ARE THE FIVE ASEAN STOCK PRICE INDICES DYNAMICALLY INTERACTED?

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Abstract: This study seeks to examine the dynamic interactions of stock price indices in five ASEAN countries, Indonesia; Malaysia; the Philippines; Singapore; and Thailand with particular attention to the 1997 Asian financial crisis and period onwards. Using monthly time series data of the stock price indices countries, a vector error correction model (VECM) is employed to empirically examine the interaction among the variables. The finding is that the five ASEAN stock market prices were found to be integrated with two cointegrating vectors during the sample period, and that accounting innovation analyses show the short run dynamic interactions among those stock markets. The important implication might be drawn from the finding is that portfolio diversification across the five ASEAN stock markets is unlikely to reduce investment risk due to high degree of financial integration of these markets.

Keywords*:* ASEAN financial crisis, stock markets integration, VECM.

Abstrak: *Studi ini bertujuan meneliti interaksi dinamis antara indeks harga saham yang terdapat di lima negara ASEAN, yaitu Indonesia, Malaysia, Filipina, Singapura, dan Thailan yang terjadi selama masa krisis finansial Asia tahun 1997 dan periode sesudahnya. Dengan menggunakan data* time series *bulanan indeks harga saham dari kelima negara tersebut selama periode penelitian, suatu* vector error correction model *(VECM) diaplikasikan untuk meneliti secara empiris interaksi dinamis yang terjadi diantara berbagai variabel yang dipergunakan dalam penelitian ini. Dari hasil penelitian ditemukan dua vektor kointegrasi (*cointegration vector*) selama masa penelitian, dan analisa inovasi akuntansi (*accounting innovation analyses*) menunjukan adanya interaksi dinamis jangka pendek diantara pasar saham tersebut. Implikasi penting yang mungkin perlu diperhatikan dari penemuan ini adalah bahwa diversifikasi portofolio saham pada lima pasar saham tersebut agaknya tidak akan secara signifikan mengurangi tingkat resiko investasi. Hal ini dikarenakan oleh tingginya tingkat integrasi diantara pasar saham tersebut.*

Kata kunci*: krisis finansial Asia, integrasi pasar modal, VECM.*

Liberalization of the five ASEAN (Indonesia, Malaysia, the Philippines, Singapore, and Thailand) financial markets in 1980s resulted in enormous capital inflows to this region. The countries' financial markets were overwhelmed by international capital inflows to finance domestic investment and current account deficits in order to raise sustainable economic growth and the standard of living in

those countries. Hence, capital inflows have been crucial to the rapid, sustained growth in ASEAN countries (Sachs and Larrain, 1993:577), particularly before the 1997 financial crisis, since domestic saving, as commonly in developing countries, had little role as development funding. At that time the five ASEAN countries enjoyed high economic growth as well as rapid financial and capital markets expansion.

Typically, the capital inflows in ASEAN pre-crisis were quite different from those of other developing Asian countries. Most of the capital inflow was dominated by bank loan and portfolio investment, not by foreign direct investment (FDI) as it was in China (DFAT, 1999:29). The higher interest rate and stock market returns in these countries relative to developed ones might have become the main factor that contributed to the large short-term capital inflows (DFAT, 1999:25-7).

As a consequence of these large capital inflows and pegged (as in Thailand and the Philippines) or crawling (as in Indonesia, and Malaysia) exchange rate regimes, which, in fact, caused domestic currency overvalues, in the pre-crisis period, the banking system grew very rapidly. This rapid growth, however, was not supported by strong and adequately-supervised financial systems in each country (Radelet and Sachs, 1999b:5). It indicates that a moral-hazard crisis might have arisen in those countries (Radelet and Sachs, 1998:4). Consequently, the competitiveness of the countries' exported commodities deteriorated leaving deficits in their current accounts.

Initiated by the drop in stock and land prices in Thailand in late 1996 and early 1997, the Thailand's financial institutions weakened. This caused foreign investors to begin withdrawing their funds from the country leading to massive capital outflows. Massive speculation against the baht, following the enormous capital outflows, worsened the Thai economy. This foreign currency crisis then turned into financial crisis.

What occurred in Thailand, quickly spread out to its ASEAN neighbors such as the Philippines, Malaysia, and Indonesia, which have similar characteristics in term of macroeconomic fundamentals, before extensively affecting the world financial and capital markets through its contagion effects. International creditors dramatically moved their assets out of those countries leaving regional currencies under pressure.

