FEA Working Paper No. 2003-4

FINANCIAL CRISIS AND INTERTEMPORAL LINKAGES ACROSS THE ASEAN-5 STOCK MARKETS

Wong Yoke Chen[a]
Goh Kim Leng[b]
&
Kok Kim Lian[c]

[a]Sunway College
No. 5, Jalan Kolej, Bandar Sunway
46150 Petaling Jaya, Selangor
Malaysia

[b,c]Department of Applied Statistics
Faculty of Economics and Administration
University of Malaya
50603 Kuala Lumpur, Malaysia

email: [a]wyc@academic.sunway.edu.my
[b]klgoh@um.edu.my
[c]kokkl@um.edu.my

May 2003

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ABSTRACT

The linkages across the stock markets of five ASEAN countries, namely, Singapore, Malaysia, Indonesia, Thailand and the Philippines are examined in this paper for the period before, during and after the 1997 financial crisis. Contemporaneous stock returns are found to be positively correlated over all three periods but the extent of co-movements grew much stronger during the crisis. Singapore and Malaysia are the market leaders before the crisis, but Indonesia is the main market leader during the crisis, while the role of Singapore weakens after the crisis. Variance decomposition shows that the relative influence of the other markets are much more important during the crisis period. The five stock markets are cointegrated before and after the crisis, but not during the crisis. The short-run linkages of Malaysia with the other four markets have weakened after the crisis, which also marks the period of imposition of capital controls in the country. The results show reduced contemporaneous co-movements and no causal relationship between Malaysia with the other four stock markets, and an increased degree of exogeneity of the stock market.

1. Introduction

The existence of linkages across different national stock markets has important implications for investors who are seeking for diversification opportunities internationally. When such linkages suggest co-movements between different markets, any one market would be a representative of the behaviour of that group of markets and this would effectively amount to a reduced scope for portfolio diversification possibilities. This implication has sparked interest in innumerable studies to investigate whether different markets are interrelated. The stock market crash in October 1987 led to many studies that looked for changing patterns in the equity market inter-relationships over time. A decade later, the financial crisis in the Asian region further increased the intensity of interest in this topic.

The financial turmoil pervaded the north Asian financial markets as well as many emerging markets in the ASEAN region. The abandonment of the exchange rate peg by the Thai government on 2 July 1997, heralded by a sharp fall of the Thai Composite Index in the previous month, is marked infamously as the starting point of the crisis. This move caused the Thai baht to immediately plunge as much as 15% against the U.S. dollar. What followed was a pandemonium of currency devaluation panic that spread rapidly to the other Southeast Asian countries, particularly, Malaysia, Indonesia and the Philippines. Within the two-month period of July and August 1997, the Philippines peso, the Indonesian rupiah and the Malaysian ringgit were floated, in that order. The rapid sharp depreciation of ringgit subsequently led to the adoption of pegged exchange rate regime in September 1998 and the imposition of capital control measures. The rapidity and pervasiveness of the financial turmoil was unexpected. In a period of less than a year, its effect was spread and felt, to a varying degree, by practically all the countries in the Asian region.

Whether the contagion effect of the crisis has changed the inter-relations among national stock markets becomes an important focal point in most of the more recent studies on market interdependence. This study examines the linkages across the stock markets of the

five member countries of the Association of Southeast Asian Nations (ASEAN), namely, Singapore, Malaysia, Indonesia, Thailand and the Philippines. These are the countries originally included in the Association when the Bangkok Declaration was signed on 8 August 1967. Although many other studies have covered these countries in their analysis, they are often a small part of a large picture with little attention devoted specifically to this geographically linked group of emerging stock markets. A focused analysis on the ASEAN-5 stock markets is warranted not only because they are historically linked through the ideologies formulated in the Bangkok Declaration, but the member countries are also important intra-regional trading partners, and with close regional economic cooperation. The other countries that joined ASEAN much later are not included in this study as their stock markets are relatively new.

This study also performs an intertemporal analysis in order to identify pattern of changes in the inter-relationships of the five stock markets prior, during and post the Asian crisis. The linkages across the markets that are examined include contemporaneous co-movements, causal relationships, responses to cross-market shocks, long-run interdependence and adjustments to disequilibrium. Attention is given to highlight the intra-regional contagion effects of the crisis that brought about changes in the patterns of linkages.

The next section of this paper reviews some past works related to stock market linkages. Section 3 describes the data and framework of analysis. The results are reported and discussed in Section 4. Finally, a summary of findings and some concluding remarks are given in Section 5.

