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The Integration of the East and South-East Asian Equity Markets

K. B. TAN
National University of Singapore

Yiu Kuen TSE
Singapore Management University, yktse@smu.edu.sg

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K.B. Tan

Department of Economics
National University of Singapore
Kent Ridge, Singapore 119260

Y.K. Tse

School of Business
Singapore Management University
11 Evans Road, Singapore 259368

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Abstract: This study examines how the degree of capital-market integration of the East and South-East Asian (ESEA) economies varied over the period 1988–2000 following the deregulation of these markets. The deregulation process varied across the countries both in terms of intensity and timing. A greater degree of co-movements in stock prices is a reflection of greater stock-market integration. We employ Geweke's (1982) measure of feedback for different pairs of markets. For each pair of markets, the Geweke measure shows how co-movements in daily returns of stock prices varied over time. This is followed by the vector autoregression (VAR) analysis to examine the linkages between the stock markets in the ESEA region. Therein we seek to explore whether the financial influence of Japan in the region has overtaken that of the US. A before- and after-Asian financial crisis analysis shows that the linkages and interactions among the markets have increased substantially in the post-crisis era, suggesting that the national markets have become more interdependent.

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1. Introduction

The explosive growth in international financial transactions and capital flows is one of the single most profound and far-reaching economic developments of the late twentieth and early twenty-first centuries. Such scene in international finance is the result of the liberalization of capital markets and is characterized by the increasing variety and complexity of financial instruments. As developing countries become more integrated in international flows of goods, they are pulled into the international capital markets. The rapidity and magnitude of the resurgence of private flows in the 1990s surprised many observers. The growing internationalization of business and finance and the vast increase in the speed and volume of information flows, aided by technological advances in communications, have allowed much more rapid assessment of and response to the real growth possibilities in many developing countries.

Freer capital flows improve the allocation of capital globally, allowing resources to move to areas with higher rates of return. On the other hand, attempts to restrict capital flows lead to distortions that are generally costly to the economies imposing the controls. All this means that capital-market liberalization is an on-going and, to certain extent, irreversible process bringing with it increased volume and volatility in international capital flows. Such financial liberalization, however, is not without its costs. The Asian financial crisis of 1997, with its repercussion effects on the world economy, has reverberated the interest in studying the linkages between national capital markets, particularly since most Asian markets have been relatively isolated from each other.

There has been much empirical work on the international capital-market integration. Empirical results commonly suggest cross-country stock market correlations are statistically significant, but small in magnitude. In this paper two different approaches will be adopted to examine the extent of capital-market integration over the period 1988–2000. The first approach adopts the Geweke (1982) measure of the extent of international integration. Daily data on national equity markets in the East and South-East Asian (ESEA) region over a 12-year period were employed to estimate the annual Geweke measure of feedback. For each pair of markets this procedure generates a time series of 12 annual measures of the extent of contemporaneous and lead/lag relationships between daily returns in the two markets. We interpret an increase (or decrease) in the Geweke measure between two years to reflect an increase (or decrease) in the extent of stock market integration for that pair of countries.

Thus, the Geweke statistics represent cardinal measures of the degree of dependence (i.e., the extent of feedback) present in a given sample.

In the second approach, the vector autoregressive (VAR) methodology is adopted. The appeal of the VAR analysis lies in its ability to trace the dynamic responses of one economic variable to another, not only in terms of size (variance decomposition) but also the time required for the response to fully take place (impulse response analysis). Complementary to the Geweke approach, we examine if there is any significant long-term linkages between the markets of the ESEA region and the US. In addition we are also interested in investigating whether the regional market of Japan has exerted any significant influences on the ESEA nations, after accounting for the impacts of the US market's influence. To investigate the stability of these market linkages over time, two sub-periods taking into consideration of the outbreak of the Asian financial crisis were analyzed. This allows us to examine whether any significant and persistent changes in the degree of market linkages have occurred across the markets analyzed.

The balance of the paper is as follows. In Section 2 we review briefly the recent literature on capital-market integration, with special reference to the Asia-Pacific region. Section 3 describes the data and presents some summary statistics. Results of a simple Granger-causality test are also reported. In Section 4 we examine the time-varying degree of market integration using the Geweke measure. The results based on the VAR model are discussed in Section 5. Finally, some concluding remarks are given in Section 6.

2. Literature Review

Questions about international capital mobility and financial market integration have long attracted the attention of both researchers and policymakers. The increasing integration of financial markets has prompted investors in certain markets to incorporate into their decisions not only information pertinent to the domestic market but also information transmitted around the world. Such behavior is consistent with the efficient markets hypothesis, provided that news generated by international stock markets are relevant for the pricing of domestic securities. It is thus interesting to see if the prices in any one market are informationally useful with respect to the prices in other markets, and also whether or not there are volatility spillovers between different financial markets. This phenomenon is of particular interest to the ESEA economies, many of which have embarked on large-scale financial market liberalizations since the early 1980s.

Co-movements across national stock markets have long been suggested. Previous studies have examined the relationship between the returns in different markets. For example, Hogan and Sharpe (1984) and Ito and Roley (1987) examined the transmission of news in the foreign exchange markets. Using data on the US and 17 foreign countries for the period 1960-1985, Wheatley (1988) supported the notion of equity market integration. Considerable interaction between stock market indexes, with one-way causality running from the US to foreign markets (including Hong Kong and Japan) were supported by Dwyer and Hafer (1988) and Eun and Shim (1989), respectively, by applying unit root tests and vector autoregression model. Jeon and Von Furstenberg (1990) noted that the degree of international co-movement between international stock indexes has increased since October 1987. King and Wadhwani (1990) provided support for the hypothesis of "contagion" effects in the three major markets where "noises" in one market can be transmitted to other markets. Mathur and Subrahmanyam (1990) found evidence of interdependence among four Scandinavian stock markets. Koch and Koch (1991) used a dynamic simultaneous-equation model to investigate the evolution of contemporaneous and lead/lag relationships among eight national stock markets. They concluded the growing regional interdependence over time with the growing dominance of the Tokyo market at the expense of the New York market.

Jeon and Chiang (1991) suggested the existence of a common stochastic trend in the system of stock prices in the New York, London, Tokyo, and Frankfurt exchanges, based on univariate and multivariate approaches. Sewell et al. (1996) examined the stock market indices and exchange rates of five Pacific Rim countries and the US, documenting evidence of varying degrees of market co-movement among the indices and exchange rates. Using a vector autoregression model for the period 1988–1996, Janakiramanan and Lamba (1998) examined the dynamic relationship between daily returns on selected Australasian stock markets. Their results showed that the US market influences all other Australasian markets, except Indonesia, and none of these markets exert any significant influence on the US market. Using the Geweke measure of integration for nine developed countries over 1972–1993, Bracker et al. (1999) concluded that significant intermarket responses across all nine markets are mostly completed within 24 hours and results reveal a strong tendency for these nine stock markets to become more integrated over time. By looking at the equalization of real interest rates using cointegrating methodology, Phylaktis (1999) concluded that Pacific-Basin countries are closely linked with world financial markets and more so with Japan than with US.

3. Preliminary Data Analysis

The ESEA markets examined in this paper are in the same time zone. Thus, the market linkages can be analyzed in a more "dynamic" setting where shocks in the system can be transmitted across markets. The data employed are the daily national stock indexes in terms of each market's own domestic currency constructed by the Morgan Stanley's Capital International.[1] The data were downloaded from the Datastream.

We use data for nine markets over the 12-year period 1988–2000. The markets analyzed are the United States, Japan, Hong Kong, Korea, Malaysia, Philippines, Singapore, Taiwan and Thailand. Throughout this study, both the US and Japan function as the base countries for our analysis with the former representing the world factor while the latter a regional force. Note that the US market is closed when all other markets are open for trading, and vice versa.

Daily returns are calculated in the continuously compounding way as $R_{jt} = \ln(P_{jt} / P_{j,t-1})$, where P_{jt} represents the closing price of market *j* on day *t*. Daily data for the nine markets are matched by calendar date. Table 1 provides some descriptive statistics for the returns of the nine markets. The mean returns of all markets are positive (with the exception of Japan), accompanied by high volatility. This is evident from the relatively higher value of standard deviation for each of the ESEA markets in comparison to the US.

With the exception of the US, Hong Kong and Singapore, there is evidence of positive skewness. The positive skewness may be due to some extreme positive returns realized within these markets. Normality is also rejected on the basis of the Jarque-Bera statistic for all markets.[2] The Ljung-Box *Q*-statistics for up to 6 lags, calculated for both the return and the squared return series, indicate the presence of significant linear and non-linear serial

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[1] The individual country indexes are fully comparable market-weighted price averages without dividends reinvested. The included companies and their total market values are available in each quarterly issue of Morgan Stanley Capital International Perspectives. One major characteristic of these data is that when a country's stock market is closed for a national holiday the previous day's closing value is retained for that day, resulting in a zero return for every country's national holidays.

[2] The Jarque-Bera statistic is a test statistic for testing whether the series is normally distributed. The test statistic measures the difference of the skewness and kurtosis of the series against those from the normal distribution.

dependence, respectively, in the returns of all markets. Linear dependence in the first moment of the distribution of returns may be due to either non-synchronous trading of the stocks that make up each index or to some form of market inefficiency. On the other hand, non-linear dependence may be due to autoregressive conditional heteroskedasticity, as documented by many studies on stock returns. As can be seen, the Ljung-Box *Q*-statistics calculated for the squared returns is several times higher than that of the returns themselves, implying higher-moment dependence is much more pronounced. This is compatible with the volatility clustering documented in stock markets. What is not clear from these statistics is whether there is asymmetry in the volatility process and if the volatility and autocorrelation are inversely related.