During the 1997 crisis, when capital flows suddenly declined and domestic currency depreciated, the ASEAN regional stock price indices and banking funds dramatically declined (DFAT, 1999:23, 27). This means that the domestic financial institutions were especially hard hit (Shapiro, 2002:39). The stock market indices dropped by 38% in the end of 1997 and 40% after one-year of crisis in the five ASEAN countries (calculated from IFS, 2004). The rush in the stock markets following the rush in other financial markets were mostly caused by negative market sentiment, higher investment risks, and financial panic (Radelet et al., 1999a:3-5). This then forced Thailand, the Philippines and then Indonesia to seek assistance from International Monetary Fund (IMF). However, the announcement of this action did not immediately cease international capital outflows from those

countries. At the end of 1997, more than US$ 11.9 billion of foreign net private capital flew away from the region (Radelet et al., 1999a:2).

However, the downturn in the five ASEAN rebounded in 1999. After the sharp output contraction in 1998, growth returned in that year as depreciated currencies spurred higher exports (Krugman and Obstfeld, 2003:693). This then led to the appreciation of regional currencies. The regional capital and financial markets also started to recover. The appreciation of the countries' exchange rates also led to economic recovery. The year of 1999 was a turning point for the five ASEAN's stock markets. The regional stock market price indices increased around 42.46% on average compared to those from two years before (calculated from IFS, 2004). This may indicate that investors' confidence started to recover and they began to invest in the five ASEAN markets. By the end of 2003, the five ASEAN's stock market prices moved relatively more stable, even though the stock markets indices were somewhat lower than those before the financial crisis (IFS, 2004).

From the facts above, it seems that the crisis began in one country and then spread out to others through financial and capital markets. This pattern indicates that there might be dynamic interactions among the ASEAN capital markets. Hence, this paper is aimed to examine the interrelations among stock markets in the five ASEAN countries during and post the crisis period.

CAPITAL MARKET INTEGRATION

The basic theoretical concept of financial market or stock market integration is adopted from the law of one price. In integrated financial markets, the assets with the same risk in different markets will result in the same yield when measured in a common currency (Stulz, 1981:924-5). However, if the yields are different across the markets, the arbitrage process will play an important role in eliminating the differences.

Operationally, capital markets integration refers to the extent that markets' participants are enabled and obligated to take notice of events occurring in other markets by using all available information and opportunities, while financial market integration is defined in terms of price interdependence between markets (Kenen 1976:9).

Moreover, stock market integration is affected by some factors (Roca 2000:14), such as: 1) Economic integration, which means that the more integrated the economies of countries, the more integrated their equity markets (Eun and Shim 1989: 256). 2) Multiple listing of stocks. This implies that a shock in a particular stock market can be transmitted to other stock market through shares listed in both markets. 3) Regulatory and information barriers. The higher the barriers, the lower the degree of stock market integration. 4) Institutionalisation and securitisation. As institutions are more willing to transfer funds overseas to increase their diversification opportunities, the integration will be promoted. 5) Market contagion. The prices between stock markets can move together due to a contagion effect (King and Wadwhani 1990:5), and this contagion effect determines significantly the dynamic relationships between international stock markets (Climent and Meneu, 2003:111). However, in emerging stock markets, this effect might be smaller than what is widely perceived (Pretorius 2002:103).

Much research has been done, mainly by using a cointegration analytical framework, to find and analyse the existence of integration in stock market across countries. The results are different depending on where, when, and how the research has being conducted.

The cointegration analytical framework has been widely applied to examine the integration of stock markets across countries. Once a cointegration vector is found among two or more stock markets, it indicates the existence of a long run relationship among them. Thus, stock price movements in one equity market will affect another in other markets.

A research conducted by Palac-McMiken (1997:299) reveals the existence of cointegration in ASEAN markets (Malaysia, Singapore, Thailand, and the Philippines), except Indonesia, during 1987 to 1995. This result was confirmed by Masih and Masih (1999:275) who report that some of ASEAN countries (Thailand, Malaysia, and Singapore) have a high degree of interdependence with other Asian (Hong Kong and Japan) and developed (the U.S. and the U.K.) stock markets. Furthermore, they also find one cointegration vector among several major Asian stock markets (Hong Kong, Korea, Singapore, and Taiwan) and major developed markets (Masih and Masih, 2001: 580-1).

Interestingly, Pretorius (2002:103) reports that the degree of bilateral trade and the industrial production growth differential significantly explained the correlation between two equity markets, and that the stock markets of countries in the same region are more interdependent than those in different regions. Consistent with this finding, Roca (2000:145) finds the existence of interdependency among all ASEAN stock markets in the short run. However, in contrast to short run interdependency, he indicates that there was no cointegration among ASEAN countries as a group during 1988-1995 and that those stock markets were not significantly related to each other in the long run.

Chan, Gup and Pan (1992:289) and DeFusco, Geppert and Tsetsekos (1996:343) also mention that there is no cointegration between the U.S and several Asian emerging stock markets (Hong Kong, Taiwan, Singapore, Korea, Malaysia, Thailand, and the Philippines) in the 1980s and early 1990s. However, these findings somewhat contradicts with those of Chung and Liu (1994) and Masih et al. (1999). This then implies that the interdependence among stock markets is not stable over time. For example, Hung and Cheung (1995:286) assert that there is no cointegration among stock markets in some Asia-Pacific countries (Malaysia, Hong Kong, Korea, Singapore, and Taiwan). In contrast, when they used US dollar denominated stock prices, it was reported that those stock markets were cointegrated after, but not before, the 1987 stock crash.

