificance in the Granger causality test.

Thailand. Implied from estimates of the ARMA-EGARCH-M model, the Thai stock market is not integrated with the US/Asian markets, so it is beneficial to diversify between Thailand and US/Asian assets. To invest in the Thai stock market, investors with assets from the US/Asian markets can rely on the "stock" channel. However, because the Thai market is positively integrated with the ASEAN bloc, and there is a feedback between the Thai market and the ASEAN bloc market, it is not beneficial combining assets of these two markets. Investor should be aware of the dependence structure of unexpected returns and contagion effect between the US and Thai markets. As shown in Appendices 1 and 2, there are important trade links between Thailand and the US and the world as well. However, since the "flow" channel is found to be insignificant in the VAR model, investors are not recommended to apply this channel for investing in Thailand.

Vietnam. Unlike the other five ASEAN6 countries, the Vietnam stock market is relatively new and underdeveloped, and is expected to be segmented from the international markets. Estimates from Table 5-6 show that it is segmented from the ASEAN bloc market, but is integrated with the US and Asian markets. While the rolling estimates reveal the segmentation from the US and Asian markets, the VAR model could not find evidence of interaction channels between the Vietnamese market and the three international markets. Dependence structure and contagion effects between unexpected returns of Vietnam and the US are found significant in Eq. (9). The above information implies that investment in Vietnamese assets can bring potential benefits for ASEAN investors. However, investors from the US and Asian markets should be aware of the one-way

influence from the US/Asia to the Vietnamese stock market. Appendices 1 and 2 show that the trade openness of Vietnam with the US and the world has increased steadily since 1997, except for a temporary drop during the GFC. From 2003 to 2013, the proportion of exports and imports in the GDP of Vietnam in relation with the US (the world) has increased from 11 (100) percent to about 17 (154) percent. However, due to the dependence of the Vietnamese stock market on the US/Asian market, especially its long impulse response to an international shock, investors should be aware of the spillover effects.

6. Conclusion

In this paper, we have studied the integration of six ASEAN markets with three international markets (the US, the ASEAN bloc, and Asia) by analyzing stock returns for January 2000-October 2015. A variety of methodologies such as the ARMA-EGARCH-M model, multivariate rolling regressions, the VAR model, and two-stage regressions have been applied to address the research questions. Our results imply some model misspecifications in Samarakoon (2011).

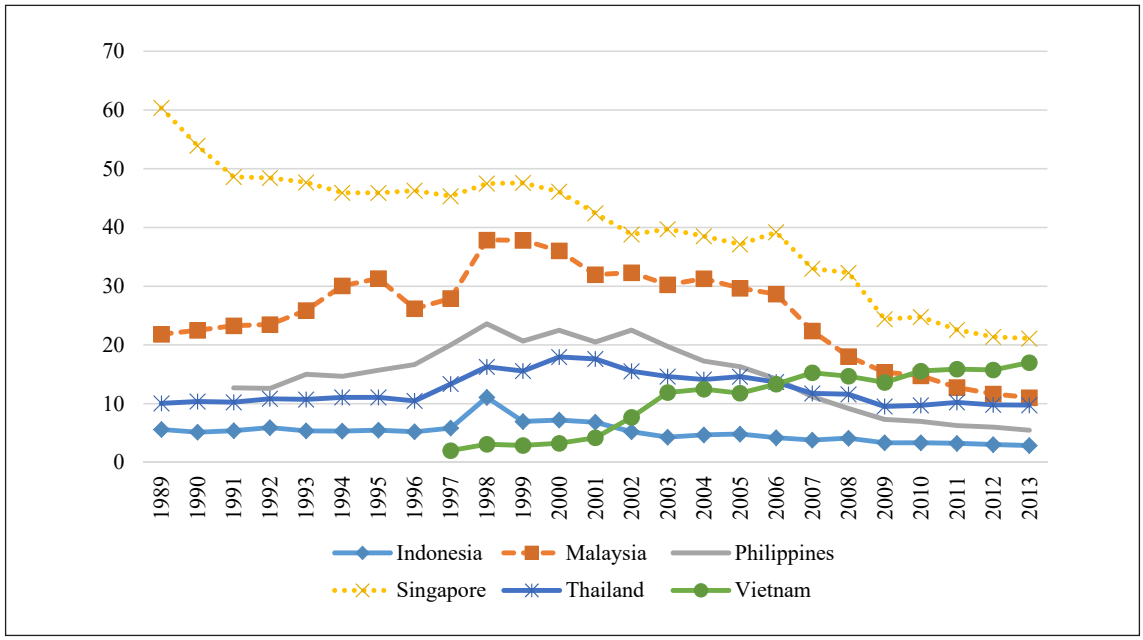
We find that Indonesia, Malaysia, the Philippines, Singapore and Thailand are highly integrated with the ASEAN bloc, so the combinations of assets from these ASEAN markets tend to be inefficient. Specifically, investors can reduce their risk by having the US/Asian and Indonesian assets in their portfolios, whereas combining assets from the Indonesian markets and ASEAN bloc market do not help reduce potential risk. There are potential benefits of investment diversification by combining assets from the Malaysian markets and the US/Asian market, but investors should not diversify their portfolios by holding both Malaysian and ASEAN assets.

