THE DYNAMIC STOCK MARKET CAPITALIZATION INTEGRATION IN THE ASIA PACIFIC REGION

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Abstract

This present study argues the use of stock market capitalization as a measure for equity size in understanding the financial integration dynamics in the Asia Pacific region. Despite a lack of financial integration, the variance decomposition analysis has found support for the geographical proximity hypothesis. The impulse response analysis shows that equity size matters in the financial integration process. A larger equity market tends to be more informationally efficient than its smaller counterpart and as an equity market becomes larger, it becomes more endogenous. This has important implications for speculative behavior and financial contagion in the Asia Pacific region.

JEL Classification: C22, G15

Keywords: Market Integration; Stock Market Capitalization; Stock Market Behavior; Variance Decomposition Analysis; Impulse Response Analysis

[1]The work described in this paper was supported by a joint grant from the Center for Risk Research of the University of Southampton and Nottingham University Business School of the University of Nottingham-Malaysia Campus.

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1. Introduction

Much of the stock market capitalization growth experienced and seen in the Asia Pacific in the 1990s were largely contributed by improved domestic policies, increased economic growth and liberalized domestic financial markets within the region. To a large extent, the increase in stock market capitalization value from $4.7 trillion in the mid-1980s to $15.2 trillion in the mid-1990s was channeled into the ever-expanding equity markets around the Asia Pacific region (Tan et al., 2009). Arguably, these significant surges in the size of the equity markets have led fund managers to resort to using stock market capitalization as a criterion for selecting investment opportunities within the booming Asia Pacific equity markets. Freeman (2000) pointed out that most Asia Pacific equity markets were largely ignored with the exceptions of Singapore and Malaysia by portfolio managers. However, the use of stock market capitalization as an indicator in measuring stock market activity is an important area of study that has been largely neglected (Torre et al., 2006; Rajan and Zingales, 1998). The stock market capitalization of an equity market has also been widely used as a measure of public confidence and consensus in the value of the entire equity market by investors. It can be employed to reflect a country's credit level and economic growth. This is due to the fact that the anticipation of future growth in the equity market is possible when the present value of future growth opportunities is capitalized in the equity market (Rajan and Zingales, 1998).

The evolution of a more closely integrated equity market worldwide has been well-documented of late in a number of papers in this journal (Bley, 2009; Ragunathan et al., 1999; Janakiramanan and Lamba, 1998; Alexakis et al., 1997) and there exists a consensus which suggests that a fully integrated financial market would benefit from a lower cost of capital (Foerster and Karolyi, 1999; Moshirian, 1998; Kadlec and McConnell, 1994; Merton, 1989), higher competition and higher allocative efficiency (Folkerts and Mathieson, 1989). An interesting feature of an integrated equity market is that these equity markets share a single common trend with only transitory deviations from this trend. This is usually associated to a lack of entry and exit barrier erected by regulatory bodies on capital flows and legislative controls over deposit rates (along with advancement in communication technologies, financial deepening and widening, increased activities by multinational corporations). In effect, this arguably will allow speculators and arbitrageurs alike to move their capital freely (Jeon and Chiang, 1991) and will render long run diversification across national borders useless as arbitrage activity. Short-term speculative trading, with the hindsight forecast that persistent deviations in equity prices will eventually revert to its long run relationship, will bring out-of-line equity prices back to the common trend. Since a single common stochastic trend among a group of equity markets suggest a perfect correlation in the long run among these equity markets, the behavior of any member equity market will serve to represent the behavior of the group (Phylaktis and Ravazzolo, 2005). In short, the faster the transmission of information between equity markets, the lower the probability of a profitable arbitrage and each individual country will have less ability to contain a contagion (Elyasiani et al., 2007).

In respect to the Asia Pacific financial integration, several questions constitute the main focus of our analysis. First, using stock market capitalization as a measure of the size of the respective equity markets, are equity markets in the Asia Pacific region financially integrated? Indeed, a strongly-linked equity market can lead to a rejection of the efficient market hypothesis within the framework postulated by Granger (1986) who argued that two or more asset prices cannot have a long run relationship as the change in the price of one asset cannot be predicted by the asset price of another (Masih and Masih, 1997). However, the deviations of prices from a long run relationship, which indicate predictable future changes of one asset price from the other, cannot be true in an efficient market (Baillie and Bollerslev, 1989; Hakkio and Rush, 1989). In recent years, this view of cointegration among equity markets which implies a violation of market efficiency is no longer upheld. For example, a cointegration of some shared economic growth factors may form the basis for explaining the cointegration among stock prices (Chen et al., 2002; Crowder and Woher, 1998). This demonstrates a lack of general equivalence between market efficiency (defined as the lack of arbitrage opportunities) and a lack of long run relationship between asset prices (Dwyer and Wallace, 1992). Thus, the study of capital integration is essentially a study of increased interdependence and policy coordination among equity markets (Diamandis, 2009) and not a direct test of the efficient market hypothesis.

A second question is whether the interactions in the stock market capitalization among equity markets in the Asia Pacific region are mutual and symmetric or unidirectional leadership-follower pattern (Elyasiani et al., 2007; Friedman and Shachmurove, 1997). This is closely related to whether equity markets are endogenous or exogenous and can be ascertained by examining the transmission impact of an innovation in one equity market has on other equity markets. It will enable the identification of a potential leader in the Asia Pacific region which will spur greater financial integration among its constituents. One contentious issue commonly raised in the study of financial integration in the Asia Pacific region is the dependence on the US equity market. Most previous studies on financial integration in the Asia Pacific region which have used the rate of returns on indices from various financial markets have included indices from US financial markets as one of the endogenous variables in the well-established vector autoregression (VAR) analysis (Stock and Watson, 2001; Sims, 1980). Hence, the inclusion of US indices in our paper as an endogenous variable will conceal our efforts to search for a potential leader among its constituents in the Asia Pacific financial markets. However, failing to include the US indices will lead to a misleading picture in describing the dynamical process of financial integration in the Asia Pacific region (Dekker et al., 2001). Our paper treats the US stock market capitalization as an exogenous variable throughout our analysis given its time series properties, which is stationary at level. This will present an excellent opportunity for us to not only include the US stock market capitalization into our analysis but also enable us to identify a potential leader for the Asia Pacific region by revealing the nature of the underlying dynamic linkages between these equity markets (Masih and Masih, 2001, Sheng and Tu, 2000, Ghosh et al., 1999, Cheung, 1997, DeFusco et al., 1996, Arshanapalli et al., 1995 Hung and Cheung, 1995, Chung and Liu, 1994, Chan et al., 1992).

In relation to the earlier two research questions, the geographical proximity hypothesis as highlighted by Janakiramanan and Lamba (1998) is also investigated. In their paper, Janakiramanan and Lamba (1998) submitted that a more dominant equity market is likely to exert a greater influence on relatively smaller equity markets. To our best of knowledge, there has not been any study which investigates whether equity markets in the same geographical vicinity and share similar groups of investors, do exert more influence on each other or not by using stock market capitalization. The use of stock market capitalization of equity markets will also avoid introducing the potential bias in the findings when the size of these equity markets are neglected (Yeh and Lee, 2000; Janakiramanan and Lamba, 1998; Koch and Koch, 1991). These papers also have not included China, which is gaining importance and size in recent years in their analysis, and in our paper, China has been included and this will allow us to examine the greater China (which consists of China, Hong Kong SAR and Taiwan) sub-region with respect to this hypothesis.

Subsequently, the next objective of this paper is to determine the pattern of information transmission among equity markets in the Asia Pacific region. We attempt to examine the instantaneous impact of an initial unanticipated shock on the individual equity markets and trace the feedback impact as a result of the initial unanticipated shock on the respective equity markets. This is important as it will enable us to explore the level of interactivity as a result of interdependence and the level of vulnerability of one equity market constituent in relation to the other equity markets in the event of speculative trading behaviors by equity traders in the Asia Pacific region. A highly interactive equity market is one with a high interdependence on other equity markets in the nexus of information transmission among equity markets. As a result, this informationally efficient equity market is not only susceptible to the dangers of speculative trading by investors but also it can potentially act as a conduit in channeling the contagion effect of a speculative attack by traders onto other equity markets.

Our paper has made some significant discovery in our findings. First, there appears to be a lack of financial integration among equity markets in the Asia Pacific region using the stock market capitalization growth rate. Only one cointegrating relationship was found among ten equity markets considered in this study. Even though a lack of financial integration would be able to somewhat contain a contagion from spreading, an investor or arbitrageur who understands the dynamics of the propagation mechanism which provides the link between the equity markets within the Asia Pacific region could use this information to execute their speculative trading activities (Masih and Masih, 1997). Second, our variance decomposition analysis reveal that the Singaporean equity market is the most endogenous equity market with close to 70 percent of its forecast error's variance being explained by the innovations in the remaining nine equity markets in the Asia Pacific region. The Chinese equity market is the most exogenous equity market since its 83 percent of its own forecast error's variance being explained by innovations emanating from its own equity market. Despite the fact that the forecast error's variance of the Australian equity market is being explained significantly by the innovations in the New Zealand equity market, it can be a potential leading equity market.