Arshanapalli and Doukas (1993:206) also mention the instability of stock market interdependence when they tested the effect of inclusion or omission of the data for the 1987 crisis and revealed that it affects the results. They conclude that the stock markets were highly integrated during the crisis. Furthermore, Arshanapalli, Doukas and Lang (1995:72) show that after the 1987 crisis the stock markets in emerging markets (Malaysia, the Philippines, and Thailand) and developed markets (Hong Kong, Singapore, the U.S., and Japan) are more interdependent as they found cointegration in the post-crisis period, but not in the

pre-crisis period. Other researchers, Liu, Pan and Shieh (1998: 59) also confirm that there is an increase in the interdependence within Asian-Pacific regional markets and the stock markets in general post-the 1987 crisis. Similarly, Sheng and Tu (2000:245) document one cointegration vector between the U.S. and several Asian stock markets (Taiwan, Malaysia, China, Thailand, Indonesia, South Korea, the Philippines, Australia, Japan, Hong Kong, and Singapore) during the crisis, but none in the year before the crisis, when they observed the stock markets using daily data.

Finally, a research recently conducted by Yang, Kolari and Min (2003:478) examined the long-run relationship and short-run dynamic causal linkages among the U.S, Japanese, and ten Asian emerging markets using daily data of 1997-1998 periods. They confirm that the stock markets of those countries have been more integrated after the 1997 Asian financial crisis than before the crisis. Both long-run cointegration relationship and short-run causal linkages among those markets become more significant during the crisis. These findings also confirm that the degree of integration among those countries tends to change over time.

The conclusion that may be drawn form the literature review is that liberalization of the financial sector in many countries has caused world stock markets to be more integrated. The degree of integration among international equity markets has increased after the 1987 stock market crash and the 1997 Asian financial crisis. Empirical evidence is given by the presence of cointegration vectors and significant short-run causal linkages. It is also worth noting that the stock markets of countries in the same region may be more interdependent than those in different regions.

RESEARCH METHODOLOGY

Basically, a stock market price index or stock market index is a portfolio of individual stocks. The index level corresponds to some average of the price levels of individual shares. Changes in the index level give rise to market returns. Thus, the stock market index can commonly be use as an indicator of the market performance. A stock market index can be viewed simply as a portfolio of shares. There are several factors that determine the level of the index, such as breadth of index, weighting system, capitalization adjustment, and dividend effect (Brailsford, Heaney and Bilson, 2004:68).

The stock market index of a country may also be an indicator of short-term portfolio investment movement in the country. An upward trend of a stock market index means that there is an increase in demand of the listed shares in the market. This indicated that investors are attracted to buy shares and invest their fund in the country. On the other hand, a downward trend movement of a stock market index indicates that the investors are unlikely to continuously hold the listed shares. Therefore, stock market movements may reflect the attractiveness of a country for investments, especially for portfolio investments.

In this research, the closing stock prices index of the last day of trading in each month of the five ASEAN's stock market, which are IHSG of Indonesia; KLSE of Malaysia; PSE of the Philippines; STI of Singapore; and SET Composite

of Thailand, will be employed as measurement of the countries' monthly stock market price movements.

Hypothesis

Some previous research (Chan et al., 1992; DeFusco et al., 1996; Masih et al., 1999) document that stock markets in the Asian region are interdependent not only among themselves, but also with some of the developed market. Furthermore, those stock markets are even more interdependent during and after financial crises (Sheng et al., 2000; Yang et al., 2003)

In the case on the ASEAN, Palac-McMiken (1997:299) reports the existence of cointegration in the countries' stock markets, except Indonesia, before the 1997 crisis. In contrast, Roca (2000:145) finds the existence of interdependency among the five ASEAN's stock markets in the short run, but not significantly related in the long run before the 1997 crisis.

Therefore, based on these findings, it is hypothesized that the five ASEAN's stock markets are interdependent during and after the 1997 Asian financial crisis.

Econometric Techniques

In order to examine the hypothesis, suitable econometric models are required. Since the objective of this research is to examine the dynamic relationships of several variables, multivariate time series models are used. The two most appropriate models for the problem are VAR and VECM.

Vector autoregressive (VAR) model is a systems regression model, which contains more than one dependent variable. In VAR all variables are endogenous, and symmetrically treated. A block causality test, which is also called multivariate generalization of the Granger-causality test, would also be implemented in VAR to examine whether the lags of one variable enter into the equation for another variable (Enders, 2004:283). On other words, it tests whether changes in one variable cause changes in another.

