STOCK MARKETS INTERDEPENDENCE AND ASIAN FINANCIAL CRISIS: EMPIRICAL EVIDENCE FROM ASEAN-PLUS-THREE

Ruzita Abdul-Rahim
Ros Zam Zam Sapian
Abu Hassan Shaari Mohd Nor
Universiti Kebangsaan Malaysia

ABSTRACT

This paper examines the impact of Asian financial crisis on stock market interdependence for the period of 16 years from January 1991 to December 2006 of ASEAN-plus-three stock markets. The preliminary results show that there is differential in risk-return behavior for pre-, during and post-crisis period. The adverse impact of the Asian financial crisis is clearly evident by the sharp decreases in average returns, coupled with sharp increases in return volatility. The results of the eight-market vector autoregressive analyses indicate that on a country-by-country basis, it is Thailand and Korea that apparently play the dominant role of influencing the stock market interdependence. This is rather surprising given the importance of Japan as one of the world's most advanced markets and the primary source of foreign funds for the other Asian markets. Overall, the results of this study lend strong evidence to support current conception that an exogenous shock like the Asian financial crisis is capable of increasing the levels of stock market interdependence. More importantly, this study proves that such a change is only temporary. The implication of these findings on investors in the ASEAN-plus-three markets is that even though there are some losses in risk reduction benefits of international portfolio diversification due to increased integration, the impact is not permanent. Once the markets recover from the crisis and regain their tranquil conditions, the level of stock market interdependence drops to their pre-crisis level. As a result, these markets will once again become the primary choice for international portfolio investors.

Keywords: Stock market interdependence; Asian financial crisis; international portfolio diversification; ASEAN-plus-three

---

* The authors wish to acknowledge that this study was funded by a research grant provided by Universiti Kebangsaan Malaysia. They also wish to thank participants of the 3rd UNITEN International Business Management Conference 2007 for valuable comments on the first draft on this paper

Introduction

Two well-known theories in the finance literature, the capital asset pricing model and the modern portfolio theory, suggest that individual and institutional investors hold a well-diversified portfolio. With an objective to minimize risk, this well-diversified portfolio must ideally be composed of assets of perfectly negative correlations. A recent trend indicates that the construction of such a well-diversified portfolio can be effectively done through international or global diversification. This is because differences exist in levels of economic growth and timing of business cycles among various countries, resulting in low or negative cross-country correlations. Even though there are disputes among investment professionals regarding the benefits and costs of international portfolio investment, there is consensus that international equity portfolio diversification is becoming more popular because of the low correlation among national stock markets. Evidently, previous researches have documented that international diversification allows for reduction in total risk without sacrificing expected returns (Cosset & Suret, 1995). And because low correlations are more likely to be the results of matching countries of differences levels of economic growth and timing of business cycles, it is almost natural that there is an explosion of international portfolio investment in 1990s especially those involving emerging markets. Like any business cycle, however, the international portfolio investment strategy could eventually reach its maturity and finally declining stage unless and until certain measures are taken to revive the process. This concern arises as some researches have demonstrated that cross-country correlation is increasing consistent with the growing interdependence among the international markets. This recent phenomenon is the inevitable results of liberalization of trade and financial markets, regionalization of economic activities (Kim 2005; Narayan et al. 2004; Mukerjee & Mishra 2008), and to some extent advances in technology and communication which basically create virtual borderless zone for investment. The implication on investment is deliberated by Liu et al. (1998) and Pretorius (2002) in that as world equity markets become more integrated, such gain from diversification effects from investing internationally might have reduced significantly.

In light of this argument, the present paper intends to address two important issues concerning stock market interdependence and its implication on investment. The first is the establishment of new evidence on the degree of interdependence among neighboring markets, enunciating earlier evidence regarding the strength of market interdependence within a certain region. In a study that covers the world most advanced stock markets (the United States, the United Kingdom,

and Japan) as well as four emerging Asian stock markets that include Hong Kong, Thailand, Singapore, and Malaysia, Masih and Masih (1999) find that certain markets set the trend for specific geographical regions. For instance, in the case of the Southeast Asia region, they find that stock market fluctuations are mostly influenced by the regional (i.e. Hong Kong) rather than the advanced markets. In a similar study, Narayan et al. (2004) also find that intra-regional interdependence between stock markets is stronger than those with the advanced markets. In addition to the close-proximity of the studied markets, the fact that the present study involves emerging market has its own merit because as expressed by Liu et al. (1998) and Narayan et al.(2004), such evidence is still lacking despite their potential in international diversification. Liu et al. (1998), Masih and Masih (1999) and Chancharoenchai and Dibooglu (2006) report that emerging markets particularly those of ASEAN have been generating enormous returns. Our concern is that based on a review of several past studies on Asian emerging markets including that of Masih and Masih (1999), Pretorius (2002) concludes that emerging Asian markets are interdependent. In this study we would like to discover to what degree do these markets dependent on one another? The answer to this question is crucial because if these markets are strongly interdependent, then bundling them in a portfolio defeats the purpose of forming the portfolio (Liu et al., 1998; Pretorius, 2002) which is to reduce risk through combination of negatively correlated assets.

