ASEAN-5+3 AND US STOCK MARKETS INTERDEPENDENCE BEFORE, DURING AND AFTER ASIAN FINANCIAL CRISIS

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Abstract

The issues of international stock markets linkages had been investigated over the time. Since the Asian financial crisis in 1997, many economists are concerned about the relationship between Asian stock markets and others in the world. This paper is conducted to examine the linkages between ASEAN-5+3 namely Malaysia, Singapore, the Philippines, Thailand, Indonesia, China, Japan and Korea and US stock markets. The data consists of weekly stock indices data. The total samples are separated into three sub-periods. First period is pre-crisis period spanning from January 1990 to June 1997. Second period is during-crisis period spanning from July 1997 to June 1998. Third period is post-crisis period spanning from July 1998 to May 2007. All the indices applied are expressed in local currencies. The empirical analysis begins with testing the stationarity properties of the data. All the countries are found to be stationary at first difference except for Japan for pre-crisis period. Next, cointegration test is employed to test the long-run stationary relationship among the stock markets. The number of significant cointegrating vector is higher during-crisis compare to other periods whereas the same number of cointegrating vector is found before and after crisis. Granger-causality based on VECM showed that Thailand is exogenous whereby Malaysia is the most endogenous at before and during the crisis. After the crisis, US become dominant compare to the other countries. In conclusion, we found that ASEAN-5+3 and US stock markets are interdependence during crisis and post-crisis periods and the impact of US stock market is effective in ASEAN-5+3 stock markets only for pre and during-crisis periods.

Keywords: Stock markets, Cointegration, Granger-causality, ASEAN

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Introduction

Until mid-1997, Asia attracted nearly half of the total capital inflow to the developing countries. At that time, Southeast Asian countries maintained high interest rate was attractive to foreign investors who look for higher return. Hence, the region's economies received a large inflow of money and a dramatic increased in asset prices. At the same time, the regional economies of Thailand, Malaysia, Indonesia, the Philippines, Singapore, and South Korea experienced high growth rates at 8-12%, in the late 80s and early 90s. This achievement was professedly by IMF and World Bank, and was known as one of the Asian economic miracle.

Regardless the disputed causes, the Asian crisis started in mid-1997 had affected the currencies, stock markets, and other asset prices of several Southeast Asian economies. Started in Latin America, whereby after the Mexican peso crisis in 1994, Western investors have lost confidence in securities in Southeast Asia. Therefore, they began to pull money out, and this situation created a domino effect.

At the mid of 1997, Thailand was hit by currency speculators, resulting in great damages in the financial sectors of country. What at first appeared to be local financial crisis in Thailand has escalated into a global financial crisis within few months. Initially, spreading to other Asian countries – Indonesia, Korea, Malaysia and the Philippines – then far afield to Russia and Latin America, especially Brazil. The Asian crisis, however, has turned out to be far more serious than its two predecessors in terms of the extent of contagion and the severity of resultant economic and social costs. Financial institutions and corporations with high foreign currencies debts in the afflicted countries were driven to financial distress and many were forced to default because of the massive depreciations in local currencies.

Several factors were responsible for the onset of Asian financial crisis: a weak domestic financial system, free international capital flows, the contagion effects of changing market sentiment and inconsistent economic policies. In recent years, both developing and developed countries were encouraged to liberalize their financial markets and allow free flows of capital across countries. As Asian developing countries eagerly sourcing foreign capitals from US, Japanese and European investors, who were attracted to these fast growing emerging markets for extra returns for their portfolios. Large inflows of private capital resulted in a credit boom in the Asian countries in the early and mid-1990s. The credit boom was often directed to speculations in real estate and stock markets as well as to investments in marginal industrial projects. Fixed or stable exchange rates also encouraged un-hedged financial transactions and excessive risk-taking by both lenders and borrowers, who were not much concerned with exchange risk.

As asset prices declined (as happened in Thailand prior to the currency crisis) in part due to the government's effort to control the overheated economy, the quality of banks' loan portfolios also declined as the same assets were held as collateral for the loans. In addition, their lending decisions were often influenced by political considerations, likely leading suboptimal allocation of resources. However, the so-called crony capitalism was not a new condition, and the East Asian economies achieved an economic miracle under the same system.

Meanwhile, the booming economies with a fixed or stable nominal exchange rate inevitably brought about an appreciation of the currencies. This, in turn, resulted in a market slowdown in export growth in these Asian countries like Thailand and Korea. If the Asian currencies had been allowed to depreciate in real terms which were not possible because of the fixed nominal exchange rates, discrete changes of the exchange rates as observed in 1997 might have been avoided. In Thailand, as the run on the Baht started, the Thai central bank initially injected liquidity to the domestic financial system and

tried to defend the currency by drawing on its foreign exchange reserves. Hence, its foreign reserves declining, the central bank of Thailand finally was forced to devalue the Baht.

International money and capital markets have become more integrated in recent years. Many studies have been undertaken to examine the integration of international stock markets. There are several reasons that contributed to the stock market interdependences, e.g. increase in capital flows across national boundaries and potential benefits from diversification of investment on international level. It is important for the investors to diversify international portfolio if they have the knowledge on the structure of equity market linkages across countries.