Since VAR models are often difficult to interpret, one solution is to use accounting innovation analysis. Accounting innovation analysis, which consists of impulse responses and forecast error variance decomposition analysis, can be useful to examine the short run dynamic interactions among variables in the model.

The other multivariate model that may suitable to be used is the vector error correction model (VECM) or cointegration framework analysis, which is one of several extensions of VAR. A VECM basically is a VAR augmented by the error correction term ($\hat{e}_{t-1}$). In general, the simple VECM takes the form (Enders 2004:329):

$$\Delta Y_t = \alpha_{10} + \alpha_Y \hat{e}_{t-1} + \sum \alpha_{11}(i)\, \Delta Y_{t-i} + \sum \alpha_{12}(i)\, \Delta Z_{t-i} + \varepsilon_{Yt}.$$

$$\Delta Z_t = \alpha_{20} + \alpha_Z \hat{e}_{t-1} + \sum \alpha_{21}(i)\, \Delta Y_{t-i} + \sum \alpha_{22}(i)\, \Delta Z_{t-i} + \varepsilon_{Yt}.$$

Where

$$\hat{e}_{t-1} = (Y_{t-1} - \beta_1 Z_{1t-1})$$

Thus, if the parameters of error correction term, which are called speed of adjustments (α_Y and α_Z) in VECM, are zero, then VECM reverts to a VAR in first

differences. However, if the speed of adjustments are not zero, the larger the speed of adjustments, the greater the response to previous periods' deviation from the long run equilibrium. Thus, a cointegration relationship is a long term or equilibrium phenomenon, since it is possible that cointegrating variables may deviate from their relationship in the short run, but their association would return in the long run (see Enders, 2004:328).

Unlike VAR, cointegration refers to a linear combination of non-stationary variables. Thus, it is necessary to test the existence of unit roots in observed variables. There are several available tests for testing for a unit root, the most common is the augmented Dicky-Fuller (ADF) test.

Cointegration also requires that all variables in a model be integrated of the same order. In order to test the existence of cointegrated variable, one may use the Engle-Granger (EG) test, which is a residuals-based approach, or the Johansen tests.

Overall, the examination procedures conducted in this research is that, firstly, unit root test is conducted at level and first difference to determine whether each variable is stationary or non-stationary. Secondly, the Engle-Granger residual-based test will test the existence of cointegration among the variables for each country. If a cointegration relationship does not exist, VAR analysis in first difference will be applied and then continued with block non-causality test and accounting innovation analysis. However, if the variables are cointegrated, the analysis will continue in a cointegration framework in which Johansen test for cointegrating vector and VECM estimation procedures are employed. Microfit 4.0 would be used to conduct all statistical analyses in this research.

All monthly stock market index data of the five ASEAN are collected from the Capital Market Supervisory Agency (BAPEPAM) website, which documents the data from each of the five ASEAN's stock market.

DATA ANALYSES

Unit Root Tests

The objective of the unit root test is to empirically examine whether a series contains a unit root. If the series contains a unit root, this means that the series is non-stationary. Otherwise, the series will be categorized as stationary.

Table 1. The Unit Root Test Results

Variables	ADF at level
LIHSG	Fail to reject Ho
LKLSE	Fail to reject Ho
LSET	Fail to reject Ho
LSTI	Fail to reject Ho
LPSE	Fail to reject Ho

Based on the unit root tests results in Table 1, all stock price indices of the five ASEAN countries are non-stationary (with 95 % confidence interval, the critical values of ADF statistic are –2.9055 for including intercept but not a trend

and –3.4779 for including intercept and a linear trend). Moreover, the existence of a unit root in Asian stock markets, including the five ASEAN, is well established in the literature. In particular, Masih et al. (1999, 2001) have conducted extensive tests, which verify the existence of a unit root for all Asian stock market index prices. Thus, it can be argued that VECM may possible to be carried out to examine the log stock prices (LSP) of the five ASEAN. Note that in this chapter, the log stock prices index variable for Indonesia would be given the notation LIHSG. For Malaysia, the Philippines, Singapore, and Thailand would be LKLSE, LPSE, LSTI, and LSET, respectively.

In VECM framework, the analysis begins with establishing the lags length. The next stages are the testing for cointegration, the estimation of the error correction model, and then the accounting innovation analysis.

Dummy Variables

Since this research covers both during and after the crisis period, the data from both periods may have experienced different movements that may have resulted in structural changes. If structural changes exist, bias results may be obtained. Therefore, a dummy variable would be inserted in the model equation. The dummy variable in this case takes form:
D = 1, for the period between July 1997 and March 1999
D = 0, for the period between April 1999 and December 2003

The reason is that since April 1999 all the ASEAN stock market prices have been relatively stable compared to those before. Then, April 1999 is taken to be the beginning of the post-crisis era for the ASEAN stock markets. This period classification is somewhat similar with that suggested by Kamin (1999:506) and Corsetti, Pesenti and Roubini (1999:307-1).