The second concern of this study is the sensitivity of market interdependence to economic shocks such as an economic crisis. This conjecture is consistent with findings by Eun and Shim (1989), Arshanapalli et al. (1995) and Liu et al. (1998) which show that the interdependence among international stock markets including the Asian markets changes after some turbulence in world equity markets. In their studies, the degree of international co-movements among stock markets has increased substantially after the October 1987 crash. Similarly, Meric and Meric (1997) who study on the changes in the co-movements of the 12 European equity markets following the 1987 crash document that the co-movements of these equity markets increased significantly following the crash, signifying that international portfolio diversification benefits decreased considerably following the crash. In brief, this study proposes that if the increased stock market integration that has been documented in earlier studies is induced by certain economic shock, then it may not represent a permanent threat to the viability of this region for international diversification. Thus, establishing evidence on the impact of economic shock on market interdependence is particularly crucial for this part of the world because it had just experienced one of most infamous exogenous event in history, i.e. the 1997 Asian financial crisis. From what was

commonly known to have started in Thailand (Chancharoenchai & Dibooglu, 2006), the Asian financial crisis quickly spread into several countries particularly those in the neighboring area. Compared to the 1987 crisis, this crisis was a lot more demeaning that its impact on stock markets interdependence is expected to be far more severe.

To achieve its objectives, this study adopts a research methodology that offers an opportunity to examine whether the stock market interdependence during the Asian financial crisis differs in any way from their behavior under normal tranquil economic conditions. Specifically, this study investigates the dynamic structure of interdependences among the ASEAN-plus-three stock markets from three perspectives. First, it examines the risk-return behavior of the eight stock markets for pre-, during and post-crisis periods. Second, it tests the degree and the speed of adjustment to shocks introduced by innovations in one market borne by other markets. Third, it explores whether the structure of market interdependence changes after the markets recover from the crisis. In brief, the sample data which includes the ASEAN-5 markets and the three largest Asian markets (China, Korea and Japan) are expected to provide an understanding of whether the contagion from the Asian financial crisis is confined only to the neighboring area of Thailand which landmarks the onset of the 1997 crisis (Chancharoenchai & Dibooglu, 2006) or also spread out to the other part of Asian markets. The period from January 1991 to December 2006 in the meantime allows us to examine whether the impact of the crisis on the degree of market interdependence is temporary or permanent.

The remainder of this article is organized in the following manner. Section 2 presents the data and methodology, section 3 presents and discusses the empirical results and section 4 provides the conclusions.

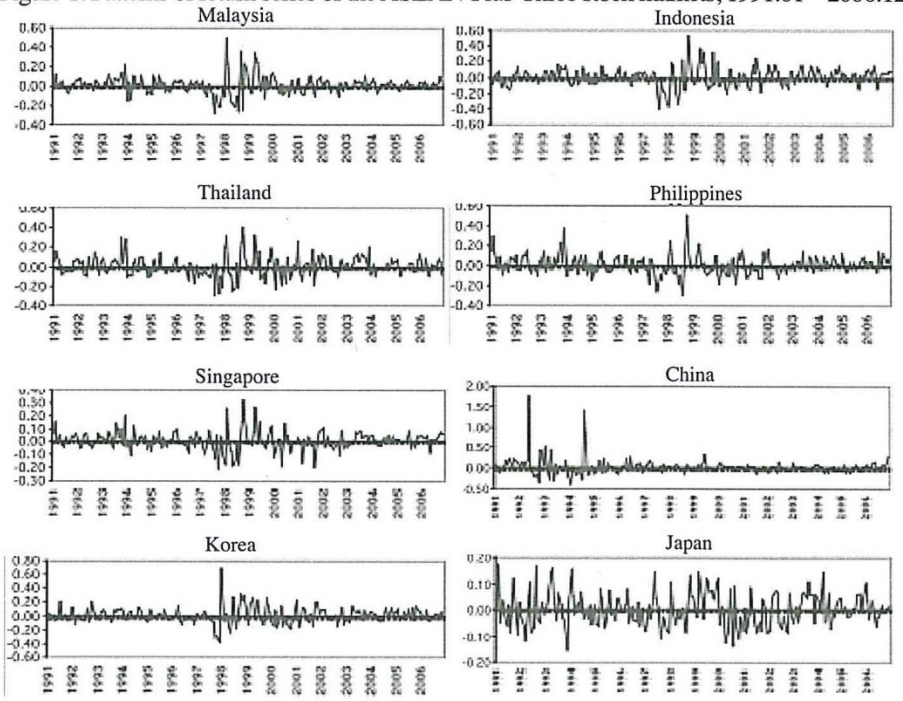
Data and Methodology

Descriptions of Data

To examine the interdependence among the ASEAN-plus-three stock markets, this study employs monthly closing stock market indices for the ASEAN-5 markets, i.e. Malaysia (Kuala Lumpur SE Composite Index), Indonesia (Jakarta SE Composite), Singapore (Straits Times Index), Thailand (SET Index), and the Philippines (PSE Composite). For the plus-three markets, this study uses Korea (Korea SE Composite), China (Shanghai Composite) and Japan (Nikkei

500 Index). All indices are denominated in the U.S. dollar and expressed in monthly percentages. The data are retrieved from the DataStream. To examine the influence of the Asian financial crisis on the structure of stock market interactions, the sample which covers the period from January 1991 through December 2006 is divided into three sub-periods; pre-crisis (1991:01-1996:12), during crisis (1997:01-1998:12) and post-crisis (1999:01-2006:12). The post-crisis period is crucial to examine whether the changes in structure of stock market interdependence induced by the crisis is temporary and accordingly revert to their pre-crisis levels.

