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Stock Market Linkages in Emerging Asia-Pacific Markets

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Abstract

This study examines the stock market integration among major stock markets of emerging Asia-Pacific economies, viz. India, Malaysia, Hong Kong, Singapore, South Korea, Taiwan, Japan, China, and Indonesia. The Johansen and Juselius multivariate cointegration test, Granger causality/Block exogeneity Wald test based on the vector error correction model (VECM) approach, and variance decomposition analysis were used to investigate the dynamic linkages between markets. Cointegration test confirmed a well-defined long-run equilibrium relationship among the major stock markets, implying that there exists a common force, such as arbitrage activity, which brings these stock markets together in the long run. The results of Granger causality/Block exogeneity Wald test based on VECM and variance decomposition analysis revealed the stock market interdependencies and dynamic interactions among the selected emerging Asia-Pacific economies. This result implies that investors can gain feasible benefits from international portfolio diversification in the short run. On the whole, the study results suggest that although long-term diversification benefits from exposure to these markets might be limited, short-run benefits might exist due to substantial transitory fluctuations.

Keywords

stock market integration, cointegration, vector error correction model, variance decomposition analysis

Introduction

Over the last three decades, degree of integration of stock markets around the globe increased significantly as a result of liberalization of markets, rapid technological progress, and financial innovations, which has created new investment and financing opportunities for business and investors around the world. Stulz (1981) defined stock markets as being integrated "if assets with perfectly correlated returns have the same price, regardless of the location in which they trade." A fully integrated market is defined as a situation where investors earn the same risk-adjusted expected return on similar financial instruments in different national markets (Jorion & Schwartz, 1986), which means arbitrage profit will not be achieved. Accordingly, the stock market integration hypothesis stated that there were potential gains from international portfolio diversification if returns from investment in different national stock markets are not perfectly correlated and the correlation structure is stable. This implies that low levels of co-movement of stock prices offer investors the benefit of diversifying their holdings across the global stock markets. That is, investors who allocate some of their portfolio to share from other countries can increase the portfolio's expected return with no increase in risk. This benefit of international diversification has led many investors to allocate some of their wealth to foreign markets and shares of foreign firms. Thus, with the growing global economy, understanding international stock market correlations has become a vital instrument for investors wishing to diversify their portfolios on a global basis. For institutional and individual investors to have effective international portfolio diversification, it is important to determine the countries whose stock prices move together, that is, to investigate the correlation structure and interdependencies among international share price indexes to a considerable extent. However, the existing empirical studies have provided mixed evidence on the interrelationship of the major global stock price indexes. Given the divergent conclusions of the researches in this area, further insights should be obtainable through an investigation of emerging markets. This study examine the stock market linkages between 11 emerging economies, viz., India, Malaysia, Hong Kong, Singapore, South Korea, Taiwan, Japan, China, Indonesia, the United States, and the United Kingdom. The U.S. and U.K. stock markets are taken into account in the present study for its significant role as the market leaders. Further, it is useful to know whether the major stock markets of the United States and the United Kingdom influence the emerging Asia Pacific markets. We used correlation analysis,

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Johansen multivariate cointegration test and vector error correction model (VECM) to investigate dependencies in stock returns of the emerging economies. The correlation analysis is performed to ascertain the degree of association among the emerging stock markets, cointegration test to verify whether long-term relationship exists, and the VECM to examine whether returns of one market influence another.

The remainder of this article is organized as follows: Section 2 provides the review of the literature on stock market linkages. Section 3 presents methodology of the study. The empirical results and discussion are provided in Section 4, and Section 5 presents concluding remarks.

Literature Review

The earlier literature pertaining to stock market integration provides strong evidence of interlinkages among the stock markets around the globe, as a result of global economic integration. The interest in the interdependencies of global stock markets strengthened after the global market crash of October 1987. Taylor and Tonks (1989) examined the market integration of the United States, Germany, the Netherlands, and Japan for the two subperiods: April 1973 to September 1979, and October 1979 to June 1986. The result showed no cointegration between the stock price returns of these countries in the former period, and there was cointegration between the stock price returns of the United Kingdom with the stock price returns of the United States, Germany, the Netherlands, and Japan in the latter period. Jeon and Von-Furstenberg (1990) showed that the degree of international co-movement in stock price indexes has increased significantly since the 1987 crash. Similarly, Arshanapalli and Doukas (1993) examined the strong interdependence among international stock markets during the pre- and post-October 1987 crisis period. Their results showed that the degree of international co-movements among stock price indices has increased substantially, except the Nikkei index, during the post-October crash period. On the other hand, Koop (1994) used Bayesian methods and concluded that there are no common trends in stock prices across countries after the crash. Cheung and Ng (1992) investigated the dynamic properties of stock returns in Tokyo and New York, using the GARCH model for the period January 1985 to December 1989. They found that in the precrash period, Tokyo stock price movements can be partially explained by the New York Stock Exchange, but the former has very little impact on the latter. Lee and Kim (1994) provided evidence for a significant increase in the co-movement of the stock price indexes after the crash. The national stock markets became more interrelated and stronger when the U.S. stock market was more volatile. Chowdhury (1994) examined the relationship among the Asian Newly Industrialized Economies (NIEs), Japan, and the United States. He found that the United States led the NIEs and that there were significant linkages between the markets. Arshanapalli, Doukas, and Lang (1995) examined the possible links and dynamic interactions between the U.S. and six major Asian stock markets before and after October 1987. The empirical results proved the presence of a long-run equilibrium relationship between the United States and Asian stock market movements during the post-October 1987 period. The cointegration results, based on the Asian equity markets alone, supported the possibility of increased regional capital market integration among the six Asian stock exchanges during the postcrash period. However, their error correction analysis, at the regional level, failed to support the presence of a strong cointegrating relationship among the Asian markets. Lastly, they concluded that the Asian equity markets were less integrated with Japanese equity markets than they were with the U.S. market. Corhay, Ray, and Urbain (1995) investigated the stock market linkages of Australia, Japan, Hong Kong, New Zealand, and Singapore over the period February 1972 to February 1992 and found no evidence of a single stochastic trend for these countries. Hassan and Naka (1996) studied the dynamic linkages among the U.S., Japan, U.K., and German stock market indices using a VECM of cointegrated variables. They showed that the U.S.–Japan–Germany stock market indices and Japan–U.K.–Germany indices are not cointegrated with each other.

Syriopoulos (1996) investigated the short- and long-run behavior of major emerging Central European (Poland, Czech Republic, Hungary, Slovakia) and developed (Germany, United States) stock markets. They showed that the Central European markets tend to display stronger linkages with their mature counterparts, whereas the U.S. market holds a world leading influential role. Chaudhuri (1997) investigated the long-run relationship between stock indexes of six Latin American markets and the United States over the period 1985 to 1993, and he found the evidence of a stochastic trend in all indexes. The cointegration tests showed the presence of a long-run relationship between the six Latin American indexes (with and without the U.S. return) and the error correction results proved the significant causality among the stated indexes. Francis and Leachman (1998) revealed that the U.S. stock market influences other markets around the world. Janakiramanan and Lamba (1998) examined the linkages between the stock markets in the Pacific-Basin region and showed that the U.S. market influences all markets, except Indonesia. They found none of these markets exert a significant influence on the U.S. market. Liu, Pan, and Shieh (1998) examined the interrelationship among the emerging and developed stock markets of Thailand, Taiwan, Japan, Singapore, Hong Kong, and the United States. They found that after the October 1987 crisis there was an increase in the general stock market interdependence among the emerging and developed stock markets and they also found interdependencies within the Asian Pacific regional markets. Chong, Wong, and Yan (1998) examined the lead–lag relationships between the Tokyo Stock Exchange and the other G7 stock markets, and found the interdependence of the

Toronto, Paris, Frankfurt, London, Milan, and New York stock exchanges with the Japanese equity market. Chen, Firth, and Rui (2002) examined the dynamic interdependence of the major stock markets in Latin America, namely, Argentina, Brazil, Chile, Colombia, Mexico, and Venezuela. The cointegration analysis and error correction vector autoregressive model revealed that the potential for diversifying risk by investing in different Latin American markets is limited. Similarly, Diamandis (2009) examined long-run relationships between four Latin America stock markets and a mature stock market that of the United States using weekly observations for the period January 1988 to July 2006. They found that although cointegration exists, there were small long-run benefits from international portfolio diversification as the stock prices adjust very slowly to these common trends.

