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Stock Market Linkages in the ASEAN 5 Plus 3 Countries: An Analysis of Pre- and Post-Crisis

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This study investigates the impact of the 1997 Asian crisis on stock market linkages in the ASEAN-5 plus 3 countries using monthly stock index data for the period of 1986:01 to 2006:12. The vector autoregressive analysis generally indicates substantial increases in the degree of interdependence among stock markets after the crisis. Beside Japan, Thailand which landmarks the onset of the crisis plays a dominant role of influencing the other markets after the crisis. As the economies return toward their tranquil conditions in the sub-period of 2002:01 to 2006:12, the degree of equity market interdependence reverts to nearly pre-crisis levels. Overall, the increased integration implies that there have been reductions in diversification benefits from this region. However, given that the increased integration is confined to the period of crisis, stock markets in this region have the potential to regain their attractiveness for international portfolio investment.

Field of Research: Stock Market Linkages; ASEAN Countries; Asian Crisis

1. Introduction

Stock market integration continues to receive tremendous attention mainly because of its implication on international portfolio investment. Portfolio theory posits that investing in less correlated assets results in greater diversification effects. On that remark, it is rather a puzzle that despite the perceived importance of emerging markets particularly those of ASEAN as investment centers capable of offering enormous payoff, studies which purely focus on linkages between emerging markets are still relatively scant (Liu, Pan & Shieh, 1998; Narayan, Smyth & Nandha, 2004). In light of its implication on international investment, there is apparently an urgent need for such a study given that economic turbulence like the 1997 Asian crisis is capable of changing the structure of stock market linkages dramatically (Liu *et al.*, 1998).

Following this line of argument, this study aims to investigate the influence of the 1997 Asian crisis on the dynamic linkages among the ASEAN-5 plus 3 stock markets. This is achieved by adopting a research methodology that offers an opportunity to examine whether the stock market linkages.

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In the spirit of Liu *et al.* (1998), this study examines the dynamic structure of interactions among national stock markets in two perspectives: (1) the degree and the speed of adjustment to shocks introduced by innovations in one market borne by other markets; and (2) whether the structure of transmission changes after the 1997 Asian crisis. The sample markets are expected to provide an understanding of whether the contagion effect of the crisis is confined only to the neighboring area of Thailand which landmarks the onset of the 1997 crisis (Chancharoenchai & Dibooglu, 2006).

The remainder of this article is organized as follows. Section 2 presents the literature review, section 3 describes the data and methodology, section 4 discusses the results, and section 5 concludes.

2. Literature Review

The notion that stock markets are increasingly becoming more integrated is consistent with the growing importance of free capital mobility arising from various economic integration mechanisms including liberalization of barriers to trade (Narayan *et al.*, 2004). In a study which includes world's most advanced stock markets in addition to emerging Asian stock markets, Masih and Masih (1999) find that certain markets set the trend for specific geographical regions. In the case of Southeast Asia, stock market fluctuations are mostly influenced by the regional (i.e. Hong Kong) rather than the advanced markets. The investment implication is that as world equity markets become more integrated, gains from diversification effects through investing internationally reduce significantly (Liu *et al.*, 1998).

Despite the fact that emerging markets particularly those of ASEAN have been identified as investment centers capable of offering enormous payoff (Masih & Masih, 1999; Liu *et al.*, 1998; Chancharoenchai & Dibooglu, 2006), studies which purely focus on linkages between emerging markets are still relatively scant (Liu *et al.*, 1998; Narayan *et al.*, 2004). More specifically are studies that concentrate on neighboring emerging markets because unlike advanced markets, their well-being and therefore potential tend to influence one another. In addition, several recent studies (Eun & Shim, 1989; Liu *et al.*, 1998) find that the international transmission in stock returns change after some turbulence in world equity markets. In light of this evidence, studies on the influence of the 1997 Asian crisis on stock market linkages is timely given its implication on the region attractiveness as an investment heaven.