Table 2 gives the correlation matrix of the market returns. As expected, the correlations among various markets are positive. Note that the correlations between returns in the ESEA markets and the previous day's return in the US market are higher than the corresponding correlations with the same-day US returns. Such low correlation with the same-day US market returns is because when the other markets are in session the US market is closed, and vice versa. Japan exhibits lower correlations with other ESEA markets than with the US market. It is also noted that geographically and economically close markets, such as Singapore and Malaysia, and Singapore and Hong Kong exhibit high return correlations.

Figure 1 displays the index series P_{jt} and the corresponding returns R_{jt}. The time series plots clearly illustrate the differing conditions across the markets over the sample period. The US market experienced unprecedented growth while the Japanese and Thailand markets have stagnated since the crash of 1990 and 1997 (Asian financial crisis), respectively. Figure 1 also suggests that the returns data display the volatility-clustering phenomenon associated with financial time series. Large (small) shocks of either sign tend to follow large (small) shocks.

To examine the lead-lag relationship between the market indices we conduct a simple pair-wise Granger-causality test with a lag length of five. Granger causality measures precedence and information content but does not by itself indicate causality in the more common use of the term. Table 3 provides the resulting *p*-values for the tests. Through this analysis we can identify three major findings: (1) Granger causality runs only one-way from the US market to Japan and all the ESEA markets; (2) Japan only Granger-causes Korea, Philippines, Taiwan and Thailand; and (3) There are significant two-way causations between Singapore and Malaysia, Hong Kong and Singapore, Thailand and Hong Kong, Thailand and

Singapore, and Thailand and Korea, and Thailand and Malaysia. These results are in lieu with findings claiming the dominance of the US influence relative to Japan's on the smaller countries of the Pacific-Basin. The last point is the consequence of the Asian financial crisis originating from the downfall in Thailand.

4. The Geweke Measure of Capital-Market Integration

Much empirical work in the literature has focused on identifying how the stock markets of different countries are interrelated. Most of these empirical results commonly suggest cross-country stock market correlations, though statistically significant, are small in magnitude. Few studies have been undertaken to measure how this extent of integration has varied over time. In this section we will provide a measure of how the extent of integration in the ESEA economies has evolved throughout the period 1988–2000 using the approach suggested by Geweke (1982).

4.1 Methodology

Consider first the dynamic interrelationship between daily returns in the stock markets of any two countries, R_{1t} and R_{2t}. We assume that each country's daily return potentially depend upon: (i) its own past returns, (ii) past returns in the other market, and (iii) the idiosyncratic noise. Such interdependence can be modeled with the following system of two seemingly unrelated regressions

$$R_{1t} = a_0 + \sum_{k=1}^{M_2} a_k R_{2,t-k} + \sum_{k=1}^{M_1} b_k R_{1,t-k} + \varepsilon_{1t} \tag{1}$$

$$R_{2t} = c_0 + \sum_{k=1}^{M_2} c_k R_{1,t-k} + \sum_{k=1}^{M_1} d_k R_{2,t-k} + \varepsilon_{2t} \tag{2}$$

with

$$\mathrm{Cov}(\varepsilon_{1t},\ \varepsilon_{2t}) = \begin{pmatrix} \sigma_1^2 & \sigma_{12} \\ \sigma_{12} & \sigma_2^2 \end{pmatrix} = \Omega \tag{3}$$

The disturbance terms ε_{1t} and ε_{2t} are assumed to be jointly normally distributed and contemporaneously correlated with covariance σ_{12}. The coefficients a_k in Equation (1) determines how the second stock market leads the first market across days while the coefficients c_k in Equation (2) reflects how the first market leads the second across days. In addition, the same-day relationship (within the same 24-hour period) is captured by the contemporaneous correlation across the error terms in the covariance matrix Ω. Finally, finite lag parameterization requires us to incorporate a longer lag length for M_1 in order to ensure that the errors are not autocorrelated, while a smaller lag length for M_2 increases the power of the tests. Following this argument, ten business days for M_1 and five business days for M_2 are chosen. These considerations lead us to specify and test the following hypothesis:

H_1: *Absence of contemporaneous relationship between R_{1t} and R_{2t} on the same day* (*i.e.*, $\sigma_{12} = 0$).

H_2: *R_{2t} does not lead R_{1t} across days* (*i.e.*, $a_k = 0$ *for all k*).

H_3: *R_{1t} does not lead R_{2t} across days* (*i.e.*, $c_k = 0$ *for all k*).

Under the joint hypothesis (**H_4: H_1, H_2,** and **H_3),** Equations (1) and (2) become:

$$R_{1t} = a_0 + \sum_{k=1}^{M_1} b_k R_{1,t-k} + \xi_{1t}, \qquad \mathrm{Var}(\xi_{1t}) = \sigma_{R1}^2 \tag{4}$$

$$R_{2t} = c_0 + \sum_{k=1}^{M_1} d_k R_{2,t-k} + \xi_{2t}, \qquad \mathrm{Var}(\xi_{2t}) = \sigma_{R2}^2 \tag{5}$$

with $\mathrm{Cov}(\xi_{1t,}\ \xi_{2t}) = 0$.

Equations (1) and (2) are estimated as a system of seemingly unrelated regressions, while Equations (4) and (5) are estimated using ordinary least squares (OLS). Subsequently, using the estimates of the residual variances and covariances in $\hat{\Omega}$, along with $\hat{\sigma}_{R1}^2$ and $\hat{\sigma}_{R2}^2$, test statistics for hypotheses **H_1** through **H_3** are used to compute the Geweke (1982) measure of feedback. We define

$$n\hat{F}_{1\otimes 2} = n \ \ln\left[\left(\hat{\sigma}_{R1}^2 \cdot \hat{\sigma}_{R2}^2\right) / \,|\,\hat{\Omega}\,|\right] \tag{6}$$

$$n\hat{F}_{2\sim 1} = n \ \ln\left(\hat{\sigma}_{R1}^2 / \hat{\sigma}_1^2\right) \tag{7}$$

$$n\hat{F}_{1\sim 2} = n \ \ln\left(\hat{\sigma}_{R2}^2 / \hat{\sigma}_2^2\right) \tag{8}$$

where n refers to the sample size in each period and $|\,\hat{\Omega}\,|$ is the determinant of $\hat{\Omega}$. Note that the Geweke measures of feedback are simply the log-likelihood ratio statistics for the null hypotheses under consideration. Thus, $n\hat{F}_{1\otimes 2}$, $n\hat{F}_{2\sim 1}$ and $n\hat{F}_{1\sim 2}$ are asymptotically distributed as χ_1^2, $\chi_{M_2}^2$ and $\chi_{M_2}^2$, respectively under **H_1, H_2** and **H_3**. Geweke's measure allows us to compare contemporaneous feedback as shown by $n\hat{F}_{1\otimes 2}$ across different years to reveal how the extent of co-movement changes over time for a given pair of markets. Similarly, comparisons made across different yearly sub-samples of the unidirectional feedback measures ($n\hat{F}_{2\sim1}$ and $n\hat{F}_{1\sim2}$) allow us to observe how a leader/follower relationship varies over time.

4.2 Empirical Results

As the trading hours for the nine markets varies, care must be taken in the interpretation of the same-day relationship. As was pointed out earlier, when other markets are in session the US market is closed, and vice versa. Thus on any given calendar date, the ESEA markets close before the US market opens. As such, the American market may respond to earlier movements in the ESEA markets, but not influence such earlier movements. The influence of market activity in America can only be evidenced in the ESEA markets later, after these markets open on the next calendar date. Such timing considerations are of utmost importance, particularly so when we are interested in tracing the degree of integration with respect to the US market over the sample period.

We distinguish between the intermarket relationship *on the same day* (within the same 24-hour period) and the lead/lag relationships *across days* (beyond 24 hours). The 'same-day relationship' represents the contemporaneous feedback, which is the focus of our hypotheses, $\mathbf{H_1}$, and is measured by $n\hat{F}_{1\otimes2}$. In contrast, for each pair of markets there are two separate 'lead/lag relationships across days', reflecting the responsiveness of each market to prior activities in the other market beyond the most recent trading session (i.e., sessions prior to that). These lagged relationships appear as the distributed lag terms in the first summation of Equation (1) and (2), respectively. These are the focus of our hypotheses, $\mathbf{H_2}$ and $\mathbf{H_3}$, and are measured by $n\hat{F}_{2\sim1}$ and $n\hat{F}_{1\sim2}$.

The contemporaneous feedback results between the seven pairs of ESEA markets vis-à-vis the base countries of the US and Japan are reported in Tables 4.1 and 4.2, respectively. The results show that there are substantial co-movements across all seven ESEA markets with both the US and Japan markets within the 24-hour period in the 12-year sample period. Tabel 4.1 shows notably that Korea and Philippines exhibit increasing integration with the US markets since the early 1990s. In contrast, the inter-relationship between the Taiwan and US market has been rather erratic. Table 4.2 shows similar findings about the relationship of Korea and Philippines with Japan. In contrast the correlation between Malaysia and both US and Japan has dropped as compared to the late 80s and early 90s. This may be due to the capital controls imposed by the Malaysia government in recent years.

Tables 5.1 and 5.2 show the unidirectional feedback from the US and Japan markets, respectively, to the seven ESEA markets. From Table 5.1, it can be seen that US displays a significant lagged impact on the markets of Hong Kong, Malaysia, Philippines, Singapore and Thailand. Korea appears to be the market least influenced by the US market, especially before the late 90s. After the Asian financial crisis, however, the impact of the US market on that of Korea appears to have increased substantially. In contrast, the impacts of the Japan market on the seven ESEA markets are much weaker. Indeed, for Hong Kong, Singapore, Malaysia and Thailand, the feedback from Japan appears to be weakening towards the later sample period.