Third, for the geographical proximity hypothesis, within the sub-region of the Australian-New Zealand equity markets, it was found that the forecast error's variance in the New Zealand equity market is explained relatively more by the innovations in the Australian equity markets than the forecast error's variance in the Australian equity market being explained by the innovations in the New Zealand equity markets. This implies that the Australian equity market has a larger influence on the New Zealand equity market with regards to the respective equity sizes which is in agreement with the argument that larger equity markets should influence smaller equity markets. For the case of the Chinese-Hong Kong SAR-Taiwanese equity markets, this hypothesis is again supported but for the Thailand-Malaysia-Singapore sub-region, there is a lack of support in respect of the geographical proximity hypothesis.

Fourth, in our impulse response analysis, it was found that a higher degree of financial linkage exists between the top six largest equity markets. These larger equity markets seem to display a higher degree of informational efficiency when compared to their smaller counterparts after including the US stock market capitalization as an exogenous variable in the vector error correction model (VECM) system of equations. Finally, this paper concludes by arguing that equity size matters. The larger an equity market is, the more endogenous it becomes. This conclusion runs contrary to findings by previous research. However, using stock market capitalization growth rates, we were able to show that the larger the equity market, the more endogenous it becomes using Spearman's rho.

The structure of the paper is as follows. In Section 2, we describe the data and methodology employed in this study. In Section 3, we investigate and discuss the dynamic impacts of the stock market capitalization relationships via cointegration, variance decomposition and impulse response analyses by highlighting the major implications of the results. The final section offers a conclusion.

2. Data and methodology

In this study, we analyzed the daily stock market capitalization (provided by *Bloomberg*) for 10 countries in the Asia Pacific region for the period spanning 22 September 2003 to 29 October 2007. By taking the natural logarithm of each equity markets, these equity market indices were scaled appropriately and were subsequently converted into the continuously compounded daily growth rates by taking the difference in the natural logarithm of the respective equity markets.

Unit Root, Multivariate Cointegration and Error Correction Model

The method employed to analyze the daily stock market capitalization growth rate involves the use of the VECM which allows to us observe the transmission of innovations across equity markets. Before this method can be applied, the time series variables need to be stationary. In this study, we applied three approaches to testing for stationarity. This includes the Augmented Dickey Fuller (ADF), which corrects for autocorrelation using an autoregressive representation (Said and Dickey, 1984; Dickey and Fuller, 1979); the Phillips-Perron (PP) test, which adjusts for autocorrelation using a nonparametric correction (Phillips and Perron, 1988); and the Kwiatkowski-Phillips-Schmidt-Shim (KPSS) test on the natural logarithm of the daily stock market capitalization and the first difference of the natural logarithm of the daily stock market capitalization (which is the stock market capitalization growth rate) when null hypothesis of unit root cannot be rejected.

In order to test for cointegration between stock market capitalizations, we employed the popular and well-established multivariate cointegration procedure introduced by Johansen (1988) and Johansen and Juselius (1990). The VAR-based cointegration procedure developed by Johansen (1991, 1995) is provided in the form of a VECM as follows (Pesaran et al., 1996; Pesaran and Shin, 1996):

$$\Delta Y_t = \mu + \gamma\delta_t - \Pi Y_{t-1} + \sum_{i=1}^{p-1}\Gamma_i \Delta Y_{t-i} + \Psi_t \quad (1)$$

where Y_t is a vector of jointly determined endogenous and exogenous stationary variables, $\Gamma_i = \sum_{j=i+1}^{p} A_j$ are the short run adjustment to changes in the variables which suggests the presence of $p-r$ number of common trends (Gonzalo and Granger, 1995) when A_i are $n \times n$ coefficient matrices, $\Pi = \sum_{i=1}^{p} A_i - I = \alpha\beta'$ is the long run multiplier matrix given that α and β' are $n \times r$ matrices (r is the number of cointegrating vector) and I is a unit matrix, μ is a vector of constants, δ_t is a vector of trend, γ is the associated coefficients to the vector of trend, Ψ_t is the vector of innovations which is allowed to be contemporaneously correlated with their own lag but uncorrelated with any of the right-hand side variables and has white noise properties. In order to remove autocorrelation in the residuals, p number of lags is needed but within the framework of cointegration as postulated by Engle and Granger (1987), the minimum number of lags to include in the VECM is $p-1$ to avoid misspecifications. The α measures the speed of adjustment to which each variable adjusts to disturbances in the long-run equilibrium while β' is a matrix of long-run coefficients (Bley, 2009). Therefore, to test the null hypothesis of at most r cointegrating vectors, the trace statistic and λ-max statistics are used. The trace statistic is given as:

$$\lambda\text{-trace} = -T\sum_{i=r+1}^{p}\ln(1-\hat{\lambda}_i) \qquad (2)$$

where λ_i is the largest i-th eigenvalue of the long-run multiplier matrix Π. The λ-max tests that there are r cointegration vectors against the alternative $r+1$ exist and is given as:

$$\lambda\text{-max} = -T\ln(1+\hat{\lambda}_{r+1}) \qquad (3)$$

Variance Decomposition and Impulse Response Analyses

Next, the variance decomposition and impulse response analysis are employed to analyze the short-run dynamic interaction of the stock market capitalization growth rates for equity markets in the Asia Pacific region. Variance decomposition is a means for determining the relative importance of shocks (or innovations) in explaining the variation in the stock market capitalization growth rate. It provides the partitioning of the forecast error's variance in an equity market into proportions which can be attributed to innovations by each individual equity markets in the system, including its own (Masih and Masih, 1997). If the innovations of an equity market do not explain any of the forecast error variance of the stock market capitalization growth rate of other equity market, then that equity market is an exogenous equity market. If the innovations from an equity market explain a large percentage of the forecast error's variance of other equity markets and its own forecast error cannot be explained by innovations in other equity markets at all horizons, it is a pure leading equity market. Likewise, if the innovations in other equity markets can explain all of the forecast error variance of the equity market capitalization growth rate in an equity market at all horizons, then that equity market is an endogenous equity market. If the innovations from the equity market explain very little percentage of the forecast error's variance of other equity markets, it is a pure follower equity market (Friedman and Shachmurove, 1997).

It is then instructive to explore the response of a variable to an innovation immediately or with various lags by conducting an impulse response analysis. The impulse response analysis will trace out the magnitude of responses of current and future values of each of the stock market capitalization growth rates to unanticipated shocks due to a one standard deviation increase in the current value of one of the VAR errors with the assumption that this error returns to zero in subsequent periods while holding other errors equal to zero (Stock and Watson, 2001). There are two ways to carry out the variance decomposition and impulse response analyses. We can either use the VAR (either using level or first difference) or the VECM and we have chosen to proceed with the VECM. This debate on which model is better is well summarized in Dekker et al. (2001).

3. Empirical results

Descriptive Statistics

Table 1 provides some descriptive statistics for the daily stock market capitalization growth rates of the respective equity markets. The stock market capitalization growth rate for all equity markets experienced positive mean during the sample period. It can also be observed that the range (measured as the difference between the maximum and the minimum stock market capitalization growth rate) is the largest for the Malaysian equity market at 41.44 percent and the lowest is the US equity market at 6.46 percent. In assessing the probability density distribution properties of the stock market capitalization growth rate, three statistical measures (skewness, kurtosis and Jacque-Bera) were used. The skewness statistic is used to measure the degree of asymmetry of a distribution while the kurtosis statistic is used to measure the heaviness of the tails of the distribution in relation to the middle of the distribution. Equity markets such as the Chinese, Malaysian and Singaporean equity markets are positively skewed while the Korean, Taiwanese, Thai, Australian, Hong Kong SAR, Japanese, New Zealand and US equity markets are negatively skewed. All equity markets display a positive kurtosis. Taken together, the equity markets of China, Malaysia and Singapore have heavy tails on the right hand side of the probability density distribution while the Korean, Taiwanese, Thai, Australian, Hong Kong SAR, Japanese, New Zealand and US equity markets have heavy tails on the left-hand side of the probability density distribution of stock market capitalization growth rates. This is verified by the Jacque-Bera test which rejects the null hypothesis of a normally distributed probability density function for stock market capitalization growth rate for all equity markets.