2. Previous Studies

One of the earliest studies on stock market linkages in the Asian region is conducted by Cheung and Mak (1992). Using weekly stock indices from January 1977 to June 1988, they examined the Granger causal relationships between the Asian-Pacific emerging markets (Australia, Hong Kong, Korea, Malaysia, Philippines, Singapore, Taiwan and

Thailand) and the two developed markets of U.S. (as a global market) and of Japan (as a regional market). Their results show that the US market leads most of the Asian-Pacific markets, except that of Korea, Taiwan and Thailand, and that the Japanese market plays a less important role in the region. However, utilizing the daily closing stock indices from four Asian emerging stock markets of Malaysia, Singapore, Hong Kong and Thailand from 14 February 1992 to 19 June 1997 to examine the link between stock market fluctuations and intra-regional contagion effects, Masih and Masih (1999) concluded that the stock market fluctuations in these Asian markets are explained mostly by their regional markets and not by the more advanced markets of US, Japan, UK and Germany.

Using monthly price indices from 1987 to 1997, Palac-McMiken (1997) used the Engle-Granger two-step procedure to show that although the ASEAN-5 stock markets are not cointegrated they are interdependent. Mansor (2000) also obtained results that are similar to those of Palac-McMiken (1997).

The 1997 Asian financial crisis has become an important focal point in most of the more recent studies on market interdependence. Sheng and Tu (2000), for instance, examined the changing patterns of linkages among the stock markets of 12 Asia-Pacific countries for the periods before and during the crisis. The daily closing prices for the period from July 1996 to June 1998 they used provide evidence of cointegration among the stock indices during the crisis, but not before. Also, using daily market returns from January 1990 to October 2000, Yang and Lim (2002) tested the extent of contagion effects among nine East Asian equity markets, comprising Hong Kong, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Thailand and Taiwan during the pre-crisis and post-crisis periods. They found no evidence of long-term co-movements among these East Asian markets, but only short-term correlations, in both the sub-periods. They also found a substantial increase in the degree of interdependence, reflecting the presence of contagion effects in the region.

Jang and Sul (2001) conducted a similar study to examine the changes in the co-movement among the stock markets of the countries that were directly affected by the

Asian financial crisis in July 1997 (i.e. Thailand, Indonesia and Korea) and some of the neighboring Asian countries (i.e. Japan, Hong Kong, Singapore and Taiwan) and showed that there is a significant increase of cointegration during the crisis period and thereafter. Similarly, they found no significant Granger-causal relationship before the crisis, but a marked increase during and after the crisis.

Moon (2001) also investigated the impact of the 1997 Asian crisis on stock market integration in East Asia and found that in the long and short run, East Asian stock markets have become increasingly integrated with the US market after the crisis, confirming the popular view that the Asian crisis brought about US dominance over Asian stock markets.

Cheung, Cheung and Ng (2002) applied the cointegration techniques to the daily equity returns in order to examine the interactions between the U.S. market and the four East Asian markets of Hong Kong, Singapore, Taiwan and Korea before (from January 1995 to June 1997), during (from July 1997 to June 2000) and after (from July 2000 to July 2002) the Asian crisis and confirmed the dominant role of the US market in all the three sub-periods. However, they obtained a rather interesting finding that, while the US market leads these East Asian markets before, during and after the crisis, it is in turn also Granger-caused by them during the crisis period. Using daily stock prices expressed in U.S. dollars, Roca (2002) examined the long-run and short-term linkages among the four Dragons' equity markets (China, Taiwan, Singapore and Hong Kong) for two sub-periods – before (from 1 January 1993 to 1 July 1997) and after (from 1 January 1998 to 10 September 2001) the Asian crisis - and found that there is an increase in the degree of interdependence among the four markets after the crisis but no long-term linkages in both sub-periods.

Using the monthly stock indices to estimate a multivariate cointegration model in both the autoregressive and moving average forms, Phylaktis and Ravazzolo (2002) examined the effect of stock market liberalization on financial linkages among seven Asian capital markets (Japan, Hong Kong, South Korea, Malaysia, Singapore, Taiwan and Thailand)

and the U.S. over two sub-periods: the 1980-1989 pre-liberalisation period and the 1990-1998 post-liberalisation period. The results show that all the stock markets are not linked together for both the 80s and the 90s periods and that U.S plays a small role while Japan's role is more significant.

