

Linkages Between ASEAN Stock Markets: A Cointegration Approach

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EXTENDED ABSTRACT

With increased market integration, the current world financial markets have become more closely correlated and interdependent over time. Understanding the information linkages and correlations between markets are important for policy makers and fund managers in their financial decisions in relation to investment and risk management. The existence of low correlation among returns from different national stock markets has been used frequently to justify the international diversification of portfolios. Another reason for investors to consider global investments is return enhancement. Securities issued by countries with higher growth rates are expected to earn higher rates of returns.

A number of studies (e.g. Copeland and Copeland 1998, Janakiraman and Lamba 1998, Jeong 1999) report significant correlation between international stock markets and established leadership role of the United States (US) equity market on other markets. Longin and Solnik (1995) found covariance of the returns between markets is more pronounced during the down periods. This suggests any dramatic movements in one stock market could have a strong impact on the markets of different sizes, structures and geographical locations across the world. In 1997, the floating of the Thai baht led to the financial meltdown in Thailand, and started a wave of contagion effects, spreading quickly to its neighbouring countries in the East Asian region. Stock markets in the region declined sharply and then partially rebounded. Such an event would affect portfolio allocation and risk evaluation based on historical estimates of relevant returns and variance-covariance matrix.

The Association of Southeast Asian Nations (ASEAN) has expanded rapidly since the 1970s and is currently the fourth largest trading region in the world, with a market of about 568 million people and a combined gross domestic product of US\$ 1,073 billion (ASEAN, 2007). This paper examines the dynamic interdependence of the five founding members of ASEAN, namely Indonesia,

Malaysia, the Philippines, Singapore and Thailand (hereafter referred to as ASEAN-5). Stock markets in the region are expected to become more open and interdependent, especially after the 1997 Asian financial crisis. The primary focus is to consider the long-run relationships among the ASEAN-5 market indices and whether there are signs of converging or increased cross-market integration after the financial crisis. The US stock market is included in the study given its significant influence on other markets across the globe.

Daily total market return indices measured in the US dollar for the sample countries are obtained from Datastream International. This study covers the period from 2nd April 1990 to 31st August 2007 with a total of 4,545 observations. The sample is divided into two sub-periods to examine the impact of the financial crisis. A comparison of summary statistics of country stock market return indices indicate the cross-market correlations and mean returns for all ASEAN-5 were higher and the market returns were less volatile during the post-crisis period.

A vector autoregression approach is used to examine the direction of Granger causality between returns of ASEAN-5 markets. The results of the Granger causality tests indicate interdependence between ASEAN-5 market returns. Overall, there has been an increase in cross-market interdependence over the post-crisis period, particularly the Indonesian market returns. Similar to other studies, returns on the US market have significant influence on returns of all ASEAN-5 markets. The Johansen maximum likelihood method is used to test for the presence of long-run cointegrating relationships between the ASEAN-5 market indices and whether they are converging over time. The test statistics indicate the existence of at least one long-run cointegrating relationship among the ASEAN-5 market indices and at least two long-run cointegrating relationships in the post-crisis period. Overall, the results indicate an increase in the integration between the ASEAN-5 markets after the financial crisis.

1. INTRODUCTION

Globalisations in capital markets and reduction of restrictions on international cross listings have led to greater flows of capital between economies, easier ownership and trading in securities from around the world. With increased market integration, the current world financial markets have become more closely correlated and interdependent over time. Understanding the information linkages and correlations between markets are important for policy makers and fund managers in their financial decisions in relation to investment and risk management. The existence of low correlation among returns from different national stock markets has been used frequently to justify the international diversification of portfolios. Another reason for investors to consider global investments is return enhancement. Securities issued by countries with higher growth rates are expected to earn higher rates of returns.

A number of studies (e.g. Copeland and Copeland 1998, Janakiraman and Lamba 1998, Jeong 1999) report significant correlation between international stock markets and established leadership role of the United States (US) equity market on other markets. Longin and Solnik (1995) found covariance of the returns between markets is more pronounced during the down periods. This suggests any dramatic movements in one stock market could have a strong impact on the markets of different sizes, structures and geographical locations across the world. In 1997, the floating of the Thai baht led to the financial meltdown in Thailand, and started a wave of contagion effects, spreading quickly to its neighbouring countries in the East Asian region. Stock markets in the region declined sharply and then partially rebounded. Such an event would affect portfolio allocation and risk evaluation based on historical estimates of relevant returns and variance-covariance matrix.