Figure 1. Patterns of return series of the ASEAN-Plus-Three stock markets, 1991:01 – 2006:12



Even though it is difficult to identify the exact starting and ending point of a crisis (Pretorius, 2002), as far as the 1997 Asian financial crisis is concerned, there is a widely accepted belief that it is triggered by the devaluation of the Thai bath in July 1997 (Karolyi, 2002). According to International Monetary Fund (1998:16), the Asian financial crisis started when the Bank of Thailand announced a managed float of the currency on July 2, 1997, effectively devaluing the bath by 15 percent in onshore markets and by 20 percent in offshore markets. In what appeared to be a local currency crisis in Thailand quickly escalated into full-blown financial turmoil,

spreading to other Asian countries like Indonesia, Korea, Malaysia and Philippines, with massive depreciation of local currencies and the collapse of stock markets. The impact of the crisis however was detected much earlier in stock markets. During early 1990s, the Asia stock markets were soaring but as early as January 1997, all Asian markets except Taiwan are already heading down toward negative values (Kaminsky & Schmukler, 1999). Accordingly, this study plots the stock returns of the studied markets (Figure 1) to determine the starting point of the crisis. As a results, in contrast to past studies that use July 1997 as the beginning of the crisis (Nagayasu, 2001; Karolyi, 2002; Ratanapakon & Sharma, 2002; Sander & Kleimeier, 2003; Lin, 2006), this study quite comfortably uses January 1997. Judging from the point when stock returns begin to drop around the 1997 event, it is rather obvious that when involving Malaysia, Thailand, the Philippines, Singapore, and Japan the decline begin as early as the end of 1996 or early 1997. This pattern suggests that there is chain of events leading towards the Asian financial crisis that has adverse impact on the stock markets movements prior to the actual financial crisis itself. The mid-1997 decline is spotted in Indonesia, China and Korea. In short, consistent with findings by Chancharoenchai and Dibooglu (2006), the patterns in Figure 1 reveals that even though with several month delays, the effects of the crisis are also felt in all other markets. To identify the end of the Asian financial crisis is even more difficult and has become an arbitrary choice in the literature (Lim et al., 2007). Consistent with Karolyi (2002) and Lim et al. (2007), this study uses December 1998 as the end of the crisis, in which most of the Asian economies have recovered to pre-crisis level of GDP and their respective currencies almost ended the depreciation spree and regained stability.

Vector-Autoregressive Analysis

The analysis of the structure of dynamic interdependence among the eight stock markets utilizes the vector-autoregressive analysis (VAR) developed by Sims (1980). The VAR analysis is applied onto an unrestricted reduced form equation system. Specifically, the VAR employed in this study encompasses the eight monthly return series;

$$R_t = \alpha + \sum_{k=1}^{L} \beta_k R_{t-k} + \varepsilon_t \quad (1)$$

where R_t is a 8 x 1 column vector of monthly stock index returns, α and β_k are respectively, 8 x 1 and 8 x 8 matrices of coefficients, L is the lag length, and εt is a 8 x 1 column vector of serially uncorrelated error terms. The i,jth component of β_k measure the direct effect on the ith market of a change in the return to the jth market in k periods. In effect, the ith component of εt is the innovation of the ith market which cannot be predicted from past returns of other markets in the

system. For the purpose of this study, the VAR analysis is adequate because it provides two important aspects of the structure of dynamic interactions among the national stock markets. The variance decomposition of the n-step ahead forecast errors captures the percentage of unexpected variation in one stock market's return accounted for by shocks from other markets in the system. The impulse response captures the magnitude of adjustment of each market to a shock (new information) of another market. The greater the responses to new shock in another market, the more important that market is to the other markets. This study employs the generalized impulse response functions developed by Pesaran and Shin (1998) to avoid variant due to Cholesky ordering.

Empirical Results

Risk and Returns Profiles of the ASEAN-plus-three markets

Table1 presents the descriptive statistics and unit root test of the return series for the pre-, during and post-crisis periods. As highlighted in Table 1, the risk-return behavior of all markets exhibits different patterns for the three sub-periods. The results in Panel A of Table 1 show that during the pre-crisis period, all the ASEAN-5 stock markets except Indonesia and Thailand provide an average yearly return of more than 18 percent with Philippines demonstrates the best performer achieving an average yearly return of 31.2 percent.[1] Meanwhile among plus-three stock markets, China exhibits the highest yearly return of 63.6 percent. Among all eight stock markets, Malaysia and Singapore demonstrate the lowest standard deviation of 6.2 and 5.5 percents, respectively and this reflects the relative stability and lower risk of these two stock markets. Surprisingly, comparing the standard deviation for Japan and Singapore indicate that the standard deviation of the latter is lower and this reflects that Singapore stock market is more stable compared to those of Japan.

During the crisis period (Panel B of Table 1), most of the markets show sharp declines in average monthly returns with four markets namely Malaysia, Indonesia, Thailand and Japan show substantial reductions of more than 300 percents. Among the ASEAN-5 markets, Indonesia is struck most by the Asian financial crisis (i.e. declines by 960 percents) meanwhile among the plus-three markets, Japan experiences the largest reductions in average returns (i.e. declines by 300 percents). According to Lim et al. (2007), this traumatic

[1]Yearly figures are calculated by multiplying the respective monthly value in Table 1 by 100 and 12 months. For example, 31.2 percent is the results of 0.026 times 100 times 12.

collapse of stock prices happens when following massive depreciation of exchange rates, investors are swamped by panic that they fail to price stocks correctly. Surprisingly, despite the stock market declines as depicted in Figure 1 which is consistent with the widely acknowledged fact that Korea is one of the hardest hit by this financial turmoil, the results in Table 1 suggests that the Asian financial crisis does not exert enough impact to drag down the average monthly return during the two years 1997-1998 period of crisis.