Applying cointegration techniques to the daily data from 1977 to 1999, Fernandez-Serrano and Sosvilla-Rivero (2000) found no evidence of long-run relationship among Asia's top five stock markets of Japan, Taiwan, South Korea, Singapore and Hong Kong. Using dummy variables to allow for structural breaks such as the recent turmoil in the stock and foreign exchange markets, they found strong evidence of long-term equilibrium between the Taiwanese and Japanese stock indices from October 1987, and some degree of cointegration between Singapore and Japan until February 1992 and between South Korea and Japan from April 1987.

It is worthwhile to note that we cannot make any comparison of the above results unless these studies involve exactly the same set of variables and factors. Generally, the choice of markets, the sample periods chosen, the frequency of observations (daily, weekly or monthly) and the types and variation of methodologies employed are some possible factors that may influence the results obtained.

3. Data and Methodology

The data used in the study are the daily closing values of the Kuala Lumpur Stock Exchange Composite Index, Singapore Stock Exchange All-Share Index, Stock Exchange of Thailand Index, Jakarta Composite Index and the Philippines Composite Index over the period of 2 January 1992 to 2 August 2002. The data are obtained from the financial data provider Bloomberg.

Three periods are identified in this study – 2 January 1992 to 31 January 1997, 1 February 1997 to 30 September 1998 and 1 October 1998 to 2 August 2002, according to the market return behaviour that is elaborated in the next section. In relation to the Asian

financial crisis, these 3 periods correspond approximately to the pre-crisis period, the crisis period and the post-crisis period, respectively.

Let p_{it} denote the natural logarithm of the price index for stock market i, where i = 1, 2, ..., 5, and t = 1, 2, ..., n, with n being the number of observations in the sample period. In this study, we stick to the order of the stock market of Singapore, Malaysia, Indonesia, Thailand and the Philippines for i = 1, 2, 3, 4 and 5, respectively. This order is according to the size of total market capitalization expressed in US dollars as at 1999 (see International Finance Corporation, 2000). The daily market returns are computed as logarithm of index relatives defined as:

$$R_{it} = p_{it} - p_{i,t-1} = \Delta p_{it} \tag{1}$$

The study is divided into three periods. To test if the average market returns underwent significant changes, the following autoregressive process is fitted:

$$R_{it} = \beta_0 + \beta_1 D_{1t} + \beta_2 D_{2t} + \sum_{k=1}^{p} \theta_k R_{i,t-k} + \varepsilon_{it} \tag{2}$$

where $D_{1t} = 1$ for observations beginning February 1997, and 0 otherwise, and $D_{2t} = 1$ for observations beginning October 1998, and 0 otherwise. Significant β_1 and β_2 would suggest structural changes in the behaviour of market returns.

To understand the time series properties of the stock market indices, the order of integration is first established using the augmented Dickey-Fuller test (Dickey and Fuller, 1979) based on the following regression:

$$\Delta p_{it} = \mu + \beta t + \delta p_{i,t-1} + \sum_{k=1}^{p} \theta_k \Delta p_{i,t-k} + \varepsilon_{it} \tag{3}$$

The augmented Dickey-Fuller t-statistic is computed to test the null hypothesis of a unit root, i.e., H_0: $\delta = 0$. The critical values applied for the test are those tabulated by MacKinnon (1991). The Phillips and Perron (1988) t-test for unit roots, which is invariant

to a wide class of weakly dependent and heterogeneously distributed errors, is also employed. The test equation contains a constant and deterministic time trend.

The impact of cross-market shocks can be felt within the same period or after a lag. The lagged impact induces causal relationship between the returns of two stock markets. The Granger F-test is performed to examine the presence of such relationships. Consider the following regression for the returns of stock markets i and j:

$$R_{it} = \mu + \sum_{k=1}^{p} \theta_{ik} R_{i,t-k} + \sum_{k=1}^{p} \theta_{jk} R_{j,t-k} + \varepsilon_{it} \quad (4)$$

The returns of stock market j is said to Granger-cause the returns of stock market i if $\theta_{jk} \neq 0$ for any k. This implies that the returns of stock market i are not independent of past shocks in stock market j. However, as will be shown later, the contemporaneous correlation between the returns of any two stock markets of the ASEAN-5 countries is highly significant. Equation (4) is therefore misspecified as the contemporaneous impact of R_{jt} on R_{it} is not taken into account. The following regression model is employed instead for the Granger causality test:

$$R_{it} = \mu + \alpha R_{jt} + \sum_{k=1}^{p} \theta_{ik} R_{i,t-k} + \sum_{k=1}^{p} \theta_{jk} R_{j,t-k} + \varepsilon_{it} \quad (5)$$

The null hypothesis of no causal relationship between market i and market j is tested using the F-test of H_0: $\theta_{jk} = 0 \ \forall k$.