As a large number of investors competing to earn high returns, stock prices in different countries should closely reflect the underlying economic fundamentals. As a result, common stochastic trends in the stock market of those countries potentially mirror their economic fundamentals that are significantly related with each other (Phengpis and Apilado, 2004). According to Kearney and Lucey (2004), increase in integration of international equity markets, the diversification benefits will tend to decline. Lack of integration between the stock markets may allow the investors to minimize portfolio risk through international diversification.

This study consider whether ASEAN-5+3 countries namely Malaysia, Singapore, Indonesia, Thailand the Philippines, China, Korea, Japan and US are integrated with each other because of importance of their economic as trading partners and in terms of investment flows. Both the multilateral and bilateral relationship between the individual ASEAN-5+3 and US stock market is examined through the cointegration and Granger-causality techniques. In addition, we are interested to know whether US stock market has any effect on the ASEAN-5+3 stock indices before, during and after Asian financial crisis.

Literature Reviews on ASEAN-5 + 3 stock markets Integration

Arshanapalli et al. (1995) investigate the presence of common stochastic trend between the Asian and U.S. stock markets movements during pre- and post-October 1987. By using daily data, the sample includes index data for Japan, Hong Kong, Malaysia, the Philippines, Singapore, Thailand and US for time period January 1, 1986 through May 12, 1992. By implying cointegration and error-correction model, they find that the effect of the US stock market innovations was found to be greater during the post-October 1987. The results also show that the Asian equity markets are less integrated with Japan's equity market compare to US equity market.

Sheng and Tu (2000) analyze the among national stock markets before and during the Asian financial crisis by conducting cointegration and variance decomposition analysis. The data consist of daily closing prices for the New York S&P 500 and the following 11 major Asia-Pasific equity market indices: Tokyo Nikkei 225, Hong Kong Hang-Seng, Singapore Straits Times, Sydney All Ordinaries, Seoul Composite Index, Taiwan Composite Index, Kuala Lumpur Composite Index, Manila Composite Index, Bangkok Composite Index, Jakarta Composite Index and Shanghai B-shares Index. The stock prices are collected for the period from July 1, 1996 to June, 1998. The results indicate that the relationship for the Southeast Asian countries is stronger compare to Northeast Asian countries. The empirical results show that there is no cointegration before the Asian financial crisis. The forecast error variance decomposition analysis finds that the degree of exogeneity for all countries indices has been reduced.

Manning (2002) employs both the Johansen Maximum Likelihood approach and the Haldane and Hall Kalman Filter technique to examine the co-movement of equity markets in Southeast Asia and taking the U.S. to be the external market at the same time. The two samples analyzed comprise weekly and quarterly information on equity indices and US Dollar series for the US, Hong Kong, Japan, Indonesia, Malaysia, Korea Singapore, Taiwan, the Philippines and Thailand over the period January 1988 to February 1999. He finds that in general, there are two common trends present in the eight Asian equity market indices modeled here, and also two trends when the US market in additionally included in Johansen VAR.

Jaag and Sul (2002) analyze the changes in the co-movement among the stock markets of the countries which have undergone the crisis directly and the neighboring Asian countries since the crisis seems to have common impact on the Asian countries as a whole. These countries are Thailand, Indonesia and Korea as direct crisis countries and Japan, Hong Kong, Singapore and Taiwan as neighbouring countries. The total sample of the study is 2 years from October 1, 1996 to September 30, 1998, which is divided into three 8-month sub periods. By using Granger Causality test and co-integration analysis, they find that before the crisis, there is almost no co-movement in the stock markets of 7 Asian countries. However, uni-directional and bi-directional linkage among Asian equity markets has increased sharply since the financial crisis in June 1997. During the post-crisis, the strong co-movement is found and in some cases, the linkages among Asian stock markets are even stronger.

Azman-Saini et al. (2002) investigate whether or not causality is present among the ASEAN-5 equity markets in the long run. The weekly Morgan Stanley Composite Index (MSCI) indices obtained from the Kuala Lumpur Stock Exchange (KLSE) covering period of January 1988 to August 1999 are used in this study. Unit root tests involved both Augmented Dickey-Fuller (ADF) and Phillips and Perron (PP) tests. Johansen and Juselius (JJ) maximum likelihood procedure is employed for the purpose of cointegration testing and the Toda-Yamamoto causality procedure is viewed as a long-run causality test. The results of Granger non-causality test due to Toda and Yamamoto find that Singapore equity market was not affected by other equity markets except by the Philippines in the long-run. This may help to explain why among the ASEAN-5 equity markets, Singapore was not badly affected by the Asian financial crisis as well as the 0effects of the Gulf War in August 1990. This result indicates that there exist opportunities for beneficial international portfolio diversification in the context of the ASEAN-5 equity markets.