With the emergence of Asian capital markets, studies have been done in the 1990s and thereafter focused the co-movements between Asian markets and the stock markets in developed countries. A. Masih and Masih (1999) studied the long- and short-term dynamic linkages among international and Asian emerging stock markets, and concluded that the U.S. stock market was leader at the global level for short as well as long term, and there was a significant relationship between the Organisation for Economic Co-operation and Development (OECD) and the Asian emerging markets. Agarwal (2000), with a correlation coefficient of 0.01 between India and developed markets, concluded that there is a lot of scope for the Indian stock market to integrate with the world market. R. Masih and Masih (2001) investigated the dynamic causal linkages among nine major international stock price indexes using the vector error-correction modeling and level vector autoregressive models. The empirical results supported the significant interdependencies between the established OECD and the Asian markets, and also the leadership of the U.S. and U.K. markets over the short and long run. Mishra (2002) investigated the international integration of India's domestic financial market with the U.S. stock market. By applying the ordinary least squares (OLS) method and cointegration technique, he found a positive correlation between NASDAQ and BSE. He concluded that BSE was influenced by the movements of NASDAQ. But there is no cointegrating vector between BSE and NASDAQ indexes, which shows that there is no long-run relationship between these two stock exchanges. Besides, the study of Kumar and Mukhopadhyay (2002) examined the short-run dynamic linkages between NSE Nifty and NASDAQ Composite during the period 1999-2001. The study supported a unidirectional Granger causality running from the U.S. stock market to Indian stock market. Nath and Verma (2003) studied the transmission of market movements among the three major stock markets in the Asian region, namely, India, Singapore, and Taiwan. The results proved that there was no long-term interrelationship, and thus, international investors could achieve long-term gains by investing in the stock markets because of the independencies of the stock markets. By using the BSE-200 index, Wong, Agarwal, and Du (2005) found that the Indian stock market is integrated with the matured markets of the world. Moreover, Hoque (2007) found the evidence that stock prices of Bangladesh, the United States, Japan, and India share a common stochastic trend. Phylaktis and Ravazzolo (2007) examined stock market linkages of a group of Pacific-Basin countries with the United States and Japan by estimating the multivariate cointegration model over the period 1980-1998. Their results showed that the stock market integrations were found to be significant in the 1990s. Li and Majerowska (2008) analyzed the linkages between the emerging stock markets in Warsaw and Budapest and the established markets in Frankfurt and the United States. They found that the emerging markets are weakly linked to the developed markets. Menon, Subha, and Sagaran (2009) examined whether the stock markets in the Indian subcontinent have any link with the major stock markets in China, Singapore, America, and Hong Kong. They found that the Indian markets are cointegrated to some of the markets around the world.

Bastos and Caiado (2010) found the evidence of integration and interdependence between the stock market returns of 46 developed and emerging countries for the period 1995-2009. Similarly, Park (2010) found strong co-movement between Asian markets. Among those, the countries with more developed financial systems (i.e., Japan, Singapore, and Hong Kong in Asia) exhibited stronger linkages to the rest of the Asian markets. Using the time-series data ranging from June 2, 2005, to April 2, 2008, Arouri and Nguyen (2010) established no significant association between stock exchange of Gulf countries and the world stock markets. Subhani, Hasan, Mehar, and Osman (2011) identified the linkage of stock prices of Karachi Stock Exchange with the stock prices of Nepal and Bombay stock exchanges except Dhaka stock exchange. Samitas and Kenourgios (2011) supported the existence of long-term relationship among Balkan stock markets and developed markets (the United States, the United Kingdom, Germany). Besides, Sakthivel and Kamaiah (2012) attempted to investigate the dynamic inter-linkages among the Asian, European, and U.S. stock markets for the period January 1998 to June 2010. They showed that the U.S. and some of the European and Asian stock markets lead the Indian stock market. Horvath and Petrovski (2012) examined the international stock market co-movements between Western Europe vis-à-vis Central (the Czech Republic, Hungary, and Poland) and South Eastern Europe (Croatia, Macedonia, and Serbia) and found that the degree of co-movements is much higher for Central Europe and the correlation of South Eastern European stock markets with developed markets is essentially zero. Tripathi and Sethi (2012) examined the short-run and long-run interlinkages of the Indian stock market with those of advanced emerging markets, viz., Brazil, Hungary, Taiwan, Mexico, Poland, and South Africa over the period ranging from January 1, 1992, to December 31, 2009. They showed that the short-run and long-run interlinkages of the Indian stock market with other markets have increased over the study period. Unidirectional causality is found in most cases.

The earlier studies pertaining to market integration and causality between world stock markets are well established, but provided the assorted results. Testing for cointegration among stock markets is a test of the level of arbitrage activity in the long run. If markets are not cointegrated, this implies that there is no arbitrage activity to bring the market together in the long run, and hence, the investors can potentially obtain long-run gains through portfolio diversification. In view of the various policy innovations in the emerging capital markets during the globalization era, it is highly desirable to test the stock market interdependencies among the emerging economies. Essentially, the degree of interdependencies of stock markets has major implications on potential benefits of portfolio diversification and on financial stability of the country. The current study attempts to examine the dynamic interdependence among major stock markets of emerging Asia-Pacific economies.

Method

Cointegration Approach

Johansen and Juselius (1990) multivariate cointegration approach and VECM have been used to investigate the dynamic linkages among selected emerging Asia-Pacific stock markets. Before doing cointegration analysis, it is necessary to test the stationary of the series. The Augmented Dickey–Fuller (ADF) test (Dickey & Fuller, 1979) was used to infer the stationary of the series. If the series are nonstationary in levels and stationary in differences, then there is a chance of cointegration relationship between them that reveals the long-run relationship between the series. Johansen's cointegration test has been used to investigate the long-run relationship between the variables. Besides, the causal nexus between selected emerging stock markets was investigated by estimating the following VECM (Johansen, 1988; Johansen & Juselius, 1990):

$$\Delta Y_{\mathrm{t}} = \mu + \Gamma_i \Delta Y_{t-i} + \ldots\ldots + \Gamma_{k-1} \Delta \mathrm{Y}_{t-k+1} + \Pi \mathrm{Y}_{t-1} + \varepsilon_t, \tag{1}$$

where ΔY_t is $(n \times 1)$ vector of stock market price changes in period t, μ is $(n \times 1)$ vector of constant terms, Γ_i ($i = 1, \ldots k - 1$) represents the $(n \times n)$ coefficient matrix of short-run dynamics, Π is the $n \times n$ long-term impact matrix, and ε_{1t} is $(n \times 1)$ vector of error term and it is independent of all explanatory variables. When cointegration is present, we can decompose the long-term response matrix into $\mathrm{A} = \alpha\beta'$, where α and β are $n \times r$ matrices. In other words, the expression $\beta' \; Y_{t-1}$ defines the stationary linear combinations (cointegration relations) of the $I(1)$ vector Y_t, while the matrix α of the error correction terms describe how the system variables adjust to the equilibrium error from the previous period, $\beta' \; Y_{t-1}$.

The Johansen's cointegration proposed two test statistics through the VAR model that are used to identify the number of cointegrating vectors, namely, the trace test statistic and the maximum eigenvalue test statistic. These test statistics can be constructed as

$$\lambda_{\text{trace}}(r) = -T \sum_{i=r+1}^{n} 1n\left(1-\hat{\lambda}_i\right), \tag{2}$$

$$\lambda_{max}(r,\; r+1) = -T1n\left(1-\hat{\lambda}_{r+i}\right), \tag{3}$$

where are the eigenvalues obtained from the estimate of the A_k matrix and T is the number of usable observations. The λ_{trace} tests the null that there are at most r cointegrating vectors, against the alternative that the number of cointegrating vectors is greater than r and the λ_{max} tests the null that the number of cointegrating vectors is r, against the alternative of $r + 1$. Critical values for the λ_{trace} and λ_{max} statistics are provided by MacKinnon, Haug, and Michelis (1999).

Granger Causality Test Based on VECM

The Granger Representation Theorem (Engle & Granger, 1987) states that if a set of variables is cointegrated, then there exists a valid error correction representation of the data, in which the short-term dynamics of the variables in this system are influenced by the deviation from long-term equilibrium. In a VECM, short-term causal effects are indicated by changes in other differenced explanatory variables (i.e., the lagged dynamic terms in Equation 1). The long-term relationship is implied by the level of disequilibrium in the cointegration relationship, that is, the lagged error correction term (ECT). Thus, in the cointegration model, the proposition of "Y_k not Granger causing Y_l" in the long term is equivalent to $\alpha_{kl} = 0$. Y_l is said to be weakly exogenous for parameter β, that is, Y_l does not react to equilibrium errors. Besides, the proposition "Y_k do not Granger-cause Y_l" in the short term is equivalent to $\Gamma_{kl}(L) = 0$, where L is the lag-operator. Hence, the VECM is useful for detecting short- and long-term Granger causality tests (Granger, 1969). The VECM corresponding to Equation 1 can be formulated as follows:

$$\Delta Y_{1t} = \mu_1 + \gamma_1 z_{t-1} + \sum_{i=1}^{p-1} \theta_{1i} \Delta Y_{1t-i} + \; + \sum_{i=1}^{p-1} \delta_{1i} \Delta Y_{2t-i} + \varepsilon_{1t}, \tag{4}$$

$$\Delta Y_{2t} = \mu_2 + \gamma_2 z_{t-1} + \sum_{i=1}^{p-1} \delta_{2i} \Delta Y_{2t-i} + \; + \sum_{i=1}^{p-1} \theta_{1i} \Delta Y_{1t-i} + \varepsilon_{2t}, \tag{5}$$

Table 1. List of Emerging Stock Markets and Its Stock Indexes.