Lags Order Test

To examine the appropriate lags order, likelihood ratio test (LR test) would be applied. After conducting LR test, three lags are chosen for this VECM analysis. The diagnostic statistics reveal that the residuals are generally well behaved and free from serial correlation problems using a F statistic test.

Cointegration Vectors

Considering the number of appropriate lags, the number of cointegrating vectors is tested by using the maximum likelihood based λmax and λtrace statistics introduced by Johansen (1988, 1991). With exclusion of linear trend, the results are presented in Table 2.

As can be seen from Table 2, using 95% critical values, there are conflicting results between λmax and λtrace statistic. The λmax statistic fails to reject the null hypothesis that r = 0. On the other hand, the λtrace statistic rejects r=0 and r<=1, and fails to reject r<=2. The λtrace statistic test, therefore, point outs that there are two cointegrating vectors.

As it is suggested by some econometricians (Johansen and Juselius, 1990; Kasa, 1992; and Serletis and King, 1997) that the λtrace tends to have more power than the λmax because λtrace takes into account all degrees of freedom (n-r) of the smallest eigenvalues, then the number of cointegration vectors suggested by the λ trace statistic would be employed.

The number of cointegrating vectors resulted from this study is consistent with the previous research conducted by Yang et al. (2003: 478) in daily data.

Table 2. Tests for the Number of Cointegrating Vector

Cointegration with unrestricted intercepts and no trends in VAR Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix (λmax)			
Null	Alternative	Statistic	95% Critical Value
r = 0	r = 1	32.9490	33.6400
r <= 1	r = 2	29.3840	27.4200
r <= 2	r = 3	19.8449	21.1200
r <= 3	r = 4	8.1333	14.8800
r <= 4	r = 5	1.9444	8.0700
Cointegration with unrestricted intercepts and no trends in VAR Cointegration LR Test Based on Trace of the Stochastic Matrix (λtrace)			
Null	Alternative	Statistic	95% Critical Value
r = 0	r >= 1	92.2556	70.4900
r <= 1	r >= 2	59.3066	48.8800
r <= 2	r >= 3	29.9226	31.5400
r <= 3	r >= 4	10.0777	17.8600
r <= 4	r = 5	1.9444	8.0700

Source: calculated by the author

Estimating VECM

Before estimating the VECM, it is necessary to identify the cointegrating vectors. Commonly normalization and zero restriction are needed. After examining the significance of the individual coefficients, the vectors are identified as shown in Table 3.

The table shows that cointegrating vector 1 is normalized by LSTI, while LPSE and LIHSG are restricted to zero. In cointegrating vector 2, LIHSG is used to normalize, while LKLSE and LPSE are restricted to zero.

The p-value of the likelihood ratio of the restriction fails to reject the null hypothesis that the restrictions are correct. Moreover, based on t-statistic at the 5% level of significance, the parameters of LSTI and LSET are significant in cointegration vector 2, and parameters of LKLSE and LSET are significant in cointegrating vector 1. This means that LKLSE, LSTI, and LSET have influence in the first cointegrating relation, while LSTI, LIHSG and LSET have influence in the second cointegrating relations

The result also indicates that LPSE (i.e. the log of the Philippines stock index), which is not significant in either of the cointegrating vectors, does not have influence the long run equilibrium of the ASEAN stock indices.

Table 3. Estimates of Restricted Cointegrating Relations (SE's in Brackets)

List of imposed restriction(s) on cointegrating vectors:

LPSE=0; LSTI=1; LIHSG=0; LPSE=0; LKLSE=0; LIHSG=1

	Vector 1	**Vector 2**
LIHSG	0.0000	1.0000
	(NONE)	(NONE)
LKLSE	-2.5626	0.0000
	(0.68330)	(NONE)
LPSE	0.0000	0.0000
	(NONE)	(NONE)
LSTI	1.0000	-0.23099
	(NONE)	(0.10776)
LSET	0.90903	-0.61896
	(0.35184)	(0.08552)

LR Test of Restrictions CHSQ(2)= 5.1097[.078]
DF=Total no of restrictions (6) - no of just-identifying restrictions (4)
LL subject to exactly identifying restrictions = 521.8299
LL subject to over-identifying restrictions = 519.2751

Source: calculated by the author
Note: cointegration with unrestricted intercepts and no trends in the VAR.