Click and Plummer (2005) examine whether the ASEAN-5 stock markets are integrated or segmented using cointegration technique to extract long-run relations. Daily and weekly stock index quotes in local currencies data from July 1, 1998 through December 31, 2002 are used. The empirical results suggest that the ASEAN-5 stock markets are cointegrated. However, only one cointegrating vector is found, leaving four common trends among the five variables. Hence, the ASEAN-5 stock markets are integrated, but that integration is still far from complete

Choudhry et. al. (2007) examine empirically the change(s) in the long run relationship(s) between the stock prices of eight Far East countries namely Thailand, Malaysia, Indonesia, Hong Kong, Singapore, the Philippines, South Korea and Taiwan around the Asian financial crisis of 1997-98. Further test are conducted to check the change in the influence of the US and Japanese stock markets in the Far East region before, during, and after the Asian financial crisis. The daily stock price indices are used ranging from January 1, 1988 to January 1, 2003. The empirical investigation such as means of rolling correlation coefficients, multivariate cointegration method, causality test and band spectrum regression are conducted. The empirical results show significant long-run relationship(s) and linkages between the Far East stock markets before, during and after the Asian financial crisis. Lastly, results also

mostly indicate larger U.S. influence in all periods but some evidence of increasing Japanese influence is also found.

Data and Empirical Results

The data set consists of the daily stock markets for ASEAN-5+3 and US stock markets covering the period from 1st January 1990 to 31st May 2007. The stork markets are Kuala Lumpur Composite Index (Malaysia), Philippines Stock Exchange Composite (Philippines) Jakarta Stock Exchange Composite (Indonesia), Bangkok Stock Exchange of Thailand (Thailand), Straits Times Index (Singapore) Nikkei 225 Stock Average (Japan), KOSPI Composite Index (Korea), Shanghai Stock Exchange Composite Index (China) and Dow Jones Industrial Average Index (United States). All stock markets are denominated in local currencies. The analysis of data is divided into three sample periods[2]: first, pre-crisis period spanning from 1st January 1990 to 30th June 1997; second, crisis-period from 1st July 1997 to 30th June 1998; and third, post-crisis period from 1st July 1998 to 31st May 2007.

Before we proceed with cointegration tests, it is important to examine the univariate properties of the each time series variable. Notably, cointegration procedure requires that all variables in the system are stationary at first difference, I(1). As shown in Table 1, all variables are non-stationary in their level form because the null hypothesis of unit root is fail to be rejected at any conventional significant level except for Japan at the pre-crisis period. For during-crisis period and post-crisis period, stock indices of ASEAN-5+3 and U.S. are stationary after first differences, that is integrated of first order and thereby implying a clear I(1) process. The confirmation of I(1) has fulfilled the requisite for the forthcoming cointegration analysis.

[2] Choudhry *et al.* (2007) also divide their total sample into sub-samples of pre-crisis and post-crisis.

Table 1: DF/ADF and PP unit root tests

Countries	ADF								PP							
	Level				1st difference				Level				1st difference			
	Constant	k	Trend	k	Constant	k	Trend	k	Constant	k	Trend	k	Constant	k	Trend	k
Pre-crisis period (Jan 1, 1990 - June 30, 1997)																
Malaysia	-0.89	0	-2.14	0	-18.38**	0	-18.35**	0	-0.94	2	-2.22	1	-18.36**	4	-18.33**	4
Singapore	-0.87	0	-2.23	0	-18.12**	0	-18.09**	0	-1.00	3	-2.49	4	-18.12**	0	-18.09**	0
Thailand	-1.23	0	-0.92	0	-18.74**	0	-18.76**	0	-1.42	7	-1.11	6	-18.80**	5	-18.80**	5
Indonesia	-0.74	2	-1.58	2	-10.34**	1	-10.43**	1	-1.01	11	-1.66	11	-18.46**	11	-18.39**	10
Philippines	-2.22	0	-2.46	0	-12.51**	0	-12.48**	0	-2.34	1	-2.46	0	-12.51**	5	-12.48**	5
Japan	-3.31*	0	-2.88	0	-20.53**	0	-20.65**	0	-3.31*	4	-2.93	5	-20.53**	5	-20.63**	4
Korea	-1.84	0	-2.38	0	-19.96**	0	-19.95**	0	-1.83	1	-2.38	0	-19.96**	3	-19.95**	3
U.S.	1.60	0	-1.36	0	-21.04**	0	-21.23**	0	1.97	13	-1.23	10	-21.04**	9	-21.32**	11
During-crisis period (July 7, 1997 - June 29, 1998)																
Malaysia	-1.40	0	-1.95	0	-7.72**	0	-7.64**	0	-1.35	3	-1.94	3	-7.75**	2	-7.67**	2
Singapore	-0.68	0	-2.56	0	-8.17**	0	-8.11**	0	-0.57	3	-2.68	4	-8.20**	2	-8.14**	2
Thailand	-0.26	0	-1.14	0	-3.65**	1	-3.61**	0	-0.56	3	-1.59	4	-6.39**	3	-6.34**	3
Indonesia	-2.45	0	-2.15	0	-8.78**	0	-8.98**	0	-2.40	1	-2.00	1	-8.74**	2	-8.98**	2
Philippines	-2.34	0	-2.20	0	-7.96**	0	-7.96**	0	-2.30	1	-2.14	1	-7.96**	0	-7.95**	1
Japan	-2.17	0	-2.04	0	-7.54**	0	-7.70**	0	-2.10	5	-1.94	3	-7.57**	4	-7.93**	6
Korea	-0.81	0	-1.75	0	-8.36**	0	-8.29**	0	-0.81	3	-1.93	4	-8.25**	4	-8.18**	4
China	-1.11	0	-2.84	1	-5.66**	0	-5.65**	0	-1.25	2	-2.23	2	-5.61**	7	-5.68**	8
US	-0.89	0	-2.63	2	-4.07**	0	-4.12**	0	-0.78	4	-2.20	3	-9.23**	1	-9.20**	1
Post-crisis period (July 6, 1998 - May 28, 2007)																
Malaysia	-1.39	1	-2.07	1	-19.09**	0	-19.07**	0	-1.65	7	-2.35	7	-19.37**	6	-19.35**	6
Singapore	-1.11	0	-1.43	0	-20.16**	0	-20.14**	0	-1.27	7	-1.64	7	-20.24**	6	-20.22**	6
Thailand	-1.27	0	-1.94	0	-13.01**	1	-13.00**	1	-1.36	3	-2.13	4	-21.56**	3	-21.54**	3
Indonesia	0.66	0	-1.36	0	-20.04**	0	-20.14**	0	0.24	11	-1.69	11	-20.49**	11	-20.53**	11
Philippines	0.04	0	-0.69	0	-19.09**	0	-19.21**	0	-0.49	7	-1.10	7	-19.46**	6	-19.52**	5
Japan	-1.04	0	-0.82	0	-21.92**	0	-22.03**	0	-1.06	6	-0.82	5	-21.92**	6	-22.02**	5
Korea	-1.88	0	-2.39	0	-23.22**	0	-23.20**	0	-1.90	9	-2.49	10	-23.15**	10	-23.13**	10
China	1.78	0	1.54	0	-19.80**	0	-19.98**	0	1.09	8	1.01	7	-20.23**	9	-20.26**	8
US	-1.67	0	-2.10	0	-23.20**	0	-23.20**	0	-1.44	8	-1.95	7	-23.38**	9	-23.39**	9