Country	Stock exchange	Index
India	National stock exchange	NIFTY
Malaysia	Kuala Lumpur stock exchange	KLSE
Hong Kong	Hong Kong stock exchange	HSI
Singapore	Strait times index	STI
South Korea	Korea composite stock price index	KOSPI
Taiwan	Taiwan stock exchange	TWI
Japan	Tokyo stock exchange	NIKKEI 225
China	Shanghai stock exchange	SSE
Indonesia	Jakarta stock exchange	JFX
The United States	New York stock exchange	S&P 500
The United Kingdom	London stock exchange	FTSE

where z_{t-1} is the error correction term derived from the cointegrating vector. θ and δ are the short-run parameters to be estimated, p is the lag length, and ε_t are assumed to be stationary random processes with a mean of zero and constant variance.

For each equation in the VECM, we use short-term Granger causality to test whether endogenous variables can be treated as exogenous by the joint significance of the coefficients of each of the other lagged endogenous variables in that equation. The short-term significance of sum of the each lagged explanatory variables (θs and δs) can be exposed either through joint F or Wald χ^2 test. Besides, the long-term causality is implied by the significance of the t-tests of the lagged error correction term. However, the nonsignificance of the t-statistics and joint F or Wald χ^2 tests in the VECM indicates econometric exogeneity of the dependent variable.

Variance Decomposition Analysis

Finally, the study used variance decomposition analysis to assess to what extent shocks to certain markets are explained by other markets in the system. Meaning, it tends to show the percentage of forecast error variance for each of the index selected that may attribute to its own shocks and to fluctuations in other indexes. Information from this analysis should provide some further evidence on the patterns of linkages among stock markets, as well as contribute to enhancing insights on how markets react to system-wide shocks and see how these responses propagate over time. This forecast error can be accounted for by its own innovations and the innovations of other variables in the system. In a statistical sense, if a variable explains most of its own shock, then it does not allow variances of other variables to contribute to it being explained and is therefore said to be relatively exogenous.

The data used in this study consist of daily stock indexes of the major stock exchange in the U.S., U.K., and emerging Asia-Pacific economies, namely, India, Japan, Malaysia, South Korea, Thailand, Indonesia, Taiwan, Singapore, and Hong Kong. The details of the stock exchanges and indices considered for the study are shown in Table 1. All indexes are expressed in terms of local currencies and are obtained from Bloomberg database. The sample period for the study covers from January 4, 2000, through January 31, 2013. Daily returns are identified as the first difference in the natural logarithm of the closing index value for the two consecutive trading days for the 11 major indices. We used daily data rather than lower frequency data such as weekly and monthly returns because longer horizon returns can obscure transient responses to innovations that may last for few days only (Andersen, Bollerslev, Diebold, & Labys, 2002; Brailsford, 1996; Elyasiani, Perera, & Puri, 1998).

Empirical Results

To assess the distributional properties of stock market return series of emerging markets, descriptive statistics are reported in Table 2. The average daily returns of emerging stock markets are found to be positive and ranges between 0.002% and 0.07%. The Indonesian market provides the highest return with an average of 0.07%, followed by Indian market, recording an average of 0.05%. The major stock markets of China, South Korea, Malaysia, and Japan recorded average returns of 0.02%, respectively. The lowest mean returns are observed for the United Kingdom, Taiwan, and the United States. Furthermore, the summary statistics show that the stock markets display a wide level of standard deviation ranging from 0.012 (Malaysia) to 0.020 (South Korea) during the sample period.

Table 3 reports the correlation coefficients of the major stock market returns of emerging economies. The table result indicates that the coefficients of correlation across the stock market returns are positive and strong linkages were detected between Taiwan and other markets such as Singapore, South Korea, Japan, and Hong Kong, showing correlation coefficients in a range between 0.5195 and 0.6181. Singapore stock market exhibits profound correlations with Hong Kong, South Korea, Japan, India, Indonesia, and the United Kingdom, ranging between 0.5071 and 0.7634. Besides, the South Korean market is strongly associated with Japan and Hong Kong stock markets, with coefficients of 0.6197 and 0.6489, respectively. The result also reveals that the Hong Kong stock market is strongly correlated with Japan, Indonesia, and India. Similarly, the United States market is highly linked with the United Kingdom stock market. However, the correlations among other market returns are considered to be low.

A perquisite for testing cointegration between stock market returns is that all variables are nonstationary. The ADF test with intercept is used to check whether the variables contain a unit root. Table 4 reports the results of ADF unit root test for the major stock market indexes of emerging economies, namely, India, Malaysia, Hong Kong, Singapore, South Korea, Taiwan, Japan, China, Indonesia, the United States, and the United Kingdom. The results reveal that all the stock

Table 2. Descriptive Statistics.

Statistics	S&P 500	TWI	STI	SSE	KLSE	KOSPI	NIKKEI 225	JFX	NIFTY	HSI	FTSE
M	0.00003	0.00003	0.0001	0.0002	0.0002	0.0002	0.0002	0.0007	0.0005	0.0001	0.00002
Median	0.0006	0.0005	0.0004	0.0001	0.0004	0.0009	0.00008	0.0021	0.0011	0.0004	0.0003
Maximum	0.0940	0.1607	0.2147	0.0932	0.1986	0.1386	0.0998	0.1362	0.1633	0.1680	0.0982
Minimum	−0.1379	−0.1260	−0.1494	−0.1416	−0.1924	−0.1677	−0.1271	−0.1360	−0.2199	−0.1597	−0.1032
SD	0.0150	0.0179	0.0152	0.0184	0.0120	0.0201	0.0173	0.0171	0.0192	0.0181	0.0145

Note. S&P 500 = New York stock exchange; TWI = Taiwan stock exchange; STI = Strait times index; SSE = Shanghai stock exchange; KLSE = Kuala Lumpur stock exchange; KOSPI = Korea composite stock price index; NIKKEI 225 = Tokyo stock exchange; JFX = Jakarta stock exchange; NIFTY = National stock exchange; HSI = Hong Kong stock exchange; FTSE = London stock exchange.

Table 3. Correlation Matrix for the Stock Market Returns.

Stock indexes	S&P 500	TWI	STI	SSE	KLSE	KOSPI	NIKKEI 225	JFX	NIFTY	HSI	FTSE
S&P 500	1.0000										
TWI	.2502	1.0000									
STI	.3675	.5701	1.0000								
SSE	.0656	.1896	.2466	1.0000							
KLSE	.1191	.3481	.4359	.1914	1.0000						
KOSPI	.2983	.6181	.6216	.1839	.3611	1.0000					
NIKKEI 225	.2754	.5195	.5943	.2173	.3495	.6197	1.0000				
JFX	.2051	.4561	.5519	.2204	.3836	.4565	.4349	1.0000			
NIFTY	.2700	.3977	.5593	.2061	.2988	.4587	.4096	.4628	1.0000		
HSI	.3306	.5673	.7634	.3389	.4045	.6489	.6334	.5423	.5632	1.0000	
FTSE	.6299	.3570	.5071	.1355	.2288	.3964	.4315	.3364	.4018	.4948	1.0000

Note. S&P 500 = New York stock exchange; TWI = Taiwan stock exchange; STI = Strait times index; SSE = Shanghai stock exchange; KLSE = Kuala Lumpur stock exchange; KOSPI = Korea composite stock price index; NIKKEI 225 = Tokyo stock exchange; JFX = Jakarta stock exchange; NIFTY = National stock exchange; HSI = Hong Kong stock exchange; FTSE = London stock exchange.

Table 4. Unit Root Test Results.