Tables 6.1 and 6.2 show the unidirectional feedback beyond one day from each of the other seven ESEA markets to the US and Japan. For the feedback on US only 11 of 91 feedback measures are statistically significant. Similarly, for the feedback on Japan only 10 of these measures are significant. As such results from these two tables indicate a tendency for the US and Japan to be more likely to lead the smaller markets than vice versa. Comparing our results to those of Bracker et al. (1999), where the same approach was applied to nine developed countries in the period of 1972−1993, we found that the Geweke measures are much larger in our analysis. Such findings might be the result of the intensified rate of integration of the ESEA markets over the sample period lending support to the growing popularity and importance of these economies.

5. Vector-autoregressive Analysis

We now proceed to analyze the daily market returns using the vector autoregression (VAR) model proposed by Sims (1980). This approach allows us to analyze the transmission of market movements across countries. VAR model is a non-structural approach used for forecasting systems of interrelated time series and for analyzing the dynamic impacts of random disturbances on the system of variables. It sidesteps the need for structural modeling by presenting every endogenous variable in the system as a function of the lagged values of all the endogenous variables in the system.

We concentrate on an indicator of capital-market integration by examining the speed of adjustment of stock returns in re-establishing the long-run equilibrium following a shock.

This is done by subjecting the system to an impulse response analysis. The greater the degree of capital mobility, the faster will be the adjustment to long-run equalization of stock market returns. Using this approach, we are able to address the question of whether there are any significant long-term linkages between the markets of the US, Japan and the other ESEA markets. In other words, besides being able to examine the degree of capital-market integration between the financial markets of the ESEA economies and the world financial markets, such as the US and Japan, this analysis also enables us to test and henceforth validate the proposition that markets in the region also exert significant influence on each other after taking into account the impacts of the US market's influence. A pre- and post-crisis analysis of the Asian financial crisis further helps to provide insights into whether there are any significant and persistent changes in the degree of market linkages across the ESEA economies thus addressing the question of the stability of these market linkages over time.

5.1 Methodology

The VAR model can be expressed in its standard form as

$$\boldsymbol{R_t} = \boldsymbol{C} + \sum_{k=1}^{p} \boldsymbol{A_k} \boldsymbol{R_{t-k}} + \boldsymbol{\varepsilon_t} \tag{9}$$

where $\boldsymbol{R_t}$ is the 9×1 column vector of daily returns on the market indices at time t, $\boldsymbol{C}$ is the 9×1 column vector of constant terms, $\boldsymbol{A_k}$ are 9×9 matrices of coefficients such that the (i, j)th component of $\boldsymbol{A_k}$ measures the effect of a change in the jth market on the ith market after k periods, $\boldsymbol{\varepsilon_t} = (\varepsilon_{1t}, ..., \varepsilon_{9t})'$ is an 9×1 column vector of innovations such that $\mathrm{E}(\varepsilon_{it}) = 0$, $\mathrm{E}(\varepsilon_{it}^2) = \sigma_i^2$, $\mathrm{E}(\varepsilon_{it}\varepsilon_{jt}) = \sigma_{ij}$ and $\mathrm{E}(\varepsilon_{is}\varepsilon_{jt}) = 0$ for $s \neq t$. Equation (9) assumes a return generating process where the return of each capital market is a function of a constant term, it's own lagged returns, the lagged returns of other variables in the system, plus an error term, ε_{it}, which is serially uncorrelated but can be contemporaneously correlated. In other words, the return of a market incorporates not only its own past information, but also the past information of other markets.

To analyze the dynamics of the system, the VAR model in Equation (9) can be transformed into a moving average representation expressed as

$$\boldsymbol{R_t} = \sum_{k=0}^{\infty} \boldsymbol{B_k} \boldsymbol{\varepsilon_{t\text{-}k}} \tag{10}$$

so that the return of a market is expressed in terms of its own past shocks plus the shocks from other markets. As mentioned earlier, the innovations in Equation (9) may be contemporaneously correlated such that the covariance matrix of innovations is not diagonal. Such contemporaneous correlation implies that a shock in one market may transmit to other markets through the innovations. It is customary to transform these correlations by orthogonalizing the innovations in the VAR system by Cholesky decomposition according to a pre-specified causal ordering so that the covariance matrix of the resulting innovations is diagonal.[3] The results of this approach are not, however, invariant to the ordering of the variables in the system. After the transformation, Equation (10) can be expressed as

$$\boldsymbol{R_t} = \sum_{k=0}^{\infty} \boldsymbol{C_k} \boldsymbol{\xi_{t\text{-}k}} \tag{11}$$

where the transformed innovations $\boldsymbol{\xi_t}$ are no longer contemporaneously correlated. Equation (11) now provides us with a convenient framework for tracing the dynamic responses to shocks in the system. The (i, j)th component of $\boldsymbol{C_k}$ now represents the impulse response of the ith market in the k periods after a shock of one standard deviation in the jth market. The issue of interest is to examine how long it takes for the impulse responses to decay following the shock. Theoretically, the impulse responses should converge to zero since the system is stationary. If the speed of convergence of one pair of the markets is faster than another pair, then it can be concluded that the first pair of markets are better integrated.

The VAR model also makes it possible to analyze the decomposition of forecast error variance thereby providing a measure of the overall relative importance of an individual market in generating variations in its own returns and in other market returns. Such method is known as variance decomposition and provides an alternative method of depicting the system dynamics. In other words, the effect that one market in the system exerts on itself and other markets over different time horizons can be measured by decomposing this forecast error variance.

We need to determine the appropriate lag structure of the VAR system. Since the main purpose of the VAR model is inference and hypothesis testing, it is important to avoid the model being under-parameterized. Henceforth, we adopt a fixed lag length of p = 15. This

[3] This essentially amounts to assuming that the first market in pre-specified ordering has an immediate impact on all markets in the VAR system. A shock in the second market in the system has an immediate impact on all markets, excluding the first market, and so on. In this paper, the markets are ordered based on their closing times during the day.

value is selected due to its overall better performance and to avoid potential problem of an unequal lag length model being under-parameterized.

5.2 Empirical Results

As mentioned earlier, the measure of contemporaneous correlations of the residual returns in the VAR system will provide us with some indications of how much a shock in one market will produce a residual return in another market, which is not predicted based on its own past returns. If there exists contemporaneous correlation between any two markets, one expects the information to be transmitted across the two markets during the same calendar day. Where the trading hours of the two markets do not overlap, one would expect the flow of information to move from the closing time of one market to the opening hours of the other. Table 7 reports the contemporaneous correlations of the residuals for all the markets included in the system. To investigate the stability of these correlations we include the sub-sample analysis, namely, pre- (1988 to end 1996) and post- (mid 1998 to 2000) crisis of 1997.

The results indicate that during the full sample period of 1988–2000, while there are significant correlations between the US and the ESEA markets, there exist even more intense correlations between Japan and the ESEA markets. This result is consistent with the fact that overlapping trading hours of the latter group contributes to a stronger correlation. In addition, the correlation between Singapore and Malaysia appears to be dominant, which can be attributed to their geographic proximity and economic closeness. A comparison between the pre- and post-crisis sub-samples indicates that while the correlation between the US and the ESEA markets (except Malaysia and Thailand) has increased after the outbreak of the Asian financial crisis, that increase is even more prominent with respect to Japan. The results show that within the ESEA region itself there is a substantial increase in the extent of capital-market integration as indicated by the increased correlation in the post-crisis era.

We now move on to examine the variance decomposition of the innovations in these markets. As was mentioned earlier, the forecast variances of each stock market can be attributed to different sources using orthogonalized innovations. The orthogonalization procedure allows us to decompose the forecast error variances into its components that are accounted for by innovations in each of the nine markets in the VAR system. Table 8 shows the results of the innovation accounting procedure. While we have examined forecast horizons of 5, 10 and 15 days, to save space only the results for the 10-day forecast are reported. We present the results for the full sample period as well as the pre- and post-crisis periods. Entries in the "All Foreign" column denote the total percentage forecast error variance of the market in each market explained by all other foreign markets. Once again we order the markets by their respective closing times.

From Table 8 we can see that the US influences all the other markets. Based on the full period, the US accounts for between 3 (for Taiwan) to 14 (for Singapore) percent of the forecast-error variance of these markets. The US exerts its greatest influence on Singapore, followed by Japan. In comparison Japan's influence appears to be weaker than that of the US, accounting for about 1 (for Philippines) to 5.3 (for Singapore) percent of the error variance in the full sample. Once again, Japan's impact is felt most strongly in Singapore. Considering the Asian markets, Malaysia is the most "exogenous" market, with almost one-third of its forecast-error variance explained by all foreign markets combined in the full sample, followed by Singapore and Thailand.

Comparison across the two sub-sample periods provides us with deeper insight into the system dynamics. We can see that in the post-crisis era, there has been significant increase in the influence of both the US and Japan on all the ESEA markets, with the exception of Malaysia. Such finding is highly attributable to the fact that Malaysia's imposition of capital control in September 1998 in their attempt to curb speculative attacks has been relatively successful in shutting out foreign influences. Other evidence that supports this view is the fall in the total percentage forecast-error variances of the Malaysian market by all foreign markets. This is in stark contrast to the increasing extent of "exogeneity" for the remaining markets. While Thailand has overtaken Malaysia as the most "exogenous" market, Korea experienced the most drastic increase in total foreign influence thereby indicating improved integration. Another point that deserves noting is that prior to the crisis, geographically and economically close countries like Singapore and Malaysia exert significant influence over each other. Singapore accounted for about 28 percent of the forecast-error variance in Malaysia. On the other hand, Malaysia accounted for less than 0.5 percent of the forecast-error variance of Singapore.

