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Stock market integration in East and Southeast Asia: The role of global factors

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ABSTRACT

This study explores the issue of financial integration among stock markets of ASEAN5 economies, plus China (mainland China and Hong Kong), Japan and South Korea (referred to as ASEAN5 + 4). Using both graph theory and a Vector Autoregressive (VAR)-based method, together with a rolling window approach, we show that the level of interconnectedness among these markets is high but with clear time varying patterns. A large share of this seemingly high level of integration is shown to be driven by common global factors. After filtering these factors from each stock market, the magnitude of interconnectedness falls substantially. Our results therefore suggest that stock market integration in East and Southeast Asia is not as strong as it looks. Although governments in this region have been promoting financial market collaboration and integration, barriers remain significant. The overestimated interconnectedness is mainly a simple reflection of stronger global influences on individual markets, while their interconnectedness attributable to non-global factors shows a descending trend after the crisis.

1. Introduction

Asian stock markets are increasingly integrated in recent years (Chien, Lee, Hu, & Hu, 2015), accompanied by joint policy efforts on building up a regionally integrated market to promote capital mobility within the region, such as the AEC Blueprint series (ASEAN, 2015). According to the 2018 Asian Economic Integration Report (ADB, 2018), Asia's share of global inward foreign direct investment has shown an increasing trend in recent years, for example, rising from 27.8% in 2016 to 36.2% in 2017. An upward trend is also seen in international holdings of Asian portfolio equity assets, rising by 1.3 trillion USD in 2017. This year also witnessed a surge of global remittances to Asia amounting to 272.5 billion USD, concurrent with strengthened global economy. Regional stock market integration was found reinforced during the turmoil of the global financial crisis (Gupta & Guidi, 2012). For the post-crisis period, while some studies find evidence of declining co-movement among certain Asian stock markets (Gupta & Guidi, 2012), others find strengthened linkages among major East Asian stock markets (Wang, 2014).

Capital market liberalization and globalization largely contribute to Asian stock market integration (Arouri & Foulquier, 2012). With ongoing financial market deregulation and capital account liberalization, cross-border financial transactions are more prevalent (Chien et al., 2015; Singh, 2009). Massive inflows of foreign investment contribute substantially to the boom of local equity markets in this region. Market capitalization of major Ease and Southeast Asian stock markets grows substantially during the last two decades. For example, the market value rises 6.51 times for Hong Kong, 9.48 times for Indonesia, 6.06 times for the Philippines, and a whopping 61.13 times for China's A-share market, with its Shanghai stock Exchange being the fourth largest in the world by the end of 2018.[1] East and Southeast Asian stock markets have become an important part of fund managers' international portfolios for the purposes of increasing returns and reducing risks (Narayan, Sriananthakumar, & Islam, 2014).

On the other hand, the global stock market exerts increasingly significant influences on Asian markets (Burdekin & Siklos, 2012; Huyghebaert & Wang, 2010). There is no doubt that the trend of globalization will inevitably lead to significantly increased stock market co-movement and stronger linkages in capital markets arising from potential spillover effects. It is, however, questionable how strong Asian equity markets are interlinked in the absence of common global factors. In other words, are regional stock markets intrinsically getting more integrated, or is it simply due to unaccounted information, most notably, common factors of the global stock market?

The logic behind this argument is that capital markets are not completely liberalized in the Asian economies, especially the Chinese

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[1] Source: Statistia, https://www.statista.com/statistics/270126/largest-stock-exchange-operators-by-market-capitalization-of-listed-companies/, last retrieved on 10 July 2019.

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and ASEAN markets, which are at different stages of development and have substantial differences in market practices, legal environments, regulatory frameworks and intuitional development (Singh, 2009). It is rather difficult for investors to switch their investment from one market to another, in the presence of capital restrictions and also exchange rate risks. Extant empirical evidence of increasing stock market co-movement may simply reflect an increasing influence from global systemic risks on individual markets. If a group of economies are commonly prone to pervasive global or regional influences, it is not surprising to see a high level of integration among their stock markets (Pukthuanthong & Roll, 2009).

Failing to account for the contribution of global common factors can lead to biased conclusions on the level of cross-market connectedness attributable to regional or local factors. So our main contribution is to see how much global common factors tend to affect stock market integration. Inspired by a global capital asset pricing model (GCAPM) (among others, Carrieri, Errunza, & Hogan, 2007; Arouri & Foulquier, 2012; Alotaibi & Mishra, 2017), we treat each individual stock market as a constituent asset of a portfolio, while the world stock market influence is viewed as a systematic common factor. Using a market model, we are enabled to remove the global parts from each stock market, and then reinvestigate their interactions.