[Insert Table 1 here]

Cointegration and Financial Integration

In Table 2, we report the findings of the ADF and PP unit root tests. For all equity markets with the exception of US, the results from the ADF and PP unit root tests lead to a rejection of the null hypothesis of a unit root at the 1 percent level of significance. Given that there is documentary evidence which suggests that the ADF test procedure has low power, this is supplemented by the procedure recommended by Kwiatkowski et al. (1992) to test the null hypothesis of level and trend stationarity. The findings from the KPSS unit root test agree with the findings from the ADF and PP test procedures. Interestingly, the natural logarithm daily stock market capitalization of US is stationary at the level and does not require differencing to achieve stationarity. As such, we have included US as an exogenous variable in our further analysis.

[Insert Table 2 here]

The results of the multivariate cointegration analysis reported in Table 3 suggest that the null hypothesis of no cointegration vector is rejected using the 5 percent level of significance following the critical values given by Osterwald-Lenum (1992). Both λ-trace and λ-max values are significant at 5 percent (not rejecting the null hypothesis of at most two cointegrating vectors). The multivariate cointegration tests are formulated to include an intercept and to incorporate for the existence of deterministic trends in the natural logarithm of stock market capitalization. The lags are appropriately selected using the Akaike Information Criterion (AIC). Our finding is in agreement with a number of previous studies in the Asia Pacific region which also found cointegrating relationships using price indices (Click and Plummer, 2005; Phylaktis and Ravazzolo, 2005; Phylaktis and Ravazzolo, 2002; Sharma and Wangbangpo, 2002; Palac-McMiken, 1997; DeFusco et al., 1996; Chung and Lin, 1994). We can draw two implications from this finding.

First, there is little to gain from international diversification in the Asia Pacific region as there is sufficient scope for arbitrageurs and speculators to bring out-of-line equity prices back to the common trend via short-term speculative trading, with the hindsight forecast that persistent deviations in equity prices will eventually revert to its long run relationship (Masih and Masih, 1997). Second, an integrated equity market does not necessarily imply a violation of the efficient market hypothesis even though the existence of an error correction model implies the ability to predict one asset price as a result in the change in the asset price in the others (Granger, 1986). The efficient market hypothesis might be still intact even though there is evidence of cointegration as these results apply strictly on total returns (inclusive of dividends) and if the error correction is considered as a proxy for risk premium (Richards, 1995). Therefore, the finding of equity market integration is not a direct contradiction with the efficient market hypothesis.

[Insert Table 3 here]

Lutkepohl and Reimers (1992) and Mellander et al. (1992) have argued that even though innovation accounting can be used to obtain information concerning the interactions among the variables in summarizing the short-run dynamic structure of market linkages, they have also shown that shocks to the *i*-th variable not only will affect the variable in question but also will be transmitted to other endogenous variables in the system via the dynamic lag structure of VAR. As a result, it is difficult to interpret the individual coefficients in the error correction model. Further, the conventional method used in orthogonalized variance decomposition and impulse response functions derived from the Cholesky factorization also suffers from the orthogonality assumption which may yield different results depending on the ordering of the variables in the VAR.

To overcome this sensitivity to the ordering of variables, Pesaran and Shin (1998) has offered an ordering-invariant generalized impulse response functions derived from Koop et al. (1996). However, it is important to note that the generalized impulse response function is not general in effect because it used extreme identifying assumptions that each variable is ordered first. In fact, when the covariance matrix is non-diagonal, the generalized impulse response functions would be in conflict each other. It is then more advisable to use an identifying assumption that consistently describes the underlying economic models rather than to use the generalized impulse response functions which require a combination of extreme assumptions which are in conflict with each other (Kim, 2009). In our case, there is no particular economic model which describes how equity markets should be integrated and as such we have retained the use of the generalized variance decomposition and impulse response analyses following Pesaran and Shin (1998). Unless the variance-covariance matrix is orthogonal (or non-zero covariance in the variance-covariance matrix) as in the case for the orthogonalized variance decomposition and impulse response functions derived under Cholesky factorization, the sum of the forecast error's variance decomposition in the generalized VAR is unlikely to add up to 100 percent. For exposition purposes, all forecast error's variances have been standardized to sum up to 100 percent for each of the individual equity market as suggested by Wang (2002).

[Insert Table 4]

Table 4 shows the results of the decomposition of the forecast error variances of the daily stock market capitalization growth rate in the Asia Pacific region to one unit standard deviation shock in the respective equity market using the generalized variance decomposition following Pesaran and Shin (1998) and reports the 5-, 10- and 15-day forecast error variances of each equity market in the first column accounted for by shocks in each of the ten equity markets in our VECM system (see Table 4). As is shown in Table 4, several observations can be made. In order to an equity market to be classified as an exogenous equity market, its innovations do not explain any of the forecast error's variance of the stock market capitalization growth rate of other equity markets. Similarly, for an equity market to be considered as an endogenous equity market, its forecast error's variance of its equity market capitalization growth rate can be explained by innovations in other equity markets (Friedman and Shachmurove, 1997). Following Dekker et al. (2001), at the 15-day horizon, the Singaporean equity market appears to be the most endogenous equity market in the Asia Pacific region with close to 70 percent of its forecast error's variance being explained by all foreign equity markets combined. The order of other equity markets (from being most exogenous to most endogenous) being most influenced by all foreign equity markets taken together in the Asia Pacific region is China, New Zealand, Malaysia, Thailand, Australia, Taiwan, Japan, Korea, Hong Kong SAR and Singapore equity markets. This is different from findings by Janakiramanan and Lamba (1998) and Dekker et al. (2001) who identified that the Japanese equity market (since the Indonesian equity market is not considered in our sample) and the Taiwanese equity market as being the most exogenous respectively. However, our finding of the Malaysian equity market being more exogenous than the Singaporean equity market is consistent with the findings by Dekker et al. (2001) but different from the findings from Janakiramanan and Lamba (1998).

The Chinese equity market remains isolated as this equity market neither exerted influence, if any at all, on other equity markets nor is being influenced much by other equity markets. Bearing in mind that high growth phases would tend to isolate emerging equity markets from the development in the advanced equity markets, this result is consistent with Dekker et al. (2001). In parallel to the findings by Dekker et al. (2001), the Australian equity market seems to exert the most amount of influence across most of the equity markets in the Asia Pacific region. Following Friedman and Shachmurove (1997), at the 15-day horizon, the percentage of forecast error's variance for the Chinese equity market being explained by its own innovation is 83; Thailand, this percentage is about 79; the corresponding percentages for New Zealand, Malaysia, Japan, Taiwan, Korea, Australia, Hong Kong SAR, Singapore equity markets range from 47 to 71. This implies that the most influenced equity market is Singapore and the least influenced equity market is China. Overall, the findings from this study are comparable to Tan et al. (2009).

For an equity market to be a pure leading equity market, the innovations from this pure leading equity market will explain a large percentage of the forecast error's variance of other equity markets while its own forecast error cannot be explained at all by innovations in other equity markets at all horizons (Friedman and Shachmurove, 1997). The findings from our results show that there is no pure leading or follower equity market. By and large, the closest candidates for the role of leading equity market should fall upon the Australian equity market followed by the Hong Kong SAR equity market. The Australian equity market is not considered as a pure leading equity market is due to the fact that its forecast error's variance is significantly explained by the innovations in the New Zealand equity markets. The role of the Japanese equity market as the leading equity market in the Asia Pacific region remains an open debate (Yang et al., 2003) as we have also observed this in our results. The result from our paper seems to suggest that the New Zealand equity market is the most exogenous equity market among the advanced equity markets in the Asia Pacific region, which is at variance with the findings by Dekker et al. (2001) and Janakiramanan and Lamba (1998).

Geographical Proximity and Equity Size

In investigating the role of geographical proximity and stock market linkages via stock market capitalization, this hypothesis is supported in general. This hypothesis will be assessed in three sub-regions, namely Australia-New Zealand, greater China and Thailand-Malaysia-Singapore.

From Table 4, it appears that the Australian and New Zealand equity markets are influencing each other in mutual and symmetric manner when they each explain about 17 to 22 percent of the forecast error's variance of the other. Dekker et al. (2001) argued that while the generalized variance decomposition and impulse response analyses following Pesaran and Shin (1998) had improved the results obtained by Janakiramanan and Lamba (1998), the innovations in the New Zealand equity market seemed to have explained a larger proportion of the forecast error's variance in Australian equity market but still runs contrary in relation to the respective equity size of these countries. Janakiramanan and Lamba (1998) and Dekker et al. (2001) found that the relationship between the Australian and New Zealand equity markets are less symmetrical. In our paper, using stock market capitalization growth as a measure of size of the respective equity markets, we found that the innovations in the New Zealand equity market explains a smaller proportion of the forecast error's variance in Australian equity market when compared to the innovations in Australian equity market explaining the forecast error's variance in the New Zealand equity market. We can now conclusively show that the Australian equity market has a larger influence on the New Zealand equity market with regards to the respective equity sizes. Findings by Janakiramanan and Lamba (1998) and Dekker et al. (2001) in this respect was inconclusive.