The cross-market linkages are also examined using the vector autoregressive approach. A vector autoregression (VAR) of order p is given by:

$$\Delta y_t = \mu + \sum_{k=1}^{p} \Gamma_k \Delta y_{t-k} + \varepsilon_t \quad (6)$$

where $\Delta y_t = (R_{1t}, R_{2t}, R_{3t}, R_{4t}, R_{5t})'$, μ is the 5x1 column vector of constants, Γ_k is the 5x5 matrix of coefficients for k = 1, 2, ..., p, and $\varepsilon_t = (\varepsilon_{1t}, \varepsilon_{2t}, ..., \varepsilon_{5t})$ is the 5x1 column vector

of disturbance terms such that $E(\varepsilon_{it}) = 0$, $E(\varepsilon_{is,}\ \varepsilon_{it}) = 0$ for $s \neq t$, and $E(\varepsilon_{it,}\ \varepsilon_{jt}) = \sigma_{ij}$. The disturbance terms are not autocorrelated but can be contemporaneously correlated when $\sigma_{ij} \neq 0$ for $i \neq j$. The variance decomposition is utilized to decompose the forecast error variance in the returns of a stock market into the component shocks attributed to the other stock markets as well as its own shocks. This facilitates the analysis of the relative influence of random innovations in each stock market on the variation of its own returns and also the returns of the other four markets.

The stock market linkages could be long-term in nature if the market indices are cointegrated. The Johansen's (1991) framework is adopted to investigate if cointegration between market indices exists. Consider the error correction model of the following form:

$$\Delta y_t = \mu + \pi y_{t-1} + \sum_{k=1}^{p} \Gamma_k \Delta y_{t-k} + \varepsilon_t \qquad (7)$$

where $y_t = (p_{1t}, p_{2t}, p_{3t}, p_{4t}, p_{5t})'$, π is a 5x5 matrix of coefficients, and the remaining notations are as defined for equation (6). The rank of the π matrix gives the number of cointegrating vectors. Johansen's method is based on estimating the π matrix in an unrestricted form, and then testing whether the restrictions implied by the reduced rank of π can be rejected. This is achieved by testing the null hypothesis of at least r cointegrating vectors against a general alternative hypothesis of more than r cointegrating vectors, based on the likelihood ratio test statistic given by:

$$Q_r = -n \sum_{k=r+1}^{5} \log(1 - \lambda_k)$$

where λ_k is the k-th largest eigenvalue defined in Johansen (1991). The critical values for the test are obtained from Osterwald-Lenum (1992).

Suppose that r cointegrating relations are found and $\pi = \alpha\beta'$ where

$$\alpha = \begin{bmatrix} \alpha_{11} & \cdots & \alpha_{1r} \\ \vdots & & \vdots \\ \alpha_{51} & \cdots & \alpha_{5r} \end{bmatrix} \quad \text{and} \quad \beta = \begin{bmatrix} \beta_{11} & \cdots & \beta_{1r} \\ \vdots & & \vdots \\ \beta_{51} & \cdots & \beta_{5r} \end{bmatrix}$$

The error correction terms in (7), i.e., $\beta' y_{t-1}$ represent deviations from the long-run equilibrium relationships among the five stock markets. We test whether stock market i adjusts to disequilibrium by using the F-test for the null hypothesis of H_0: $\alpha_{i1} = ... = \alpha_{ir} = 0$.

4. Results

A number of regression models in this study involve the use of lagged variables on the right hand side of the equation. The number of lags to be included in equations (2), (3), (5), (6) and (7), or the value of p, has to be determined. We fitted the models for p = 1 to 5, and applied the Akaike and Schwarz information criteria to choose the optimal lag length. The Schwarz information criterion is prone to selecting p = 1 in almost all the cases, whereas the lag length seldom exceeds 3 when the Akaike information criterion is used. Except for very few cases, variables of four- and five-day lags are also found to be insignificant. In view of this, the value of p = 3 is used unless otherwise mentioned.