Among the studies focusing on East and Southeast Asian stock markets, most of them attempt to explore the interconnectedness and integration between China and ASEAN5 (Chien et al., 2015; Jayasuriya, 2011). Our study seeks to investigate the integration of the ASEAN5[2] (Indonesia, Malaysia, the Philippines, Singapore and Thailand) and four other major East Asian stock markets including Japan, China (mainland China and Hong Kong) and South Korea. The 1997–98 Asian financial crisis not only severely hit most East and Southeast Asian economies and led to economic and political turmoil in some countries and areas, but also induced financial contagion and raised fears of a worldwide economic meltdown. Since then, leaders of these governments have been striving for regional financial integration. For example, the Chiang Mai Initiative (CMI) was introduced in May 2000 to establish a regional coalition force to cope with short-term liquidity problems.

In terms of methodology, we start from a simple correlation analysis and extend it to a classic minimum spanning tree (MST) based on graph theory to visualize the interdependence structure among the ASEAN5 + 4 stock markets. The leading stock markets which play critical roles in connecting other markets in the network are identified by the MST. Considering the profound and long-lasting influence of the 2008 financial crisis on global economy and equity markets, the analysis is conducted for the full sample and two subperiods divided by a date close to the Lehman Brothers episode (15 September 2008). To test the robustness of the correlation and MST results, we use a recently developed multivariate time series approach proposed by Diebold and Yilmaz (2014) to construct a connectedness matrix and find the total connectedness for the system. A rolling-window approach is adopted to depict how the interconnectedness evolves over time, as a complement to the static description of the full-sample.

We find evidence of time-variant interconnectedness, with the importance of individual markets and links among them varying over time. Singapore is on average the most integrated market over the full sample, based on both filtered and non-filtered analysis, confirming extant evidence that Singapore plays a gatekeeper role for many Asian markets (Chowdhury, Dungey, Kangogo, Sayeed, & Volkov, 2019). Mainland China, despite its big market value, is among the most segmented, which is in line with the argument that China's big internal market tends to offset its dependence on global financial and economic shocks (Aityan, Ivanov-Schitz, & Izotov, 2010). It also implies that market size seems not a critical factor affecting a market's level of integration in this region.

In contrast to the general perception that individual stock markets in Asia are becoming increasingly integrated, our results suggest that it is not exactly the case. Though none of these stock markets appears to be completely segmented, the level of cross-market integration in this region is shown to be quite low after we manage to filter out the influences from the world stock market. The interconnectedness in the system is increasingly overestimated over time, implying that the ASEAN5 + 4 stock markets are becoming more exposed to some common world stock market factors, while their interconnectedness attributable to non-global factors shows a descending trend after the crises.

The remainder of this paper is organized as follows. Section 2 reviews related literature. Section 3 introduces the main methodologies adopted in this study. Section 4 presents the data. Section 5 discusses the results from empirical analysis. The final section concludes with some practical implications.

2. Literature review

The evolution of stock market integration is a complex, gradual and time-varying process, with occasional reversals (Bekaert & Harvey, 1995). The degree and time variation of global or regional stock market integration are affected by both institutional and behavioral factors and are subject to on-going economic, political and institutional reforms. Financial market development and financial liberalization progress significantly bolster stock market integration, by reducing barriers to portfolio flows and increasing availability of market substitutes (Carrieri et al., 2007). With increased accessibility for global investors to the domestic stock market, or from the opposite direction, domestic assets are inevitably more exposed to information spillover and shocks from foreign markets, leading to more integrated domestic stock markets into the regional or global market (Arouri & Foulquier, 2012).

There exists a consensus that financial market integration benefits long-term economic development and helps strengthen domestic stock markets, by bringing more diversified financing sources and investment channels, broadening investor base and financial product range, lowering equity capital cost, improving corporate and market governance and reducing stock return volatility (Singh, 2009). It enables domestic markets to compete globally, improves shock-absorbing capacity of the economy and mitigates risks arising from cross-border financial contagion, therefore bolstering financial stability (Narayan et al., 2014). Investors are enabled to actively seek for wider investment opportunities to achieve efficient capital allocation and gain international portfolio diversification benefits (Chien et al., 2015), which, however, tend to decline as cross-market financial integration increases (Billio, Donadelli, Paradiso, & Riedel, 2017).