We now further investigate the speed of the transmission of information across the ESEM markets. This analysis can be carried out by examining the pattern of the dynamic impulse response of the stock returns to shocks in other markets. Such an approach allows us to address the issues relating to the change in the degree of capital market integration in the post-crisis era, and whether Japan has increased its domination in the region. The faster the speed of adjustment, the greater the extent of capital market integration. Figures 2.1 to 2.4 summarize the results.

In general, the figures show that the national stock markets of the ESEM region respond to shocks in both the US and Japan stock markets. This result is similar to that of Eun and Shim (1989) in that the impulse response to a unit shock in the US market takes a delayed effect for the impact to be felt in the ESEM economies. While it is clearly evident from the figures that there is a significant increase in the sensitivity of these impulse responses to both the shocks in the US and Japan during the post-crisis era, the magnitude of these responses continues to be stronger for the US shock. This finding suggests that though these markets have indeed become more integrated over time (especially so since the Asian financial crisis), the US economy still remains as the dominant force in the region. Results from the impulse response analysis also show that the geographically and economically close markets of Singapore and Malaysia affect each other strongly.

6. Conclusions

In this paper we have examined the capital-market integration in the East and South-East Asian economies. Our main concern is to see whether there has been any significant increase in the degree of capital-market integration with the world’s two largest economies, namely the US and Japan. Attempts have also been made to identify whether the degree of capital-market integration of the ESEA economies with respect to Japan has overtaken that with respect to the US. We further investigate the magnitude and changing nature of the return spillovers from Japan and the US to the ESEA markets

The results from the Geweke measure provide supportive evidence of increasing degree of capital-market integration of the ESEA economies. The estimated Geweke measure indicates significant inter-market responses across all markets, most of which are completed within twenty-four hours. The results also show a stronger co-movement of the stock returns of the ESEA economies with respect to Japan, suggesting a growing dominance of the regional force. From the variance decomposition of the VAR model we have found additional evidence in support of the increasing extent of integration of the ESEM markets. Fianlly, the results from the impulse response functions provide evidence of strong responses of these markets to the US.

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TABLE 1: SUMMARY STATISTICS FOR DAILY EQUITY MARKET RETURNS[a]

	Hong Kong	Japan	Korea	Malaysia	Philippines	Singapore	Taiwan	Thailand	US
Mean	0.0005	-0.0001	0.0001	0.0002	0.0003	0.0003	0.0003	0.0000	0.0005
Median	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003
Maximum	0.1046	0.0735	0.1145	0.1035	0.0882	0.0745	0.1265	0.1185	0.0486
Minimum	-0.1046	-0.0724	-0.1192	-0.1035	-0.0882	-0.0745	-0.1031	-0.1083	-0.0553
Std. Dev.	0.0167	0.0122	0.0205	0.0158	0.0145	0.0122	0.0211	0.0197	0.0091
Skewness	-0.3181	0.2638	0.2640	0.2377	0.1258	-0.1253	0.0132	0.3641	-0.2583
Kurtosis	9.6428	7.4651	7.0346	12.2157	7.9738	9.2057	5.5566	8.2257	7.0244
Jarque-Bera	6251.178	2837.782	2324.108	11953.690	3481.617	5414.731	917.609	3907.754	2310.969
***p*-value**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ljung-Box(6)	33.795	42.969	19.012	68.355	161.310	90.273	22.976	75.294	19.453
***p*-value**	0.0000	0.0000	0.0040	0.0000	0.0000	0.0000	0.0010	0.0000	0.0030
Ljung-Box^2(6)	979.70	429.58	788.65	1734.4	291.72	766.16	1058.8	682.2	281.14
***p*-value**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	3369	3369	3369	3369	3369	3369	3369	3369	3369

[a] All daily equity market returns are calculated in local currencies.

Ljung-Box(6) and Ljung-Box^2(6) are the Ljung-Box statistic for returns and squared returns with six lags, respectively.

TABLE 2: CORRELATION MATRIX BETWEEN DAILY MARKET RETURNS IN LOCAL CURRENCY TERMS

	Hong Kong	Japan	Korea	Malaysia	Philippines	Singapore	Taiwan	Thailand	US	US(-1)[a]
Hong Kong	1									
Japan	0.2955	1								
Korea	0.1839	0.1503	1							
Malaysia	0.3980	0.2510	0.1649	1						
Philippines	0.2789	0.1359	0.1260	0.2238	1					
Singapore	0.5359	0.3231	0.2105	0.5442	0.3282	1				
Taiwan	0.1617	0.1477	0.1096	0.1519	0.1341	0.1941	1			
Thailand	0.3488	0.2049	0.2276	0.3595	0.2708	0.4205	0.1582	1		
US	0.0987	0.1080	0.0713	0.0406	0.0593	0.1120	0.0247	0.0637	1	
US(-1)	0.3361	0.2776	0.1880	0.2894	0.2412	0.3673	0.1610	0.2477	0.0190	1

[a] Corresponds to the one-day lagged return in the US market.

TABLE 3: PAIRWISE GRANGER CAUSALITY TESTS[a]

	Hong Kong	Japan	Korea	Malaysia	Philippines	Singapore	Taiwan	Thailand
Japan	0.0104							
	0.7826							
Korea	0.0019	0.2051						
	0.0001	0.0050						
Malaysia	0.0588	0.8731	0.0585					
	0.0000	0.4336	0.0069					
Philippines	0.0785	0.8362	0.9233	0.1447				
	0.0000	0.0004	0.0002	0.0000				
Singapore	0.0016	0.2518	0.0000	0.0137	0.0000			
	0.0000	0.6662	0.3103	0.0171	0.1736			
Taiwan	0.8656	0.7058	0.1089	0.1520	0.0182	0.0062		
	0.0001	0.0061	0.0193	0.0000	0.0973	0.0000		
Thailand	0.0034	0.7195	0.0004	0.0299	0.0000	0.0203	0.0005	
	0.0000	0.0023	0.0000	0.0018	0.0821	0.0000	0.1388	
US	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.3353	0.3237	0.6843	0.6004	0.4006	0.8870	0.0377	0.0831
US(-1)	0.7522	0.9383	0.3045	0.7387	0.1723	0.0051	0.2313	0.1584
	0.0000	0.0000	0.0018	0.1822	0.0008	0.0000	0.0157	0.0003

[a]Granger-causality test with the null hypothesis that each pair of countries do not Granger-cause one another. For each pair of countries, the first cell tests the null hypothesis that the row does not Granger-cause the column, while the second cell tests the null hypothesis that the column does not Granger-cause the row. All values reported in the table are the *p*-values. The tests are based on regressions with five lags.

Table 4.1: CONTEMPORANEOUS FEEDBACK BETWEEN US AND THE ESEA MARKETS

Obs.	Year	Hong Kong	Korea	Malaysia	Philippines	Singapore	Taiwan	Thailand
260	1988	* 82.498	* 4.802	* 90.874	* 16.783	* 92.351	* 21.959	* 39.803
260	1989	* 22.808	* 10.999	* 77.703	* 25.122	* 64.187	* 13.869	* 30.927
261	1990	* 62.933	* 28.372	* 86.553	* 26.693	* 95.862	* 16.189	* 70.551
261	1991	* 38.538	* 17.281	* 47.948	* 50.350	* 62.490	* 21.297	* 43.948
262	1992	* 15.510	* 10.130	* 22.013	* 17.627	* 19.725	* 15.564	* 21.832
261	1993	* 15.967	* 17.876	* 8.839	* 11.772	* 12.549	* 14.295	* 24.018
260	1994	* 80.652	* 17.165	* 33.707	* 15.644	* 57.317	* 18.853	* 55.191
260	1995	* 50.422	* 20.256	* 26.959	* 19.961	* 35.983	* 12.480	* 32.738
262	1996	* 108.852	* 13.032	* 39.314	* 23.492	* 29.314	* 2.681	* 10.143
261	1997	* 65.455	* 17.444	* 18.250	* 43.340	* 74.328	* 31.764	* 20.302
261	1998	* 36.054	* 24.394	* 33.962	* 39.477	* 41.987	* 42.413	* 23.840
261	1999	* 59.583	* 28.818	* 26.893	* 43.095	* 32.057	* 8.828	* 26.275
239	2000	* 67.858	* 69.299	* 21.864	* 40.095	* 47.421	* 35.121	* 33.368

This table reports the annual contemporaneous Geweke measures of feedback between the US and the seven ESEA markets in the study, from 1988-2000. The statistics measure the extent of a relationship between daily returns in each pair of markets on the same day. The larger the measure the greater is the extent of a contemporaneous relationship. Each statistic has an approximate asymptotic chi-square distribution with 1 df under the null hypothesis of no contemporaneous relationship between $R_{us,t}$ and $R_{j,t}$; j represents one of the seven ESEA markets. An asterisk means significance at the 5% level.