Augmented Dickey–Fuller Test		
Variables	Level	First difference
HSI	−1.332	−50.87*
JFX	0.255	−46.45*
KLSE	−0.476	−51.39*
KOSPI	−0.811	−51.11*
NIKKEI 225	−2.365	−50.53*
NSE	−0.453	−49.24*
S&P500	−2.043	−53.45*
SSE	−1.426	−50.06*
STI	−1.078	−50.18*
TWI	−2.177	−48.33*
FTSE	−2.447	−51.92*

Note. Optimal lag length is determined by the Schwarz Information Criterion (SIC). HSI = Hang Seng index; JFX = Jakarta stock exchange; KLSE = Kuala Lumpur stock exchange; KOSPI = Korea composite stock price index; NIKKEI 225 = Tokyo stock exchange; NSE = National stock exchange; S&P 500 = New York stock exchange; SSE = Shanghai stock exchange; STI = Strait times index; TWI = Taiwan stock exchange; FTSE = London stock exchange.
*Significance at 1% level.

indexes are stationary at the first differences, and hence they are integrated in the order of I(1).

Johansen and Juselius (1990) multivariate cointegration test was performed to examine the long-run relationship between the major stock markets of emerging Asia-Pacific economies and the results are reported in Table 5. Trace and maximum eigenvalue indicates the presence of single cointegrating vector among all the stock markets at 5% significant level. This implies that there is a well-defined long-run equilibrium relationship among the major stock markets, which suggests the stock market indexes move together and have high correlation in the long run, so there are limited benefits from portfolio diversification across the stock markets in the long run. By and large, the cointegrated stock markets imply that there is a common force, such as arbitrage activity, which brings the stock markets together in the long run. These findings are consistent with the results of Jang and Sul (2002) and Choudhry and Lin (2004), who found a significant long-run relationship between the emerging Asian equity markets.

The results of the estimated multivariate VECM are presented in Table 6. As already proved by cointegration test, the stock market prices are cointegrated, that is, there is a well-defined long-run equilibrium relationship between the major stock markets. The validity of the estimated cointegration model is tested using the serial correlation Lagrange Multiplier (LM) test. The LM statistic is found to be 4.263

Table 5. Johansen Maximum Likelihood Cointegration Test.

Null hypothesis	Alternative hypothesis	Trace statistics	5% critical value	Maximum Eigen statistics	5% critical value
H_0: $r = 0$	H_1: $r = 1$	308.42**	285.14**	73.1552	70.53
H_0: $r \leq 1$	H_1: $r = 2$	235.26	239.23	59.9463	64.50
H_0 :$r \leq 2$	H_1: $r = 3$	175.32	197.37	54.1847	58.43
$H_{0:}$ $r \leq 3$	H_1: $r = 4$	121.13	159.52	33.5259	52.36
H_0: $r \leq 4$	H_1: $r = 5$	87.61	125.61	26.7449	46.23
H_0: $r \leq 5$	H_1: $r = 6$	60.86	95.75	22.4532	40.07
H_0: $r \leq 6$	H_1: $r = 7$	38.41	69.81	13.4763	33.87
H_0: $r \leq 7$	H_1: $r = 8$	24.93	47.85	10.2109	27.58
H_0: $r \leq 8$	H_1: $r = 9$	14.72	29.79	8.5068	21.13
H_0: $r \leq 9$	H_1: $r = 10$	6.217	15.49	5.8904	14.26
H_0: $r \leq 10$	H_1: $r = 11$	0.329	3.841	0.3292	3.841

Note. r is the number of cointegrating vector. Critical values are noted from MacKinnon, Haug, and Michelis (1999).
**Significance at 5% level.

Table 6. Vector Error Correction Model Estimates.

	ΔNIFTY	ΔJFX	ΔNIKKEI 225	ΔKOSPI	ΔFTSE	ΔKLSE	ΔSSE	ΔSTI	ΔHSI	ΔTWI	ΔS&P 500
Z_{t-1}	−0.0902*	−0.1398*	−0.1648*	−0.1869*	−0.1488*	−0.0558*	−0.0354**	−0.1754*	−0.1394*	−0.1980*	0.0662*
	(−6.275)	(−11.21)	(−13.90)	(−13.15)	(−14.20)	(−6.201)	(−2.526)	(−14.13)	(−12.88)	(−15.46)	(5.794)
Constant	−0.00006	−0.00007	−0.00002	−0.00003	−0.00003	−0.00001	−0.00003	−0.00001	−0.00005	−0.00002	−0.00003
	(−0.014)	(−0.020)	(−0.064)	(−0.007)	(−0.012)	(−0.068)	(−0.095)	(−0.048)	(−0.018)	(−0.074)	(0104)

Note. NIFTY = National stock exchange; JFX = Jakarta stock exchange; NIKKEI 225 = Tokyo stock exchange; KOSPI = Korea composite stock price index; FTSE = London stock exchange; KLSE = Kuala Lumpur stock exchange; SSE = Shanghai stock exchange; STI = Strait times index; HSI = Hong Kong stock exchange; TWI = Taiwan stock exchange; S&P 500 = New York stock exchange.
*Significance at 1% level. **Significance at 5% level.

with a probability value of .376; thus, the null hypothesis of no autocorrelation is accepted and the residuals of the estimated Johansen multivariate cointegration are purely white noise.

The long-run dynamics was examined through the effect of the lagged error correction term in the VECM. Table 6 results clearly show significant error correction terms with a negative sign for all the major stock market returns except the United States market. This implies that these major stock markets are significantly adjusted to disequilibrium from the long-run relationship or the response with which the previous period's deviations from the long-run relationship are corrected is found to be significant in these major stock markets. The empirical results reveal that all the major stock market returns of emerging economies are significantly influenced by each other, suggesting a stronger long-run bilateral relationship between major stock markets of India, Malaysia, Hong Kong, Singapore, South Korea, Taiwan, Japan, China, Indonesia, the United States, and the United Kingdom.

Table 7 provides the results of Granger causality/Block exogeneity Wald test based on VECM to identify the short-run causality between the stock markets and to have an apparent inference of which market exert influence over the others. The empirical results confirm a unidirectional short-run causality running from Indian stock market to Hong Kong, Japan, Korea, and Taiwan markets. The Chinese stock market exerts significant influence on Hong Kong, India, Indonesia, Japan, Malaysia, and Taiwan stock markets. Besides, there is a one-way short-run unidirectional causation between Indonesia and Malaysia, Japan and Singapore, and Hong Kong and Indonesia. The direction of causality is also observed from Malaysian stock market to Hong Kong, Japan, Korea, and Singapore stock markets. The findings also indicated that stock markets of Hong Kong, Indonesia, and Korea are significantly influenced by the Taiwan market. Moreover, one-way Granger causation is detected between the United States and Hong Kong, and between Singapore and Taiwan markets. As for the U.K. market, it does have a significant influence over Korea and Indonesia. Most importantly, it is evident from the test results that there exist short-run bidirectional relationships running between India and Indonesia, Indonesia and Japan, Indonesia and Korea, Japan and Korea, the United Kingdom and India, the United Kingdom and Japan, the United Kingdom and Malaysia, China and Korea, China and the United Kingdom, Singapore and India, Singapore and the United Kingdom, Japan and Taiwan, the United Kingdom and Taiwan, Malaysia and

Table 7. Short-Run Granger Causality/Block Exogeneity Wald Test Based on VECM.

Dependent variable	ΔNIFTY	ΔJFX	ΔNIKKEI 225	ΔKOSPI	ΔFTSE	ΔKLSE	ΔSSE	ΔSTI	ΔHSI	ΔTWI	ΔS&P 500
Wald χ^2 statistics											
ΔNIFTY	—	21.82*	3.005	5.210	35.70*	1.839	8.260**	13.81*	0.573	6.151	17.87*
ΔJFX	7.296***	—	8.595**	11.90*	97.15*	3.208	8.285**	2.258	13.66*	11.24*	57.41*
ΔNIKKEI 225	9.967**	15.77*	—	7.439***	176.75*	19.75*	17.40*	2.647	14.55*	8.919**	62.20*
ΔKOSPI	7.295***	17.92*	8.743**	—	170.93*	19.25*	14.25*	6.093	3.367	26.15*	83.00*
ΔFTSE	12.06*	3.505	15.71*	2.557	—	15.17*	8.902**	6.821***	29.76*	70.70*	89.52*
ΔKLSE	2.188	15.76*	5.998	1.903	33.04*	—	7.222***	0.306	1.808	10.60**	13.73*
ΔSSE	1.172	4.508	1.181	10.25**	15.02*	1.244	—	1.015	4.926	4.720	2.363
ΔSTI	12.64*	2.544	13.35*	2.323	111.93*	10.92**	5.667	—	2.513	20.70*	80.81*
Δhis	15.21*	2.940	8.242**	4.865	172.86*	6.253***	17.83*	3.999	—	19.96*	92.45*
ΔTWI	9.217**	5.982	27.92*	3.170	169.38*	16.34*	12.65*	10.82**	2.487	—	126.48*
ΔS&P 500	17.35*	15.33*	13.97*	13.95*	17.88*	10.15**	5.778	2.303	2.625	5.771	—

Note. Δ implies first difference operator. Optimal lag length was determined by Final prediction error criterion (FPE) and Akaike information criterion (AIC). VECM = Vector Error Correction Model; NIFTY = National stock exchange; JFX = Jakarta stock exchange; NIKKEI 225 = Tokyo stock exchange; KOSPI = Korea composite stock price index; FTSE = London stock exchange; KLSE = Kuala Lumpur stock exchange; SSE = Shanghai stock exchange; STI = Strait times index; HSI = Hong Kong stock exchange; TWI = Taiwan stock exchange; S&P 500 = New York stock exchange.
*Significance at 1% level. **Significance at 5% level. ***Significance at 10% level.