Rapid economic growth in several East Asian economies¹ prior to the Asian currency crisis in 1997 brought increased integration to countries in the South-East Asian region, and strengthened its

position in the world economy. The Association of Southeast Asian Nations (ASEAN) is the fourth largest trading region in the world, with a market of about 568 million people and a combined gross domestic product of US\$ 1,073 billion.² ASEAN was established in 1967 to promote economic, social and cultural cooperation, and to safeguard economic and political stability in the region. The agreement in 1992 to create the ASEAN Free Trade Area aimed to increase ASEAN's competitive edge in the global market, eliminate intra-regional trade barriers, encourage greater economic integration among member economies, and attract more direct foreign investments into the region.

Study by Hassapis and Kalyvitis (2002) found output growth responds significantly to unanticipated changes in domestic and foreign stock returns. It would be crucial for the financial institution and policy makers to understand how shocks are transmitted across markets. Stock markets are found to react differently to good and bad news and a negative shock to one country could have a negative impact to other neighbouring countries such as the 1997 financial crisis. Using weekly and monthly data from January 1988 to February 1999, Manning (2002) found convergence of the South-East Asian equity markets from 1992 to mid-1997 and divergence occurring during the financial crisis. It would be beneficial to examine if there are signs of converging or increased correlation among stock markets in the region after the financial crisis using more recent data sampled at different frequency. This is particularly important as estimates of correlation coefficients tend to increase and may be biased upward during the crisis when markets are more volatile.

This paper examines the dynamic interdependence of the five founding members of ASEAN, namely Indonesia, Malaysia, the Philippines, Singapore and Thailand (hereafter referred to as ASEAN-5). Stock markets in the region are expected to become more open and interdependent, especially after the 1997 Asian financial crisis. The primary focus is to consider the long-run relationships among the ASEAN-5 market indices and whether there are signs of converging or increased cross-market integration after the financial crisis using daily data from 2nd April 1990 to 31st August 2007. The US stock market is also included in the study given its significant influence on other markets across the world.

¹ The World Bank [1993] reported that from 1965 to 1990 the eight high-performing Asian economies, namely Japan, Hong Kong, South Korea, Taiwan, Singapore, Malaysia, Thailand and Indonesia, had grown more than twice as fast as the rest of East Asia, roughly three times as fast as Latin America and South Africa, and twenty-five times faster than Sub-Saharan Africa.

² These figures are extracted from the ASEAN (2007) statistics for 2006.

The plan of this paper is as follows. Section 2 outlines the time series method used to test long-run cointegrating relationship and interdependence among the ASEAN-5 stock markets. Section 3 examines the time series data and the historical pattern of co-movements among the sample markets. Section 4 presents empirical results of the study and some concluding remarks are given in Section 5.

2 METHODOLOGY

In this paper, three different time series methods are used to test the presence of converging trends and market linkages between the stock markets in the South-East Asian region. The first method examines the direction of Granger causality between returns of two countries and groups of countries using an unrestricted vector autoregression, the second method applies a simple statistical test for market index trends, while the third method applies unit root tests and cointegration analysis to the market index series.

2.1 Granger Causality Test

Granger causality tests are conducted to test the significance and direction of causality between the market returns. According to Granger (1969), a variable X is said to ‘Granger cause’ Y if past values of X help in the prediction of Y after controlling for past values of Y , or equivalently if the coefficients on the lagged values of X are statistically significant. On the assumption that all returns are stationary, the equations for pairwise Granger causality tests are given by

$$R_{X,t} = \alpha_0 + \sum_{j=1}^n \alpha_j R_{X,t-j} + \sum_{j=1}^n \beta_j R_{Y,t-j} + u_t \quad (1)$$

$$R_{Y,t} = \alpha_0 + \sum_{j=1}^n \alpha_j R_{Y,t-j} + \sum_{j=1}^n \beta_j R_{X,t-j} + \varepsilon_t \quad (2)$$

where $R_{X,t}$ and $R_{Y,t}$ are daily returns for stock markets X and Y , respectively, and u_t and ε_t are random disturbances with zero means and finite variances. Equations (1) and (2) are estimated using an unrestricted vector autoregression (VAR). A test of the null hypothesis that returns on Y do not Granger cause returns on X is obtained using a Wald-test for joint significance of each of the lagged returns on Y in equation (1).