Before proceeding to the analysis of the linkages among the ASEAN stock markets, it would be of interest to understand the behaviour of market returns for the selected periods of the study. Table 1 shows that the mean daily returns are significantly positive for Malaysia, Indonesia and the Philippines before the start of the crisis. The mean daily returns for Singapore and Thailand are positive, but not significant. However, during the crisis, the mean daily returns are significantly negative for all five countries. After the crisis, the figures increased and thereby suggesting signs of recovery in the stock markets although they are not significantly different from zero. Equation (2) was estimated and the results are presented in Table 2. The coefficients for both the dummy variables D_{1t} and D_{2t} are significant in all the cases. The coefficients of D_{1t} are negative, suggesting a drop in the average market returns since the start of the crisis. Although the period after

September 1998 did not see positive returns from the five stock markets, the average daily returns have increased markedly from the negative values during the crisis period, as indicated by the significantly positive coefficients of D_{2t}.

Table 3 reports the results of the unit root test. Both the augmented Dickey-Fuller and Phillips-Perron tests provide evidence that the stock market indices contain a unit root, and thereby are not stationary, but the return series are stationary. The only exception to this finding is the Philippines where the null hypothesis of a unit root in p_{it} is rejected for the post-crisis period. Although equation (3) was used for the test, the underlying data generating process is unknown. When the test equation that does not include the deterministic trend was used, the ADF test statistic is -0.914 and the Phillips-Perron test statistic is -0.807 for testing presence of unit roots in p_{it}. The corresponding figures are -19.889 and -25.294 for the tests performed on first differences of the series. This evidence supports that the Philippines Composite Index is integrated of order one.

The correlation matrix was computed to examine the contemporaneous co-movements between the ASEAN stock markets. The results are given in Table 4. All the coefficients are significantly positive, indicating a rise (or drop) in the returns of a stock market causes returns in another stock market to move in the same direction on the very same day. Comparing across different periods, the correlations are the strongest during the crisis, showing that the news from one market have higher impact within the same day on another market than during the pre- and post-crisis periods. This also reflects the contagion effect of the financial crisis. Interestingly, although the contemporaneous correlation between the stock markets of Singapore, Indonesia, Thailand and Philippines has strengthened in the post-crisis period compared to the pre-crisis period, that between the Malaysian market and each of these four markets has weakened considerably. In fact, the Malaysian and Singapore stock markets shared the highest correlation coefficient before and during the crisis, but this is no longer true for the post-crisis period.

To study the lead-lag relationship between stock market returns, the Granger causality test was performed based on equation (5) and the p-values of the test statistics are

reported in Table 5. The α coefficient is positive and significant at the 1% level in all the estimated equations, supporting the earlier findings on contemporaneous relationships. In the pre-crisis period, the Singapore market leads the other four stock markets, while the Malaysian market leads all except the stock market of Thailand. The causality runs one-way from Thailand to Indonesia and the Philippines. Feedback is found only between Singapore and Malaysia, and Malaysia and Indonesia. The results offer some evidence that the larger stock markets tend to lead the smaller markets.

This evidence, however, no longer holds true during the crisis period. Indonesia, being one of the worst affected economies in the region by the financial turmoil, is leading the bigger markets like Singapore and Malaysia, and also the Philippines. During this period, Indonesia suffered not only stock market collapse, but also serious social and political unrests and sharp fall of the rupiah. Its stock market was constantly affected by bad news and the impact rippled to the other stock markets in the region. The bigger markets, Malaysia and Singapore, lost their dominant role. One-way causation is found only from Malaysia to Indonesia. Although some traits of causal relationship from Singapore to Indonesia and Philippines are seen, the evidence is a lot weaker compared to the period before the crisis started.

The post-crisis period witnesses some changes to the causal relationship. While the Thai stock market regains its pre-crisis dominance over the stock markets of Indonesia and the Philippines, Singapore leads only the stock markets of Thailand and the Philippines. The pre-crisis causation from Singapore to Malaysia and Indonesia no longer exists. Malaysia is no longer leading or being led by any other stock markets. The disappearance of its causal links with the other markets could be that the implementation of capital controls in the country since September 1998 has caused the other markets to find a new anchor.

The findings are further substantiated by the results of the variance decomposition provided in Table 6. The entries in the table are the percentage of return forecast error variance of a market that can be explained by random innovations of its own market as well as those of the other markets. The component explained by own market innovations

is commonly used as a measure for the degree of exogeneity of that market, because this nets out foreign influences. It does not take more than 5 trading days for the component values of the variance decomposition to converge, and those reported in Table 6 are for 10-day ahead forecasts.