Notes: Asterisk (**) and (*) denotes 99% and 95% of significant level.

Cointegration test is used to investigate the long-run relationship between non-stationary variables. Two or more non-stationary variables are cointegrated if a linear combination of these is stationary. Table 2 shows the cointegration tests results in three parts; pre-crisis (part A), during-crisis (part B) and post-crisis (part C). For each period, cointegration tests are conducted on two models: the first model includes all the ASEAN-5 with China, Korea and Japan in the VAR and in the second model the US stock index is added in the VAR. In this way, the second model check for the presence of the US index in the long-run relationship between the stock indices of the ASEAN-5 with China, Korea and Japan: before, during and after financial crisis.

For the pre-crisis period (part A) in Table 2, both the trace test and maximum eigenvalues statistics in model 1 failed to reject the null hypothesis of no cointegrating vector. Thus, the first result from the pre-crisis period is failed to show any possible significant long-run stationary relationships between the ASEAN-5 with Korea (excluding Japan due to its stationary properties and China due to lack of data). This result change when US index is added in model 2. Trace test show two significant vectors whereas maximum eigenvalues test show only one significant vector. Therefore, since both test agreed upon one significant vector, this may imply that US is a crucial element in the cointegrating vector(s) and would indicate interdependence among these ASEAN-5 and Korea stock markets with the larger market of US during the pre-crisis period. Since all the eigenvalues in all the tests are less than one, it show that the system as a whole is stable.

Results from the crisis period are shown in Table 2 (part B). Once again, two models are tested. In the first model (ASEAN-5 with China, Korea and Japan), the trace test indicates three vectors whereas maximum eigenvalues indicates two vectors at 1% significant level. Thus, result shows two[3] stationary long-run relationships between the ASEAN-5 with China, Korea and Japan stock indices. In the second model, when US is added in the VAR, both trace test and maximum eigenvalues test indicate six vectors and three vectors at 1% significant level. As compared to pre-crisis period, the number of cointegrating vector increased from 1 to 3. This proves an increase in the degree of linkages among these stock markets. Based on Ratanapakorn and Sharma (2002), globalization increased during the Asian financial crisis and more number of long-run relationships during the period may be due to the increased globalization among the stock markets. They also find evidence of increased linkages among the stock markets during the Asian financial crisis period. More number of cointegrating vectors imply that during the crisis period, diversification and portfolio risk management may not reduce risk significantly. Other than that, including the US stock index many not help in reducing the portfolio risk. Most previous studies also find significant linkages among the Asian stock markets during the Asian financial crisis. Again, the eigenvalues in all tests are less than one.

Table 2 (part C) presents the post-crisis results. Both the trace and maximum eigenvalues statistics in model 1 and 2 show that only one significant cointegrating vector exists. Thus, during the post-crisis period, only one stationary long-run relationship is found between the ASEAN-5 with China, Korea and Japan with or without the US index in the VAR. The number of cointegrating vector had decreased if we compared to during-crisis period. The decrease in the degree of linkages of these markets could be due to specific risks, such as liquidity, currency risk, macroeconomic instability and etc. All these factors may discouraged foreign investors and lowered the globalization in the region.