Table 4.2: CONTEMPORANEOUS FEEDBACK BETWEEN JAPAN AND THE ESEA MARKETS

Obs.	Year	Hong Kong	Korea	Malaysia	Philippines	Singapore	Taiwan	Thailand
260	1988	* 67.82476	* 11.001	* 25.639	* 28.214	* 38.710	* 17.724	* 35.581
260	1989	* 27.47550	* 14.049	* 27.861	* 10.291	* 23.270	* 5.851	* 7.868
261	1990	* 94.02129	* 17.040	* 121.445	* 33.135	* 130.260	* 16.069	* 49.384
261	1991	* 84.25882	* 33.835	* 85.434	* 14.000	* 96.732	* 37.444	* 42.965
262	1992	* 17.68796	* 18.430	* 45.265	* 12.772	* 37.506	* 10.625	* 18.305
261	1993	* 11.58655	* 12.497	* 12.316	* 16.959	* 11.213	* 10.013	* 15.732
260	1994	* 17.50759	* 22.794	* 34.780	* 17.589	* 31.344	* 17.841	* 17.464
260	1995	* 43.96941	* 15.488	* 26.949	* 19.800	* 46.238	* 20.496	* 23.393
262	1996	* 51.57392	* 17.178	* 41.595	* 13.239	* 26.136	* 11.177	* 21.880
261	1997	* 50.59354	* 25.626	* 9.606	* 11.051	* 44.393	* 14.713	* 14.212
261	1998	* 36.39486	* 34.189	* 51.462	* 32.738	* 44.096	* 15.802	* 32.136
261	1999	* 46.06957	* 23.068	* 16.997	* 22.794	* 38.668	* 22.644	* 28.773
239	2000	* 51.47432	* 73.324	* 20.689	* 33.043	* 34.309	* 25.312	* 36.129

This table reports the annual contemporaneous Geweke measures of feedback between Japan and one of the other seven ESEA markets in the study, from 1988-2000. The statistics measure the extent of a relationship between daily returns in each pair of markets on the same day. The larger the measure the greater is the extent of a contemporaneous relationship. Each statistic has an approximate asymptotic chi-square distribution with 1 df under the null hypothesis of no contemporaneous relationship between $R_{Jap,t}$ and $R_{j,t}$; j represents one of the seven ESEA markets. An asterisk means significance at the 5% level.

TABLE 5.1: UNIDIRECTIONAL FEEDBACK FROM US TO THE ESEA MARKETS

Obs.	Year	Hong Kong	Korea	Malaysia	Philippines	Singapore	Taiwan	Thailand
260	1988	* 72.329	1.323	* 85.907	5.197	* 80.230	* 15.033	* 36.097
260	1989	* 17.341	4.685	* 69.914	* 16.627	* 58.766	7.520	* 25.671
261	1990	* 49.453	* 15.723	* 55.058	* 22.226	* 58.240	* 13.369	* 58.747
261	1991	* 19.834	8.518	* 27.260	* 34.673	* 44.970	* 12.711	* 28.923
262	1992	* 13.836	2.832	* 15.756	6.469	* 16.319	9.248	3.752
261	1993	9.248	8.031	6.876	4.661	4.569	3.164	10.180
260	1994	* 77.853	7.124	* 24.521	10.332	* 49.790	* 16.637	* 47.676
260	1995	* 40.936	8.126	* 21.435	9.370	* 23.632	5.279	* 26.285
262	1996	* 102.836	6.987	* 33.134	* 13.240	* 27.209	0.000	4.665
261	1997	* 24.581	8.214	* 15.791	* 30.848	* 62.159	* 24.174	* 16.227
261	1998	* 16.343	* 17.991	* 32.104	* 23.335	* 28.263	* 26.179	* 15.855
261	1999	* 50.616	* 26.468	* 13.031	* 29.233	* 23.680	5.003	* 19.106
239	2000	* 62.260	* 61.356	* 16.585	* 35.211	* 41.778	* 20.505	* 27.326

This table reports the annual unidirectional Geweke measure of feedback from the US to each of the seven ESEA markets, for 1988-2000. The statistics measure the extent of a relationship from the US daily returns to one of the seven markets at least 1 day later. The larger the measure, the greater is the extent of a unidirectional relationship. Each statistic has an approximate asymptotic chi-square distribution with 5 df under the null hypothesis that $R_{us,t}$ does not lead $R_{j.t}$ across days; j represents one of the seven ESEA markets. An asterisk denotes significance at the 5% level.

TABLE 5.2: UNIDIRECTIONAL FEEDBACK FROM JAPAN TO THE ESEA MARKETS

Obs.	Year	Hong Kong	Korea	Malaysia	Philippines	Singapore	Taiwan	Thailand
260	1988	* 12.65926	5.334	7.237	* 14.310	2.268	3.529	* 16.566
260	1989	* 13.94397	7.059	* 12.209	9.370	7.273	3.444	2.232
261	1990	* 11.14588	8.157	4.848	* 19.916	1.746	1.721	* 14.027
261	1991	1.00177	2.406	8.774	1.252	7.621	* 11.268	10.237
262	1992	7.88897	* 15.224	* 13.064	4.295	5.758	3.047	7.558
261	1993	5.72108	6.405	8.489	9.406	9.220	7.982	* 11.667
260	1994	4.02487	* 16.312	* 16.088	3.399	* 13.139	5.428	8.299
260	1995	* 11.71261	8.126	3.768	6.996	1.332	10.668	5.049
262	1996	* 13.35015	3.470	* 24.322	9.295	* 13.251	3.235	* 12.629
261	1997	2.21370	* 12.892	6.726	0.857	3.480	7.123	4.476
261	1998	2.80994	9.425	9.850	* 12.906	2.069	3.269	4.323
261	1999	4.48678	4.689	0.849	5.238	4.026	3.325	7.475
239	2000	9.35706	* 11.966	1.339	1.643	3.406	* 17.045	4.853

This table reports the annual unidirectional Geweke measure of feedback from Japan to each of the other seven ESEA markets, for 1988-2000. The statistics measure the extent of a relationship from the Japan daily returns to the other seven markets at least 1 day later. The larger the measure, the greater is the extent extent of a unidirectional relationship. Each statistic has an approximate asymptotic chi-square distribution with 5 df under the null hypothesis that $R_{Jap,t}$ does not lead $R_{j.t}$ across days; j represents one of the seven ESEA markets. An asterisk denotes significance at the 5% level.

TABLE 6.1: UNIDIRECTIONAL FEEDBACK FROM THE ESEA MARKETS TO THE US

Obs.	Year	Hong Kong	Korea	Malaysia	Philippines	Singapore	Taiwan	Thailand
260	1988	2.679	3.440	4.702	* 11.430	4.702	6.925	3.125
260	1989	5.390	5.192	4.319	8.268	5.192	5.629	4.319
261	1990	2.588	7.738	3.246	4.436	6.533	1.766	6.232
261	1991	9.163	0.698	* 11.760	1.748	5.992	7.781	4.570
262	1992	1.632	7.114	5.516	9.528	3.138	6.314	* 17.742
261	1993	5.372	8.949	1.962	6.934	7.940	4.934	* 12.002
260	1994	2.639	8.137	3.667	5.149	2.930	2.194	5.149
260	1995	5.639	* 11.767	4.643	1.153	9.370	4.643	4.643
262	1996	5.678	2.096	4.209	6.339	2.096	2.623	3.150
261	1997	* 37.718	4.925	2.451	* 12.490	9.944	4.925	2.451
261	1998	1.596	3.729	1.858	5.613	3.729	* 13.290	3.729
261	1999	8.429	2.260	* 13.862	* 13.862	6.839	2.260	6.839
239	2000	5.358	4.467	4.467	4.467	2.969	* 12.104	5.975

This table reports the annual unidirectional Geweke measure of feedback to the US from each of the seven ESEA markets, for 1988-2000. The statistics measure the extent of an impact on the US daily returns from each of the seven ESEA markets at least 1 day later. The larger the measure, the greater is the extent of a unidirectional relationship. Each statistic has an approximate chi-square distribution with 5 df under the null hypothesis that $R_{j.t}$ does not lead $R_{us,t}$ across days; j represents one of the seven ESEA markets. An asterisk denotes significance at the 5% level.

TABLE 6.2: UNIDIRECTIONAL FEEDBACK FROM THE ESEA MARKETS TO JAPAN

Obs.	Year	Hong Kong	Korea	Malaysia	Philippines	Singapore	Taiwan	Thailand
260	1988	* 16.489	5.272	4.788	9.667	8.193	5.272	5.272
260	1989	6.712	5.425	9.370	0.768	10.167	2.311	5.425
261	1990	8.938	6.908	10.939	0.976	* 23.419	0.976	1.955
261	1991	8.380	10.922	4.314	6.498	2.148	* 13.162	* 13.162
262	1992	5.529	1.172	7.114	7.114	10.744	4.721	10.744
261	1993	3.967	5.534	3.676	7.405	1.832	1.832	3.676
260	1994	4.600	6.479	* 13.124	11.007	* 11.711	* 11.711	8.907
260	1995	4.129	5.632	5.632	1.864	9.456	1.864	0.000
262	1996	2.094	* 13.153	0.494	1.981	2.479	7.508	0.494
261	1997	* 12.910	* 12.072	0.000	0.000	2.966	4.462	9.001
261	1998	3.333	5.300	3.965	5.300	2.636	6.642	3.965
261	1999	1.667	0.000	7.621	1.884	3.783	3.783	3.783
239	2000	5.154	1.738	5.253	7.030	3.489	0.000	3.489

This table reports the annual unidirectional Geweke measure of feedback to Japan from each of the other seven ESEA markets, for 1988-2000. The statistics measure the extent of an impact on the Japan daily returns from each of the other seven ESEA markets at least 1 day later. The larger the measure, the greater is the extent of a unidirectional relationship. Each statistic has an approximate chi-square distribution with 5 df under the null hypothesis that $R_{j,t}$ does not lead $R_{Jap,t}$ across days; *j* represents one of the other seven ESEA markets. An asterisk denotes significance at the 5% level.