It can be seen that the relative influence of the other stock markets on any of the five markets is the highest during the period of crisis, due to the contagion effect. This supports the common belief that bad news in the financial system have larger impacts than good news. It also means that the crisis has reduced the degree of exogeneity of the five stock markets. The relative impact of innovations in Indonesia on the other stock markets increases during the crisis period. With the exception of Malaysia, the relative importance of foreign influence is about the same for the period before and after the crisis for the other four stock markets. The relative importance of foreign influence is, in fact, the highest for Malaysia before and during the crisis, mainly attributed to the innovations of the Singapore market. The foreign influence, however, reduced markedly in importance for the post-crisis period. The imposition of capital control could have reduced or shut out foreign influences, resulting in this increase in the degree of exogeneity in the Malaysian stock market.

In terms of linkages of long-run nature, Table 7 shows that the null hypothesis of no cointegration is rejected for the pre- and post-crisis periods. One cointegrating relation is found for the period before the crisis, and two for the period after the crisis. There is no evidence of cointegration during the crisis period. The results suggest that the stock market indices are bonded together by long-run equilibrium relationships before and after the crisis, but not during the crisis. Such long-run relationships are expected given the close regional integration of the five ASEAN financial markets. The lack of a long-run relationship during the crisis is not surprising as it was difficult for the markets to find a common long-term niche in the face of intense uncertainties.

Given any deviation from the long-run relationships, Table 8 provides the results for analyzing the stock markets that adjust significantly to restore equilibrium. For the pre-

crisis period, Indonesia and the Philippines make significant adjustments to disequilibrium. These adjustments were not found to be significant for the other three markets which are clearly dominant as revealed by the causal relationship reported earlier. However, all the five markets adjusted significantly in reaction to disequilibrium in the post-crisis period. This could be that there is no clear market leader, or that the markets are more sensitive to disequilibrium as an aftermath of the crisis.

5. Conclusion

This paper examines the linkages across the stock markets of five ASEAN countries, namely, Singapore, Malaysia, Indonesia, Thailand and the Philippines for the period before, during and after the 1997 financial crisis. These periods are identified with different market return behaviour. Most of these stock markets experienced positive average daily returns in the pre-crisis period. The average returns turned negative during the period of crisis, after which the returns hover around the zero level. Contemporaneous stock returns are found to be positively correlated over all three periods but the extent of co-movements grew much stronger during the crisis, reflecting the contagion effect of the financial turmoil.

In terms of causal relationship, the stock market of Singapore plays the dominant role in leading the other markets in the pre-crisis period, while that of Malaysia has the second dominant role. This is clearly related to the market size, where the bigger markets tend to lead. The worst hit Indonesia was leading all of the other markets except Thailand during the crisis. After the crisis, the dominant role of Singapore weakens considerably, while Malaysia loses its role totally. The relative influence of other markets are also much more important during the crisis period, and this implies that the crisis has reduced the degree of exogeneity for all the five markets considerably.

The five stock markets are cointegrated, i.e., they share the same long-run equilibrium relationships before and after the crisis, but not during the crisis. The linkages are mainly short-term in nature in the crisis period. The smaller markets are mainly those that

respond to disequilibrium before the crisis, but all the markets make adjustments to deviations from the long-run equilibrium after the crisis for the lack of a clear market leader.

Although Malaysia is integrated into the ASEAN stock market network in the long run, its short-run linkages with the other four markets have weakened after the crisis period. The results show reduced contemporaneous co-movements and no causal relationship with the other four stock markets, and increased degree of exogeneity of the stock market. This period coincides the imposition of capital controls by the country and the measures may have led to reduced cross-market influences on and from Malaysia.

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Table 1
Mean Daily Returns (percentage)

Period	Singapore	Malaysia	Indonesia	Thailand	Philippines
Pre Crisis	0.0288	0.0718*	0.0935**	0.0092	0.0969*
	(0.9544)	(1.2599)	(0.9437)	(1.5807)	(1.4099)
Crisis	-0.1779*	-0.3244*	-0.2520*	-0.3112*	-0.2746*
	(1.8329)	(3.6818)	(2.8823)	(2.9369)	(2.4825)
Post Crisis	0.0389	0.0783	0.0570	0.0415	-0.0168
	(1.5067)	(1.5824)	(2.0031)	(2.0901)	(1.7419)

Note:
Figures in parentheses are standard deviations.
* Significant at 5% level (1-tailed test).
** Significant at 1% level (1-tailed test).