By comparing the cointegration results between the three periods, the results indicate that long-run relationships existed among the stock indices.[4] In the three sub-periods, more non-zero cointegration vectors are found during the Asian financial crisis period. Higher number of nonzero cointegration vectors (lower number of common trends) implies that diversification and minimizing portfolio risk by investors was harder during the crisis period compared to other periods. Furthermore, the results show that the relationships between the stock markets of the region did not change much at before and after the Asian financial crisis. Common stochastic trends in the stock markets of those countries potentially mirror their economic fundamentals that are related significantly with each other. Overall, based on cointegration results, the inclusion of the US index in a portfolio of ASEAN-5 with China, Korea and Japan markets may not help to reduce portfolio risk.

[3] both test show different significant level. Therefore, we only consider when both statistics agreed upon at two significant cointegrating vectors.

[4] except ASEAN-5 with Korea before crisis.

Table 2: Cointegration Tests Results

Vectors	r = 0	r ≤ 1	r ≤ 2	r ≤ 3	r ≤ 4	r ≤ 5	r ≤ 6	r ≤ 7
Part A : Pre-crisis results (Jan 1, 1990 - June 30, 1997), Lags = 5								
Model 1: ASEAN-5 with Korea in the VAR								
Trace	97.844	60.684	39.742	21.414	8.212	0.076	-	-
Critical Value (1%)	103.18	76.07	54.46	35.65	20.04	6.65	-	-
Max-Eeigen	37.16	20.942	18.328	13.202	8.136	0.076	-	-
Critical Value (1%)	45.1	38.77	32.24	25.52	18.63	6.65	-	-
Eigenvalues	0.202	0.119	0.105	0.077	0.048	0	-	-
Model 2: ASEAN-5 with Korea and U.S. in the VAR								
Trace	145.177[a]	92.771	60.592	38.334	17.079	5.399	0.7	-
Critical Value (1%)	133.57	103.18	76.07	54.46	35.65	20.04	6.65	-
Max-Eeigen	52.407[a]	32.179	22.258	21.255	11.679	4.7	0.7	-
Critical Value (1%)	51.57	45.1	38.77	32.24	25.52	18.63	6.65	-
Eigenvalues	0.272	0.177	0.126	0.121	0.068	0.028	0.004	-
Part B : Crisis results (July 1, 1997 - Jun 30, 1998), Lags = 3								
Model 1: ASEAN-5 with China, Korea, Japan in the VAR								
Trace	230.413[a]	169.929[a]	118.119[a]	73.133	42.051	20.883	6.738	0.005
Critical Value (1%)	168.36	133.57	103.18	76.07	54.46	35.65	20.04	6.65
Max-Eeigen	60.484[a]	51.810[a]	44.986	31.083	21.168	14.144	6.733	0.005
Critical Value (1%)	57.69	51.57	45.1	38.77	32.24	25.52	18.63	6.65
Eigenvalues	0.747	0.692	0.64	0.507	0.382	0.275	0.142	0.000
Model 2: ASEAN-5 with China, Korea, Japan and U.S. in the VAR								
Trace test	378.608[a]	272.429[a]	200.273[a]	137.640[a]	95.281[a]	58.550[a]	27.126	7.894
Critical Value (1%)	204.95	168.36	133.57	103.18	76.07	54.46	35.65	20.04
Max-Eeigen	106.179[a]	72.157[a]	62.633[a]	42.358	36.731	31.424	19.232	6.847
Critical Value (1%)	62.80	57.69	51.57	45.1	38.77	32.24	25.52	18.63
Eigenvalues	0.91	0.806	0.759	0.618	0.566	0.51	0.354	0.144
Part C : Post-crisis results (July 6, 1998 - May 28,2007), Lags = 6								
Model 1: ASEAN-5 with China, Korea, Japan in the VAR								
Trace test	192.575[a]	128.098	81.915	49.077	29.283	14.872	4.509	0.747
Critical Value (1%)	168.36	133.57	103.18	76.07	54.46	35.65	20.04	6.65
Max-Eeigen	64.477[a]	46.183	32.838	19.794	14.411	10.363	3.761	0.747
Critical Value (1%)	57.69	51.57	45.1	38.77	32.24	25.52	18.63	6.65
Eigenvalues	0.16	0.117	0.085	0.052	0.038	0.028	0.01	0.002
Model 2: ASEAN-5 with China, Korea, Japan and U.S. in the VAR								
Trace test	229.335[a]	161.961	116.318	79.069	45.881	24.531	10.796	2.169
Critical Value (1%)	204.95	168.36	133.57	103.18	76.07	54.46	35.65	20.04
Max-Eeigen	67.374[a]	45.643	37.249	33.188	21.35	13.735	8.627	1.303
Critical Value (1%)	62.80	57.69	51.57	45.1	38.77	32.24	25.52	18.63
Eigenvalues	0.166	0.116	0.096	0.086	0.056	0.036	0.023	0.004

Note : [a] denotes respectively, the significance at 99% confidence interval.