2.2 Test for Converging Trend

In a time series framework, a simple statistical test for converging or diverging trends of a market index series, as proposed by Verspagen (1994), can be written as follows:

$$W_{i,t} = p_{i,t} - p_t^* \quad (3)$$

where $p_{i,t}$ is the logarithm of the market index for country i at time t and p_t^* is the logarithm of average market index for n countries in the sample ($p_t^* = (\sum_{i=1}^n p_{i,t})/n$). It is assumed that, for each time period, W_i changes according to the following process:

$$W_{i,t+1} = \Psi W_{i,t} + \eta_{i,t} \quad (4)$$

If $\Psi > 1$, the market index in country i diverges from the sample group; if $\Psi < 1$, convergence of the market index occurs.

2.3 Cointegration Method

A stochastic definition of convergence requires two data series to follow a stationary process. This definition is applied to test for convergence in market return indices across countries. Bernard and Durlauf (1995) have proposed a time series test for convergence and common trends. The notion of convergence in multivariate market indices can be defined such that the long-term forecasts of market indices for all countries, $i = 1, \dots, n$, are equal at a fixed time t :

$$\lim_{k \rightarrow \infty} E(p_{1,t+k} - p_{i,t+k} | I_t) = 0, \quad \forall i > 1, \quad (5)$$

where I_t is the information set at time t . Applying the concepts of unit roots and cointegration, the convergence test determines whether $p_{1,t+k} - p_{i,t+k}$ in equation (5) is a zero mean stationary process in a cointegration framework. Convergence in market indices for two countries, x and y , implies that the stock markets are cointegrated, with cointegrating vector $[1, -1]$.

Empirically, testing for convergence and common trends in a cointegration framework requires the individual market index series to be integrated of order one. The following augmented Dickey-Fuller (1981) (ADF) test is used to determine the order of integration for market indices in the ASEAN-5 countries:

$$\Delta p_{i,t} = a_{0i} + a_{1i}t + \beta_i p_{i,t-1} + \sum_{j=1}^n \delta_{ji} \Delta p_{i,t-j} + \varepsilon_{i,t} \quad (6)$$

where $\Delta p_{i,t}$ approximates the rate of return on stock market, t is the deterministic trend, n is the order of the autoregressive process, and $\Delta p_{i,t-j}$ is included to accommodate (possible) serial correlation in the errors.

The rank of the cointegrating matrix in a multivariate framework can be estimated using the following VAR representation (Johansen, 1991):

$$\Delta P_t = \Gamma(L)\Delta P_t + \Pi P_{t-k} + \mu + \varepsilon_t, \quad (7)$$

where P_t is a $n \times 1$ vector of the logarithms of total market indices for n ASEAN-5 countries, Π represents the long-run relationships of the cointegrating vectors, $\Gamma(L)$ is a polynomial of order $k - 1$ to capture the short-run dynamics of the system, and ε_t are independent Gaussian errors with zero mean and covariance matrix Ω . The reduced rank ($0 \leq \text{rank}(\Pi) = r < n$) of the long-run impact matrix is formulated as follows:

$$\Pi = \alpha\beta', \quad (8)$$

where β is the $n \times r$ matrix of cointegrating vectors and α is the $n \times r$ matrix of adjustment coefficients.

Applying the Johansen maximum likelihood estimation method, convergence in multivariate market indices, as defined in equation (5), would require $r = n - 1$ cointegrating vectors for n ASEAN-5 countries of the form $[1, -1]$ (i.e. one common long-run trend for the individual market index series in P_t). The Johansen procedure permits hypothesis testing of the cointegrating relations and their adjustment coefficients, using the likelihood ratio test which follows a chi-squared distribution. This method is necessary to determine whether the r cointegrating vectors are of the form $[1, -1]$, which requires a unit restriction imposed on all the coefficients of the r cointegrating vectors.