3. Data and Methodology

To investigate the short-term dynamic linkages among the ASEAN-5 plus 3 markets, this study employs monthly closing stock market indices for Malaysia (Kuala Lumpur SE Composite Index), Indonesia (Jakarta SE Composite), Singapore (Straits Times Index), Thailand (SET Index), the Philippines (PSE Composite), Korea (Korea SE Composite), Hong Kong (Hang Seng), and Japan (TOPIX). All indices, expressed in the U.S. dollar

and then transformed into monthly returns, are retrieved from DataStream. Note that Hong Kong is used in place of China for three reasons: (1) data for China is only available on DataStream starting 1991; (2) results of our pilot study using available data suggests that China has no particular linkages with the other countries in the region; and (3) beside previous evidence on its leading role in the regional stock markets (Masih & Masih, 1999; Narayan *et al.*, 2004), Hong Kong is one of the largest Asian countries that is adversely affected by the 1997 crisis beside Korea (Chancharoenchai & Dibooglu, 2006). To examine the changes in the structure of stock market interactions due to crisis, the sample which covers the period from January 1986 through December 2006 is divided into two periods—pre-crisis (1986:01-1996:12) and post-crisis (1997:01-2006:12). To examine whether the structure of stock market linkages revert to their pre-crisis levels, the post-crisis period is further divided into two sub-periods─sub-period 1 (1997:01-2001:12) and sub-period 2 (2002:01-2006:12).

The analysis of the structure of dynamic linkages 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 encompasses the eight monthly return series;

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

where R_t is an 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 ε_t is an 8 x 1 column vector of serially uncorrelated error terms. A VAR analysis 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 speed of adjustment of a market to a shock in another market. The generalized impulse response function developed by Pesaran and Shin (1998) is employed to avoid variant due to Cholesky ordering.

4. Empirical Findings and Discussions

The descriptive statistics of the index return series are not reported to conserve space. But briefly, except Malaysia and Japan, the average monthly returns are higher than 10%. The low standard deviation for Singapore and Hong Kong reflect the relative stability of these markets. Japan reports the lowest average return and accordingly, lowest volatility. Except for Singapore and Hong Kong, all index returns tend to be positively skewed, with fat tails. The resulting Jarque-Bera statistics clearly reject the null hypothesis that returns index are normally distributed whereas the augmented Dickey-Fuller tests consistently reject the null hypothesis of unit root for all index return series .

4.1 Variance Decomposition

The estimated eight-market VAR system produces variance decomposition of forecast errors for the sub-periods. To conserve space, only the variance decompositions of the 2-month and 12-month ahead forecast errors are reported.