Table 8. Diagnostic Test Statistics of the Estimated Vector Error Correction Model.

Diagnostic tests	Purpose of test	Test statistics	Probability	Inference
Jarque−Bera test	Normality	0.549	0.719	Normally distributed
Breusch−Godfrey Lagrange Multiplier test	Serial correlation	1.691	0.184	No serial correlation
ARCH Lagrange Multiplier test	Heteroskedasticity	0.414	0.657	No heteroskedasticity
Ramsey RESET test	Specification	0.959	0.413	Properly specified

Note. ARCH = Autoregressive Conditional Heteroskedasticity.

Taiwan, Taiwan and Singapore, the United States and India, Indonesia and the United States, Japan and the United States, Korea and the United States, the United Kingdom and the United States, Malaysia and the United States, Japan and Hong Kong, and the United Kingdom and Hong Kong.

Besides, the study used various diagnostic tests, viz., the Jarque−Bera Normality test, Breusch−Godfrey Serial Correlation LM test, Autoregressive Conditional Heteroskedasticity (ARCH) test, White Heteroskedasticity test, and Ramsey RESET specification test to examine the validity and reliability of the VECM and the results are presented in Table 8. The results indicate that the Granger causality test based on the VECM passes through all diagnostic tests where there is no evidence of autocorrelation and heteroskedasticity in the residuals. The Jarque−Bera test statistic indicates that residuals of the estimated model are normally distributed with constant variances. The Breusch−Godfrey Lagrange Multiplier and ARCH-LM tests suggest that the errors are free from serial correlation as well as heteroskedasticity problems. The Ramsay RESET test indicates that the model is properly specified.

The results of variance decomposition analysis based on VECM for the major stock markets of emerging Asia-Pacific economies over a 20-day horizon are presented in Table 9. The table result shows that the Chinese stock market was 89.51% explained by its own shock on the first trading day, and then it continued to reduce to 86.89% on the 20th trading day. The shock of other equity markets on China ranges between 0.03% and 10.14% at the 20th day, indicating that the degree to which other major stock markets influence stock prices of China is petite. For the Malaysian market, about 77.36% of the variation is explained by itself and shocks explained by other markets range between 0.01% and 23.64% on the 20th day. Moreover, the results confirm that majority of the stock markets, viz., China (86.89%) followed by Malaysia (77.36%), Hong Kong (76.36%), India (69.96%), the United Kingdom (69.85%), Indonesia (61.99%), Japan (52.31%), Taiwan (50.80%), South Korea (48.38%), Singapore (38.95%), and the United States (33.25%) are said to be fairly exogenous markets, as they are explained by itself for its own shock on the 20th day. Furthermore, the Indonesia, Japan, South Korea, United Kingdom, Hong Kong, India, Singapore, Taiwan, and United States accounts for 0.03% to 17.44%, 0.06% to 22.47%, 0.12% to 24.32%, 0.07% to 13.88%, 0.08% to 16.78%, 0.01% to 23.64%, 0.03% to 37.39%, 0.09% to 50.80% and

Table 9. Variance Decomposition Analysis.

Days	*SE*	ΔHSI	ΔNIFTY	ΔJFX	ΔNEKKEI 225	ΔKOSPI	ΔFTSE	ΔKLSE	ΔSSE	ΔSTI	ΔTWI	ΔS&P 500
Variance decomposition of ΔSSE												
1	0.02	9.64	0.04	0.18	0.00	0.29	0.02	0.33	89.51	0.00	0.00	0.00
2	0.02	9.83	0.14	0.26	0.10	0.30	0.71	0.31	87.80	0.01	0.00	0.55
3	0.02	9.72	0.16	0.24	0.13	0.57	0.73	0.34	87.45	0.04	0.01	0.63
4	0.02	10.03	0.14	0.27	0.12	0.76	0.66	0.32	87.03	0.03	0.05	0.59
5	0.03	9.64	0.16	0.23	0.11	0.65	0.57	0.32	87.44	0.03	0.10	0.74
6	0.03	9.92	0.18	0.27	0.13	0.71	0.57	0.31	87.03	0.04	0.10	0.74
7	0.03	9.92	0.18	0.26	0.14	0.79	0.52	0.31	87.02	0.04	0.09	0.75
8	0.03	9.95	0.18	0.25	0.14	0.80	0.49	0.31	87.01	0.04	0.08	0.76
9	0.03	9.96	0.19	0.25	0.14	0.78	0.46	0.31	87.03	0.04	0.08	0.78
10	0.03	10.01	0.19	0.25	0.14	0.81	0.44	0.30	86.96	0.04	0.07	0.80
11	0.03	10.02	0.19	0.24	0.14	0.82	0.41	0.30	86.96	0.04	0.07	0.80
12	0.03	10.04	0.20	0.24	0.14	0.82	0.40	0.30	86.95	0.04	0.06	0.81
13	0.03	10.06	0.20	0.24	0.15	0.83	0.38	0.30	86.94	0.04	0.06	0.82
14	0.04	10.07	0.20	0.24	0.15	0.84	0.36	0.30	86.93	0.04	0.06	0.83
15	0.04	10.09	0.20	0.24	0.15	0.84	0.35	0.30	86.92	0.04	0.05	0.83
16	0.04	10.10	0.20	0.23	0.15	0.84	0.34	0.30	86.91	0.04	0.05	0.84
17	0.04	10.11	0.21	0.23	0.15	0.85	0.33	0.29	86.90	0.04	0.05	0.84
18	0.04	10.12	0.21	0.23	0.15	0.85	0.32	0.29	86.90	0.04	0.05	0.85
19	0.04	10.13	0.21	0.23	0.15	0.86	0.31	0.29	86.89	0.03	0.05	0.85
20	0.04	10.14	0.21	0.23	0.15	0.86	0.30	0.29	86.89	0.03	0.04	0.86
Variance decomposition of ΔKLSE												
1	0.01	10.88	0.77	2.60	0.60	0.49	0.01	84.66	0.00	0.00	0.00	0.00
2	0.01	10.68	1.23	2.96	0.61	0.53	1.30	79.43	0.08	0.03	0.00	3.14
3	0.01	10.72	1.28	2.99	0.59	0.53	1.26	78.97	0.11	0.03	0.00	3.51
4	0.02	10.70	1.46	2.77	0.53	0.54	1.19	78.52	0.13	0.03	0.05	4.09
5	0.02	10.10	1.44	2.58	0.55	0.51	1.03	79.54	0.12	0.03	0.05	4.07
6	0.02	10.47	1.53	2.84	0.55	0.54	1.24	78.37	0.12	0.03	0.04	4.28
7	0.02	10.46	1.57	2.81	0.53	0.54	1.19	78.23	0.11	0.03	0.04	4.49
8	0.02	10.46	1.64	2.78	0.52	0.55	1.15	78.13	0.10	0.02	0.04	4.61
9	0.02	10.38	1.67	2.73	0.51	0.54	1.12	78.18	0.09	0.03	0.04	4.71
10	0.02	10.44	1.70	2.77	0.51	0.55	1.12	77.91	0.09	0.02	0.04	4.86
11	0.02	10.44	1.73	2.76	0.50	0.55	1.10	77.84	0.08	0.02	0.04	4.94
12	0.02	10.43	1.76	2.75	0.49	0.56	1.08	77.77	0.08	0.02	0.04	5.02
13	0.02	10.43	1.78	2.74	0.49	0.56	1.07	77.72	0.07	0.02	0.04	5.09
14	0.02	10.43	1.80	2.74	0.48	0.56	1.06	77.63	0.07	0.02	0.04	5.16
15	0.02	10.43	1.82	2.74	0.48	0.56	1.05	77.58	0.07	0.02	0.04	5.22
16	0.02	10.43	1.84	2.73	0.48	0.56	1.04	77.53	0.06	0.02	0.04	5.27
17	0.02	10.43	1.85	2.73	0.47	0.56	1.04	77.48	0.06	0.02	0.04	5.32
18	0.03	10.43	1.86	2.73	0.47	0.57	1.03	77.44	0.06	0.02	0.04	5.36
19	0.03	10.43	1.88	2.73	0.47	0.57	1.02	77.40	0.06	0.02	0.04	5.40
20	0.03	10.43	1.89	2.72	0.46	0.57	1.02	77.36	0.06	0.02	0.04	5.44
Variance decomposition of ΔJFX												
1	0.02	23.20	3.67	73.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.02	20.41	4.96	67.41	0.07	0.01	1.20	0.07	0.01	0.01	0.22	5.62
3	0.02	19.81	5.86	66.42	0.07	0.05	1.12	0.11	0.01	0.01	0.29	6.26
4	0.02	20.27	6.17	64.15	0.23	0.11	1.17	0.16	0.04	0.04	0.27	7.39
5	0.02	19.03	6.03	64.76	0.21	0.10	1.02	0.14	0.07	0.03	0.38	8.23
6	0.02	18.81	6.48	64.44	0.20	0.09	1.19	0.15	0.07	0.03	0.38	8.15
7	0.03	18.63	6.87	63.87	0.21	0.08	1.13	0.16	0.06	0.03	0.40	8.56
8	0.03	18.64	6.98	63.43	0.23	0.08	1.11	0.16	0.06	0.03	0.39	8.89
9	0.03	18.32	7.07	63.39	0.22	0.07	1.08	0.16	0.06	0.03	0.42	9.18