In the case of greater China (which consists of China, Hong Kong SAR and Taiwan), innovations in Hong Kong SAR equity market appears to be explaining about 5.23 percent of the forecast error's variance in the Chinese equity market and 11.10 percent of the forecast error's variance in the Taiwanese equity market. The innovations in the Chinese equity market appear to be explaining about 2.95 percent and 0.46 percent of the forecast error's variance in the Hong Kong SAR and Taiwanese equity markets respectively. The innovations in the Taiwanese equity market, on the other hand, seem to explain 0.49 percent and 8.45 percent of the forecast error's variance in the Chinese and Hong Kong SAR equity markets respectively. Innovations in the Chinese equity market seem to have the largest explanatory power on the forecast error's variance in Hong Kong SAR when compared to the forecast error's variance of the rest of the other equity markets being explained by innovations in the Chinese equity market. Similarly, innovations in the Hong Kong SAR equity market seem to explain the most of forecast error's variance in Chinese equity market which implies that equity markets are fast becoming more integrated with each other. Even though there appears to be a asymmetrical and unidirectional relationship pattern between the Chinese and Hong Kong SAR equity markets, this should be seen as a healthy development towards a closer financial integration between Hong Kong SAR and China after the return of Hong Kong SAR to China in 1997 (Yeh and Lee, 2000). Innovations in the Hong Kong SAR equity market appear to explain the most forecast error's variance in the Taiwanese equity market after the Korean equity market while innovations in the Taiwanese equity market appear to be the third largest in explaining the forecast error's variance in the Hong Kong SAR equity market after the Australian and Korean equity markets. Once more, the asymmetrical and unidirectional relationship pattern can be observed between the Hong Kong SAR and the Taiwanese equity markets. This implies that Hong Kong SAR plays an important intermediary role between the Chinese and Taiwanese equity markets. In general, the geographical proximity is supported in this sub-region.

The last sub-region to test the geographical proximity hypothesis will consist of the Malaysian, Singaporean and Thai equity market. None of the innovations in these equity markets seem to explain a larger proportion of the forecast error's variance in the remaining two equity markets. Forecast error's variance in the Singaporean equity market is more heavily influenced by innovations in the Australian, Taiwanese, Korean and Hong Kong SAR equity markets than the Malaysian and Thai equity markets. It would seem that the

Singaporean equity market is much more integrated to these larger equity markets and decoupled from its neighbors within the sub-region. Thus, the geographical proximity hypothesis is not supported in this sub-region.

Dynamic Impulse Responses and Information Transmission Pattern

To complement the variance decomposition analysis and to understand the mechanism of international transmission of equity market movements, the impulse response analysis is performed to explore the dynamic response of a variable to a shock instantaneously or with various lags over a pre-determined time horizon from simulated responses of the VECM system through moving average representations. Once the VECM system is estimated, this insightful technique can be applied to highlight how significantly an innovation, usually measured as one standard error shock in a particular market at time t, would affect other equity markets through dynamic interaction at time $t+n$. Table 5 shows the impulse response analysis of the stock market capitalization growth rate in the Asia Pacific region to a unit standard deviation shock in the individual equity market. In our study, we introduced a shock of one standard deviation in an individual equity market, and its dynamic effects are traced throughout the system for the next 15 trading days. The more responsive an equity market is with respect to information transmission efficiency, the greater the speed of an innovation in a particular equity market is transmitted to other equity markets in the Asia Pacific region.

In Table 5, we have taken 0.5 percent as the threshold value to determine the relative importance of the impact of an innovation for the purpose of discussion. Any values above the 0.5 percent threshold value is considered to be a significant impact while any value less than the 0.5 percent threshold value is considered to have a lesser impact. In general, almost all initial shocks would have long-lasting effects and significant permanent effect on its level for each equity market which is expected for non-stationary variables (Wang and Dunne, 2003). In the case for the Australian equity market, the impulse response coefficient to a unit shock in the New Zealand equity market is 0.54 percent on day 0. Similarly, the impulse response coefficient to a unit shock in the Australian equity market on the New Zealand equity market is 0.055 percent on day 0. This symmetric response may reflect a higher degree of economic and financial integration and the free flow of information between the two countries (Eun and Shim, 1989). This supports our earlier discussion on the findings on geographical proximity hypothesis testing. The initial shocks from other equity markets have a lesser impact on the Australian equity market.

For the case of the Chinese, Hong Kong SAR and Taiwanese equity markets, the impulse response coefficient in the Chinese equity market to a unit shock in the Hong Kong SAR equity market is 0.54 percent on day 0 but none of the unit shocks in the remaining equity markets had an impact on the impulse response coefficient in the Chinese equity market (which includes Taiwan). The impulse response coefficient in the Hong Kong SAR equity market to a unit shock in the Taiwanese equity market on day 0 is given as 0.53 percent but the impact of a unit shock in the Chinese equity market does not have a significant impact on the impulse response coefficient in the Hong Kong SAR equity market. The impact of a unit shock in the Hong Kong SAR equity market creates a 0.64 percent effect on the impulse response coefficient in the Taiwanese equity market on day 0. Similar to the impact of a unit of shock in the Chinese equity market has on the impulse response coefficient in the Hong Kong SAR equity market, the impulse response coefficient in the Taiwanese equity market is about 0.1 percent on day 0. But the impulse response coefficient in the Hong Kong SAR equity market due to a unit shock in the Chinese equity market (0.28 percent) is higher than the impulse response coefficient in the Taiwanese equity market. This also agrees with results obtained in the geographical proximity hypothesis testing earlier. For the Thailand-Malaysia-Singapore sub-region, the results from the impulse response analysis again confirm the lack of support for the geographical proximity hypothesis. There appears to be neither a mutual and symmetrical nor a unidirectional leader-follower pattern in the relationship among these equity markets.

[Insert Table 5]

Another interesting observation can be made from the impulse response analysis. Taking the 0.5 percent as the threshold value, it can be observed that an initial impact from New Zealand is transmitted to the Australian equity market. Figure 1 shows the information transmission propagation mechanism and the impulse response relationship among the equity markets in the Asia Pacific region. It can be seen from Figure 1 that from the Australian equity market, the impact to a unit shock is instantaneously fed into the Japanese, Korean and New Zealand equity markets in day 0. This unit shock in the Japanese equity market is potentially transmitted to the Korean equity market and the Taiwanese equity market. Likewise, the Korean equity market will arguably transmit this unit shock to the Japanese, Hong Kong SAR, Taiwanese and Thai equity markets instantaneously. The Taiwanese equity market will also likely to feed this information to the Hong Kong SAR equity market and back to the Japanese and Korean equity markets instantaneously. The Hong Kong equity market is assumed to subsequently transmit this information effect back to the Japanese, Korean, Taiwanese and Thai equity markets. In addition, this unit shock is transmitted to the Chinese equity market. By and large, these unit shocks which are predominantly transmitted among themselves represent the top six largest equity markets in the Asia Pacific region. Therefore, it can be concluded that equity markets with larger equity size are more informationally efficient and this implies that it is less likely for profitable speculative opportunities. However, this will increase the probability of a contagion effect should one arises.

Equity markets such as Hong Kong SAR, Malaysia, Singapore, Taiwan and Thailand had reacted to the unit shock from the Australian equity market in day 2, day 3, day 3, day 1 and day 1 onwards respectively. Despite the fact that Hong Kong SAR and Taiwan equity markets felt the impact from the one unit shock from Australia directly only in day 2 and day 1 respectively, the indirect effect from the same unit of shock from Australia is assumed to be already felt through the Korean and Taiwanese equity markets for Hong Kong SAR equity market; and the Korean, Japanese and Hong Kong SAR equity markets. As such, equity markets with smaller equity market size are less informationally efficient when compared to their counterparts with larger equity size. It would seem that there are profitable opportunities to be made here from speculative trading but these equities would be more resilient to resist a contagion. Arguably, an arbitrageur could find gainful opportunities by exploiting the lack of financial integration in the smaller equity markets but once, if ever, this contagion is picked up in the Australian equity market, it will spread quickly to the larger equity markets in the Asia Pacific region. This painful lesson was learnt during the 1997 the Asian financial crisis where the Malaysian equity market was severely affected and the Malaysian government had to impose capital control measures which were subsequently repealed and banning short selling activities only to be replaced with a restricted short selling scheme in response to the crisis. (Yang et al., 2003). This is shown in Figure 1. On further examination of the results in Table 5 and Figure 1, the conclusions are somewhat different from those arrived by Park and Fatemi (1993). Park and Fatemi (1993) found that the Korean and Taiwanese equity markets were not affected by the US and/ or Japanese equity markets in a significant way despite the fact that their economies are heavily dependent on trade with the US and Japan. In our paper, we found a higher interactivity between the Korean and Japanese equity markets after including US equity market as an exogenous variable in the VECM system of equations. One mitigating factor to a higher degree financial integration process in the Asia Pacific region is the intervention by the respective governments (Park and Fatemi, 1993).