Another way of looking at the impact of the Asian financial crisis is from the volatility of the markets. During the Asian financial crisis, stock markets throughout the world, especially in Asia, demonstrate tremendous volatility. This is clearly proven from Panel B of Table 1, in which the crisis period demonstrates increases in volatility as reflected by the standard deviation in several markets such as Malaysia, Indonesia, Thailand, Philippines, Singapore and Korea. This finding is consistent with International Monetary Fund's (1998: 4) report that the volatility of Asian markets during the year 1997 reached level in excess of that in Latin American markets at the peak of the 1994-1995 Mexican crisis. Out of the eight stock markets, only China shows a reduction in volatility as its standard deviation reduces from 31.0 percents to 7.5 percents. This is consistent with the relative stability of Chinese stock returns shown in Figure 1 during the crisis period of 1997/98, indicating that relatively China experiences the smallest impact of the Asian financial crisis.

Table 1. Descriptive statistics and Unit Root Tests for pre-, during , and post-crisis sub-periods

MARKET	MAS	INDO	THAI	PHIL	SNG	CHN	KOR	JPN
Panel A: Pre-crisis sub-period (1991:01 – 1996:12)								
Mean	0.015	0.005	0.007	0.026	0.015	0.053	-0.001	0.002
Std. Dev.	0.062	0.071	0.086	0.091	0.055	0.310	0.071	0.067
Skewness	0.182	0.065	0.873	1.062	0.675	3.388	0.676	0.592
Kurtosis	4.265	2.607	4.731	5.131	4.184	18.115	3.265	3.269
JB-Stats	5.197	0.514	18.145**	27.146**	9.679**	823.16**	5.691	4.422
ADF-Stats	-5.140**	-6.466**	-7.623**	-8.409**	-9.009**	-8.833**	-8.531**	-8.311**
Panel B: During crisis sub-period (1997:01 – 1998:12)								
Mean	-0.044	-0.043	-0.033	-0.023	-0.013	0.012	0.004	-0.004
Std. Dev.	0.193	0.226	0.183	0.167	0.138	0.075	0.233	0.068
Skewness	1.240	0.524	0.750	1.272	0.733	0.205	0.955	0.545
Kurtosis	4.094	3.215	2.979	5.661	3.123	2.729	4.346	2.645
JB-Stats	7.347*	1.146	2.250	13.551**	2.166	0.242	5.461	1.314
ADF-Stats	-4.893**	-3.681*	-3.572*	-3.274*	-4.212**	-4.114**	-4.284**	-3.626*
Panel C. Post-crisis sub-period (1999:01 – 2006:12)								
Mean	0.013	0.020	0.011	0.005	0.011	0.012	0.017	0.005
Std. Dev.	0.069	0.110	0.094	0.076	0.065	0.073	0.094	0.062
Skewness	1.340	0.493	0.245	0.123	-0.065	1.302	0.232	0.058
Kurtosis	8.059	3.616	3.949	3.245	6.341	6.371	2.932	2.383
JB-Stats	131.10**	5.408	4.567	0.484	44.710**	72.556**	0.877	1.575
ADF-Stats	-7.532	-8.492**	-10.28**	-8.963**	-9.576**	-7.075**	-9.306**	-8.042**

Note: In Panel A, N = 72 , the Augmented Dickey-Fuller (ADF) tests are conducted with lag 12 and the MacKinnon critical values are -3.5256 and -2.9030 for the 1% and 5% significant levels. In Panel B, N= 24, the ADF tests are conducted with lag 6 and the MacKinnon critical values are -3.7529 and -2.9981 for the 1% and 5% significant levels. In Panel C, N = 96, the Augmented Dickey-Fuller (ADF) tests are conducted with lag 12 and the MacKinnon critical values are -3.5007 and -2.8922 for the 1% and 5% significant levels. Asterisks * and ** denote 5% and 1% significant level, respectively.

The risk-return behavior during the post-crisis period as reported in Panel C of Table 1 reflects that the stock market performance of the eight countries have reverted to their pre-crisis level. Most of the stock markets have shown increases in returns while several such as Indonesia, Thailand, Korea and Japan have demonstrated even higher returns. The stability of these markets, as reflected by the reductions in standard deviations, also appears to improve from the crisis period. The changes in risk-return behavior during the post-crisis period provide preliminary supports for our argument that the Asian financial crisis might have significant influence, but only temporarily, on the nature and degree of market interactions. Once the markets regain their strength, the region is good to be re-considered as an attractive choice for an international portfolio diversification.

Moving beyond the basic mean and standard deviation measurement to higher-order-moments, except Singapore, all returns tend to be positively skewed, with fat tails. The resulting Jarque-Bera statistics in the three sub-periods consistently reject the null hypothesis that returns are normally distributed except for Indonesia, Korea and Japan. This finding is not an isolated case and in fact it is a widely accepted stylized fact that financial data is not normally distributed. Fortunately, in time-series analysis the assumption that is of more concern is the stationarity of the series, which in this study is determined by computing the Augmented Dickey-Fuller (ADF). The ADF specifies the null hypothesis (H0: $\gamma = 0$) that the series have a unit root is rejected if the ADF statistic is greater than the MacKinnon critical value. At the bottom of each panel in Table 1, the ADF values for all return series appear to be always greater than the critical value, suggesting that the unit root hypothesis is consistently rejected (p-value < 0.01). These results confirm that the return series are in stationary process and therefore suitable for the VAR method employed in this study.