(continued)

Table 9. (continued)

Days	*SE*	ΔHSI	ΔNIFTY	ΔJFX	ΔNEKKEI 225	ΔKOSPI	ΔFTSE	ΔKLSE	ΔSSE	ΔSTI	ΔTWI	ΔS&P 500
10	0.03	18.17	7.26	63.14	0.23	0.07	1.07	0.16	0.06	0.03	0.43	9.39
11	0.03	18.08	7.41	62.94	0.23	0.06	1.04	0.16	0.05	0.03	0.43	9.56
12	0.03	17.99	7.50	62.78	0.23	0.06	1.03	0.16	0.05	0.03	0.44	9.74
13	0.03	17.88	7.59	62.66	0.23	0.06	1.01	0.16	0.05	0.03	0.45	9.89
14	0.03	17.80	7.68	62.53	0.24	0.05	1.00	0.16	0.05	0.03	0.45	10.02
15	0.03	17.72	7.76	62.41	0.24	0.05	0.99	0.16	0.04	0.03	0.46	10.14
16	0.03	17.66	7.83	62.31	0.24	0.05	0.98	0.16	0.04	0.03	0.46	10.25
17	0.04	17.59	7.89	62.22	0.24	0.05	0.97	0.16	0.04	0.03	0.46	10.35
18	0.04	17.53	7.95	62.14	0.24	0.04	0.96	0.16	0.04	0.03	0.47	10.44
19	0.04	17.48	8.01	62.06	0.24	0.04	0.95	0.16	0.04	0.03	0.47	10.52
20	0.04	17.44	8.05	61.99	0.24	0.04	0.94	0.17	0.03	0.03	0.47	10.60
Variance decomposition of ΔNEKKEI 225												
1	0.02	29.59	0.49	0.67	69.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.02	24.93	1.33	0.53	54.87	0.01	5.28	0.48	0.17	0.12	0.46	11.83
3	0.02	24.21	1.49	0.52	54.91	0.07	4.93	0.46	0.26	0.14	0.46	12.56
4	0.02	23.71	1.45	0.53	54.53	0.19	4.57	0.69	0.24	0.13	0.53	13.42
5	0.02	23.05	1.50	0.47	54.99	0.18	4.01	0.60	0.21	0.13	0.63	14.24
6	0.02	23.51	1.64	0.49	53.64	0.16	4.61	0.63	0.20	0.12	0.65	14.35
7	0.03	23.19	1.70	0.46	53.53	0.17	4.39	0.63	0.20	0.11	0.65	14.96
8	0.03	23.04	1.72	0.43	53.47	0.17	4.24	0.65	0.18	0.10	0.67	15.33
9	0.03	22.94	1.77	0.40	53.36	0.16	4.10	0.63	0.17	0.10	0.71	15.67
10	0.03	22.92	1.81	0.37	53.04	0.16	4.09	0.63	0.16	0.09	0.73	16.01
11	0.03	22.83	1.84	0.35	52.97	0.16	4.00	0.63	0.15	0.09	0.73	16.26
12	0.03	22.76	1.86	0.33	52.89	0.15	3.92	0.63	0.14	0.08	0.75	16.48
13	0.03	22.72	1.89	0.31	52.78	0.15	3.86	0.62	0.13	0.08	0.76	16.69
14	0.03	22.68	1.91	0.30	52.68	0.15	3.82	0.62	0.13	0.07	0.77	16.88
15	0.03	22.63	1.93	0.28	52.60	0.15	3.77	0.62	0.12	0.07	0.78	17.05
16	0.03	22.59	1.95	0.27	52.54	0.14	3.72	0.62	0.12	0.07	0.79	17.20
17	0.03	22.56	1.97	0.26	52.47	0.14	3.69	0.62	0.11	0.06	0.80	17.33
18	0.04	22.53	1.98	0.25	52.41	0.14	3.65	0.62	0.11	0.06	0.80	17.46
19	0.04	22.50	2.00	0.24	52.35	0.14	3.62	0.62	0.10	0.06	0.81	17.58
20	0.04	22.47	2.01	0.23	52.31	0.14	3.59	0.61	0.10	0.06	0.82	17.68
Variance decomposition of ΔKOSPI												
1	0.02	32.85	1.30	0.74	7.24	57.86	0.00	0.00	0.00	0.00	0.00	0.00
2	0.02	28.85	2.36	0.63	6.23	50.66	3.12	0.47	0.08	0.28	0.08	7.24
3	0.02	28.10	2.39	1.07	6.20	49.86	3.08	0.58	0.24	0.26	0.13	8.08
4	0.03	27.38	2.31	1.10	5.89	49.29	2.98	0.68	0.22	0.28	0.13	9.74
5	0.03	26.06	2.47	0.94	5.72	50.20	2.55	0.58	0.21	0.24	0.26	10.77
6	0.03	26.24	2.68	0.87	5.68	49.31	3.15	0.67	0.20	0.24	0.26	10.70
7	0.03	25.90	2.71	0.91	5.61	49.04	3.06	0.68	0.19	0.23	0.28	11.39
8	0.03	25.65	2.71	0.86	5.50	49.03	2.98	0.70	0.18	0.23	0.27	11.90
9	0.03	25.37	2.79	0.81	5.46	49.06	2.86	0.69	0.18	0.22	0.30	12.27
10	0.03	25.25	2.86	0.77	5.41	48.82	2.90	0.71	0.17	0.21	0.31	12.59
11	0.03	25.12	2.89	0.75	5.37	48.77	2.85	0.71	0.16	0.21	0.31	12.88
12	0.03	24.99	2.91	0.72	5.32	48.72	2.82	0.71	0.15	0.21	0.31	13.15
13	0.04	24.86	2.95	0.69	5.29	48.67	2.78	0.72	0.15	0.20	0.32	13.37
14	0.04	24.77	2.98	0.66	5.26	48.60	2.76	0.72	0.14	0.20	0.33	13.58
15	0.04	24.67	3.00	0.64	5.23	48.56	2.74	0.73	0.14	0.20	0.33	13.77
16	0.04	24.59	3.02	0.63	5.21	48.51	2.72	0.73	0.13	0.19	0.34	13.94
17	0.04	24.51	3.05	0.61	5.19	48.48	2.69	0.73	0.13	0.19	0.34	14.09
18	0.04	24.44	3.07	0.59	5.16	48.44	2.68	0.74	0.12	0.19	0.35	14.23
19	0.04	24.38	3.08	0.58	5.14	48.41	2.66	0.74	0.12	0.19	0.35	14.36

(continued)

Table 9. (continued)