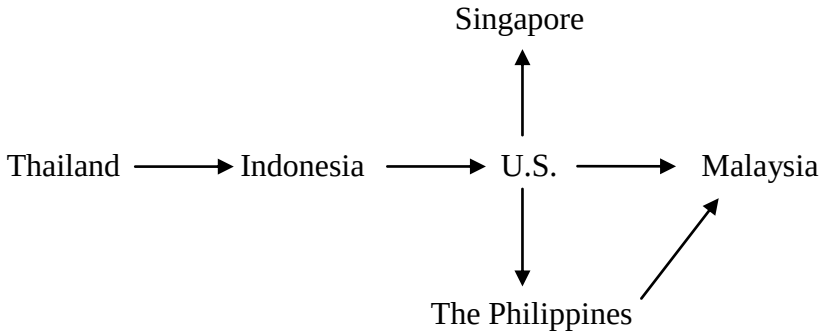
The next step would be identifying the direction of causality among these ASEAN-5+3 and US stock markets. Granger causality tests based on VECM for pre-crisis period are conducted and the results are reported in Table 3. For Singapore, Korea and the Philippines, the error correction terms (ECTs) are negative and statistically significant at 95% significance level. The temporal causality effects are active, consequently, Singapore, the Philippines and Korea are endogenously determined in the model and sharing the burden of short-run adjustment to long-run equilibrium. The temporal causality channels are abstracted from Table 3 and summarized in Figure 1.There are unidirectional causal effect running from Thailand to Indonesia and Indonesia to US before the risk spread to other countries. Changes in the Philippines, Malaysia and Singapore stock market is being led by changes in US stock market. From Figure 1, it's clearly show that when the Asian financial crisis in 1997 started in Thailand, this crisis spread to Indonesia, Malaysia and the Philippines.

Table 3: Granger-causality based on VECM [pre-crisis (with U.S.)]

k=5, r=1	Independent variables							
Dependent Variables	Δ *US*	Δ *MAS*	Δ *SIN*	Δ *PHI*	Δ *IND*	Δ *THAI*	Δ *KOR*	*ECT*
	F-statistics							
Δ *US*		2.142	2.239	0.752	2.900[b]	1.217	0.949	-0.001
		[0.079]	[0.068]	[0.558]	[0.024]	[0.307]	[0.438]	
Δ *MAS*	2.564[b]		1.367	2.629[b]	1.541	1.419	1.375	-0.010
	[0.041]		[0.249]	[0.037]	[0.194]	[0.231]	[0.246]	
Δ *SIN*	2.177[b]	0.479		1.207	1.175	0.441	0.742	-0.059[a]
	[0.075]	[0.751]		[0.311]	[0.325]	[0.779]	[0.565]	
Δ *PHI*	2.594[b]	0.183	1.510		2.310	1.836	0.523	-0.055[b]
	[0.039]	[0.947]	[0.203]		[0.061]	[0.126]	[0.719]	
Δ *IND*	1.638	0.425	0.893	0.199		2.943[b]	0.860	0.010
	[0.168]	[0.791]	[0.470]	[0.938]		[0.023]	[0.490]	
Δ *THAI*	0.797	0.528	0.337	0.652	0.253		0.480	0.050
	[0.529]	[0.715]	[0.853]	[0.627]	[0.907]		[0.751]	
Δ *KOR*	1.377	0.875	0.713	1.833	1.594	0.081		-0.084[a]
	[0.245]	[0.481]	[0.584]	[0.126]	[0.179]	[0.988]		

Notes: The ECT was derived by normalizing the cointegration vector on *US*, with the residual checked for stationarity by way of unit root tests and inspection of its ACF. Figures presented in the final column are coefficient values associated with estimated *t*-statistics testing the null that the ECT is statistically insignificant for each equation. All other estimates are asymptotic Granger *F*-statistics. [a] and [b] indicate significance at the 1% and 5% levels. P-values are presented in the parenthesis [ ]. The following notations apply in the table: US=United States, MAS=Malaysia, SIN=Singapore, PHI=Philippines, IND=Indonesia, THAI=Thailand and KOR=Korea.

Figure 1: Short-run causality effect [pre-crisis (with U.S.)]



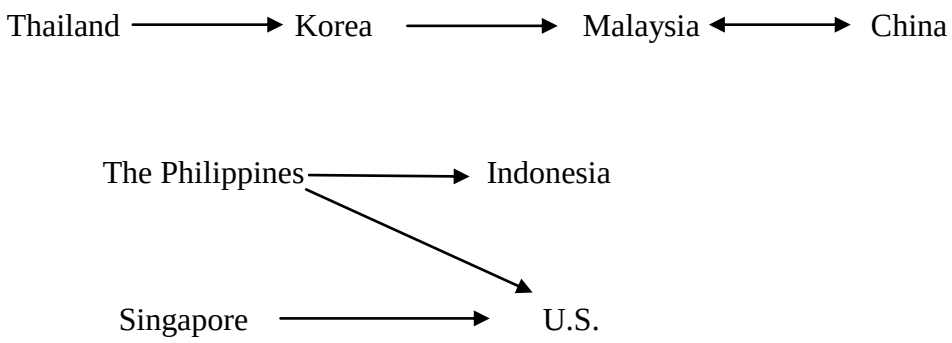
During-crisis period, the results in Table 2 (part B), for the second model indicates that there are three significant cointegrating vectors among ASEAN-5, China, Korea, Japan and US stock markets. Table 4 reports the results of Granger causality test based on VECM for these nine markets. With regard to ECTs, our discussion will focus only on negative and significant ECTs within the three ECTs. China is the only stock market which had negative significant ECTs without mixture with positive significant ECTs. Therefore, China stock market is clearly endogenous determined in the system and bear the burden of short-run adjustment towards the long-run equilibrium. Korea and the Philippines stock markets had mixture positive and negative significant ECTs while Indonesia, Malaysia and Singapore stock markets had positive significant ECTs. The temporal causality channels are abstracted from table 4 and summarized in Figure 2. Since there are three significant long run relationships between the variables, therefore we get three groups of short run relationships. For the first group, changes in Thailand stock market will affect Korea stock market and indirectly affected Malaysia stock market too via Korea. There is one bidirectional causal effect between Malaysia and China stock markets. In the second group, the Philippines spread out the risk to Indonesia and US stock markets. Meanwhile, the last group has a unidirectional causal effect running from Singapore to the US stock market.