[Insert Fig. 1]

Does Size Really Matter?

In our discussion so far, we have analyzed the important role that equity size has on financial integration. One question remains. Does equity size really matter? It would seem that it does. In qualitative terms, as an equity market in the Asia Pacific region becomes larger, it tends to be more endogenous. In quantitative terms, the strength of association between the rankings provided by Janakiramanan and Lamba (1998), Dekker et al. (2001) and those provided by this paper (from most exogenous to most endogenous) is measured using Spearman's rho. It is found that the correlation between the rankings provided by Janakiramanan and Lamba (1998) is 0.214 (p-value of 0.645, the number of observations = 7). This positive relationship suggests that as an equity market becomes larger in equity size, it becomes more exogenous. For Dekker et al. (2001), this positive relationship is even weaker as the Spearman's rho gives a value of 0.167 (p-value of 0.693, the number of observations = 8). The findings in our study gives a higher Spearman's rho of 0.345 (p-value of 0.328, the number of observations = 10). However, the relationship obtained is negative, which implies that as an equity market becomes larger in equity size, it becomes more endogenous. From Figure 1, it can be clearly seen that as the initial round of information is transmitted from New Zealand to Australia (smaller equity size to larger equity size), this information is assumed to be diffused across the network of equity markets in the Asia Pacific region instantaneously in day 0. Upon the receipt of information transmitted from Australia, the effects are then assumed to be communicated to the Korean and Japanese equity markets (an even larger equity market) which is subsequently disseminated to the next top four large equity markets in the Asia Pacific region (Japan, China, Korea and Taiwan) instantaneously. This higher degree of interactivity among these equity markets increases the degree of endogeneity of these equity markets concerned. This provides the basis of the argument that as an equity market becomes larger, the more endogenous the equity market becomes.

4. Conclusion

The objective of this study is to investigate the dynamics and contemporaneous interactions of stock market capitalization of equity markets in the Asia Pacific region. Overall test results have revealed the lack of financial integration among equity markets in the region. Only one cointegrating relationship was found and this suggests there could be potential gainful opportunities for arbitrageurs in rewarding their speculative behaviors. However, the lack of financial integration among the constituent equity markets in the Asia Pacific region would fare better in containing a financial contagion should one arises. In the exogeneity-endogeneity issue, the Singaporean equity market is the most endogenous while the Chinese equity market is the most exogenous market. In testing the geographical proximity hypothesis, there is evidence to support this hypothesis in the Australian-New Zealand equity markets and China-Hong Kong SAR-Taiwan sub-regions but lacked evidence in support of this hypothesis in the Thailand-Malaysia-Singapore equity markets sub-region. The Australian equity market is found to influence the New Zealand equity market more as the innovations in the Australian equity market explains more of the forecast error's variance of the New Zealand equity market than the innovations in the New Zealand equity market explaining the forecast error's variance of the Australian equity market. We also found that there exists a higher degree of informational efficiency between equity markets in the top six largest equity markets in the Asia Pacific region which forms the basis for our argument that the larger an equity market is, the more endogenous it becomes. Finally, we conclude that the size of the equity market matters in explaining the nature of the underlying financial integration dynamics and information transmission when the US equity market is included in the VECM system of equations as an exogenous variable.

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Table 1 Summary statistics for the Asia Pacific Region stock market capitalization growth rate. (Alphabetical order)

The mean, median, maximum, minimum, standard deviation variables for stock market capitalization growth rates of the individual equity markets are in percentages. The Size column is given as the average daily stock market capitalization values of the individual equity markets in US thousand dollars.

Equity Market/Block	Observations	Size	Mean	Median	Maximum	Minimum	Standard Deviation	Skewness	Kurtosis	Jacque-Bera
China	804	872,365	0.252712	0.148682	14.74330	-13.33755	2.108571	1.054343	13.84873	4091.739 (0.000000)
Korea	804	603,410	0.178092	0.227295	9.047688	-10.20539	1.716930	-0.379022	8.027944	866.1375 (0.000000)
Malaysia	804	202,169	0.089398	0.085619	22.53604	-18.90583	1.417832	1.748985	120.1315	460022.9 (0.000000)
Taiwan	804	525,615	0.087780	0.076779	6.552638	-9.631353	1.406584	-0.634823	8.214600	964.9358 (0.000000)
Thailand	804	125,441	0.126796	0.090324	8.387183	-18.09835	1.806624	-1.160238	17.47232	7196.892 (0.000000)
Australia	804	739,516	0.128607	0.153209	6.091474	-6.985456	1.231713	-0.661688	7.083151	617.1854 (0.000000)
Hong Kong SAR	804	1,175,232	0.197815	0.196401	7.344550	-4.858187	1.231599	-0.030482	6.588313	431.4702 (0.000000)
Japan	804	4,151,712	0.059106	0.065170	8.217246	-11.45942	1.482886	-0.624344	10.28117	1828.253 (0.000000)
New Zealand	804	37,649	0.062486	0.114082	5.128684	-5.450827	1.142369	-0.560684	6.503264	453.2657 (0.000000)
Singapore	804	272,480	0.159678	0.185507	7.727672	-5.310166	1.158874	0.131213	9.197445	1288.986 (0.000000)
US	804	15,500,716	0.048935	0.079916	2.817191	-3.641058	0.808624	-0.337000	4.878916	133.4842 (0.000000)

Table 2 Results for unit root tests on the level and first difference of the stock market capitalizations in the Asia Pacific Region. (Alphabetical order)

ADF, PP and KPSS denote the Augmented Dickey-Fuller, Phillips-Perron and the Kwiatkowski, Phillips, Schmidt and Shin tests for unit roots respectively.
The optimal number of lags was chosen based on Schwarz Information Criterion (SIC).

Equity Markets	ADF		PP		KPSS	
	Level	First Difference	Level	First Difference	Level	First Difference
China	0.469374 (0.9992)	-29.81759*** (0.0000)	0.600821 (0.9995)	-29.88150*** (0.0000)	0.812606***	0.198810**
Korea	-2.728390 (0.2253)	-29.77294*** (0.0000)	-2.666407 (0.2510)	-29.80621*** (0.0000)	0.191257**	0.040454
Malaysia	-1.592228 (0.7956)	-33.90998*** (0.000)	-1.691526 (0.7544)	-33.92986*** (0.0000)	0.576219***	0.070640
Taiwan	-2.308498 (0.4283)	-26.90513*** (0.0000)	-2.557013 (0.3005)	-26.94272*** (0.0000)	0.441196***	0.028794
Thailand	-2.498841 (0.3287)	-30.21654*** (0.0000)	-2.591914 (0.2842)	-30.15659*** (0.0000)	0.283833***	0.068527
Australia	-2.242185 (0.4649)	-25.84193*** (0.0000)	-2.232086 (0.4705)	-25.78425*** (0.0000)	0.544973***	0.032151
Hong Kong SAR	-0.269791 (0.9914)	-28.26337*** (0.0000)	-0.278466 (0.9912)	-28.26284*** (0.0000)	0.730495***	0.066522
Japan	-2.416508 (0.3706)	-32.68983*** (0.0000)	-2.611104 (0.2754)	-32.69831*** (0.0000)	0.369078***	0.031763
New Zealand	-2.231059 (0.4711)	-25.68229*** (0.0000)	-2.146914 (0.5182)	-25.61229*** (0.0000)	0.344397***	0.096314
Singapore	-1.456686 (0.8434)	-30.18433*** (0.0000)	-1.390064 (0.8634)	-30.13564*** (0.0000)	0.613243***	0.045183
US	-4.176078*** (0.0050)		-4.142209*** (0.0057)		0.092231	

*Denotes statistical significance at the 10 percent level.
**Denotes statistical significance at the 5 percent level.
***Denotes statistical significance at the 1 percent level.

Table 3 Results for multivariate cointegration of stock market capitalization in the Asia Pacific Region.

The number of cointegration vectors *r* is shown as well as the critical values for trace (λ trace) and maximum eigenvalue (λ max) statistics. The critical values are taken from Osterwald-Lenum (1992).

Null Hypotheses	Eigenvalues	λ trace	λ max
$r = 0$	0.1116	341.8444** (255.0700)	95.0566** (66.1700)
$r \leq 1$	0.0925	2467878** (213.4000)	77.9368** (60.4800)
$r \leq 2$	0.0524	168.8510 (174.8800)	43.2468 (54.1700)
$r \leq 3$	0.0496	125.6042 (140.0200)	40.8433 (48.5700)

**Denotes statistical significance at the 5 percent level
The values in parentheses are the 95 percent critical values

Table 4 Results of generalized forecast error variance decomposition.

Each entry denotes the total percentage of forecast error variance of the individual equity market in the first column explained by the market in the first row.
Error variance decomposition has been standardized for each of the explained equity market such that the sum is 100 percent.
Entries in the "All foreign" column denote the total percentage forecast error variance of the market in the first column explained by all foreign markets.