TABLE 7: RESIDUAL-CORRELATION MATRIX OF THE VAR MODEL

Panel A: 1988-2000

	US	Japan	Philippines	Taiwan	Korea	Hong Kong	Singapore	Malaysia	Thailand
US	1								
Japan	0.1013	1							
Philippines	0.0714	0.0758	1						
Taiwan	0.0157	0.1066	0.0759	1					
Korea	0.0637	0.1100	0.0712	0.0719	1				
Hong Kong	0.0990	0.2310	0.2110	0.1117	0.1288	1			
Singapore	0.1182	0.2543	0.2416	0.1305	0.1502	0.4661	1		
Malaysia	0.0315	0.1949	0.1441	0.1008	0.1090	0.3374	0.4864	1	
Thailand	0.0655	0.1484	0.1898	0.1002	0.1887	0.2872	0.3380	0.2947	1

Panel B: 1988-1996 (Pre-Crisis)

	US	Japan	Philippines	Taiwan	Korea	Hong Kong	Singapore	Malaysia	Thailand
US	1								
Japan	0.1305	1							
Philippines	0.0615	0.0544	1						
Taiwan	0.0160	0.1097	0.0647	1					
Korea	0.0556	0.0421	0.0335	0.0643	1				
Hong Kong	0.0812	0.1999	0.1489	0.0881	0.0503	1			
Singapore	0.1229	0.2803	0.1868	0.1230	0.1153	0.4217	1		
Malaysia	0.0858	0.2289	0.1666	0.0858	0.0862	0.3919	0.6988	1	
Thailand	0.0802	0.1332	0.1405	0.0938	0.1374	0.2407	0.3120	0.2977	1

Panel C: 1998-2000 (Post-Crisis)

	US	Japan	Philippines	Taiwan	Korea	Hong Kong	Singapore	Malaysia	Thailand
US	1								
Japan	0.0846	1							
Philippines	0.1072	0.1308	1						
Taiwan	0.0628	0.1033	0.1426	1					
Korea	0.0667	0.2412	0.1261	0.1480	1				
Hong Kong	0.0872	0.2338	0.2246	0.1574	0.3065	1			
Singapore	0.1177	0.2271	0.2199	0.1472	0.2588	0.4690	1		
Malaysia	-0.0559	0.1562	0.0906	0.1084	0.1194	0.1851	0.1987	1	
Thailand	0.0367	0.2077	0.2770	0.1378	0.2983	0.3905	0.3870	0.2088	1

[a]Represents the contemporaneous correlation of the residuals of the VAR model between pairs of markets.

TABLE 8: DECOMPOSITION OF FORECAST ERROR VARIANCES[a]

Market	Period	US	Japan	Philippines	Taiwan	Korea	Hong Kong	Singapore	Malaysia	Thailand	All Foreign
US	**Full**	97.3510	0.2562	0.4877	0.3417	0.1566	0.3223	0.5870	0.1803	0.3173	2.6490
	Pre-crisis	96.5647	0.2435	0.4418	0.8510	0.3142	0.4951	0.3314	0.5726	0.1856	3.4353
	Post-crisis	86.2798	1.2946	1.5237	2.5778	1.5699	1.5169	2.3823	1.0059	1.8492	13.7202
JAPAN	**Full**	8.7027	89.1679	0.4500	0.2018	0.4302	0.1284	0.2044	0.3635	0.3511	10.8321
	Pre-crisis	6.2385	90.3014	0.5780	0.6118	0.6484	0.2416	0.4226	0.3676	0.5901	9.6986
	Post-crisis	17.1351	74.7908	1.4519	1.0866	0.8096	1.8684	0.2922	1.5885	0.9769	25.2092
Philippines	**Full**	6.5058	1.0990	87.2178	0.8198	0.6202	1.5081	0.5385	0.8030	0.8879	12.7822
	Pre-crisis	4.6011	0.8969	88.8288	1.0112	0.2285	2.4197	0.3065	1.2994	0.4079	11.1712
	Post-crisis	9.6506	2.6072	74.6350	2.5486	2.2166	2.1233	2.0043	2.5737	1.6407	25.3650
Taiwan	**Full**	2.9907	1.5659	0.9078	92.4094	0.4047	0.3888	0.7543	0.3974	0.1810	7.5906
	Pre-crisis	2.3921	1.7633	0.9697	92.3471	0.7012	0.3599	0.9017	0.2527	0.3124	7.6529
	Post-crisis	5.1374	3.1039	2.2482	81.7362	1.9072	1.5776	2.0248	1.8453	0.4195	18.2638
Korea	**Full**	4.2744	1.4070	0.4265	0.7875	90.8606	0.9482	0.5044	0.3727	0.4186	9.1394
	Pre-crisis	1.1459	1.1324	0.5904	0.6391	95.2431	0.3179	0.2809	0.4880	0.1624	4.7569
	Post-crisis	11.8710	4.7267	1.5810	2.2596	70.2934	1.4484	2.5425	2.6859	2.5915	29.7066
Hong Kong	**Full**	11.8006	4.6884	3.4664	0.5998	1.1467	77.1300	0.4319	0.2903	0.4458	22.8700
	Pre-crisis	9.4321	3.9320	2.3328	0.7770	0.7947	81.7945	0.4568	0.1553	0.3249	18.2055
	Post-crisis	14.0964	5.1916	4.4504	2.5052	5.4188	65.3088	0.5435	0.7526	1.7327	34.6912
Singapore	**Full**	13.9206	5.3332	4.3149	1.0066	1.0352	12.0092	61.2917	0.6159	0.4726	38.7083
	Pre-crisis	13.1415	6.0726	3.1219	1.3018	1.0263	10.5794	63.9339	0.3546	0.4680	36.0661
	Post-crisis	14.3550	5.6840	4.5020	2.9848	3.2082	10.2314	54.7956	2.2041	2.0349	45.2044
Malaysia	**Full**	8.0597	3.3491	1.7702	0.6936	1.0504	7.3888	11.1634	66.2539	0.2709	33.7461
	Pre-crisis	10.3657	4.3560	2.7803	0.9719	0.6835	10.1633	28.1141	42.1693	0.3959	57.8307
	Post-crisis	9.5267	3.6190	1.9969	2.2285	2.2042	4.0113	3.0313	72.1015	1.2805	27.8985
Thailand	**Full**	6.3835	2.4009	3.1296	0.6852	2.8308	4.6273	4.6350	1.7814	73.5262	26.4738
	Pre-crisis	6.7748	2.0062	2.4190	1.0892	1.6368	4.7836	5.0888	0.9871	75.2145	24.7855
	Post-crisis	6.9302	5.4006	6.8830	2.3260	4.4903	6.1444	5.5518	2.9335	59.3401	40.6599

[a] The markets are ordered by closing time: US, Japan, Philippines, Taiwan, Korea, Hong Kong, Singapore, Malaysia and Thailand. The forecast horizon is ten days.