Table 4: Granger-causality based on VECM [during-crisis (with U.S.)]

k=3, r=3	Independent variables											
Dependent variables	Δ *CHI*	Δ *JAP*	Δ *KOR*	Δ *IND*	Δ *MAS*	Δ *PHI*	Δ *SIN*	Δ *THAI*	Δ *US*	ECT_1	ECT_2	ECT_3
	F -statistics											
Δ *CHI*		2.755	1.110	0.905	4.113[b]	0.090	0.938	0.342	0.067	-0.219	-0.625[a]	0.131
		[0.086]	[0.347]	[0.419]	[0.030]	[0.914]	[0.406]	[0.714]	[0.936]			
Δ *JAP*	0.693		1.104	0.155	0.776	1.182	0.565	1.323	2.891	-0.218	0.053	0.105
	[0.510]		[0.348]	[0.858]	[0.472]	[0.325]	[0.576]	[0.286]	[0.076]			
Δ *KOR*	3.161	0.552		1.198	0.876	2.664	0.411	7.837[a]	1.832	-1.902[a]	-1.252[b]	0.694[a]
	[0.061]	[0.583]		[0.320]	[0.430]	[0.091]	[0.668]	[0.003]	[0.183]			
Δ *IND*	1.179	2.679	2.702		1.159	4.313[b]	2.539	0.877	1.518	0.090	1.792[a]	-0.095
	[0.326]	[0.090]	[0.089]		[0.331]	[0.026]	[0.100]	[0.430]	[0.240]			
Δ *MAS*	3.418[b]	2.156	5.332[b]	0.470		0.935	0.032	0.632	0.222	0.534	1.232[b]	-0.374
	[0.050]	[0.139]	[0.013]	[0.631]		[0.407]	[0.969]	[0.541]	[0.803]			
Δ *PHI*	0.996	2.206	1.638	0.381	0.570		1.033	2.001	0.256	0.897[b]	1.595[a]	-0.658[a]
	[0.385]	[0.133]	[0.216]	[0.687]	[0.573]		[0.372]	[0.158]	[0.777]			
Δ *SIN*	1.082	2.531	1.671	0.265	0.952	0.624		1.022	0.214	0.566	1.066[b]	-0.396
	[0.355]	[0.102]	[0.210]	[0.769]	[0.401]	[0.545]		[0.376]	[0.809]			
Δ *THAI*	1.599	0.421	3.019	1.226	0.076	1.531	3.178		2.037	0.434	0.660	-0.216
	[0.224]	[0.661]	[0.069]	[0.312]	[0.927]	[0.238]	[0.060]		[0.153]			
Δ *US*	0.169	0.216	0.668	0.538	0.265	7.553[a]	7.016[a]	1.504		-0.102	-0.138	0.012
	[0.846]	[0.808]	[0.522]	[0.591]	[0.770]	[0.003]	[0.004]	[0.243]				

Notes: The ECT_1 was derived by normalizing the cointegration vector on *CHI*, The ECT_2 was derived by normalizing the cointegrating vector on *JAP* whereas The ECT_3 was derived by normalizing the cointegrating vector on *KOR*, with the residual checked for stationarity by way of unit root tests and inspection of its ACF. Figures presented in the final column are coefficient values associated with estimated t-statistics testing the null that the lagged ECT is statistically insignificant for each equation. All other estimates are asymptotic Granger F-statistics. [a] and [b] indicate significance at the 1% and 5% levels. P-values are presented in the parenthesis [ ]. The following notations apply in the table: CHI=China and JAP=Japan.

Figure 2: Short-run causality effect [during-crisis (with U.S.)]