Decomposition of Forecast Error Variance

The estimated eight-market VAR system in Equation (1) produces variance decomposition of forecast errors for the pre-, during and post-crisis sub-periods as reported in Tables 2, 3 and 4 respectively. In order to conserve space, only the variance decompositions of the 1-month and 6-month ahead forecast errors are reported. The results in Table 2 indicate that during the pre-crisis period, most of the markets are rather interactive in the sense that a very high percentage of the error variance is accounted for innovations in other markets (as indicated by the OTH column). At the end of the 6-month horizon, other markets innovation generally account for more than 34 percents, with an average of 61 percents. Compared to the results in Liu et al. (1998), this finding is consistent with

the recent view regarding increasing regional integration. Across the markets, Malaysia appears to be the most interactive (i.e. least exogenous) with about 80 percents of its error variance is explained by other markets. Relative to the other markets, China demonstrates the most exogenous market where the error variance is mostly explained by its innovations which is about 80 percents. In the meantime, Singapore demonstrates the most influential market among the eight equity markets. Not only innovation in Singapore accounts for 27 percents of its own variance, it also accounts for quite large fractions of variances of Malaysia (12%), the Philippines (36%), and Japan (11%).

Table 2. Decomposition of forecast error variance for the pre-crisis sub-period from 1991:01 – 1996:12

MARKET	t	S.E.	MAS	INDO	THAI	PHIL	SNG	CHN	KOR	JPN	OTH
MAS	1	0.056	29.366	39.980	11.122	8.476	9.440	1.427	0.146	0.042	70.634
	6	0.070	20.245	33.286	11.464	6.703	12.222	1.797	10.302	3.983	79.755
INDO	1	0.071	0.023	40.808	40.852	8.171	7.187	2.632	0.006	0.322	59.192
	6	0.081	1.972	31.732	36.110	7.393	8.426	5.362	6.705	2.300	68.268
THAI	1	0.087	2.042	2.873	34.274	54.239	1.296	2.582	0.251	2.444	65.726
	6	0.096	4.057	4.239	31.284	45.676	6.214	4.376	0.430	3.724	68.716
PHIL	1	0.088	11.776	3.822	6.318	30.118	39.342	2.035	2.430	4.159	69.882
	6	0.097	12.765	6.067	6.070	25.974	35.868	4.637	4.934	3.685	74.026
SNG	1	0.053	54.111	6.668	0.007	0.471	31.686	0.247	1.173	5.636	68.314
	6	0.060	46.722	7.967	3.229	3.580	27.259	1.267	4.043	5.933	72.741
CHN	1	0.322	3.542	1.304	7.386	1.319	4.354	80.488	0.863	0.744	19.512
	6	0.358	4.246	4.983	7.615	4.760	6.867	66.488	1.842	3.204	33.512
KOR	1	0.068	0.012	0.005	0.777	2.967	0.145	0.625	73.677	21.792	26.323
	6	0.081	6.497	4.259	3.020	7.680	3.475	2.148	52.907	20.014	47.093
JPN	1	0.068	0.510	0.327	5.570	0.934	12.754	0.242	16.465	63.198	36.802
	6	0.074	1.989	2.584	7.418	1.799	10.970	6.782	13.955	54.504	45.496

While the results in Table 2 already indicate stock market interdependence at a level higher than that found by Liu et al. (1998) before the 1987 market crash, the results in Table 3 for the period of crisis demonstrate even stronger interactions. Based on the 6-month horizon, the interactions that are depicted by the decomposition of error variance has increased from 20 percents minimum to almost 28 percents whereas the average has increased from 61 percents to 91 percents. Unlike the results for pre-crisis period, Singapore has become the most interactive (i.e. least exogenous) market, with the fraction of the error variance explained by other markets has risen from 73 percents to 91 percents. Unlike the results for pre-crisis period, none of these markets appear to be exogenous. However, to some extent China still demonstrates the nature of a segmented market in that its error variance is still mostly explained by its own innovations, which is about 59 percents. More importantly, contrary to the results in Table 2, Thailand demonstrates the most influential market. During this crisis period, the influence of Thailand innovations has increased on all stock markets except

for China, which shows a decrease from 7.6 percents to 3.2 percents. The overwhelming increased integration in all markets, coupled with the influence of Thailand support our earlier conjecture that the Asian financial crisis is capable to changing the structure of the stock market interdependence.