Among the voluminous relevant literature, many investigate global stock market integration, especially between developed and emerging markets (Chen, Chen, & Lee, 2014; Guidi & Ugur, 2014; Kenourgios, Samitas, & Paltalidis, 2011; Labidi, Rahman, Hedström, Uddin, & Bekiros, 2018; Mobarek, Muradoglu, Mollah, & Hou, 2016). For emerging markets per se, there is evidence showing that financial market integration promotes international risk sharing especially for them (Carrieri et al., 2007). Integration of geographically clustered emerging markets or those belonging to a regional intergovernmental political and economic union has also been discussed, such as GCC markets (Alotaibi & Mishra, 2017). Chen (2018) finds that regional and global common factors can simultaneously affect stock markets across the world, leading to increasing linkages and co-movements among these markets.

While earlier empirical evidence shows that emerging Asian

[2] The Association of Southeast Asian Nations (ASEAN), founded on 8 August 1967, first included five member countries (Indonesia, Malaysia, the Philippines, Singapore and Thailand, referred to as ASEAN5). By 1999, five more countries had joined, including Brunei, Vietnam, Laos, Myanmar and Cambodia. By the end of 2018, the ASEAN5 countries constitute 73.6% of the total ASEAN population and 87.45% of GDP (Source: Statistia).

markets usually have low level of exposure to global factors or integration with western developed markets, more recent evidence suggests that Asian stock markets tend to follow some leading western developed markets, most discussed, the US market (Aityan et al., 2010). Jiang, Yu, and Hashmi (2017) find that the 2008 financial crisis reinforces the interdependence among stock markets of China, Hong Kong, Japan, Germany, the UK and US, using a vector autoregression (VAR) model and Granger causality tests. Wang (2014) finds strengthened linkages among six major East Asian stock markets after the 2008 global financial crisis, and declining influences of Hong Kong, Singaporean and US stock markets on East Asian stock markets but increasing importance of South Korean and Japanese stock markets after the crisis. Burdekin and Siklos (2012) find evidence of integration of the Chinese stock market with the US market and many regional stock markets from 1995 to 2010. Guidi, Savva, and Ugur (2016) investigate the dynamic co-movements among the Greater China region (Mainland China, Hong Kong and Taiwan) and the UK and US stock markets, and find only intermittent episodes of cointegration. The time-varying interdependence between the markets of the Greater China region and Singapore, South Korea and Japan are also studied in Huyghebaert and Wang (2010) focusing on the impacts of the 1997–98 Asian financial crisis, and the authors find significant roles of Hong Kong, Singapore and US markets on all those East Asian markets except for Mainland China. Across Asian markets, Gupta and Guidi (2012) explore the interdependence between Indian stock market and three developed Asian markets (Hong Kong, Japan and Singapore) from 1999 to 2009, and find the role of the crisis in enhancing their linkages and evidence of a short-term but no long-run linkage among them.

Among the sparse studies focusing on East and Southeast Asian stock markets, most of them attempt to explore the interconnectedness and integration between China and ASEAN5. Chien et al. (2015) investigate the dynamic convergence among Chinese and ASEAN5 stock markets using recursive cointegration analysis, and find evidence of gradually increased regional financial integration between these countries. Jayasuriya (2011) uses a VAR model to investigate the interlinkages between China's stock market and three neighbor emerging markets, Thailand, Indonesia and the Philippines, from 1993 to 2008, and finds no significant evidence of interrelation between the aggregate markets unless taking foreign investors returns into account, but evidence of shock transmission from the Chinese to other markets.

Motivated by these studies, we extend the scope by encompassing the most important (and also the biggest) stock markets, ASEAN5 plus Japan, China (mainland China and Hong Kong), as well as South Korea in this region to draw a bigger picture depicting the cross-market interdependencies in Asia, hoping to provide useful implications to both policy makers and market participants.

3. Methodology

3.1. Graph theory and minimum spanning tree

Deeley (2016) uses graph theory to illustrate within-system dependencies via a simple mapping strategy. We adopt the minimum spanning tree (MST) to provide graphic evidence on the network structure of ASEAN5 + 4 stock markets, following extant literature (Ji & Fan, 2016; Wu, Zhang, & Zhang, 2019). As a classic tree derived from graph theory, MST has the advance of extracting the most important relationships among all variables in the system, while expressing it in a simplest way that is easy to visualize and identify the most crucial nodes and relationships. By construction, it chooses only the K-1 strongest links among all K(K-1)/2 possible links for K vertices in a system, to construct a network with possibly shortest path to connect all these vertices, thus much reducing the complexity of constructing the network.