VECM estimation based on the general restrictions on the cointegrating vectors (Table 3) can be seen in Table 4. Using a 5% critical value, the speed of adjustment coefficient for the first cointegrating vector, α_1, for the Philippines stock index is statistically zero, but for the second cointegrating vector, α_2, is significant. This means that the second cointegrating vector contributes to the convergence of this variable to its long run path, although the Philippines stock index does not have a significant influence on any of the cointegrating vectors. The speed of adjustment coefficient estimate for the second cointegrating vector, is statistically significant and negative. The Philippines' stock index will react to a disequilibrium between the Malaysian stock index (KLSE), the Singaporean stock index (STI) and the Thailand stock index (SET). Note that this vector does not contribute to the log of KLSE, STI, or SET's return to their long run equilibrium. In comparison, both vectors are significant in the long run path of the log of the Indonesian stock index (IHSG). It is also worth noting that the negative value of the significant speed of adjustment indicates a downward long run adjustment. Conversely, the positive value of the significant α_i implies an upward long run adjustment.

Table 4. Speed of Adjustment Parameter of the Error Correction Term Based on a Cointegrating VAR(3)

ECT for :	LIHSG	LKLSE	LPSE	LSTI	LSET
Speed of adjustment :					
- ecm1 (α_1)	0.13795	0.18496	0.03185	0.13985	0.17126
- ecm2 (α_2)	-0.54820	0.06037	-0.29019	0.02247	-0.14819
p-value of :					
- ecm1 (α_1)	0.005	0.002	0.510	0.007	0.008
- ecm2 (α_2)	0.000	0.637	0.036	0.875	0.402
p-value of serial correlation in the residuals of each equation in the model based on F test :	0.096	0.061	0.270	0.271	0.560

Source: calculated by the author

Using the restricted cointegrating vectors in Table 3, the error correction term for each stock market index can then be written as:
α_1 (0.0000 LIHSG – 2.5626 LKLSE – 0.0000 LPSE + LSTI + 0.90903 LSET)
α_2 (LIHSG – 0.0000 LKLSE – 0.0000 LPSE – 0.23098 LSTI – 0.61896 LSET)

The Persistence Profile

Figure 1 and Figure 2 show the persistence profile of both cointegration vectors. The persistence profile provides important information on the speed with which a system-wide shock on the cointegration relations disappears and as they return to their equilibrium states (Pesaran and Pesaran, 1997:445).

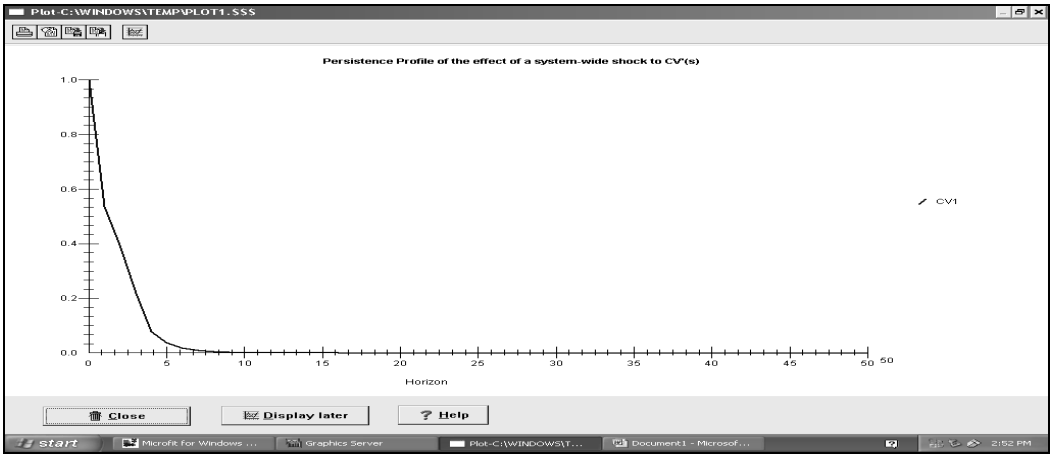

Figure 1. Persistence Profile of the Effect of a System-wide Shock to Cointegration Vector 1

In Figure 1, the persistence profile shows that the values immediately start to move back to zero after the shock and reach its equilibrium level after 8 periods or months. In Figure 2, the values immediately start to move back to zero after the shock and reach its equilibrium level after 5 periods, which is shorter than that in Figure 1. These graphs indicate the long run equilibrium relationships do exist and are stable in the five ASEAN stock price indices.