Table 2
Regression Results for Testing for Significance of Shift in Mean Daily Returns due to Pre- and Post-crisis Period

	Independent variables					
	Constant	D_{1t}	D_{2t}	$R_{i,t-1}$	$R_{i,t-2}$	$R_{i,t-3}$
Singapore	0.0002	-0.0019*	0.0020*	0.0847**	0.0224	-0.0187
	(0.0004)	(0.0008)	(0.0008)	(0.0209)	(0.0209)	(0.0209)
Malaysia	0.0007	-0.0037**	0.0038**	0.0432*	0.0073	0.0051
	(0.0006)	(0.0012)	(0.0012)	(0.0209)	(0.0209)	(0.0209)
Indonesia	0.0008	-0.0030**	0.0027*	0.2005**	-0.0168	-0.0661**
	(0.0005)	(0.0011)	(0.0011)	(0.0208)	(0.0212)	(0.0208)
Thailand	0.0001	-0.0027*	0.0030*	0.0827**	0.0443*	0.0091
	(0.0006)	(0.0012)	(0.0013)	(0.0209)	(0.0209)	(0.0209)
Philippines	0.0008	-0.0032**	0.0023*	0.1515**	-0.0117	-0.0171
	(0.0005)	(0.0010)	(0.0011)	(0.0209)	(0.0211)	(0.0208)

Note: The dependent variable is R_{it}. See equation (2) in text for definitions of the variables.
Figures in parentheses are standard errors.
* Significant at 5% level.
** Significant at 1% level.

Table 3
Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) Test for Unit Root in ASEAN Stock Market Indices

	Level			First difference		
	Lag (p)	ADF test statistic	PP test statistic	Lag (p)	ADF test statistic	PP test statistic
Pre-crisis Period						
Singapore	1	-1.4505	-1.4211	1	-23.5447**	-31.9255**
Malaysia	1	-2.0605	-1.8824	1	-21.8554**	-27.6490**
Indonesia	1	-1.9237	-1.6549	1	-18.8972**	-23.4721**
Thailand	1	-0.3337	-0.2369	1	-21.5051**	-30.4548**
Philippines	1	-1.6654	-1.5746	1	-20.3190**	-27.7083**
Crisis Period						
Singapore	1	-3.0724	-2.8308	1	-11.8259**	-16.3919**
Malaysia	1	-2.815	-2.8576	3	-11.8305**	-19.5346**
Indonesia	1	-2.161	-1.8612	2	-12.1791**	-15.6997**
Thailand	1	-2.0223	-1.948	1	-12.3737**	-17.7752**
Philippines	1	-2.0005	-1.8407	1	-12.9522**	-16.5835**
Post-crisis Period						
Singapore	1	-3.1846	-3.206	1	-19.4700**	-27.1394**
Malaysia	1	-3.1419	-3.1566	1	-18.6914**	-26.2671**
Indonesia	1	-3.1343	-3.1024	1	-19.2453**	-24.6639**
Thailand	1	-2.8367	-2.7651	1	-18.5845**	-26.1129**
Philippines	1	-3.9657*	-3.9810**	1	-20.0102**	-25.3931**

Note:
The Schwarz criterion is used in choosing the lag length for the ADF test regression.
* Significant at 5% level.
** Significant at 1% level.

Table 4
Correlation Matrix for Returns of ASEAN Stock Markets

	Singapore	Malaysia	Indonesia	Thailand	Philippines
Pre-crisis Period					
Singapore	1.0000				
Malaysia	0.5773**	1.0000			
Indonesia	0.2895**	0.3161**	1.0000		
Thailand	0.3724**	0.4157**	0.2597**	1.0000	
Philippines	0.2227**	0.2264**	0.2982**	0.2260**	1.0000
Crisis Period					
Singapore	1.0000				
Malaysia	0.5890**	1.0000			
Indonesia	0.4953**	0.4500**	1.0000		
Thailand	0.4538**	0.4857**	0.4490**	1.0000	
Philippines	0.5293**	0.3903**	0.4162**	0.4259**	1.0000
Post-crisis Period					
Singapore	1.0000				
Malaysia	0.3177**	1.0000			
Indonesia	0.3559**	0.2094**	1.0000		
Thailand	0.4834**	0.2765**	0.3332**	1.0000	
Philippines	0.3326**	0.1943**	0.2846**	0.3240**	1.0000