Table 3. Decomposition of forecast error variance during crisis sub-period from 1997:01 – 1998:12

MARKET	t	S.E.	MAS	INDO	THAI	PHIL	SNG	CHN	KOR	JPN	OTH
MAS	1	0.181	42.696	1.467	28.967	8.343	5.963	7.849	1.077	3.546	57.304
	6	0.246	24.868	1.190	27.661	8.384	8.599	15.988	10.175	3.136	75.132
INDO	1	0.216	11.823	29.820	32.324	8.803	14.809	0.001	1.777	0.642	70.180
	6	0.283	13.105	21.790	42.943	5.372	10.448	0.015	5.916	0.411	78.210
THAI	1	0.190	0.095	0.297	15.924	53.153	6.586	0.163	23.526	0.257	84.076
	6	0.230	9.559	7.388	11.482	37.692	9.295	1.090	23.224	0.271	88.518
PHIL	1	0.157	0.034	0.069	1.180	24.276	69.326	1.546	0.438	3.131	75.724
	6	0.207	9.477	11.785	3.607	15.270	49.192	1.808	6.373	2.489	84.730
SNG	1	0.143	12.911	37.426	9.409	2.496	11.998	1.232	4.892	19.637	88.002
	6	0.171	11.735	31.603	10.403	2.373	8.740	1.167	19.947	14.032	91.260
CHN	1	0.083	10.169	0.142	1.100	0.158	17.044	70.002	1.369	0.016	28.898
	6	0.094	8.084	3.015	3.216	0.401	17.139	59.269	8.341	0.535	40.731
KOR	1	0.259	0.780	0.544	8.552	6.685	1.666	0.940	28.118	52.713	71.882
	6	0.289	11.642	1.117	7.807	8.438	1.428	1.309	22.803	45.456	77.197
JPN	1	0.066	17.587	16.171	19.337	0.054	5.471	3.429	8.134	29.817	70.183
	6	0.083	25.450	10.656	12.306	0.851	3.712	16.364	9.364	21.297	78.703

Table 4. Decomposition of forecast error variance for post-crisis sub-period from 1999:01 – 2006:12

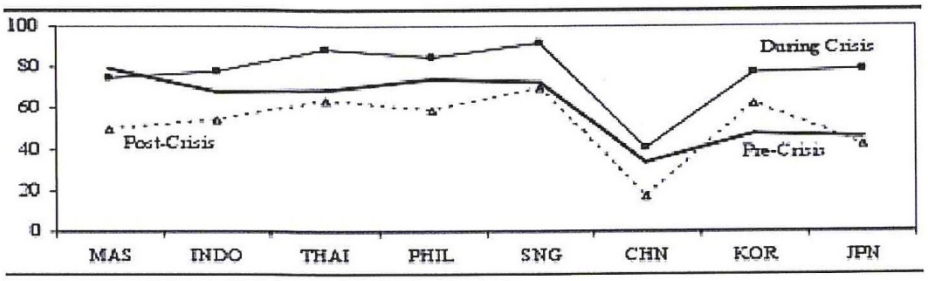
MARKET	t	S.E.	MAS	INDO	THAI	PHIL	SNG	CHN	KOR	JPN	OTH
MAS	1	0.066	58.528	24.165	3.597	2.814	5.840	2.856	0.041	2.160	41.472
	6	0.072	50.682	24.778	3.196	3.864	9.798	3.681	1.025	2.976	49.318
INDO	1	0.110	5.010	50.156	33.280	5.167	5.451	0.258	0.214	0.646	49.844
	6	0.115	6.122	45.665	30.554	5.522	8.344	1.080	1.428	1.284	54.336
THAI	1	0.093	1.426	0.514	36.618	43.209	14.250	0.128	3.628	0.228	63.382
	6	0.098	1.293	2.422	36.723	38.815	13.016	3.360	3.704	0.666	63.277
PHIL	1	0.076	0.927	8.041	7.216	45.782	34.616	0.368	2.322	0.729	54.218
	6	0.080	1.014	8.340	9.227	41.514	35.279	1.528	2.429	0.670	58.486
SNG	1	0.062	10.075	7.185	4.395	1.325	36.581	0.021	40.327	0.090	63.419
	6	0.068	8.971	6.916	10.728	4.215	30.630	3.416	35.288	0.557	69.370
CHN	1	0.071	4.080	0.456	0.461	0.340	0.662	93.436	0.464	0.100	6.564
	6	0.077	11.193	1.108	0.512	1.493	1.199	83.148	1.087	0.261	16.852
KOR	1	0.097	8.914	2.007	10.373	1.999	3.147	0.065	39.507	33.988	60.493
	6	0.099	8.902	2.172	11.928	2.671	3.150	0.257	38.265	32.655	61.735
JPN	1	0.062	1.529	5.805	7.280	0.870	2.307	0.559	19.774	61.875	38.125
	6	0.065	2.967	5.452	8.560	1.583	2.102	2.261	18.678	58.396	41.604

Our argument that the changes in market interactions are triggered by the Asian financial crisis is further supported by the results in Table 4, with special highlights on the decrease in the influence of Thailand innovations on other markets. By comparing the results in Table 3 and 4, one could easily detect the sharp decrease in the influence of Thailand innovations on other markets

except the Philippines and Korean stock markets. At the end of the 6-month horizon, Malaysian and Indonesian stock markets exhibit a drop in the fractions of forecast errors variance due to innovations in Thailand from 28 percents to 3 percents and from 43 percents to 31 percents, respectively. Diminishing role of Thailand is also observed in Chinese and Japanese stock markets where the fractions due to Thailand innovations drop from 3 percents to 0.5 percents and from 12 percents to 8 percents, respectively. Similar to the results of crisis period, Singapore remains the most interactive market with fraction of the error variance explained by other markets is 69 percents. While similar to the pre-crisis period, China regains its title as the most exogenous market as its own variance explains about 83 percent of its error variance.