Equity Market Explained	Days after shock	By innovations in										
		Australia	China	Hong Kong SAR	Japan	Korea	Malaysia	New Zealand	Singapore	Taiwan	Thailand	All Foreign
Australia	5	54.2474	0.1992	5.0752	4.6257	7.1318	4.4411	17.5812	0.9355	3.7499	2.0131	45.7526
	10	54.6123	0.1891	4.8583	4.3245	6.9789	4.4581	17.9975	0.9510	3.6189	2.0115	45.3877
	15	54.5773	0.1847	4.7636	4.2002	6.9009	4.4521	18.0952	0.9561	3.5599	2.0065	45.4227
China	5	2.6252	83.6894	5.3441	0.5044	0.4634	4.1089	1.2080	0.9993	0.5004	0.5570	16.3106
	10	2.8925	83.3270	5.2639	0.4739	0.4580	4.1971	1.3559	0.9691	0.4943	0.5682	16.6730
	15	3.0079	83.2046	5.2276	0.4596	0.4556	4.2254	1.4191	0.9436	0.4904	0.5663	16.7954
Hong Kong SAR	5	13.5603	2.8638	45.5782	4.1255	10.2700	6.1205	4.2607	0.9863	9.4028	2.8320	54.4218
	10	16.2403	2.9118	44.5106	3.4137	10.1273	5.8277	5.4680	0.5853	8.8263	2.0889	55.4894
	15	17.9049	2.9462	43.6600	3.0138	10.0173	5.5882	6.2150	0.5476	8.4547	1.6523	56.3400
Japan	5	12.3788	0.3366	8.2830	50.1150	13.0531	1.9458	3.2794	0.4438	9.0687	1.0958	49.8850
	10	14.1270	0.3428	7.9445	48.7545	13.1626	1.8107	3.9997	0.3468	8.7719	0.7395	51.2455
	15	15.2611	0.3507	7.7008	47.8074	13.1709	1.7104	4.4646	0.4322	8.5525	0.5494	52.1926
Korea	5	10.9764	0.3310	11.0266	9.2816	44.6434	3.5293	3.5140	0.9224	13.5668	2.2086	55.3566
	10	11.4018	0.3351	10.9415	9.1198	44.3931	3.5486	3.7338	0.8385	13.5616	2.1262	55.6069
	15	11.6163	0.3375	10.8976	9.0405	44.3086	3.5488	3.8395	0.7855	13.5495	2.0760	55.6914
Malaysia	5	11.7214	2.1279	8.5913	1.3456	5.0539	60.5854	3.6215	0.6178	4.4948	1.8403	39.4146
	10	14.0725	2.1814	8.1978	1.0499	5.0533	58.8591	4.6067	0.4346	4.2216	1.3230	41.1409
	15	15.5249	2.2142	7.8881	0.8773	5.0169	57.6923	5.2264	0.5202	4.0209	1.0188	42.3077
New Zealand	5	21.3553	0.0217	0.7092	0.9859	2.1798	0.8776	72.7293	0.1839	0.8158	0.1416	27.2707
	10	21.7752	0.0209	0.6411	0.8609	2.0729	0.8244	72.8684	0.1162	0.6995	0.1205	27.1316
	15	21.9763	0.0208	0.6107	0.8063	2.0287	0.7986	72.9138	0.0858	0.6518	0.1073	27.0862
Singapore	5	12.5451	1.6897	7.5554	5.5266	5.6950	5.1847	4.8684	48.4418	7.6165	0.8767	51.5582
	10	20.1470	2.0571	7.3680	4.7873	6.3333	5.0021	8.2716	37.7012	7.6425	0.6899	62.2988
	15	25.6844	2.2784	6.9913	4.1557	6.5710	4.6948	10.8177	30.4776	7.3871	0.9421	69.5224
Taiwan	5	8.6016	0.4169	11.4730	6.2311	13.9118	3.8298	3.6985	1.9302	48.9894	0.9177	51.0106

	10	9.6408	0.4434	11.2414	5.8390	13.9466	3.7727	4.2697	1.4774	48.6557	0.7132	51.3443
	15	10.2681	0.4581	11.0966	5.6222	13.9665	3.7161	4.6012	1.2022	48.4743	0.5948	51.5257
Thailand	5	10.2121	0.1256	7.3344	2.4052	6.5780	3.2294	2.0110	0.5464	5.1361	62.4218	37.5782
	10	12.7274	0.1368	7.1674	2.1125	6.8808	3.1518	2.8025	0.3466	5.1821	59.4922	40.5078
	15	14.3506	0.1466	7.0146	1.9181	7.0120	3.0600	3.3336	0.3832	5.1322	57.6490	42.3510

Table 5 Impulse response analysis of the stock market capitalization in the Asia Pacific region to a unit standard deviation shock in the individual equity market.

Equity Market Responding	Days after shock	To one S.D. impulse in									
		Australia	China	Hong Kong SAR	Japan	Korea	Malaysia	New Zealand	Singapore	Taiwan	Thailand
Australia	0	0.0108	0.0009	0.0042	0.0044	0.0045	0.0031	0.0054	0.0014	0.0035	0.0023
	1	0.0109	0.0005	0.0030	0.0026	0.0038	0.0032	0.0064	0.0014	0.0026	0.0020
	2	0.0111	0.0007	0.0032	0.0031	0.0039	0.0031	0.0064	0.0015	0.0028	0.0022
	3	0.0111	0.0006	0.0032	0.0030	0.0039	0.0032	0.0064	0.0015	0.0028	0.0021
	4	0.0111	0.0006	0.0032	0.0030	0.0039	0.0032	0.0064	0.0015	0.0028	0.0021
	5	0.0111	0.0006	0.0032	0.0030	0.0039	0.0032	0.0064	0.0015	0.0028	0.0021
	6	0.0111	0.0006	0.0032	0.0030	0.0039	0.0032	0.0064	0.0015	0.0028	0.0021
	7	0.0111	0.0006	0.0032	0.0030	0.0039	0.0032	0.0064	0.0015	0.0028	0.0021
	8	0.0111	0.0006	0.0032	0.0030	0.0039	0.0032	0.0064	0.0015	0.0028	0.0021
	9	0.0111	0.0006	0.0032	0.0030	0.0039	0.0032	0.0064	0.0015	0.0028	0.0021
	10	0.0111	0.0006	0.0032	0.0030	0.0039	0.0032	0.0064	0.0015	0.0028	0.0021
	11	0.0111	0.0006	0.0032	0.0030	0.0039	0.0032	0.0064	0.0015	0.0028	0.0021
	12	0.0111	0.0006	0.0032	0.0030	0.0039	0.0032	0.0064	0.0015	0.0028	0.0021
	13	0.0111	0.0006	0.0032	0.0030	0.0039	0.0032	0.0064	0.0015	0.0028	0.0021
	14	0.0111	0.0006	0.0032	0.0030	0.0039	0.0032	0.0064	0.0015	0.0028	0.0021
	15	0.0111	0.0006	0.0032	0.0030	0.0039	0.0032	0.0064	0.0015	0.0028	0.0021
China	0	0.0017	0.0208	0.0054	0.0019	0.0017	0.0037	0.0004	0.0021	0.0016	0.0011
	1	0.0036	0.0195	0.0049	0.0014	0.0013	0.0047	0.0025	0.0022	0.0015	0.0017
	2	0.0038	0.0196	0.0049	0.0015	0.0015	0.0044	0.0026	0.0022	0.0015	0.0017
	3	0.0038	0.0196	0.0049	0.0014	0.0014	0.0045	0.0026	0.0022	0.0015	0.0017
	4	0.0038	0.0196	0.0049	0.0014	0.0014	0.0045	0.0026	0.0022	0.0015	0.0017
	5	0.0038	0.0196	0.0049	0.0014	0.0014	0.0045	0.0026	0.0021	0.0015	0.0017
	6	0.0038	0.0196	0.0049	0.0014	0.0014	0.0045	0.0027	0.0021	0.0015	0.0017
	7	0.0038	0.0196	0.0049	0.0014	0.0014	0.0045	0.0027	0.0021	0.0015	0.0016
	8	0.0039	0.0196	0.0049	0.0014	0.0014	0.0045	0.0027	0.0021	0.0015	0.0016
	9	0.0039	0.0196	0.0049	0.0014	0.0014	0.0045	0.0027	0.0021	0.0015	0.0016
	10	0.0039	0.0196	0.0049	0.0014	0.0014	0.0045	0.0027	0.0020	0.0015	0.0016
	11	0.0039	0.0196	0.0049	0.0014	0.0014	0.0045	0.0027	0.0020	0.0015	0.0016
	12	0.0039	0.0196	0.0049	0.0014	0.0014	0.0045	0.0027	0.0020	0.0015	0.0016
	13	0.0039	0.0196	0.0049	0.0014	0.0014	0.0045	0.0027	0.0020	0.0015	0.0016
	14	0.0039	0.0196	0.0049	0.0014	0.0014	0.0044	0.0027	0.0020	0.0015	0.0016
	15	0.0039	0.0196	0.0049	0.0014	0.0014	0.0044	0.0027	0.0020	0.0015	0.0016
Hong Kong SAR	0	0.0042	0.0028	0.0108	0.0043	0.0053	0.0036	0.0014	0.0023	0.0053	0.0032
	1	0.0049	0.0023	0.0096	0.0026	0.0044	0.0038	0.0029	0.0019	0.0043	0.0026
	2	0.0054	0.0024	0.0097	0.0028	0.0046	0.0036	0.0031	0.0014	0.0043	0.0025
	3	0.0056	0.0024	0.0096	0.0026	0.0045	0.0036	0.0032	0.0010	0.0043	0.0022