Figure 1.1: Stock price index and return of Hong Kong, Japan and Korea

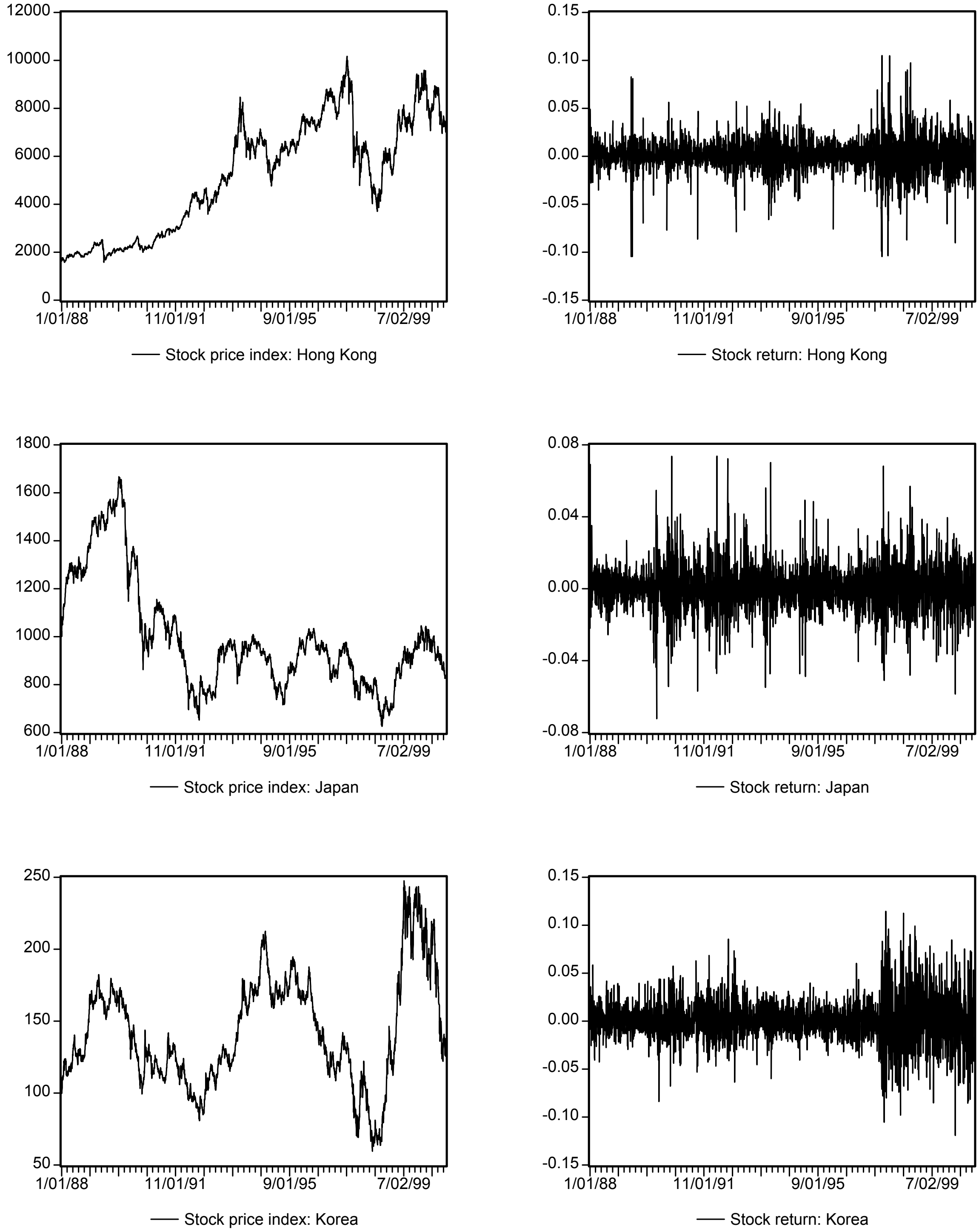

Figure 1.2: Stock price index and return of Malaysia, Phillippines and Singapore

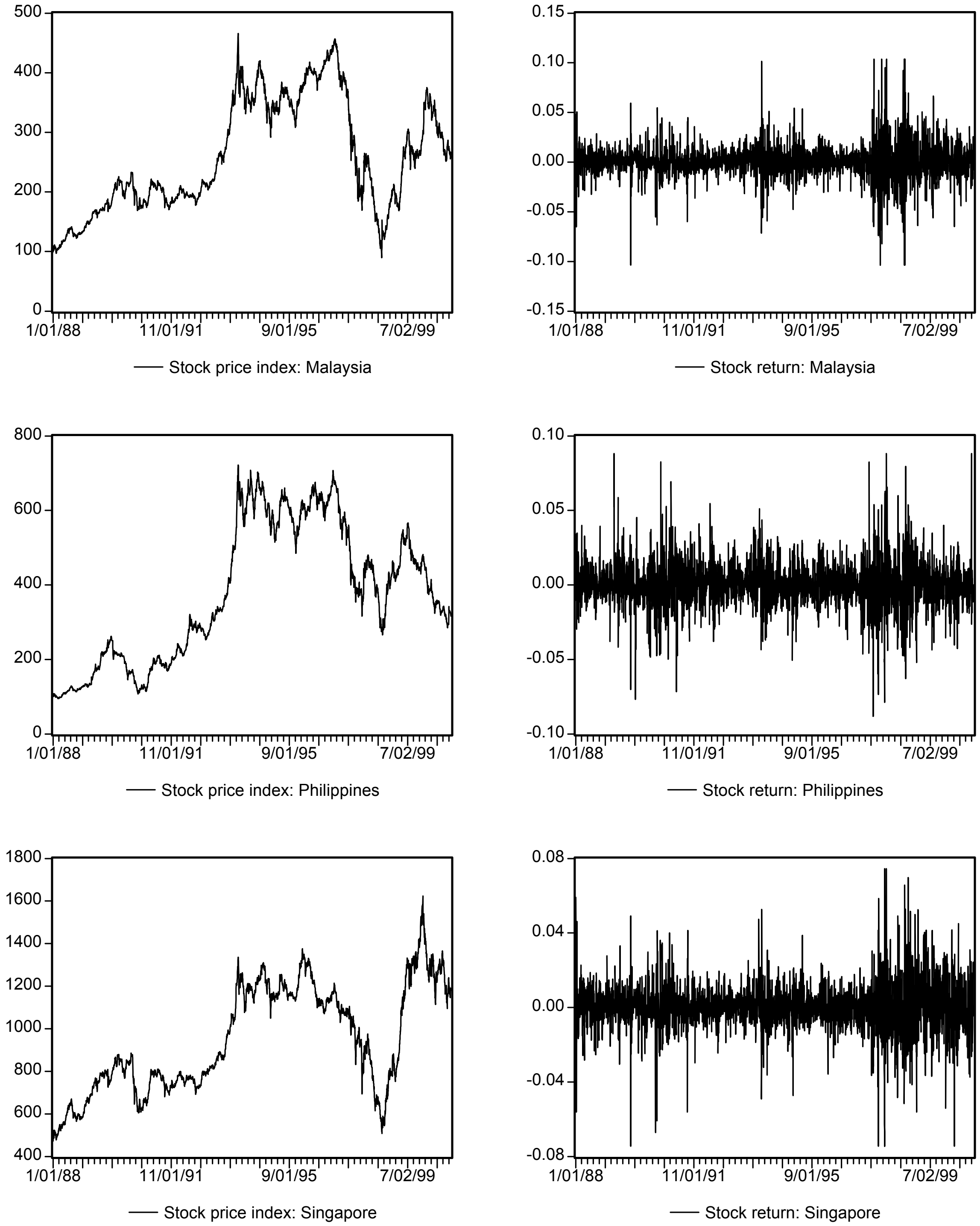

Figure 1.3: Stock price index and return of Taiwan, Thailand and US

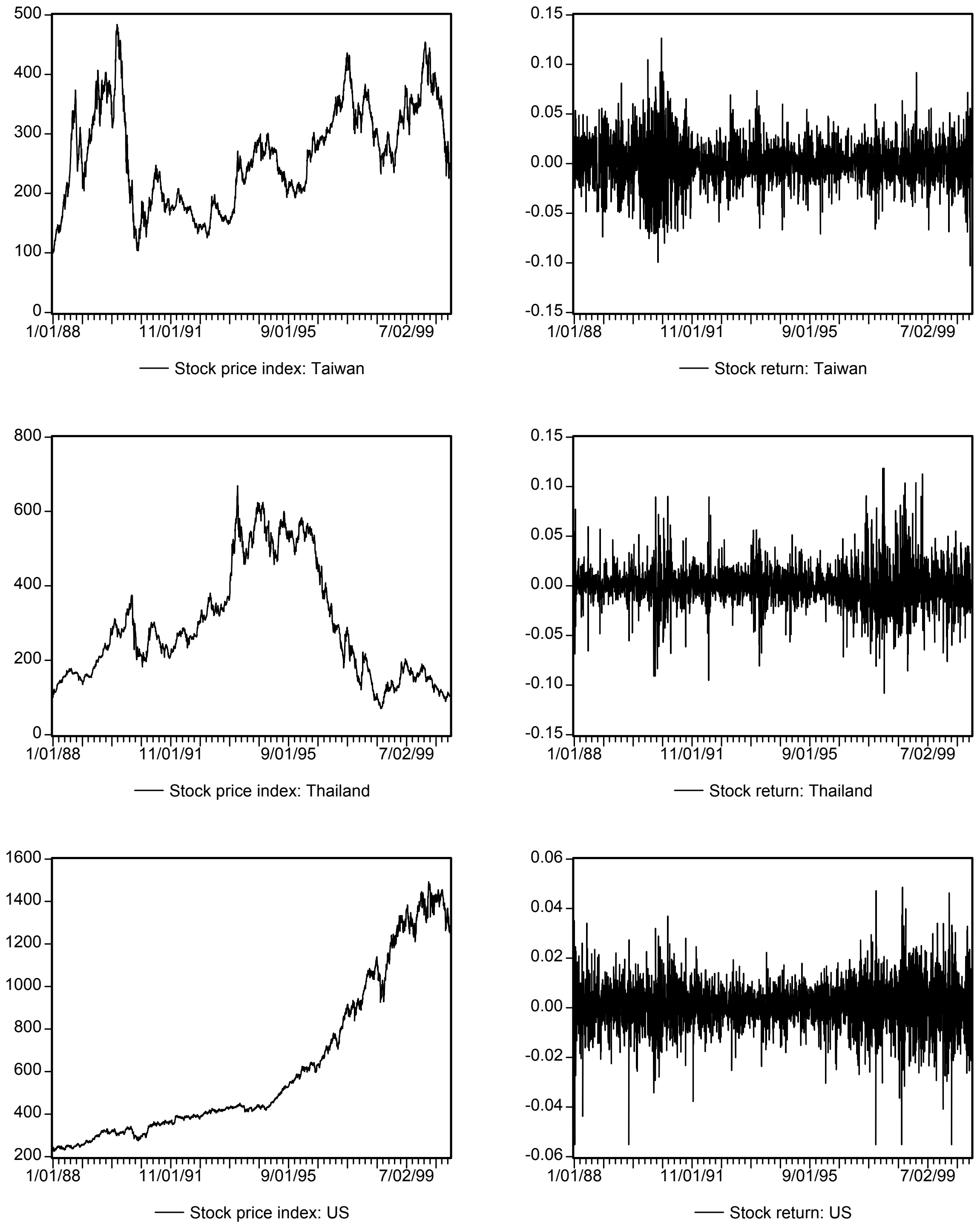