TABLE 1. Variance Decomposition for the Pre- and Post-Crisis Periods

Markets	Period	S.E.	MAS	INDO	SNG	THAI	PHIL	KOR	HKG	JPN	OTH
Panel A: Pre-Crisis Period											
Malaysia	2	0.08	26.28	0.91	59.62	8.67	2.88	0.02	1.09	0.54	73.72
	12	0.08	25.85	0.96	59.46	8.61	2.92	0.26	1.14	0.80	74.16
Indonesia	2	0.12	0.23	88.48	2.00	2.83	0.63	2.37	0.50	2.95	11.52
	12	0.13	0.27	87.81	2.28	3.05	0.72	2.42	0.51	2.93	12.19
Singapore	2	0.08	23.04	0.13	22.80	12.95	13.35	0.85	25.74	1.14	77.20
	12	0.08	22.64	0.30	23.08	13.02	13.20	1.33	25.18	1.24	76.92
Thailand	2	0.09	8.10	0.55	4.11	79.88	3.65	0.84	1.43	1.45	20.12
	12	0.10	8.05	0.74	4.27	78.90	4.04	1.03	1.43	1.54	21.10
Philippines	2	0.12	4.86	1.12	2.39	7.00	68.44	3.94	11.93	0.33	31.56
	12	0.12	4.95	1.30	2.81	6.96	67.64	4.15	11.75	0.43	32.36
Korea	2	0.08	0.63	2.54	1.12	0.06	0.55	79.67	3.03	12.42	20.33
	12	0.08	0.63	2.73	1.12	0.13	0.56	79.32	3.17	12.36	20.69
Hong Kong	2	0.08	27.84	1.09	6.93	4.57	5.09	0.20	51.71	2.56	48.29
	12	0.08	27.59	1.09	7.28	5.01	5.07	0.64	50.75	2.58	49.25
Japan	2	0.08	2.56	2.47	1.58	0.67	0.90	10.02	0.78	81.02	18.98
	12	0.08	2.57	2.52	1.59	0.74	0.90	10.06	0.84	80.79	19.21
Panel B. Post-Crisis Period											
Malaysia	2	0.10	60.77	0.49	3.37	25.45	0.64	5.84	0.30	3.14	39.23
	12	0.11	53.60	0.56	4.39	29.49	0.62	6.15	1.02	4.17	46.40
Indonesia	2	0.14	0.90	46.04	13.81	35.97	1.30	0.93	0.03	1.02	53.96
	12	0.15	0.83	40.20	12.81	41.85	1.24	1.04	0.16	1.88	59.81
Singapore	2	0.08	0.43	1.78	18.88	51.27	8.72	1.74	16.43	0.76	81.12
	12	0.09	0.42	1.71	18.08	50.39	8.59	2.99	15.91	1.92	81.92
Thailand	2	0.12	0.15	0.98	0.81	72.11	0.38	1.56	2.98	21.04	27.89
	12	0.12	0.15	1.01	0.91	71.95	0.38	1.57	3.02	21.02	28.05
Philippines	2	0.10	1.02	5.89	8.03	34.39	32.23	0.68	4.30	13.46	67.77
	12	0.10	1.12	5.59	7.64	35.71	30.15	0.76	4.71	14.32	69.86
Korea	2	0.13	0.71	0.15	0.62	14.40	1.46	48.99	5.55	28.12	51.01
	12	0.14	0.69	0.15	3.19	14.62	1.46	46.58	5.35	27.96	53.42
Hong Kong	2	0.08	1.89	7.31	19.47	15.32	0.91	1.12	31.89	22.09	68.11
	12	0.08	1.82	7.19	19.67	14.81	1.04	2.19	30.83	22.45	69.17
Japan	2	0.06	6.79	1.69	2.61	15.33	1.38	1.86	5.61	64.74	35.26
	12	0.06	6.70	1.79	2.73	16.73	1.36	1.84	5.73	63.14	36.86

The results in Panel A of Table 1 indicate that prior to the crisis, most of the markets are rather interactive in the sense that a very high percentage of the error variance is accounted for by innovations in other markets (OTH column). Other markets' innovations generally account for more than 11%, with an average of 38%. Across the

markets, Singapore prevails as the most interactive (least exogenous) with about 77% of the error variance is explained by other markets. This finding is consistent with that in Liu *et al.* (1998), only stronger. As expected, Japan emerges as one of the most exogenous markets as its own innovations account for 81% of error variance. Surprisingly, Indonesia reports the least forecast error variance due to other markets (12%). One possible explanation is that the market is secluded from investment target because of prolonged political and economic uncertainties. Observation on the individual innovations suggests that no market appear to be a particularly influential foreign-source variance for other markets, including Japan.