3 DATA

This study examines the five markets in ASEAN, namely Indonesia (ID), Malaysia (MY), the Philippines (PH), Singapore (SG) and Thailand (TH). Daily total market-return indices for ASEAN-5 and the US markets are obtained from DATASTREAM over the period from 2nd April 1990 to 31st August 2007. These indices have been adjusted for dividends and provide the longest common sampling data available for the 6 countries from the same source of database. The whole sample period for each market consists of 4,545 daily observations. The daily returns for each stock market are computed as logarithmic differences of daily market indices over the entire sample period. To examine the effect of the Asian financial crisis in 1997, the whole sampling period was divided into two sub-periods from 2nd April 1990 to 31st July 1997 (1914 observations) and

from 3rd August 1998 to 31st August 2007 (2370 observations).

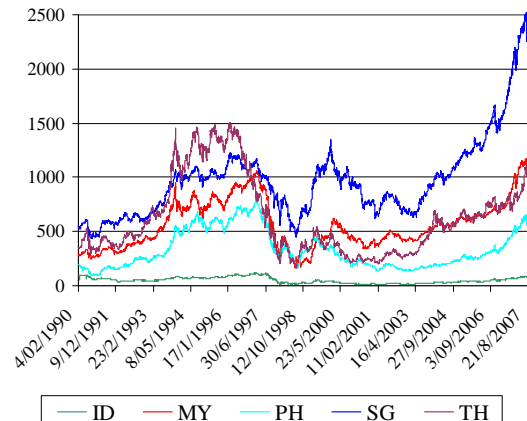


Figure 1. Total market return indices for ASEAN-5 markets, 2/4/1990-31/8/2007

Figure 1 depicts daily total market return indices for ASEAN-5 markets over the entire period. Summary statistics of ASEAN-5 and the US market return indices are given in Table 1. It is evident from Figure 1 that the return indices of all stock markets had fallen sharply during the 1997 financial crisis. Apart from Singapore, none of the ASEAN-5 markets have recovered from their pre-crisis levels. The slower recovery in the four ASEAN-5 markets could be attributed to a substantial weakening in their currencies as the market indices are measured in US dollar. Among the ASEAN-5 currencies, the Indonesian rupiah suffered the largest drop in value, particularly from December 1997 to October 1998, as a result of political instability. The Malaysian government also chose to fix its exchange rate at ringgit 3.80 per US\$ in October 1998.

Table 1. Summary statistics (total market return indices), 1990-2007

Country	ID	MY	PH	SG	TH	US
Mean	49.3	561.5	330.5	968.8	626.9	2128.3
Max	115.5	1171.3	792.9	2516.7	1503.9	4247.0
Min	9.8	155.5	91.7	433.8	172.4	505.8
Std Dev	27.3	221.1	175.3	372.8	356.4	1059.1
Pre-Crisis Period						
Mean	71.8	610.4	406.8	842.3	850.0	1011.0
Std Dev	20.7	244.5	214.8	232.6	396.1	363.9
Post-Crisis Period						
Mean	32.4	539.5	268.1	1094.8	475.3	3008.4
Std Dev	17.8	196.2	112.1	433.0	211.8	501.8

In addition to the 1997 financial crisis, ASEAN-5 markets were also affected by the terrorist suicide attacks upon the U.S. on September 11, 2001 (hereafter referred to as 9/11 attacks), which caused a sharp fall in global market indices. All ASEAN-5 market indices were less volatile over the post-crisis period compared with the pre-crisis period, with the exception of Singapore (see Table 1). As shown in Figure 1, the Singapore market was more affected by the 9/11 attacks than the other ASEAN-5 markets.

Table 2. Summary statistics (daily stock market returns), 1997-2000

Country	Full Sample		Pre-Crisis		Post-Crisis	
	Mean	SD	Mean	SD	Mean	SD
ID	-0.005	2.822	0.001	2.474	0.060	2.268
MY	0.028	1.728	0.053	1.207	0.065	1.627
PH	0.023	1.589	0.054	1.479	0.035	1.464
SG	0.032	1.218	0.031	0.962	0.061	1.219
TH	0.023	2.057	0.035	1.813	0.063	1.905
US	0.043	0.098	0.069	0.711	0.019	1.139

Table 3. Correlation matrix of stock market returns: pre- and post-financial crisis

Country	ID	MY	PH	SG	TH	US
ID	1.00	0.27	0.30	0.36	0.33	0.02
MY	0.17	1.00	0.17	0.26	0.20	-0.02
PH	0.10	0.22	1.00	0.32	0.29	0.04
SG	0.14	0.64	0.24	1.00	0.45	0.15
TH	0.08	0.35	0.15	0.35	1.00	0.06
US	0.01	0.12	0.03	0.15	0.08	1.00

Note: The bottom and top (bold) diagonals display the correlation coefficients over the pre- and post-crisis periods, respectively.