The construction of MST is based on the calculation of pairwise correlations. Denote the correlation between two variables i and j as ρ_{ij} at time T, which is calculated by:

$$\rho_{ij}^{T} = \frac{\sum_{t=1}^{T} (r_{i,t} - \bar{r}_i)(r_{j,t} - \bar{r}_j)}{\sqrt{\sum_{t=1}^{T} (r_{i,t} - \bar{r}_i)^2 \sum_{t=1}^{T} (r_{j,t} - \bar{r}_j)^2}} \tag{1}$$

The correlation coefficient cannot be applied to measure distance. Instead, the correlation coefficient can be converted to a distance variable using a simple distance function:

$$d_{ij} = \mathrm{f}(\rho_{ij}) = \sqrt{2(1 - \rho_{ij}^{T})} \tag{2}$$

where d_{ij} denotes the distance between node i and j at time T, which satisfies the three axioms of Euclidean distance, including: (1) $d_{ij} = 0$, if and only if $i = \mathrm{j}$; (2) $d_{ij} = d_{ji}$; and (3) $d_{ij} \leq d_{ik} + d_{kj}$. A smaller value of d_{ij} implies that the two stock markets are more correlated and compact. The pairwise distances then form a distance matrix, which is used to connect all stock markets in an undirected network graph G. An MST can then be constructed to link together all nodes (stock markets) in the graph G with minimum possible total edge weight (Mantegna & Stanley, 2000).

3.2. VAR-based approach

A battery of econometric techniques have been applied in the literature to studying equity market integration and interdependencies, including the generalized autoregressive conditional heteroscedasticity model (GARCH) (Jayasuriya, 2011), dynamic conditional correlation (DCC) (Mobarek et al., 2016), cointegration test (Chen et al., 2014), cross quantile dependence/correlation (Labidi et al., 2018), Bayesian dynamic latent factor model (Chen, 2018), time-varying Copula (Kenourgios et al., 2011), etc. Billio et al. (2017) compare the performance of a wide range of measures describing several dimensions of financial integration. Yu, Fung, and Tam (2010) survey the various indicators used in Asian equity market integration studies.

Drawn on the seminal work of Allen and Gale (2000), network theory has been inspiring the exploring and modelling of interconnectedness in financial markets, and the structural vulnerability that may induce risk propagation and imperil system-wide stability. More recent studies in this vine try to detect potential interconnectedness among financial institutions using quantitative network methods, for the purpose of testing the resilience of a network and identifying systemic importance of the nodes. Prominent quantitative network methodologies using market data are, for example, the Granger-causality network (Billio, Getmansky, Lo, & Pelizzon, 2012) and the vector-autoregressive (VAR) model (Diebold & Yilmaz, 2009, 2012, 2014).

The core method used in our study is the seminal approach proposed by Diebold and Yilmaz (2009) and improved by their later works (Diebold & Yilmaz, 2012, 2014), which explicitly measures the interdependence among the variables based on the vector autoregressive (VAR) model (Sims, 1980) and the generalized forecast error variance decomposition method (GFEVD) (Koop, Pesaran, & Potter, 1996; Pesaran & Shin, 1998). This approach generalizes the univariate autoregressive models by incorporating multivariate time series to enable a more flexible and rich structure, without having to specify which variables are endogenous or exogenous. Given no prior information on the underlying relationships between the series of a system, all variables are considered endogenous and can be estimated in a VAR model (Sims, 1980).

The initial model of Diebold and Yilmaz (2009) has a methodological limitation of relying on the ordering of variables for the variance decomposition, arising from its adoption of the Cholesky factor identification of VARs. Diebold and Yilmaz (2012) tackle this problem by replacing the Cholesky factorization by the generalized VAR framework of Koop et al. (1996) and Pesaran and Shin (1998), to make variance decomposition invariant to ordering. Diebold and Yilmaz (2014) further refine the basic VAR model to set up a network analysis. Their model has been widely applied in empirical studies to investigate the interconnectedness between stock market returns and oil shocks (Zhang, 2017), international commodity markets (Zhang & Broadstock, 2018), energy markets (Ji, Zhang, & Geng, 2018; Zhang, Shi, & Shi, 2018), housing markets (Zhang & Fan, 2018), sectoral interconnectedness in stock markets (Wu et al., 2019), etc.