TABLE 2. Variance Decomposition for the Post-Crisis Sub-Periods

Markets	Period	S.E.	MAS	INDO	SNG	THAI	PHIL	KOR	HKG	JPN	OTH
Panel A. Sub-Period 1											
Malaysia	2	0.15	53.78	0.27	1.36	31.08	0.55	7.01	0.20	5.75	46.22
	12	0.16	46.31	0.46	3.11	34.69	0.48	7.13	1.56	6.27	53.70
Indonesia	2	0.18	0.58	41.84	13.48	42.02	0.07	0.50	0.16	1.34	58.17
	12	0.20	0.73	35.77	12.63	47.40	0.07	0.83	0.35	2.23	64.23
Singapore	2	0.11	0.18	1.60	13.03	58.81	8.79	2.83	13.24	1.53	86.97
	12	0.12	0.27	1.50	12.82	55.95	8.50	5.07	12.97	2.92	87.18
Thailand	2	0.16	0.55	1.98	0.77	66.15	0.47	3.10	5.55	21.44	33.85
	12	0.16	0.59	2.01	0.89	65.85	0.48	3.09	5.69	21.40	34.15
Philippines	2	0.13	0.61	6.41	7.44	36.03	20.54	2.01	5.76	21.21	79.46
	12	0.14	0.98	5.96	7.15	36.68	18.64	2.22	6.55	21.82	81.36
Korea	2	0.18	1.18	0.41	4.23	14.21	1.74	35.42	11.28	31.53	64.58
	12	0.19	1.17	0.49	9.04	13.50	1.65	32.88	10.45	30.82	67.12
Hong Kong	2	0.11	0.37	9.50	21.69	16.03	0.07	1.38	26.00	24.97	74.01
	12	0.11	0.39	9.39	21.92	15.19	0.18	2.62	25.04	25.27	74.96
Japan	2	0.07	12.56	1.81	3.18	13.95	1.94	3.48	7.29	55.80	44.20
	12	0.07	12.32	2.24	3.27	14.56	1.94	3.39	7.93	54.36	45.65
Panel B. Sub-Period 2											
Malaysia	2	0.04	37.31	9.79	28.53	10.99	2.50	0.57	5.62	4.70	62.69
	12	0.04	36.01	9.51	28.27	12.82	2.54	0.73	5.52	4.60	63.99
Indonesia	2	0.08	2.07	53.66	11.50	14.03	9.63	3.89	1.99	3.23	46.34
	12	0.08	2.16	50.67	12.63	15.44	9.91	3.67	2.00	3.52	49.33
Singapore	2	0.05	12.21	1.40	30.54	20.25	12.61	13.31	9.63	0.06	69.46
	12	0.05	12.56	1.38	29.94	20.62	12.49	13.06	9.87	0.08	70.06
Thailand	2	0.07	7.61	3.30	4.08	64.28	2.60	2.05	1.34	14.74	35.72
	12	0.07	7.29	3.37	4.78	62.50	3.08	2.07	1.82	15.09	37.50
Philippines	2	0.06	2.03	13.78	12.57	8.24	57.76	3.04	2.46	0.12	42.24
	12	0.06	1.98	13.39	12.96	8.56	57.05	2.98	2.82	0.27	42.95
Korea	2	0.07	2.30	3.18	8.31	5.14	3.40	43.02	11.14	23.51	56.98
	12	0.07	3.09	3.48	8.18	6.53	3.73	41.36	10.66	22.98	58.64
Hong Kong	2	0.05	12.55	1.05	5.31	5.10	8.27	4.43	43.98	19.30	56.02
	12	0.05	12.82	1.19	5.45	6.36	8.09	4.97	42.14	18.99	57.86
Japan	2	0.05	8.87	2.19	3.38	21.36	4.34	3.31	3.85	52.70	47.30
	12	0.05	9.17	2.24	3.89	22.93	4.59	3.23	3.75	50.21	49.79

Panel B of Table 1 shows substantial increases in interactions during the post-crisis period. Specifically, the minimum fraction of the forecast errors explained by other

markets rises from 11% to 28% whereas the average increases from 38% to 55%. Similar to the results for pre-crisis period, Singapore remains the most interactive, with fraction of the error variance explained by other markets rises from 77% to 81%. The drop in the inter-market interactions in Malaysia is an isolated case because the remaining markets document substantial increases in interactions particularly the Philippines, Korea, and Indonesia. More importantly, the post-crisis period shows Thailand emerges as the most influential market. Thailand's innovations explain substantial fractions of the forecast error variance of all markets particularly the ASEAN markets. The findings so far support our prediction that the degree of stock market linkages changes significantly due to the crisis and the effect is in general transmitted from the location of the onset of the crisis, namely Thailand. It is also important to note that Japan is the most influential market next to Thailand. The results in Panel B show that innovations in Japan explain forecast error variance of Thailand (21%), the Philippines (14%), Korea (28%), and Hong Kong (22%).