It is also important to examine the cross-market relationships of the daily percentage returns of the ASEAN-5 indices. Table 2 and Table 3 present the summary statistics of country daily market returns and their correlation coefficients. Across both the pre- and post- crisis samples, the mean returns for all ASEAN-5 were generally higher and less volatile during the post-crisis period. As shown in Table 3, the correlations between ASEAN-5 market returns were relatively low which would be ideal for international diversification. However, the correlations between ASEAN-5 returns were trending upward over time. Of particular note was the lower correlation between the returns of the Malaysian and Singapore markets over the post-crisis period.

4 EMPIRICAL RESULTS

The paper applies time series tests to daily total market return indices in natural logarithms (LMI) for the US and five ASEAN-5 countries from 2nd April 1990 to 31st August 2007. All estimation results are derived using the EViews 5.0 software.

4.1 Granger Causality

Testing the direction of Granger causality between returns of ASEAN-5 and the US markets is conducted using a VAR of order 10. The chi-squared test statistics for joint significance of each of lagged returns on individual ASEAN-5 returns are reported in Table 4. The results of the Granger

Table 4. Granger causality tests on daily stock market returns using a VAR(10) model

	Full Sample	Pre-Crisis	Post-Crisis
Indonesia			
MY	75.21*	24.36*	31.73*
PH	15.90	12.86	15.46
SG	9.19	4.49	21.48*
TH	34.74*	6.24	24.32*
US	109.20*	14.75	110.58*
Malaysia			
ID	22.46*	20.95	14.44
PH	14.18	19.19*	22.46*
SG	27.05*	7.48	37.55*
TH	19.41*	18.97*	18.84*
US	193.05*	102.99	134.72*
Philippines			
ID	49.89*	12.23	19.64*
MY	40.35*	22.16*	65.51*
SG	26.28*	22.59*	10.53
TH	78.62*	37.84*	48.73*
US	242.82*	59.00*	196.08*
Singapore			
ID	41.89*	28.82*	14.50
MY	42.69*	11.88	65.05*
PH	8.03	25.23*	11.73
TH	22.74*	9.60	18.37*
US	482.86*	146.93*	338.21*
Thailand			
ID	34.84*	22.22*	12.13
MY	36.44*	13.83	26.47*
PH	19.10*	36.57*	11.86
SG	47.45*	20.40*	22.44*
US	174.69*	58.46*	115.58*

Note: * denotes significance at the 5% level.

causality tests indicate interdependence between ASEAN-5 market returns. Overall, there has been an increase in cross-market interdependence over the post-crisis period, particularly the Indonesian market returns. Similar to other studies, returns on the US market have significant influence on returns of all ASEAN-5 markets with relatively higher test statistics than any individual ASEAN-5 markets.

4.2 Converging Trend

Using the simple statistical test of Verspagen (1994) for converging or diverging trends of the LMI series (see equations (3) and (4)), estimation results are reported in Table 5. Among the ASEAN-5 countries, Indonesia and Singapore are the two diverging countries, whereas the remaining three countries converge towards the ASEAN-5 mean LMI level. Comparing the pre-post crisis periods, Indonesia and Singapore are diverging over the pre-crisis and post-crisis periods, respectively.

Table 5. Test results for converging trend, 1990-2007

Country	ID	MY	PH	SG	TH
ASEAN-5	1.0000*	0.9971	0.9998	1.0000*	0.9989
US	1.0001*	0.9999	1.0000*	0.9999	0.9999
Pre-Crisis Period					
ASEAN-5	1.0001*	0.9989	0.9994	0.9997	0.9995
US	1.0002*	1.0001*	1.0000*	1.0017*	1.0001*
Post-Crisis Period					
ASEAN-5	0.9999	0.9976	0.9999	1.0000*	0.9975
US	0.9999	0.9997	0.9999	0.9995	0.9997

Notes: * indicates that the LMI of the country diverge from the ASEAN-5 or the US market index.

On the other hand, the market indices of Indonesia and the Philippines are two ASEAN-5 countries diverging from the US market index. Overall, all ASEAN-5 market indices that diverged from the US market index during the pre-crisis period are converging during the post-crisis period.