Finally, to highlight the changes in the degree of stock market interdependence during the three sub-periods, we plot the other markets innovations (OTH) in Figure 2. The resulting patterns suggest that the degree of market interactions increases during the crisis but returns to the original level of the pre-crisis period, in fact lower during the post-crisis period. Again, the graphical results in Figure 2 reinforce our argument that the Asian financial crisis has influenced the market interactions of the eight countries under study.

Figure 2. Levels of market interactions in the pre-crisis, during crisis, and post-crisis sub-periods



Dynamic Response Patterns

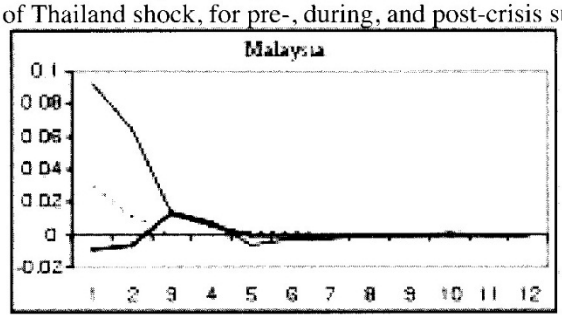
In addition to variance decomposition, VAR system also offers the estimated impulse responses to analyze the speed that each of the eight markets responds to innovations from other markets. In order to conserve space, only market responses to shocks in Thailand and Korea are reported in Figure 3 and 4. While the importance of Thailand in this study relates well to its significance in the Asian financial crisis, it is the influential roles of these markets that serve as basis criterion. Recall that the results of the variance decomposition reveal that Thailand represent the most influential markets among the ASEAN-5 in

the crisis and post-crisis sub-periods whereas Korea among the plus-three components in all three sub-periods. The results, as illustrated in Figure 3, show that for the pre-crisis period (tick line) the responses to Thailand shocks ¬are immediate and positive in the case of Indonesia, Philippines, Singapore, China, and Thailand itself. In Malaysia and Korea, the responses are negative initially but turning positive after the third and seventh month, respectively. Meanwhile, stock prices in Japan do not seem to respond to innovation in Thailand, not until the second month when there is a positive response, which last for only one month. Generally, the markets responses to Thailand shocks during the pre-crisis period only flatten out and diminish after the sixth month.

The responses of these markets to Thailand shocks during the crisis (thin line) as compared to pre-crisis period increase rather tremendously in all markets except China, which shows negative responses. This could be due to strong fundamental values but more likely to be the results of fund switching from the ASEAN to China, sufficient to counter the negative influence by shocks in Thailand during the crisis period. If the scale of the responses are good proximate of the market responses to the crisis, then it suggests that Thailand gets the worst blow from the crisis, followed surprisingly by Korea but as expected by Indonesia, the Philippines, and Singapore.

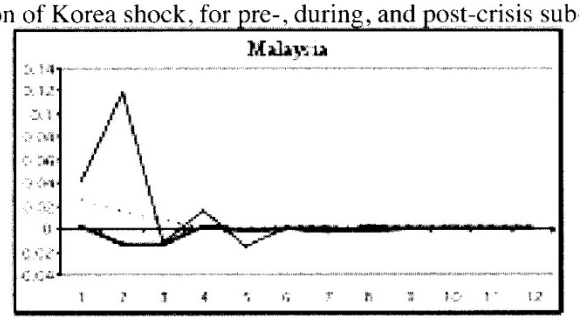
Also illustrated in Figure 3 are the responses of the markets to shocks in Thailand during the post-crisis period (broken line). In general, the degree of the market responses to shock in Thailand in the post-crisis period is very similar to that for the pre-crisis period. However, these responses diminish more rapidly, that is, as soon as the second month after the shock. Similar to the results of the variance decomposition, these findings support our argument that the significant change detected in the degree of market interactions is induced by the Asian financial crisis. Whereas, the speed at which these markets adjust to shock may be taken as an indication that there is some lesson well learn from the crisis, which makes the market to become more efficient in adjusting to new information. Without showing any perplexing responses, this study provides evidence that contradicts explanation by Lim et al. (2007). They argue that during chaotic environment such as Asian financial crisis, the investor would overreact not only to local news, but also to news originating in the other markets, especially when the news is adverse.

Figure 3. Generalized impulse responses of the ith market to one standard deviation of Thailand shock, for pre-, during, and post-crisis sub-periods



Note: The tick, thin, and broken lines represent pre-crisis (1991-1996), during crisis (1997/98), and post-crisis (1999-2006) periods, spectively.

Figure 4. Generalized impulse responses of the ith market to one standard deviation of Korea shock, for pre-, during, and post-crisis sub-periods



Note: The tick, thin, and broken lines represent pre-crisis (1991-1996), during crisis (1997/98), and post-crisis (1999-2006) periods, respectively.

Figure 4 demonstrates the impulse response of the markets to shocks in Korea. As depicted in the graph, all markets except Korea itself and Japan give either barely noticeable or negative responses to Korean shocks during pre-crisis period (tick line). During the crisis period (thin line), the responses of most markets except China increase substantially, which is similar to those in Thailand. The responses of Malaysia, Indonesia, Philippines and Singapore markets to shocks in Korea reach the maximum level during the second month. The response of China is initially negative and only turns positive after the third month. During the post-crisis period (broken line), the responses of all markets except China return to their pre-crisis patterns. Similar to responses to Thailand shock, responses to Korean shock also diminish after the second month in most markets. Again, the results in Figure 4 support our hypothesis that the increased in responses to Korean shocks are attributes to the Asian financial crisis because as in the case to Thailand shocks, the significant increase in responses of those markets are confined to the crisis period.