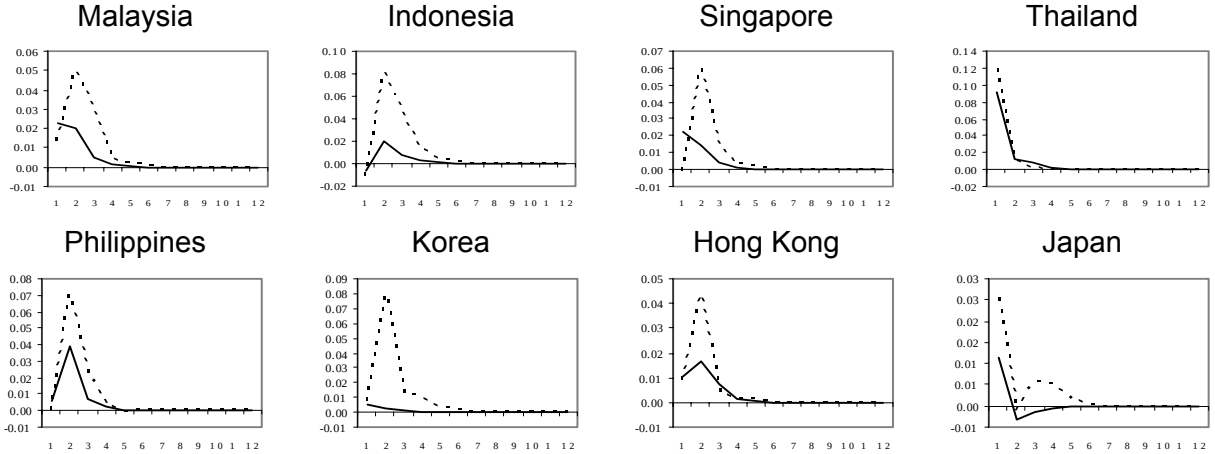
The results in Table 2 add support to our argument that the changes in market interactions are triggered by the 1997 crisis and originated from Thailand where the crisis started. By comparing the results in Panels A and B, one could easily identify that the influence of innovations in Thailand declines dramatically from sub-periods 1 to 2. Only in the case of Japan the innovations in Thailand increase from 15% to 23%. The leading role of Japan in the Asian markets also seems to be triggered by the crisis. Similar to Table 1, the results in Panel A of Table 2 show that Japan explains significant fractions of error variances of these markets, and slightly stronger. As is the case for Thailand, the results in Panel B show that Japan's influences on ASEAN markets are barely noticeable after the crisis.