4.3 Cointegration Results

Before testing for convergence based on the method of Bernard and Durlauf (1995), it is essential to determine the order of integration for each of the market index series. ADF tests are used to test for the presence of unit roots in the logarithms of total market return indices in the US and five ASEAN-5 countries. Although detailed results are not reported to save space, the ADF t-

statistics do not reject the null hypothesis of a unit root for the six LMI series, implying that each is non-stationary. Upon taking first differences of the series which indicate stationarity of the transformed series, the ADF tests indicate all six LMI series are integrated of order one.

Based on the definition in Bernard and Durlauf (1995), the six LMI series are tested for convergence between each ASEAN country. The Schwarz information criterion is used to determine the order of the VAR model, with the test statistics and choice criteria indicating a VAR model of order two. If the LMI for two countries are cointegrated, the restriction $[1, -1]$ is imposed on the cointegrating vector. Assume no deterministic trend in the data and restricted intercept in cointegrating equation. Table 6 reports the trace statistic of the stochastic matrix to determine the number of cointegrating vectors (r) that are significant at the 5% level.

Table 6. Trace Statistics for the VAR(2) Model, 1990-2007

	Full Sample $H_0: r=0,$ $H_a: r \geq 1$	Pre-Crisis $H_0: r=0,$ $H_a: r \geq 1$	Post-Crisis $H_0: r=0,$ $H_a: r \geq 1$
Indonesia			
MY	–	24.45*	–
PH	–	22.10	–
SG	–	24.97*	–
US	–	30.00*	–
TH	30.01*	–	15.58*
Philippines			
MY	–	24.93	–
SG	–	35.65	–
TH	24.10*	–	–
Singapore			
MY	–	–	22.30*
ASEAN-5	78.58	84.12	57.91 ^a

Notes: * denote a unit restriction is not rejected at the 5% level of significance.

^a denotes significance at the 5% level for $H_0: r=1$ and $H_a: r \geq 2$.

The trace statistics reject the existence of a long-run cointegrating relationship between the US market and each of the five ASEAN markets, with the exception of Indonesia in the pre-crisis period. As shown in Table 6, there are five and two long-run relationships between ASEAN-5 market indices in the pre- and post-crisis periods, respectively. Of the 10 cointegrating vectors given

in Table 6, the likelihood ratio test rejects the null hypothesis of a unit restriction for three cointegrating vectors (namely, the Philippines with Indonesia, Malaysia and Singapore, respectively) at the 5% significance level. The results indicate convergence in two pairs of ASEAN-5 market indices across the entire sample and both periods before and after the financial crisis.

For the five ASEAN-5 countries, tests for the presence of a common long-run trend for individual LMI series in the group are also undertaken. The test statistics indicate the existence of at least one long-run cointegrating relationship among the ASEAN-5 market indices in the pre-crisis period and at least two long-run cointegrating relationships in the post-crisis period. The results indicate the number of common trends reduced from four to three which suggests a partial convergence of the indices.

5 CONCLUSION

This paper examines the dynamic interdependence and long-run relationships between the ASEAN-5 stock markets, and whether there are signs of converging or increased cross-market integration after the 1997 Asian financial crisis. An examination of the ASEAN-5 stock market returns indicates higher average returns and correlations over the post-crisis period. The Granger causality results also indicate an increase in the integration between the ASEAN-5 markets after the financial crisis with minor changes in directions of Granger causality between pairwise ASEAN-5 returns across the pre- and post-crisis periods. Consistent with past studies, the US market returns are found to have significant influence on the returns of all ASEAN-5 markets.

Among the ASEAN-5 markets, Indonesia and Singapore are two diverging countries, whereas the remaining three countries converge towards the group average using the statistical test for converging trend. However, all ASEAN-5 have shown signs of converging with the US market in the post-crisis period. Using the cointegration method, convergence of all ASEAN-5 market indices was not supported, except for convergence in two pairs of ASEAN-5 markets. Apart from Indonesia, none of the ASEAN-5 had a long-run cointegrating relationship with the US market. Reduction of common trends among ASEAN-5 markets in the post-crisis period suggests a partial convergence of the indices. Overall, there is some evidence of an increase in the level of integration and interdependence between the ASEAN-5 markets after the financial crisis.

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