The results of cointegration during post-crisis period in Table 2 (part C), for second model indicates that only one significant long run relationship exist among ASEAN-5, China, Japan, Korea and US stock markets. Table 5 reports the result of Granger-causality tests based on VECM. Statistically significant ECT only in the equations for Singapore, China and Indonesia. However, only the ECTs for Singapore and China carried the correct sign. This imply that when there is a deviation from the equilibrium cointegrating relationships in this system, it is mainly the changes in China and Singapore

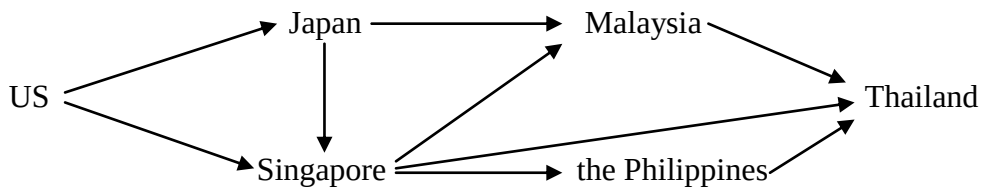
stock markets that adjust to clear the disequilibrium. The temporal causality channels are abstracted from Table 5 and summarized in Figure 3. It's clearly showed that US stock market is exogenous whereas Thailand stock market is endogenous in the short run. There is unidirectional causal effect running from US to Japan and US to Singapore. At the same time, Singapore stock market also affected by Japan stock market. Malaysia stock market is Granger-caused by Japan and Singapore stock markets. There also causal effect from Singapore to the Philippines. Lastly, changes in Thailand stock market caused by changes in Malaysia, Singapore and the Philippines stock markets.

Table 5: Granger-causality based on VECM [post-crisis (with U.S.)]

k=6, r=1	Independent variables									
Dependent variables	Δ *THAI*	Δ *MAS*	Δ *PHI*	Δ *SIN*	Δ *JAP*	Δ *US*	Δ *CHI*	Δ *IND*	Δ *KOR*	*ECT*
	F -statistics									
Δ *THAI*		3.864[a]	2.825[b]	3.734[a]	2.152	2.188	2.237	0.966	0.999	-0.007
		[0.002]	[0.016]	[0.003]	[0.059]	[0.055]	[0.051]	[0.439]	[0.418]	
Δ *MAS*	0.675		1.485	4.727[a]	2.773[b]	2.135	0.265	1.638	1.509	-0.009
	[0.642]		[0.194]	[0.000]	[0.018]	[0.061]	[0.932]	[0.149]	[0.186]	
Δ *PHI*	1.239	2.161		3.522[a]	1.910	1.111	0.447	0.569	0.373	-0.005
	[0.290]	[0.058]		[0.004]	[0.092]	[0.354]	[0.815]	[0.724]	[0.867]	
Δ *SIN*	0.654	0.709	1.922		2.667[b]	3.603[a]	0.341	0.929	0.915	-0.019[a]
	[0.659]	[0.617]	[0.090]		[0.022]	[0.004]	[0.888]	[0.462]	[0.472]	
Δ *JAP*	0.863	0.114	0.955	1.275		3.631[a]	0.521	0.077	1.087	0.010
	[0.506]	[0.989]	[0.445]	[0.274]		[0.003]	[0.760]	[0.996]	[0.367]	
Δ *US*	0.948	0.616	0.574	0.643	1.334		0.446	0.726	0.991	0.003
	[0.450]	[0.688]	[0.720]	[0.667]	[0.249]		[0.816]	[0.604]	[0.423]	
Δ *CHI*	0.491	0.475	0.477	1.287	1.361	0.570		2.238	0.666	-0.017[b]
	[0.783]	[0.795]	[0.793]	[0.269]	[0.239]	[0.723]		[0.051]	[0.650]	
Δ *IND*	0.538	1.312	1.206	1.280	0.391	0.949	0.968		0.966	0.026[a]
	[0.747]	[0.259]	[0.306]	[0.272]	[0.855]	[0.449]	[0.437]		[0.439]	
Δ *KOR*	1.228	0.741	0.468	0.848	0.718	2.024	1.208	1.024		-0.011
	[0.295]	[0.593]	[0.800]	[0.517]	[0.610]	[0.075]	[0.305]	[0.403]		

Notes: The ECT was derived by normalizing the cointegration vector on *THAI*, with the residual checked for stationarity by way of unit root tests and inspection of its ACF. Figures presented in the final column are coefficient values associated with estimated t-statistics testing the null that the lagged ECT is statistically insignificant for each equation. All other estimates are asymptotic Granger F-statistics. [a] and [b] indicate significance at the 1% and 5% levels. P-values are presented in the parenthesis [ ].

Figure 4.3: Short-run causality effect [post-crisis (with US)]



Conclusions

This study attempts to examine the linkages between the ASEAN-5+3 and U.S. stock markets. The empirical analysis of this study begins with the Augmented Dickey-Fuller and Phillips-Perron stationarity tests in order to determine at which level do the data exhibit stationarity for the purpose of cointegration analysis application. Results show that the long-run relationships between ASEAN-5+3 stock markets occur only for during- and post-crisis period. For the pre-crisis period, there is no significant cointegrating vector among the ASEAN-5+3 stock markets. Before and during-crisis, the number of cointegrating vector increased after US stock market had been included in the model during the crisis. This implied that the system is more interdependence. Hence, by adding US stock market is not helping investors to reduce the portfolio risk. The results of short-run Granger-causality based on VECM showed that Thailand stock market is the most exogenous markets. Surprisingly, China and Korea stock markets are active in short-run only during-crisis but not before and after crises. These probably due to most of the markets are more sensitive to changes in other's market during the crisis period.

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