4.2 Dynamic Response Patterns

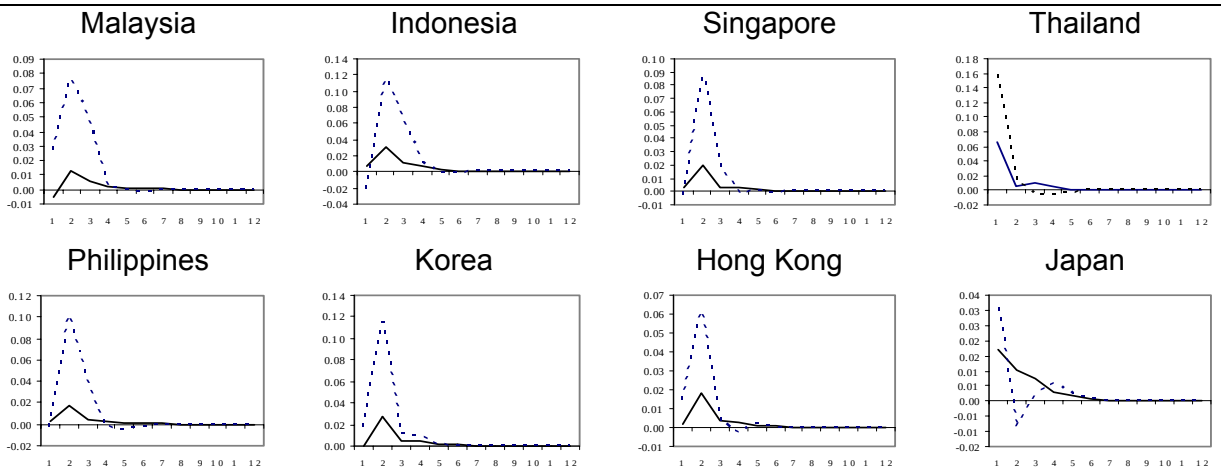
The estimated impulse responses provide an additional insight in examining how each of the markets responds to innovations in other markets. Although the tests are conducted for all eight markets, only results for influential markets (Thailand and Japan) are reported to conserve space. Panel A of Figure 1 shows that the responses to Thailand shock during the pre-crisis period are immediate and positive in all excepts three markets. That is, in Indonesia and the Philippines, the responses are also positive but after a 2-month delay. Korea barely shows noticeable responses. The market responses generally flatten out and diminish after the fourth month. Compared to the pre-crisis period, the post-crisis responses of these markets to Thailand shock generally increase tremendously but delayed for about two months. In short, similar to the results of the variance decomposition, this finding also support our argument that the significant change detected in the degree of market interactions is induced by the 1997 Asian crisis. This is further evidenced by the substantial differences between the responses during sub-periods 1 and 2 of the post-crisis. As depicted in Panel B, the responses during sub-period 1 are similar to those during the post-crisis period in Panel A, only stronger. On the contrary, the responses during the sub-period 2 revert to their lean shapes during pre-crisis period. These findings suggest that the patterns detected Panel A of the post-crisis period are attributes of the period of crisis.

FIGURE 1. Impulse Response of One SD Thailand Innovation

Panel A. Pre-and Post-Crisis Periods



Panel B. Post-Crisis Sub-Periods

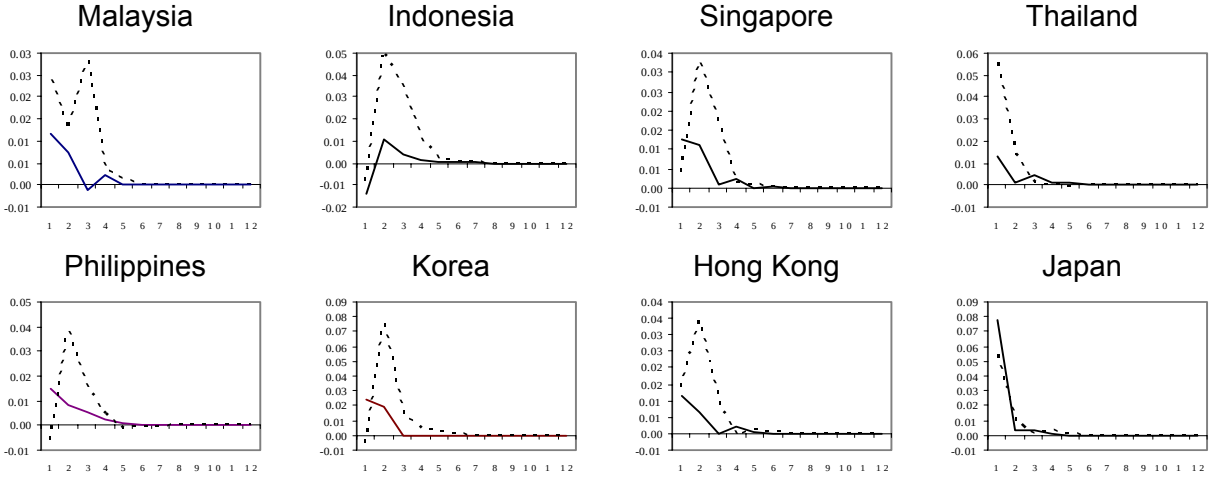


Note: In Panel A, tick lines represent pre-crisis period whereas broken lines represent post-crisis period. In Panel B, broken lines represent sub-period 1 whereas tick lines represent sub-period 2.