Figure 2.1: Impulse response functions of the Hong Kong and Korea markets

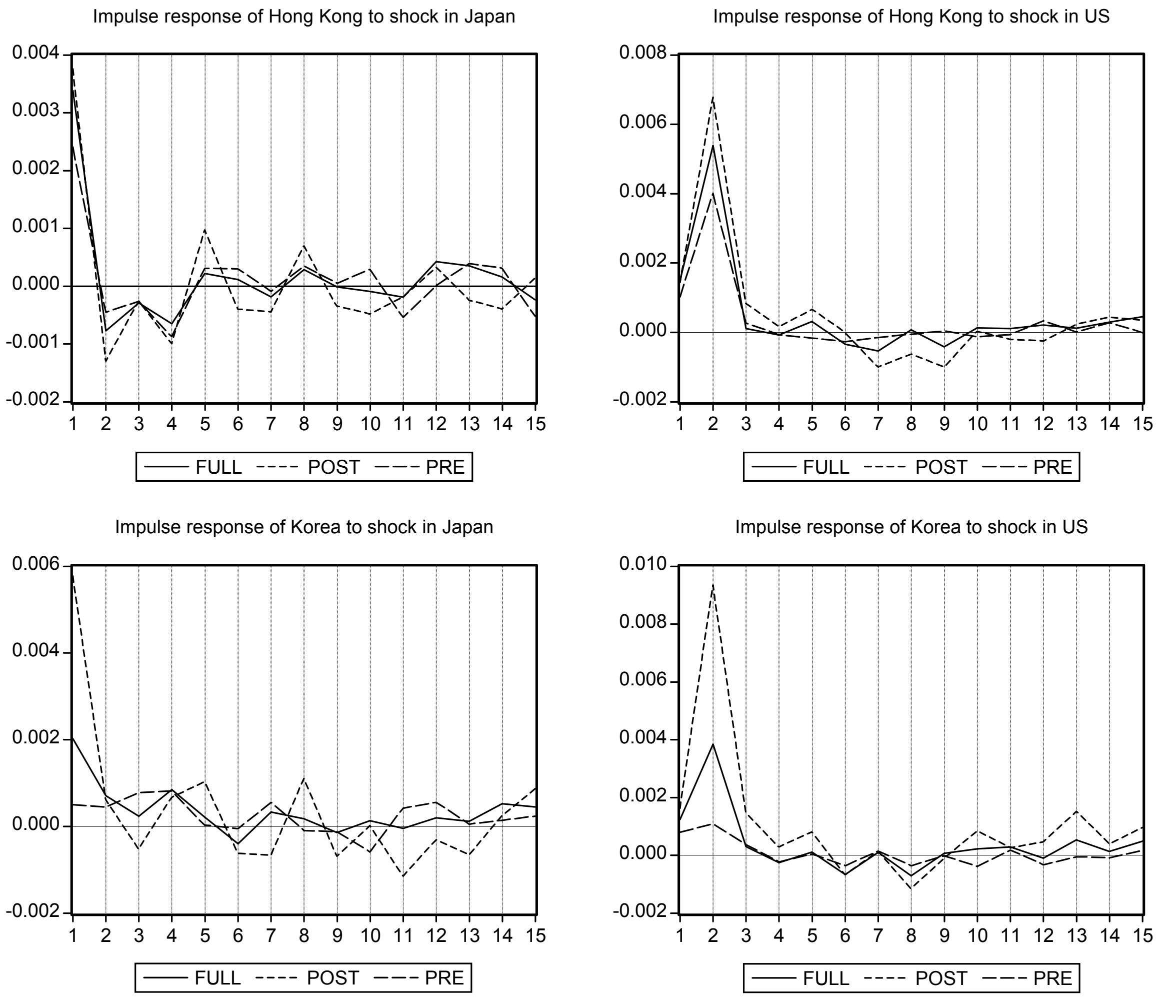

Figure 2.2: Impule response functions of the Malaysia and Philippines markets

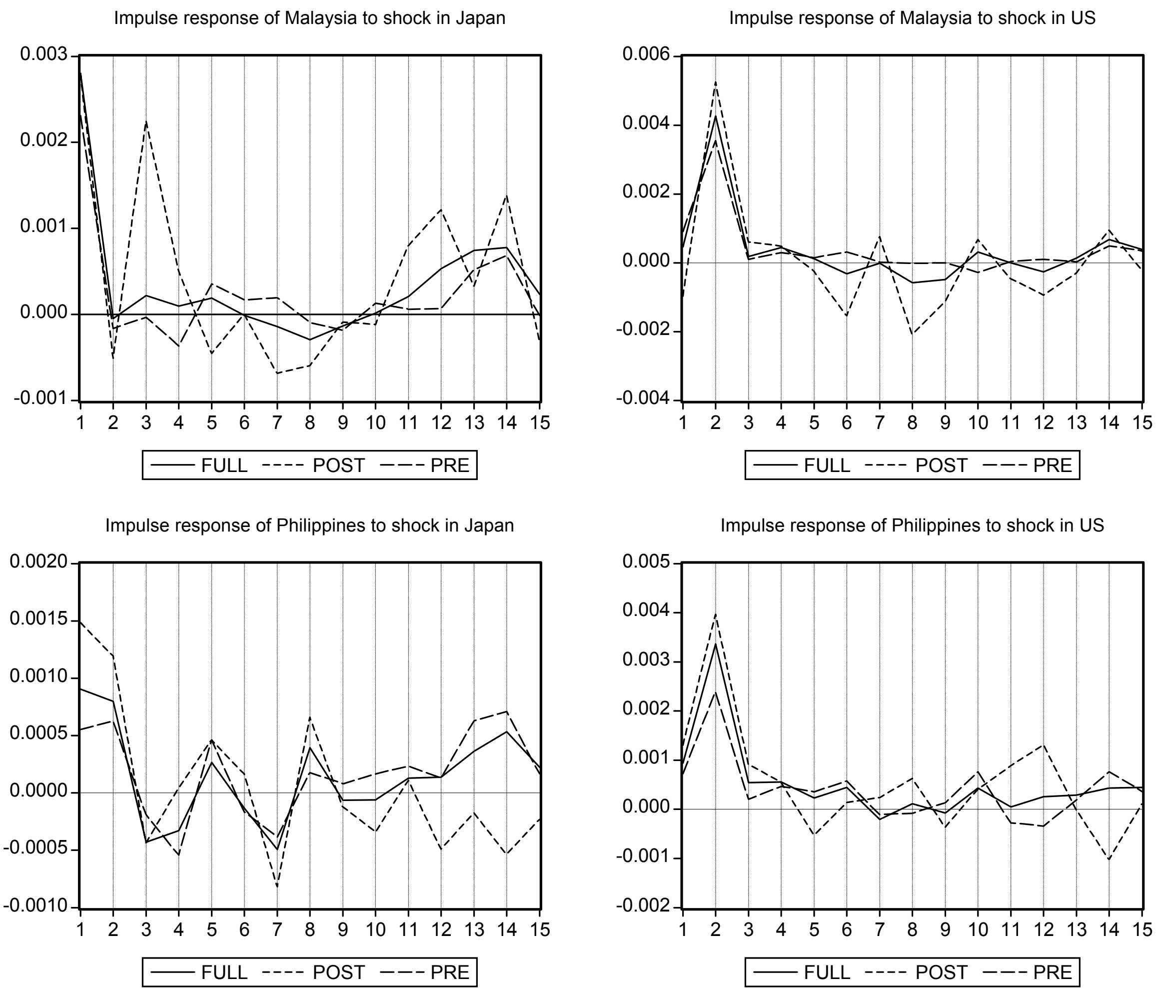

Figure 2.3: Impulse response functions of the Singapore and Taiwan markets

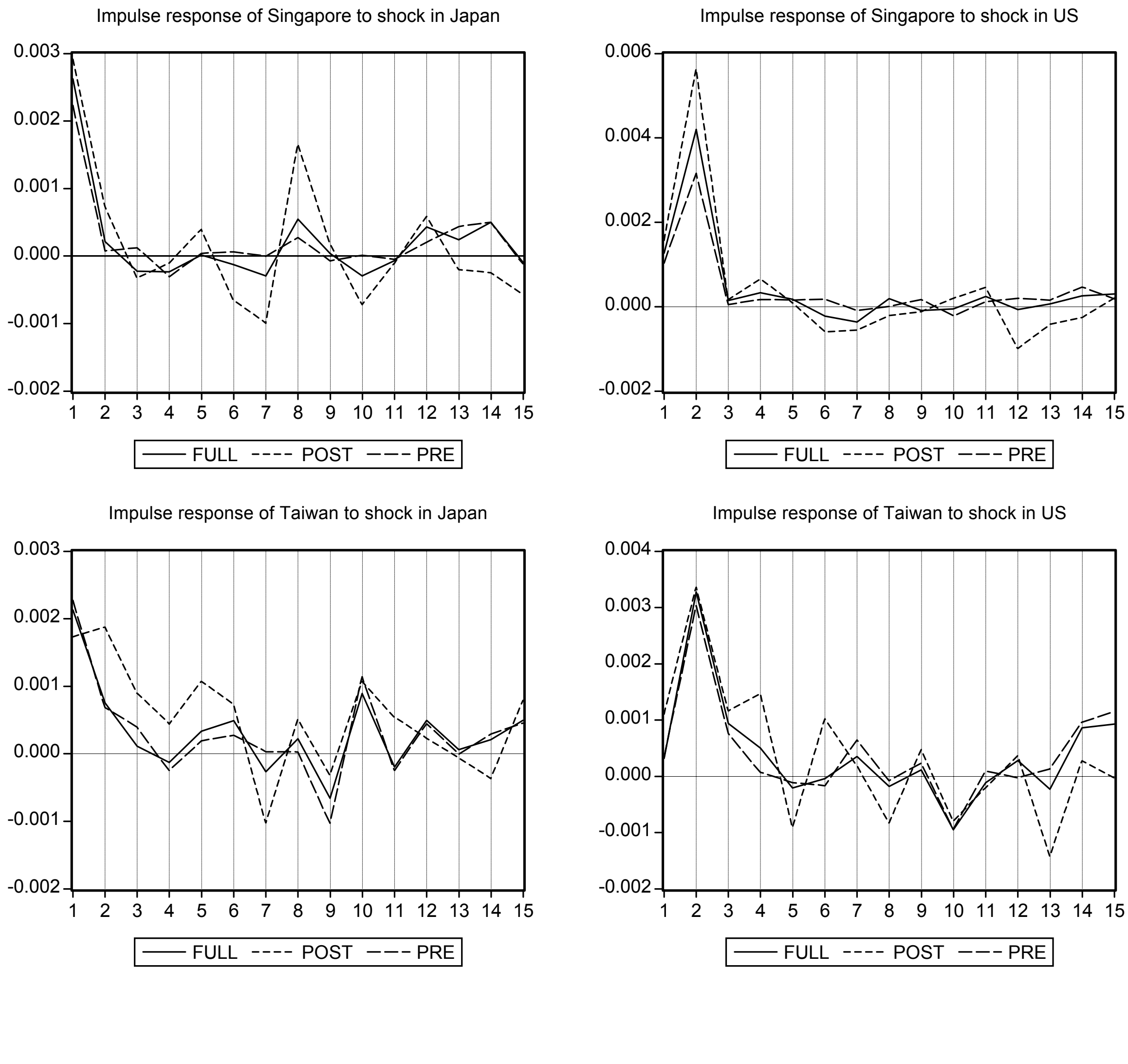

Figure 2.4: Impulse response functions of the Thailand market