	4	0.0058	0.0024	0.0095	0.0025	0.0045	0.0035	0.0034	0.0006	0.0042	0.0020
	5	0.0059	0.0024	0.0095	0.0024	0.0045	0.0034	0.0035	0.0003	0.0042	0.0019
	6	0.0061	0.0024	0.0094	0.0024	0.0045	0.0034	0.0036	0.0001	0.0041	0.0017
	7	0.0062	0.0024	0.0094	0.0023	0.0045	0.0033	0.0037	-0.0002	0.0041	0.0016
	8	0.0063	0.0024	0.0093	0.0022	0.0045	0.0033	0.0038	-0.0003	0.0040	0.0015
	9	0.0064	0.0025	0.0093	0.0022	0.0045	0.0033	0.0038	-0.0005	0.0040	0.0014
	10	0.0065	0.0025	0.0093	0.0022	0.0045	0.0033	0.0039	-0.0007	0.0040	0.0013
	11	0.0065	0.0025	0.0092	0.0021	0.0045	0.0032	0.0039	-0.0008	0.0040	0.0013
	12	0.0066	0.0025	0.0092	0.0021	0.0045	0.0032	0.0040	-0.0009	0.0039	0.0012
	13	0.0066	0.0025	0.0092	0.0021	0.0045	0.0032	0.0040	-0.0010	0.0039	0.0012
	14	0.0067	0.0025	0.0092	0.0020	0.0044	0.0032	0.0040	-0.0011	0.0039	0.0011
	15	0.0067	0.0025	0.0092	0.0020	0.0044	0.0032	0.0041	-0.0011	0.0039	0.0011
Japan	0	0.0056	0.0013	0.0055	0.0138	0.0064	0.0024	0.0024	0.0023	0.0056	0.0026
	1	0.0052	0.0007	0.0045	0.0107	0.0058	0.0026	0.0028	0.0010	0.0048	0.0017
	2	0.0056	0.0009	0.0045	0.0111	0.0057	0.0021	0.0029	0.0007	0.0047	0.0016
	3	0.0057	0.0009	0.0045	0.0109	0.0057	0.0022	0.0030	0.0004	0.0047	0.0014
	4	0.0059	0.0009	0.0044	0.0109	0.0057	0.0021	0.0031	0.0001	0.0046	0.0012
	5	0.0060	0.0009	0.0044	0.0108	0.0057	0.0021	0.0032	-0.0002	0.0046	0.0011
	6	0.0061	0.0009	0.0043	0.0107	0.0057	0.0020	0.0033	-0.0004	0.0045	0.0010
	7	0.0062	0.0009	0.0043	0.0107	0.0057	0.0020	0.0034	-0.0006	0.0045	0.0009
	8	0.0063	0.0009	0.0042	0.0106	0.0057	0.0020	0.0035	-0.0007	0.0045	0.0008
	9	0.0064	0.0009	0.0042	0.0106	0.0057	0.0020	0.0035	-0.0009	0.0045	0.0007
	10	0.0064	0.0009	0.0042	0.0106	0.0057	0.0019	0.0036	-0.0010	0.0044	0.0007
	11	0.0065	0.0009	0.0042	0.0105	0.0056	0.0019	0.0036	-0.0011	0.0044	0.0006
	12	0.0065	0.0009	0.0042	0.0105	0.0056	0.0019	0.0036	-0.0012	0.0044	0.0006
	13	0.0066	0.0009	0.0041	0.0105	0.0056	0.0019	0.0037	-0.0012	0.0044	0.0005
	14	0.0066	0.0009	0.0041	0.0105	0.0056	0.0019	0.0037	-0.0013	0.0044	0.0005
	15	0.0066	0.0009	0.0041	0.0105	0.0056	0.0019	0.0037	-0.0014	0.0044	0.0004
Korea	0	0.0066	0.0013	0.0077	0.0073	0.0157	0.0039	0.0033	0.0024	0.0082	0.0036
	1	0.0069	0.0012	0.0068	0.0062	0.0133	0.0040	0.0039	0.0020	0.0076	0.0030
	2	0.0070	0.0012	0.0068	0.0062	0.0137	0.0039	0.0040	0.0020	0.0076	0.0030
	3	0.0070	0.0012	0.0068	0.0062	0.0136	0.0039	0.0040	0.0019	0.0076	0.0030
	4	0.0070	0.0012	0.0068	0.0062	0.0136	0.0039	0.0041	0.0019	0.0076	0.0030
	5	0.0071	0.0012	0.0068	0.0062	0.0136	0.0039	0.0041	0.0018	0.0076	0.0030
	6	0.0071	0.0012	0.0068	0.0061	0.0136	0.0039	0.0041	0.0018	0.0076	0.0030
	7	0.0071	0.0012	0.0068	0.0061	0.0136	0.0039	0.0041	0.0018	0.0076	0.0029
	8	0.0071	0.0012	0.0068	0.0061	0.0136	0.0039	0.0041	0.0018	0.0076	0.0029
	9	0.0071	0.0012	0.0068	0.0061	0.0136	0.0039	0.0041	0.0017	0.0076	0.0029
	10	0.0071	0.0012	0.0068	0.0061	0.0136	0.0039	0.0041	0.0017	0.0076	0.0029
	11	0.0071	0.0012	0.0068	0.0061	0.0136	0.0039	0.0041	0.0017	0.0076	0.0029
	12	0.0071	0.0012	0.0067	0.0061	0.0136	0.0039	0.0041	0.0017	0.0076	0.0029
	13	0.0071	0.0012	0.0067	0.0061	0.0136	0.0039	0.0041	0.0017	0.0075	0.0029
	14	0.0071	0.0012	0.0067	0.0061	0.0136	0.0039	0.0041	0.0017	0.0075	0.0029