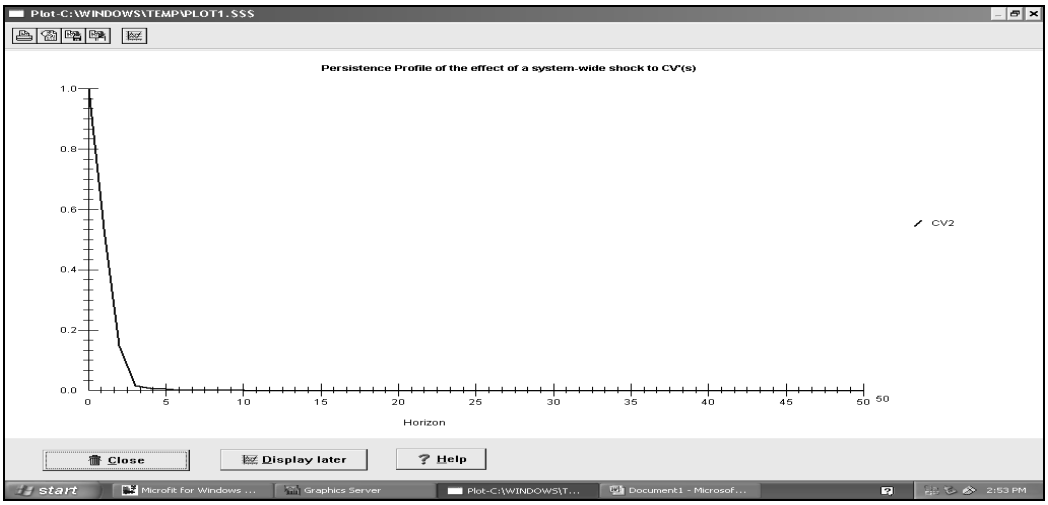

Figure 2. Persistence Profile of the Effect of a System-wide Shock to Cointegration Vector 2

Accounting Innovation Analysis

A direct interpretation of the cointegration relations may be difficult or misleading (Lutkepohl and Reimers, 1992:53). Therefore, accounting innovation analysis can provide a solution to the interpretation problem, and might be the most appropriate method to explain the short run dynamic structure of market linkages (Yang et al., 2003:479). However, since the variables are cointegrated, the accounting innovation analysis will be conducted based on VECM (Enders, 2004:359)

Generalized Impulse Response for Cointegrating Relations

Since the effects of shocks on individual variables in a cointegration VAR model do not die out and persist forever, the effect of variable-specific shocks to the cointegrating relations would be an alternative approach to test their response. Considering the issue, Pesaran et al (1997:444) state that the effect of shocks on cointegrating relations is bound to die out, and their time profile contains useful information on the speed of convergence of the model to its cointegrating (or equilibrium) relations.

Table 5 presents the results of the generalized impulse responses to a one standard error shock to the cointegrating relations. The table shows that the speeds of convergence of the two cointegrating vectors are different to respond shocks. Cointegrating vector 1 needs more than a year to reach its equilibrium, but cointegrating vector 2 requires a shorter period.

A shock to the Singaporean stock index would result in an immediate reaction of 0.0458 by cointegrating vector 1 and of – 0.0349 by cointegrating vector 2. These reactions fade away, and the system returns to their equilibrium in less than two years. Similarly to the Singaporean stock index, less than two years is needed by the system to converge to its equilibrium due to a shock to the Philippines stock index, a shock to Indonesian stock index, or a shock to Thai stock index.

Table 5. Generalized Impulse Response

Shock in the equation for :	Time Horizon	Reaction on :	
		Cointegrating Vector 1	Cointegrating Vector 2
LIHSG	0	0.0043	0.0427
	1	-0.0265	0.0331
	12	-0.0013	0.0001
	24	0.0000	0.0000
LKLSE	0	-0.0972	-0.0166
	1	-0.0866	-0.0021
	12	-0.0031	0.0000
	24	-0.0001	0.0000
LPSE	0	0.0231	-0.0152
	1	-0.0075	-0.0033
	12	-0.0016	0.0000
	24	0.0000	0.0000
LSTI	0	0.0458	-0.0349
	1	0.0204	-0.0160
	12	-0.0009	0.0000
	24	0.0000	0.0000
LSET	0	0.0519	-0.0440
	1	0.0078	-0.0301
	12	-0.0011	0.0000
	24	0.0000	0.0000

Source: calculated by the author
Note: Cointegration with unrestrictied intercepts and no trends in VAR

Shocks to the Malaysian stock index would result in negative contemporaneous reactions by cointegrating vector 1 and mostly positive reactions by cointegrating vector 2. Unlike the other countries' stock index, the reactions by cointegrating vector 1 do not die out for more than two years.

Generalized Forecast Error Variance Decomposition

The values shown in the body of Table 6 are the percentage amount of the forecast error variance of a variable (X) equals the proportion of the forecast error variance of X due to an innovation in variable (Y) divided by the total proportion of the forecast error variance of all variables, including variable X.

Table 6 shows the results of the generalized forecast error variance decomposition for the five ASEAN stock indices. As can be seen from the table 17.61% of the forecast error variance of the Philippines stock index is due to an innovation in the Indonesian stock index instantly. After a month, the percentage increased to 20.39%. In comparison, after a month, a 39.76% of the error variance of the Indonesian stock index is due to its own shock. Shocks to the Singaporean

stock index contribute a 6.84% to the error variance of the Indonesian stock index in the first month.