Days	*SE*	ΔHSI	ΔNIFTY	ΔJFX	ΔNEKKEI 225	ΔKOSPI	ΔFTSE	ΔKLSE	ΔSSE	ΔSTI	ΔTWI	ΔS&P 500
20	0.04	24.32	3.10	0.57	5.13	48.38	2.65	0.74	0.12	0.18	0.35	14.48
Variance decomposition of ΔFTSE												
1	0.02	18.32	2.67	0.18	1.81	0.06	76.96	0.00	0.00	0.00	0.00	0.00
2	0.02	15.49	2.55	0.57	1.52	0.18	68.06	0.30	0.00	0.03	0.05	11.26
3	0.02	14.57	2.65	0.54	1.47	0.22	68.55	0.40	0.24	0.03	0.07	11.25
4	0.02	13.70	2.75	0.82	1.34	0.26	68.76	0.44	0.28	0.08	0.31	11.25
5	0.02	13.50	2.84	0.72	1.27	0.23	68.36	0.38	0.24	0.11	0.27	12.08
6	0.02	13.12	2.83	0.68	1.22	0.28	68.57	0.46	0.25	0.11	0.27	12.20
7	0.02	12.57	2.92	0.69	1.18	0.28	68.87	0.48	0.28	0.11	0.26	12.38
8	0.02	12.28	2.98	0.72	1.12	0.26	68.96	0.48	0.27	0.10	0.26	12.57
9	0.02	12.04	3.00	0.69	1.09	0.25	69.02	0.46	0.27	0.10	0.24	12.85
10	0.02	11.77	3.02	0.68	1.06	0.26	69.16	0.47	0.27	0.09	0.22	13.00
11	0.02	11.53	3.06	0.68	1.03	0.25	69.30	0.48	0.27	0.09	0.21	13.10
12	0.03	11.36	3.09	0.68	1.00	0.25	69.36	0.48	0.27	0.09	0.20	13.24
13	0.03	11.19	3.11	0.67	0.98	0.24	69.45	0.47	0.27	0.08	0.19	13.35
14	0.03	11.03	3.13	0.66	0.96	0.24	69.53	0.48	0.27	0.08	0.18	13.45
15	0.03	10.89	3.15	0.66	0.95	0.24	69.59	0.48	0.27	0.08	0.17	13.54
16	0.03	10.76	3.16	0.66	0.93	0.24	69.65	0.48	0.27	0.08	0.17	13.62
17	0.03	10.65	3.18	0.65	0.91	0.24	69.71	0.48	0.27	0.07	0.16	13.69
18	0.03	10.54	3.19	0.65	0.90	0.23	69.76	0.48	0.27	0.07	0.15	13.76
19	0.03	10.44	3.21	0.65	0.89	0.23	69.80	0.48	0.27	0.07	0.15	13.82
20	0.03	10.35	3.22	0.65	0.88	0.23	69.85	0.48	0.27	0.07	0.14	13.88
Variance decomposition of ΔHSI												
1	0.02	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.02	82.55	0.57	0.14	0.14	0.03	4.41	0.13	0.18	0.23	0.21	11.40
3	0.02	81.20	0.72	0.36	0.15	0.16	4.15	0.20	0.17	0.21	0.21	12.45
4	0.02	80.65	0.70	0.57	0.38	0.34	3.80	0.28	0.16	0.19	0.20	12.72
5	0.02	80.13	0.63	0.69	0.34	0.31	3.33	0.25	0.14	0.18	0.38	13.61
6	0.02	79.18	0.73	0.63	0.35	0.34	4.09	0.27	0.17	0.18	0.36	13.69
7	0.03	78.65	0.76	0.72	0.36	0.37	3.87	0.28	0.15	0.17	0.35	14.29
8	0.03	78.42	0.76	0.77	0.39	0.37	3.73	0.29	0.14	0.16	0.35	14.62
9	0.03	78.19	0.76	0.81	0.39	0.35	3.60	0.28	0.13	0.16	0.38	14.93
10	0.03	77.83	0.78	0.81	0.40	0.36	3.63	0.29	0.13	0.15	0.38	15.23
11	0.03	77.66	0.78	0.84	0.40	0.37	3.53	0.29	0.12	0.15	0.37	15.47
12	0.03	77.50	0.79	0.86	0.41	0.37	3.47	0.29	0.11	0.14	0.38	15.67
13	0.03	77.34	0.79	0.89	0.41	0.36	3.42	0.29	0.11	0.14	0.39	15.86
14	0.03	77.18	0.80	0.90	0.42	0.37	3.38	0.29	0.10	0.14	0.38	16.04
15	0.03	77.05	0.80	0.91	0.42	0.37	3.34	0.29	0.10	0.13	0.39	16.19
16	0.03	76.94	0.81	0.92	0.42	0.37	3.30	0.29	0.10	0.13	0.39	16.33
17	0.03	76.83	0.81	0.94	0.43	0.37	3.26	0.29	0.09	0.13	0.39	16.46
18	0.04	76.73	0.82	0.95	0.43	0.37	3.23	0.29	0.09	0.12	0.39	16.57
19	0.04	76.64	0.82	0.96	0.43	0.37	3.20	0.29	0.09	0.12	0.39	16.68
20	0.04	76.56	0.82	0.96	0.44	0.37	3.18	0.29	0.08	0.12	0.39	16.78
Variance decomposition of ΔNIFTY												
1	0.02	28.63	71.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.02	26.68	69.08	0.34	0.00	0.10	0.88	0.00	0.12	0.08	0.04	2.66
3	0.02	26.20	68.81	0.58	0.00	0.09	1.12	0.01	0.17	0.07	0.08	2.85
4	0.02	25.96	68.20	1.21	0.02	0.10	1.03	0.04	0.15	0.31	0.08	2.88
5	0.03	24.91	69.41	1.03	0.02	0.08	0.88	0.03	0.13	0.30	0.12	3.08
6	0.03	24.93	69.16	1.04	0.02	0.09	1.14	0.03	0.13	0.29	0.12	3.06
7	0.03	24.72	69.15	1.15	0.02	0.08	1.15	0.03	0.12	0.28	0.12	3.18
8	0.03	24.64	69.14	1.24	0.02	0.07	1.10	0.04	0.11	0.29	0.11	3.23

(continued)

Table 9. (continued)