It is beneficial to diversify assets from the Philippines and the US. Investors with US/Asian assets can rely on both "flow" and "stock" channels to invest in the Philippines stock markets, and they should be aware of the contagion effect of these international markets to the Philippines stock market. Diversifying portfolios among the Philippines and ASEAN bloc assets will not reduce the potential risk because these markets are highly integrated.

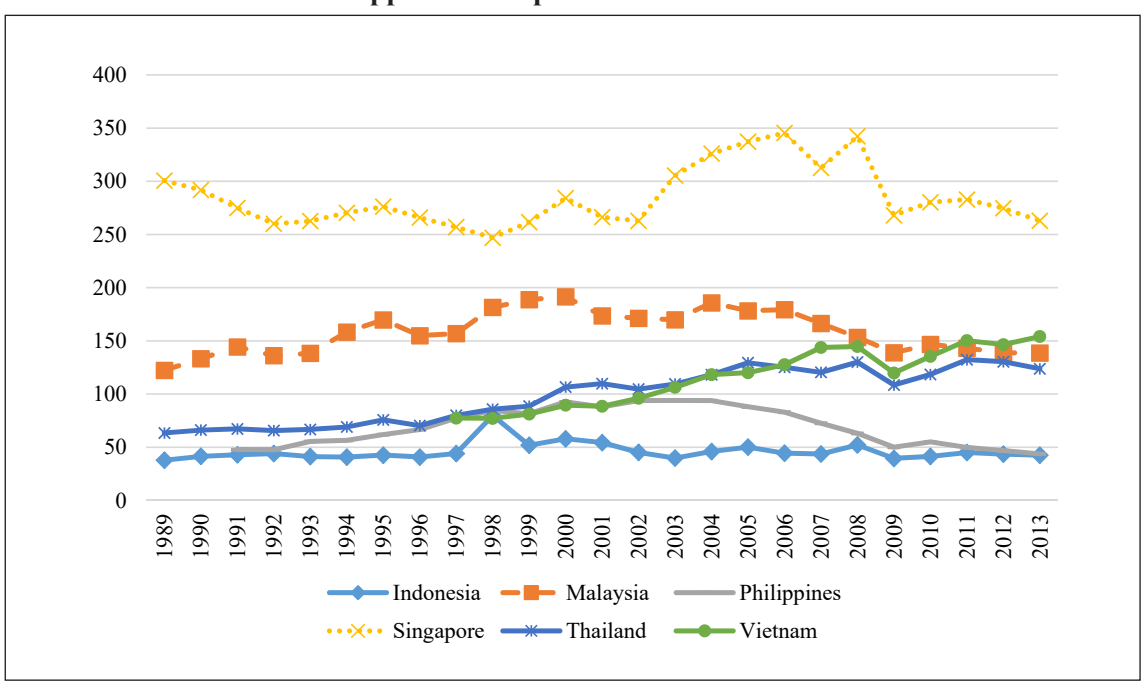
Since the Singaporean market does not have any channel connection to the ASEAN bloc and Asian markets, investors with assets from these international markets should not invest in the Singapore stock market and investing in the Singaporean market might not reduce potential risk for US investors. To invest in the Thailand stock market, investors with assets from the US/Asian markets can rely on the "stock" channel. However, it is not beneficial combining assets from the ASEAN bloc and Thailand, and investors should be aware of the dependence structure of unexpected returns and contagion effect between the US and Thai markets. However, ASEAN investors could invest in the Vietnamese stock market to exploit the segmentation between Vietnam and ASEAN bloc markets.

APPENDIX

Appendix 1: Openness to the US



Appendix 2: Openness to the World



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Notes:

1. In contrast to Phylaktis and Ravazzolo (2005), this paper does not use real exchange rates due to the non-availability of weekly inflation rate data needed to transform nominal exchange rates to real exchange rates. Moreover, following real exchange rate calculation methodology in Phylaktis and Ravazzolo (2005), we find high correlation coefficients between monthly nominal and real exchange rates as well as between their returns in each of the ASEAN6 countries. Phylaktis and Ravazzolo (2005) use log of price indices in their regressions, whereas this research uses return series which are free of the units of measurements, justifying the use of nominal exchange rate returns.
2. The inclusion of AR and/or MA terms in rolling regression of equation (1) depends on the significance of these terms in the ARMA(r,s)-EGARCH-M regressions.
3. This specific crisis period is chosen in accordance with the consensus in the literature.
4. The sample size is 826 for every country except Vietnam. In the case of Vietnam the sample size is only 796, due to the availability of the total exports and imports in the UNComtrade Database.
5. To keep the paper short, we do not report the detailed test results. However, they are available on request.
6. It is worth noting that in the returns of the ASEAN bloc, Asia and the US are reasonably strongly correlated with each other, e.g. (Correlation (ASEAN bloc, Asia) = 0.7373; correlation (ASEAN bloc, US) = 0.5230; and correlation (Asia, US) = 0.5907. Hence these regressions might suffer from multicollinearity. For this reason the results in Table 6 have to be interpreted carefully.
7. The details are available on request.

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