Compared with other ASEAN stock markets, shocks in the Thailand stock index are likely to have a bigger influence on the error variance of the Singaporean and the Philippines stock indices. An innovation in the Thailand stock index accounts for the second largest proportion of the error variance in the Singaporean and the Philippines stock prices after their own shocks. A similar argument is relevant for the error variances of the Indonesian and the Thailand stock index, which are largely influenced by innovations in the Philippines stock index, as well as the Malaysian stock index, which is influenced by shocks in the Singaporean stock index.

Table 6. Generalized Forecast Error Variance Decomposition

Innovation in:	Step Ahead	Forecast Error Variance on :				
		LIHSG	LKLSE	LPSE	LSTI	LSET
LIHSG	0	52.09%	8.46%	17.61%	10.12%	11.72%
	1	39.76%	10.25%	20.39%	15.62%	13.98%
	12	9.98%	3.03%	18.15%	34.61%	34.24%
	24	6.10%	2.27%	16.60%	37.69%	37.35%
LKLSE	0	7.73%	47.62%	13.57%	15.99%	15.09%
	1	9.26%	37.70%	16.36%	17.95%	18.72%
	12	5.39%	12.64%	17.88%	34.53%	29.56%
	24	4.11%	8.77%	16.45%	39.35%	31.33%
LPSE	0	13.01%	10.97%	38.49%	16.50%	21.04%
	1	10.64%	12.07%	33.67%	21.03%	22.60%
	12	3.51%	6.16%	30.91%	30.32%	29.10%
	24	2.73%	4.93%	30.61%	31.66%	30.08%
LSTI	0	7.71%	13.31%	17.00%	39.65%	22.34%
	1	6.84%	12.49%	18.11%	40.35%	22.20%
	12	5.01%	4.80%	14.89%	53.99%	21.31%
	24	4.55%	3.88%	13.29%	58.19%	20.08%
LSET	0	8.48%	11.95%	20.61%	21.25%	37.71%
	1	8.64%	11.20%	21.13%	22.28%	36.75%
	12	3.06%	3.24%	18.36%	31.70%	43.64%
	24	2.05%	2.32%	17.04%	33.45%	45.14%

Source: calculated by the author
Note: Cointegration with unrestrictied intercepts and no trends in VAR

CONCLUSION AND POLICY IMPLICATIONS

Conclusion

The objective of this study is to observe the dynamic interaction among stock prices in five ASEAN countries, namely Indonesia, Malaysia, the Philippines, Singapore, and Thailand, with particular attention to the 1997 Asian financial crisis and the period onwards.

The maximum likelihood based λtrace statistics introduced by Johansen (1988, 1991) finds two cointegrating vectors among the five ASEAN's stock indices

during the sample period. This means that those stock price indices are highly integrated during the period. Thus, the hypothesis that the countries' stock markets are interdependent is confirmed by this result.

This research reveals that Indonesia is the only market that reacts to disequilibrium in both cointegrating vectors, all other markets only respond to a disequilibrium in one of the vectors. The estimation also finds that the Thailand stock index and the Singaporean stock index have significant influences on both cointegrating vectors, while the Philippines stock index is not significant in any cointegrating vectors. It indicates that the Philippines stock market index does not have a significant influence on either of the cointegrating relations. However, this market is reactive to a disequilibrium of the second cointegrating vector. Since the speed of adjustment coefficient of the first cointegrating vector is significant in the Malaysian, the Singaporean, and the Thailand stock index, the first cointegrating vector contributes to those variables' return to their long run equilibrium.

The persistence profile graphs show that more than eight periods are needed by the equilibrium among the Malaysian, the Singaporean and the Thailand stock indices (cointegrating vector 1) to reach its long run equilibrium after a wide-system shock. Meanwhile, the equilibrium among the Indonesian, the Singaporean and the Thailand stock indices (cointegrating vector 2) needs more than five periods to reach its long run equilibrium.

The general impulse responses obtained from the VECM show a consistent and different response between the two cointegrating vectors to shocks in each individual stock market index. Vector 1 takes over a year to return to equilibrium, while vector 2 requires less than a year in all cases.

The forecast error variance decomposition analysis shows that the largest proportion of the forecast error variance of a country's stock index is due to its own shocks. Shocks to the Thailand stock index largely influence the error variance of the Singaporean and the Philippines stock indices, while an innovation in the Philippines stock index greatly influences the error variance of the Thailand and the Indonesian stock index. Larger percentage of the error variance of the Malaysian stock index is due to a shock to the Singaporean stock index rather than a shock to the other stock indices.

Policy Implications

The five ASEAN stock indices are highly integrated. This means that the countries' stock indices influence each other and move together to their long run equilibrium. A decrease in one stock index would be followed by the others. Since most of the ASEAN stock markets, except for the Singaporean stock market, have not been well developed, as their price indices widely fluctuate, they provide not only higher returns, but also higher risks to their investors. Therefore, diversification of portfolio within the ASEAN stock markets is unlikely to reduce the risk due to the high degree of financial integration of these markets.

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