** Significant at 1% level.

Table 5
Granger Test of Causality between Returns of ASEAN Stock Markets

	Singapore	Malaysia	Indonesia	Thailand	Philippines
Pre-crisis Period					
Singapore		0.0044*	0.0000**	0.0111*	0.0003**
Malaysia	0.0127**		0.0017**	0.9955	0.0002**
Indonesia	0.1247	0.0277**		0.5269	0.4985
Thailand	0.3399	0.1595	0.0003**		0.0077**
Philippines	0.7576	0.2202	0.2044	0.0902	
Crisis Period					
Singapore		0.4959	0.0640	0.5985	0.0851
Malaysia	0.1595		0.9371	0.5877	0.0002**
Indonesia	0.0325*	0.0451*		0.4244	0.0238*
Thailand	0.9378	0.9394	0.5515		0.2509
Philippines	0.1954	0.3125	0.9671	0.1393	
Post-crisis Period					
Singapore		0.3523	0.1333	0.0099**	0.0008**
Malaysia	0.7595		0.5953	0.7172	0.9947
Indonesia	0.4596	0.3454		0.5848	0.8280
Thailand	0.0796	0.8066	0.0011**		0.0001**
Philippines	0.2816	0.9234	0.6395	0.0799	

Note:
Each entry in the table shows the p-value of the F-statistic for testing the null hypothesis that returns of the stock market listed in the first column does not Granger cause the stock market listed in the first row.
* Significant at 5% level.
** Significant at 1% level.

Table 6
Variance Decomposition at Ten-day ahead Horizon

	Asymptotic standard error	Singapore	Malaysia	Indonesia	Thailand	Philippines
Pre-crisis Period						
Singapore	0.0095	97.5721	1.8545	0.0618	0.2297	0.2820
Malaysia	0.0126	33.4402	65.2081	0.1859	0.7733	0.3925
Indonesia	0.0094	13.5022	3.8418	81.2627	0.8512	0.5421
Thailand	0.0158	14.8477	5.6805	1.2376	77.5427	0.6915
Philippines	0.0141	6.7375	2.6877	3.5432	1.4729	85.5588
Crisis Period						
Singapore	0.0183	95.2223	1.2768	2.8058	0.1357	0.5595
Malaysia	0.0370	34.0162	61.7478	3.6025	0.1698	0.4636
Indonesia	0.0289	23.4688	3.5510	72.2170	0.4433	0.3199
Thailand	0.0294	20.9447	6.9682	6.3721	64.9417	0.7734
Philippines	0.0249	28.1607	3.0838	4.6033	2.7074	61.4449
Post-crisis Period						
Singapore	0.0150	98.7659	0.0095	0.1059	0.9237	0.1950
Malaysia	0.0158	10.8137	88.4329	0.2530	0.1034	0.3971
Indonesia	0.0200	13.1689	1.0374	84.0382	1.6750	0.0805
Thailand	0.0209	24.3493	1.7533	2.5957	70.6219	0.6798
Philippines	0.0174	12.8680	0.7053	2.0989	3.3990	80.9288

Note:
A VAR(3) model is used to generate the variance decomposition.
The ordering of variables is the returns of the Singapore, Malaysia, Indonesia, Thailand and Philippines stock market.
Each entry shows the percentage of forecast error variance of the stock market listed in the first column that is explained by the stock market listed in the first row.

Table 7
Johansen's Test for Cointegration among the ASEAN Stock Market Indices

H_0	H_1	Eigenvalue	Likelihood ratio
Pre-crisis Period			
r = 0	r > 0	0.0273	70.0449*
r ≤ 1	r > 1	0.0210	39.6116
r ≤ 2	r > 2	0.0102	16.3068
r ≤ 3	r > 3	0.0034	5.0498
r ≤ 4	r = 5	0.0012	1.2644
Crisis Period			
r = 0	r > 0	0.0601	49.7443
r ≤ 1	r > 1	0.0304	27.4469
r ≤ 2	r > 2	0.0268	16.3163
r ≤ 3	r > 3	0.0171	6.5428
r ≤ 4	r = 5	0.0009	0.3280
Post-crisis Period			
r = 0	r > 0	0.0672	108.0796**
r ≤ 1	r > 1	0.0316	49.6855*
r ≤ 2	r > 2	0.0176	22.7773
r ≤ 3	r > 3	0.0088	7.8676
r ≤ 4	r = 5	0.0005	0.4344

Note: r denotes the number of cointegrating equations.
* Significant at 5% level.
**Significant at 1% level.

Table 8
F-test for Adjustment to Disequilibrium among the ASEAN Stock Markets

	Pre-crisis Period	Post-crisis Period
Singapore	0.4110	0.0054**
Malaysia	0.1315	0.0000**
Indonesia	0.0010**	0.0000**
Thailand	0.7601	0.0150*
Philippines	0.0003**	0.0001**

Note: Each entry in the table shows the p-value of the F-statistic for testing (joint) significance of the error correction term in the error correction model.
* Significant at 5% level.
**Significant at 1% level.