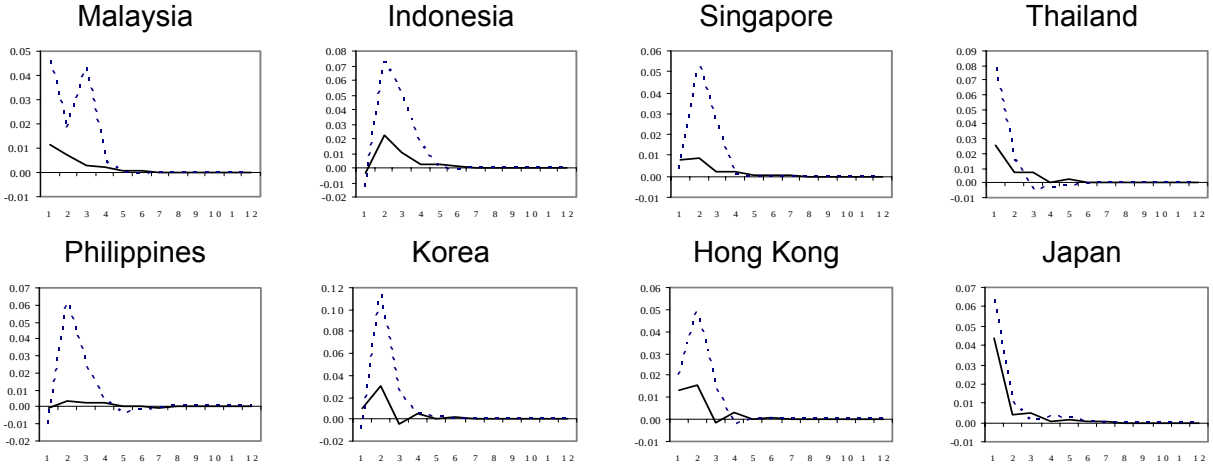
Figure 2 reports the impulse responses to innovations in Japan. The patterns in both panels reveal that the responses to innovations in Japan are similar to those in Thailand. Panel A shows that except Indonesia, all markets respond immediately and positively to shocks in Japan during the pre-crisis period. During the post-crisis period, most markets (except Thailand and Japan) wait until the second month before responding to the shock. There are also substantial increases in the responses to innovations in Japan as to those in Thailand during the post-crisis period. In addition, the response patterns in Panel B also support our argument that those increases are attributes of the crisis since the significant increases are confined to sub-period 1. In sub-period 2, the patterns of responses revert to the pre-crisis forms.

FIGURE 2. Impulse Response of One SD Japan Innovation

Panel A. Pre-and Post-Crisis Periods



Panel B. Post-Crisis Sub-Periods



Note: Use definition for Figure 1.

5. Conclusions and Implications

This study uses a vector-autoregressive analysis to examine the dynamic structure of international transmission in stock returns of ASEAN-5 plus 3 countries—Malaysia, Indonesia, Singapore, Thailand, the Philippines, Korea, Hong Kong, and Japan. The analyses use monthly stock index data from January 1986 through December 2006. The empirical evidence generally suggests that: (1) the degree of interdependence among national stock markets increases substantially after the 1997 Asian crisis; (2) Thailand which landmarks the onset of the crisis plays a dominant role of influencing the ASEAN-5 plus 3 markets after the crisis; (3) the role of Japan in the other Asian markets increases substantially after the crisis; and (4) as the economies return toward their tranquil conditions during the second half of the post-crisis period (2002:01 – 2006:12), the degree of interdependence among national markets reverts to nearly pre-crisis

levels. Overall, the results of this study adds to the current literature by presenting evidence that some decreases in the risk reduction benefits of international portfolio diversification have occurred due to increased integration in some of the world equity markets. However, given that the increased integration is confined to the period of crisis, these markets still serve as viable choices for risk reduction in international portfolio investing.

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