Conclusions

This study estimates an eight-market vector-autoregressive (VAR) system to investigate the impact of Asian financial crisis on the dynamic structure of international transmission in stock returns of ASEAN-plus-three markets, namely Malaysia, Indonesia, Singapore, Thailand, Philippines, Korea, China, and Japan. The tests are conducted using monthly stock returns on broad based index of the respective markets for the period of 16 years from January 1991 through December 2006. The empirical evidence generally suggests the following: (1) the changes in risk-return behavior is attributed to the Asian financial crisis; (2) the degree of interdependence among national stock markets increased substantially during the crisis; (3) the dominant role of Thailand in influencing the other stock markets after the crisis relates well to the fact that the country landmarks the onset of the crisis; (4) the crisis does seem not affect China stock market, and (5) as the economies return toward their tranquil conditions during the post-crisis period, the degree of interdependence among national equity markets also revert to nearly pre-crisis levels. Overall, the results of this study lend strong evidence to support our hypothesis that an exogenous shock like the Asian financial crisis is capable of increasing the levels of stock market interdependence. The results also reveal that such changes induced by crisis leave only a temporary effect. In short, "should the Asian financial crisis scare foreign investors out of ASEAN-plus-three markets?" (Karolyi, 2002). The findings of this study suggest that these foreign investors should not shy away too quickly. Even though there are some losses in risk reduction benefits of international portfolio diversification due to increased integration during the crisis, the impact is not likely to be permanent. Once the markets recover from the crisis and regain their tranquil conditions, the level of stock market interdependence drops to their pre-crisis level. As a result, these markets will once again become the primary choice for international portfolio investors.

References

Arshanapalli, B., Doukas, J. & Lang, L.H.P. (1995). Pre- and post-October 1987 stock market linkages between US and Asian markets. *Pacific Basin Finance Journal,* Vol. 3: 57-73.

Chancharoenchai, K. & Dibooglu, S. (2006). Volatility, spillovers and contagion during the Asian crisis: Evidence from six Southeast Asian stock markets. *Emerging markets Finance and Trade*, Vol. 42: 4-17.

Cosset, J.C., & Suret, J.M., (1995). Political risk and the benefits of international portfolio diversification. *Journal of International Business Studies*, Vol.26:301-318.

Eun, C.S. & Shim, S. (1989). International transmission of stock market. *Journal of Financial and Quantitative Analysis,* Vol. 24: pp.241–256.

International Monetary Fund (1998). World economic and financial surveys: international capital markets developments, prospects and key policy issues. Washington, D.C. International Monetary Fund.

Kaminsky, G., & Schmukler, S. (1999). What triggers markets jitters? A chronicle of the Asian crisis. *Journal of International Money and Finance,* Vol. 18, 537-560.

Karolyi, G.A. (2002). Did the Asian financial crisis scare foreign investors out of Japan? *Pacific-Basin Finance Journal*, Vol. 10: 411-442.

Lim, K.P., Brooks, R.D. & Kim, J.H. (2007). Financial crisis and stock market efficiency: Empirical evidence from Asian countries. *International Review of Financial Analysis,* doi:10.1016/j.irfa.2007. 03.001.

Lin, A.Y. (2006). Has the Asian crisis changed the role of foreign investors in emerging equity markets: Taiwan's experience. *International Review of Economics and Finance,* Vol. 15: 364-382.

Liu, Y.A., Pan, M.S. & Shieh, J.C.P. (1998). International transmission of stock price movement: evidence from the US and five Asian-Pacific markets. *Journal of Economics and Finance*, Vol. 22: 59–69.

Masih, M.M., Abul & Masih, R. (1999). Are Asian stock market fluctuations due mainly to intra-regional contagion effects? Evidence based on Asian emerging stock markets. *Pacific Basin Finance Journal*,Vol. 7: 251 – 282.

Meric, I., & Meric, G., (1997). Co-movements of European equity markets before and after the 1987 crash. *Multinational Finance Journal*, Vol. 1: 137-154.

Mukerjee, K.N. & Mishra, R.K. (2008). Stock market integration and volatility spillover: India and its major Asian counterparts. *Munich Personal RePEc Archive* paper no. 12788. Available at http://mpra.ub.uni-muenchen.de/12788/

Nagayasu, J. (2001). Currency crisis and contagion: evidence from exchange rates and sectoral stock indices of the Philippine and Thailand. *Journal of Asian Economics,* Vol. 12: 529-546.

Narayan, P., Smyth, R., & Nandha, M. (2004). Interdependence and dynamic linkages between the emerging stock markets of South Asia. *Accounting and Finance,* Vol. 44: 419 – 439.

Pesaran, G.C. & Shin, Y. (1998). Generalized impulse response analysis in linear multivariate models. *Economic Letter*, Vol. 58: 17-29.

Pretorius, E. (2002). Economic determinants of emerging stock market interdependence. *Emerging Markets Review*, Vol. 3: 84-105.

Ratanapakorn, O., & Sharma, S.C. (2002). Interrelationships among regional stock indices. *Review of Financial Economics,* Vol. 11: 91-108.

Sander, H., & Kleimeier, S. (2003). Contagion and causality: an empirical investigation of four Asian crisis episodes. Journal of International Financial Markets, Institutions and Money, 13: 171-186.

Sims, C.A. (1980). Microeconomics and reality. Econometrica, 48: 1-48.