Days	*SE*	ΔHSI	ΔNIFTY	ΔJFX	ΔNEKKEI 225	ΔKOSPI	ΔFTSE	ΔKLSE	ΔSSE	ΔSTI	ΔTWI	ΔS&P 500
9	0.03	24.34	69.50	1.20	0.02	0.07	1.05	0.03	0.10	0.27	0.11	3.30
10	0.03	24.29	69.48	1.22	0.02	0.06	1.08	0.03	0.10	0.26	0.12	3.35
11	0.03	24.19	69.53	1.25	0.02	0.06	1.07	0.03	0.09	0.25	0.11	3.38
12	0.03	24.11	69.59	1.27	0.02	0.06	1.05	0.03	0.09	0.24	0.11	3.42
13	0.04	24.00	69.70	1.28	0.02	0.05	1.04	0.03	0.08	0.24	0.11	3.45
14	0.04	23.95	69.73	1.29	0.01	0.05	1.04	0.03	0.08	0.23	0.11	3.48
15	0.04	23.88	69.77	1.30	0.01	0.05	1.03	0.03	0.07	0.22	0.11	3.51
16	0.04	23.82	69.82	1.31	0.01	0.05	1.02	0.03	0.07	0.22	0.11	3.53
17	0.04	23.77	69.86	1.31	0.01	0.05	1.02	0.03	0.07	0.21	0.11	3.55
18	0.04	23.72	69.89	1.32	0.01	0.04	1.01	0.03	0.06	0.21	0.11	3.57
19	0.04	23.68	69.93	1.33	0.01	0.04	1.01	0.03	0.06	0.21	0.11	3.59
20	0.04	23.64	69.96	1.34	0.01	0.04	1.00	0.03	0.06	0.20	0.11	3.61
Variance decomposition of ΔSTI												
1	0.02	51.36	2.75	1.76	1.68	1.09	0.74	0.69	0.01	39.93	0.00	0.00
2	0.02	43.94	3.09	1.52	1.43	0.93	2.72	0.67	0.03	36.59	0.14	8.94
3	0.02	43.37	3.52	1.41	1.41	0.89	2.71	0.62	0.07	36.17	0.13	9.71
4	0.02	42.37	3.55	1.31	1.28	0.80	2.78	0.57	0.06	36.89	0.12	10.28
5	0.02	41.42	3.62	1.16	1.30	0.86	2.43	0.65	0.06	37.73	0.26	10.52
6	0.02	40.72	3.81	1.09	1.27	0.81	3.07	0.60	0.05	37.58	0.24	10.76
7	0.02	40.29	3.97	1.01	1.23	0.79	3.03	0.56	0.06	37.57	0.23	11.28
8	0.02	39.91	4.02	0.93	1.17	0.76	3.05	0.52	0.05	37.86	0.22	11.51
9	0.02	39.44	4.09	0.86	1.16	0.74	2.99	0.49	0.05	38.20	0.24	11.73
10	0.03	39.13	4.18	0.81	1.13	0.72	3.10	0.46	0.05	38.18	0.24	12.01
11	0.03	38.90	4.25	0.76	1.11	0.71	3.09	0.43	0.05	38.28	0.23	12.20
12	0.03	38.66	4.29	0.72	1.09	0.69	3.11	0.41	0.04	38.41	0.23	12.36
13	0.03	38.41	4.35	0.68	1.07	0.68	3.11	0.39	0.04	38.54	0.23	12.50
14	0.03	38.23	4.39	0.65	1.06	0.67	3.13	0.37	0.04	38.58	0.23	12.65
15	0.03	38.06	4.43	0.62	1.04	0.66	3.13	0.35	0.04	38.66	0.23	12.78
16	0.03	37.90	4.47	0.59	1.03	0.65	3.14	0.34	0.04	38.74	0.22	12.89
17	0.03	37.75	4.50	0.56	1.02	0.64	3.15	0.33	0.04	38.80	0.22	12.99
18	0.03	37.63	4.53	0.54	1.01	0.63	3.16	0.31	0.03	38.85	0.22	13.09
19	0.03	37.51	4.56	0.52	1.00	0.63	3.16	0.30	0.03	38.91	0.22	13.17
20	0.03	37.39	4.59	0.50	0.99	0.62	3.17	0.29	0.03	38.95	0.22	13.25
Variance decomposition of ΔTWI												
1	0.02	23.71	0.71	2.24	3.03	6.75	0.03	0.18	0.01	1.01	62.33	0.00
2	0.02	20.93	1.86	1.90	2.80	5.93	1.60	0.24	0.05	1.57	54.58	8.53
3	0.02	19.94	2.13	1.92	2.83	5.71	1.60	0.36	0.08	1.45	53.64	10.35
4	0.02	18.71	2.11	1.74	2.62	5.31	1.46	0.42	0.12	1.67	53.12	12.72
5	0.02	18.11	2.14	1.53	2.51	5.51	1.29	0.42	0.12	1.58	52.87	13.93
6	0.03	18.14	2.39	1.41	2.63	5.36	1.48	0.41	0.11	1.66	52.41	14.01
7	0.03	17.74	2.49	1.30	2.62	5.28	1.45	0.40	0.10	1.64	52.03	14.94
8	0.03	17.41	2.51	1.20	2.55	5.22	1.42	0.39	0.10	1.70	51.95	15.56
9	0.03	17.16	2.57	1.12	2.54	5.17	1.37	0.36	0.10	1.70	51.83	16.08
10	0.03	16.99	2.66	1.04	2.54	5.11	1.37	0.35	0.10	1.71	51.59	16.54
11	0.03	16.82	2.70	0.98	2.53	5.08	1.36	0.34	0.10	1.72	51.47	16.92
12	0.03	16.67	2.73	0.92	2.51	5.04	1.34	0.33	0.10	1.73	51.38	17.26
13	0.03	16.53	2.77	0.87	2.51	5.01	1.33	0.32	0.09	1.74	51.29	17.56
14	0.03	16.41	2.81	0.82	2.50	4.98	1.32	0.31	0.09	1.75	51.18	17.83
15	0.03	16.30	2.84	0.78	2.49	4.95	1.31	0.30	0.09	1.75	51.10	18.08
16	0.04	16.20	2.86	0.75	2.49	4.93	1.30	0.29	0.09	1.76	51.03	18.30
17	0.04	16.11	2.89	0.71	2.48	4.91	1.29	0.28	0.09	1.77	50.97	18.50
18	0.04	16.03	2.91	0.68	2.48	4.89	1.29	0.28	0.09	1.77	50.91	18.68

(continued)

Table 9. (continued)

Days	*SE*	ΔHSI	ΔNIFTY	ΔJFX	ΔNEKKEI 225	ΔKOSPI	ΔFTSE	ΔKLSE	ΔSSE	ΔSTI	ΔTWI	ΔS&P 500
19	0.04	15.96	2.93	0.66	2.47	4.87	1.28	0.27	0.09	1.78	50.85	18.85
20	0.04	15.89	2.95	0.63	2.47	4.86	1.27	0.27	0.09	1.78	50.80	19.01
Variance decomposition of ΔS&P 500												
1	0.02	16.46	0.83	0.10	2.29	0.75	32.81	0.15	0.13	0.25	0.19	46.05
2	0.02	16.57	0.88	0.24	2.27	0.79	33.47	0.51	0.16	0.25	0.37	44.50
3	0.02	16.68	0.97	0.25	2.90	0.74	33.86	0.57	0.15	0.26	0.56	43.08
4	0.02	16.96	0.93	0.26	2.73	0.85	34.50	0.66	0.15	0.30	0.52	42.14
5	0.02	18.64	0.86	0.41	3.16	0.80	35.26	0.58	0.14	0.27	0.73	39.17
6	0.02	18.42	0.94	0.40	3.13	0.74	35.77	0.77	0.13	0.26	0.76	38.69
7	0.02	18.56	0.97	0.38	3.24	0.71	36.15	0.79	0.12	0.26	0.82	38.01
8	0.02	18.86	0.96	0.35	3.22	0.69	36.54	0.82	0.12	0.26	0.82	37.37
9	0.02	19.10	0.94	0.33	3.32	0.67	36.84	0.80	0.11	0.26	0.86	36.78
10	0.02	19.23	0.96	0.31	3.34	0.64	37.23	0.85	0.11	0.25	0.89	36.18
11	0.02	19.36	0.97	0.30	3.38	0.62	37.47	0.86	0.10	0.25	0.92	35.78
12	0.03	19.51	0.97	0.28	3.40	0.61	37.70	0.87	0.10	0.25	0.93	35.38
13	0.03	19.62	0.97	0.27	3.44	0.59	37.93	0.88	0.09	0.25	0.95	35.02
14	0.03	19.73	0.98	0.25	3.46	0.57	38.13	0.89	0.09	0.25	0.97	34.68
15	0.03	19.82	0.98	0.24	3.48	0.56	38.31	0.90	0.09	0.25	0.98	34.40
16	0.03	19.91	0.98	0.23	3.50	0.55	38.47	0.91	0.08	0.24	1.00	34.13
17	0.03	19.99	0.98	0.22	3.52	0.54	38.62	0.92	0.08	0.24	1.01	33.88
18	0.03	20.07	0.98	0.21	3.53	0.53	38.76	0.93	0.08	0.24	1.02	33.65
19	0.03	20.13	0.99	0.20	3.55	0.52	38.88	0.93	0.08	0.24	1.03	33.45
20	0.03	20.20	0.99	0.20	3.56	0.51	39.00	0.94	0.08	0.24	1.04	33.25

Note. HSI = Hong Kong stock exchange; NIFTY = National stock exchange; JFX = Jakarta stock exchange; NIKKEI 225 = Tokyo stock exchange; KOSPI = Korea composite stock price index; FTSE = London stock exchange; KLSE = Kuala Lumpur stock exchange; SSE = Shanghai stock exchange; STI = Strait times index; TWI = Taiwan stock exchange; S&P 500 = New York stock exchange.

0.08% to 39.0%, respectively, of the shock explained by other markets on the 20th business day. The results of variance decomposition analysis suggest that there exists feasible opportunity for the short-term portfolio diversification benefits from exposure to these markets, while the long-term portfolio diversification benefits from exposure to these markets are limited.

Conclusion

This study examines the stock market integration among major stock markets of emerging Asia-Pacific economies, viz., India, Malaysia, Hong Kong, Singapore, South Korea, Taiwan, Japan, China, and Indonesia. Johansen and Juselius (1990) multivariate cointegration test, Granger causality/Block exogeneity Wald test based on VECM approach, and variance decomposition analysis was used to investigate the dynamic linkages between markets. Cointegration test confirmed a well-defined long-run equilibrium relationship among the major stock markets, implying that there exists a common force, such as arbitrage activity, which brings these stock markets together in the long run. These findings are consistent with the results of Jang and Sul (2002) and Choudhry and Lin (2004), who found a significant long-run relationship between the emerging Asian equity markets. The results of Granger causality/Block exogeneity Wald test based on VECM and variance decomposition analysis revealed the stock market interdependencies and dynamic interactions among the selected emerging Asia-Pacific economies. This result implies that investors can gain feasible benefits from international portfolio diversification in the short run. On the whole, the study results suggest that although long-term diversification benefits from exposure to these markets might be limited, short-run benefits might exist due to substantial transitory fluctuations.

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