	15	0.0072	0.0012	0.0067	0.0061	0.0136	0.0039	0.0042	0.0017	0.0075	0.0029
Malaysia	0	0.0038	0.0024	0.0045	0.0023	0.0033	0.0133	0.0018	0.0021	0.0034	0.0023
	1	0.0046	0.0019	0.0044	0.0017	0.0032	0.0102	0.0025	0.0013	0.0031	0.0024
	2	0.0049	0.0020	0.0041	0.0016	0.0032	0.0110	0.0028	0.0010	0.0030	0.0019
	3	0.0051	0.0020	0.0041	0.0015	0.0032	0.0107	0.0029	0.0006	0.0030	0.0018
	4	0.0053	0.0021	0.0040	0.0014	0.0032	0.0107	0.0030	0.0003	0.0029	0.0016
	5	0.0055	0.0021	0.0040	0.0013	0.0032	0.0106	0.0031	0.0000	0.0029	0.0015
	6	0.0056	0.0021	0.0040	0.0013	0.0032	0.0106	0.0032	-0.0002	0.0028	0.0013
	7	0.0057	0.0021	0.0039	0.0012	0.0032	0.0106	0.0033	-0.0004	0.0028	0.0012
	8	0.0058	0.0021	0.0039	0.0011	0.0031	0.0105	0.0034	-0.0006	0.0028	0.0011
	9	0.0059	0.0021	0.0038	0.0011	0.0031	0.0105	0.0034	-0.0008	0.0027	0.0010
	10	0.0059	0.0021	0.0038	0.0011	0.0031	0.0105	0.0035	-0.0009	0.0027	0.0010
	11	0.0060	0.0021	0.0038	0.0010	0.0031	0.0105	0.0035	-0.0010	0.0027	0.0009
	12	0.0060	0.0021	0.0038	0.0010	0.0031	0.0104	0.0036	-0.0011	0.0027	0.0009
	13	0.0061	0.0021	0.0038	0.0010	0.0031	0.0104	0.0036	-0.0012	0.0027	0.0008
	14	0.0061	0.0021	0.0038	0.0010	0.0031	0.0104	0.0036	-0.0013	0.0026	0.0008
	15	0.0062	0.0021	0.0037	0.0009	0.0031	0.0104	0.0037	-0.0013	0.0026	0.0007
New Zealand	0	0.0055	0.0002	0.0014	0.0019	0.0023	0.0015	0.0110	0.0011	0.0018	0.0005
	1	0.0064	0.0002	0.0012	0.0013	0.0020	0.0013	0.0117	0.0005	0.0012	0.0006
	2	0.0064	0.0002	0.0011	0.0012	0.0019	0.0012	0.0118	0.0005	0.0011	0.0005
	3	0.0065	0.0002	0.0011	0.0012	0.0019	0.0012	0.0118	0.0004	0.0011	0.0005
	4	0.0065	0.0002	0.0011	0.0012	0.0019	0.0012	0.0118	0.0004	0.0011	0.0005
	5	0.0065	0.0002	0.0011	0.0012	0.0019	0.0012	0.0118	0.0003	0.0011	0.0005
	6	0.0065	0.0002	0.0010	0.0012	0.0019	0.0012	0.0119	0.0003	0.0011	0.0005
	7	0.0065	0.0002	0.0010	0.0012	0.0019	0.0012	0.0119	0.0003	0.0010	0.0004
	8	0.0066	0.0002	0.0010	0.0012	0.0019	0.0012	0.0119	0.0003	0.0010	0.0004
	9	0.0066	0.0002	0.0010	0.0012	0.0019	0.0012	0.0119	0.0002	0.0010	0.0004
	10	0.0066	0.0002	0.0010	0.0012	0.0019	0.0012	0.0119	0.0002	0.0010	0.0004
	11	0.0066	0.0002	0.0010	0.0012	0.0019	0.0012	0.0119	0.0002	0.0010	0.0004
	12	0.0066	0.0002	0.0010	0.0012	0.0019	0.0012	0.0119	0.0002	0.0010	0.0004
	13	0.0066	0.0002	0.0010	0.0012	0.0019	0.0012	0.0119	0.0002	0.0010	0.0004
	14	0.0066	0.0002	0.0010	0.0012	0.0019	0.0012	0.0119	0.0002	0.0010	0.0004
	15	0.0066	0.0002	0.0010	0.0012	0.0019	0.0012	0.0119	0.0002	0.0010	0.0004
Singapore	0	0.0013	0.0010	0.0023	0.0017	0.0016	0.0016	0.0010	0.0104	0.0021	0.0009
	1	0.0036	0.0016	0.0038	0.0038	0.0031	0.0033	0.0019	0.0088	0.0038	0.0020
	2	0.0040	0.0014	0.0033	0.0027	0.0029	0.0027	0.0025	0.0080	0.0033	0.0011
	3	0.0044	0.0016	0.0032	0.0027	0.0029	0.0027	0.0028	0.0072	0.0033	0.0008
	4	0.0048	0.0016	0.0031	0.0025	0.0028	0.0026	0.0030	0.0065	0.0031	0.0004
	5	0.0051	0.0016	0.0030	0.0023	0.0028	0.0024	0.0033	0.0060	0.0030	0.0001
	6	0.0053	0.0016	0.0029	0.0022	0.0028	0.0024	0.0034	0.0055	0.0030	-0.0002
	7	0.0056	0.0016	0.0028	0.0020	0.0028	0.0023	0.0036	0.0051	0.0029	-0.0004
	8	0.0058	0.0017	0.0027	0.0019	0.0028	0.0022	0.0038	0.0047	0.0028	-0.0006

	9	0.0059	0.0017	0.0027	0.0019	0.0028	0.0022	0.0039	0.0044	0.0028	-0.0008
	10	0.0061	0.0017	0.0026	0.0018	0.0027	0.0021	0.0040	0.0041	0.0027	-0.0009
	11	0.0062	0.0017	0.0026	0.0017	0.0027	0.0021	0.0041	0.0039	0.0027	-0.0011
	12	0.0063	0.0017	0.0025	0.0017	0.0027	0.0020	0.0042	0.0037	0.0027	-0.0012
	13	0.0064	0.0017	0.0025	0.0016	0.0027	0.0020	0.0042	0.0035	0.0026	-0.0013
	14	0.0065	0.0017	0.0025	0.0016	0.0027	0.0020	0.0043	0.0033	0.0026	-0.0014
	15	0.0066	0.0017	0.0024	0.0015	0.0027	0.0020	0.0043	0.0032	0.0026	-0.0014
Taiwan	0	0.0043	0.0010	0.0064	0.0054	0.0068	0.0033	0.0022	0.0026	0.0131	0.0023
	1	0.0051	0.0011	0.0061	0.0043	0.0068	0.0037	0.0034	0.0030	0.0127	0.0017
	2	0.0055	0.0012	0.0062	0.0045	0.0068	0.0036	0.0036	0.0027	0.0127	0.0018
	3	0.0056	0.0012	0.0061	0.0043	0.0068	0.0036	0.0037	0.0024	0.0126	0.0016
	4	0.0057	0.0012	0.0061	0.0043	0.0068	0.0036	0.0038	0.0022	0.0126	0.0015
	5	0.0058	0.0012	0.0060	0.0043	0.0068	0.0035	0.0039	0.0021	0.0126	0.0014
	6	0.0058	0.0012	0.0060	0.0042	0.0068	0.0035	0.0039	0.0019	0.0126	0.0013
	7	0.0059	0.0012	0.0060	0.0042	0.0067	0.0035	0.0040	0.0018	0.0125	0.0013
	8	0.0060	0.0012	0.0060	0.0042	0.0067	0.0035	0.0040	0.0017	0.0125	0.0012
	9	0.0060	0.0012	0.0059	0.0041	0.0067	0.0034	0.0041	0.0016	0.0125	0.0012
	10	0.0061	0.0013	0.0059	0.0041	0.0067	0.0034	0.0041	0.0015	0.0125	0.0011
	11	0.0061	0.0013	0.0059	0.0041	0.0067	0.0034	0.0041	0.0015	0.0125	0.0011
	12	0.0061	0.0013	0.0059	0.0041	0.0067	0.0034	0.0041	0.0014	0.0125	0.0011
	13	0.0061	0.0013	0.0059	0.0041	0.0067	0.0034	0.0042	0.0014	0.0125	0.0010
	14	0.0062	0.0013	0.0059	0.0041	0.0067	0.0034	0.0042	0.0013	0.0125	0.0010
	15	0.0062	0.0013	0.0059	0.0041	0.0067	0.0034	0.0042	0.0013	0.0124	0.0010
Thailand	0	0.0037	0.0009	0.0051	0.0033	0.0040	0.0030	0.0008	0.0016	0.0031	0.0174
	1	0.0060	0.0004	0.0056	0.0032	0.0054	0.0038	0.0025	0.0024	0.0050	0.0154
	2	0.0064	0.0007	0.0054	0.0032	0.0052	0.0037	0.0028	0.0016	0.0047	0.0154
	3	0.0067	0.0007	0.0053	0.0030	0.0052	0.0036	0.0031	0.0012	0.0046	0.0151
	4	0.0070	0.0007	0.0053	0.0028	0.0052	0.0035	0.0032	0.0007	0.0046	0.0149
	5	0.0072	0.0007	0.0052	0.0027	0.0052	0.0035	0.0034	0.0003	0.0045	0.0147
	6	0.0073	0.0007	0.0051	0.0026	0.0052	0.0034	0.0035	0.0000	0.0044	0.0145
	7	0.0075	0.0007	0.0051	0.0026	0.0051	0.0034	0.0036	-0.0003	0.0044	0.0143
	8	0.0076	0.0007	0.0050	0.0025	0.0051	0.0033	0.0037	-0.0005	0.0044	0.0142
	9	0.0077	0.0008	0.0050	0.0024	0.0051	0.0033	0.0038	-0.0007	0.0043	0.0141
	10	0.0078	0.0008	0.0049	0.0024	0.0051	0.0032	0.0039	-0.0009	0.0043	0.0140
	11	0.0079	0.0008	0.0049	0.0023	0.0051	0.0032	0.0039	-0.0011	0.0043	0.0139
	12	0.0080	0.0008	0.0049	0.0023	0.0051	0.0032	0.0040	-0.0012	0.0042	0.0138
	13	0.0080	0.0008	0.0049	0.0023	0.0051	0.0032	0.0040	-0.0013	0.0042	0.0138
	14	0.0081	0.0008	0.0048	0.0023	0.0051	0.0032	0.0041	-0.0014	0.0042	0.0137
	15	0.0081	0.0008	0.0048	0.0022	0.0051	0.0031	0.0041	-0.0015	0.0042	0.0137

Fig. 1 The transmission of information propagation mechanism and impulse response in the stock market capitalization in the Asia Pacific region.

These lines show the effect of efficient transmission of information from one equity market to another.
The solid line arrows show the instantaneous effect and the dotted line arrows show the lagged effect.