The lag length for the VAR model in this study is selected by minimizing the value of Bayesian information criteria, as by construction it induces a higher penalization for the model with an intricate parametrization compared to the Akaike information criterion.[3] For a K-variable VAR(p) model, it can be expressed as:

$$\boldsymbol{y}_t = \boldsymbol{c} + \boldsymbol{A}_1 y_{t-1} + \boldsymbol{A}_2 y_{t-2} + \ldots + \boldsymbol{A}_p y_{t-p} + \boldsymbol{u}_t \tag{3}$$

where $\mathbf{y}$ is a (k × 1) vector of variables at time t; $\boldsymbol{c}$ and $\boldsymbol{u}$ are (k × 1) vectors of constants and error terms at time t, respectively; $\mathbf{A}$s are (k × k) matrices of coefficients. A more compact version for the VAR model is:

$$Y_t = C + AY_{t-1} + U_t \tag{4}$$

Upon estimating the VAR model, the forecast error variance decomposition (FEVD) approach can then be applied to the estimated VAR to find out how much one variable i can help in explaining the variation of another variable j, or how long these effects require to take place. In practice, FEVD usually adopts Cholesky decomposition, and the results are therefore sensitive to the ordering of variables. Instead of changing the order of variables to check the robustness of FEVD results, we adopt the generalized decomposition method (Koop et al., 1996; Pesaran & Shin, 1998) to circumvent the issue of ordering in standard VAR analysis, following the suggestion of Diebold and Yilmaz (2014). After estimating the VAR model, the mean squared error of the H-step forecast of variable y_i is:

$$MSE\left[y_{i,t}(H)\right] = \sum_{j=0}^{H-1} \sum_{k=1}^{K} (e_i{}' \Theta_j e_k)^2 \tag{5}$$

where e_i is the ith column of I_k; $\Theta_j = \Phi_j P$, where P is a lower triangular matrix through a Cholesky decomposition of the variance covariance matrix $\Omega_u = E(u_t u_t')$, and $\Phi_j = JA^j J'$, with $J = [I_k, 0, \ldots, 0]$. In this paper, we follow Diebold and Yilmaz (2014) and Zhang (2017), and adopt MSE to conduct the generalized variance decomposition. It is worth mentioning that besides MSE, other alternatives are also possible, such as MAPE, RMSE, RMSP and MAD (Witt & Witt, 1992), which we hope to explore in future work.[4]

The contribution of variable k to variable i, based on the H-period-ahead generalized variance decomposition, is specified as:

$$\varphi_{ik,H}^{g} = \frac{\sigma_{kk}^{-1} \sum_{j=0}^{H-1} (e_i{}' \Phi_j \sum e_k)^2}{MSE\left[y_{i,t}(H)\right]} \tag{6}$$

where σ_{kk} is the standard deviation of the error term of the kth equation.

Denoting the GFEVD of any two variables as φ_{ij}, which measures how much variable i is explained by variable j, then a K×K connectedness matrix (for example, Zhang, 2017) can be constructed for a K-variable system. Between any given pair of variables (i, j), the relative contribution, or net contribution, from variable j to i can be calculated as $\varphi_{ij} - \varphi_{ji}$, and vice versa. A positive value of the net contribution from j to i indicates that variable j contributes more to than receiving from variable i, or, variable j is a net contributor to variable i. The top net contributor in a system makes most net contributions to other variables, meaning that it is the most influential component in the system among all and has the strongest explanatory power of the future variations in all other variables. It therefore can be used to forecast the market dynamics.

To find how the whole system is interconnected, or in other words, integrated, Diebold and Yilmaz (2014) define a measure called total connectedness, which essentially is the aggregation of pairwise connectedness. In the K by K connectedness matrix for a K-variable system, it is calculated as the sum of all non-diagonal elements divided by the total number of variables in the system:

$$s = \frac{1}{K} \sum_{i,j=1}^{K} \varphi_{ij,H}, \; for, \; i \neq j \tag{7}$$

By construction, diagonal elements of the connectedness matrix show self-contributions (when i = j), and are thus excluded when calculating the total connectedness. The value of s ranges between zero and one, respectively indicating that the system components are all mutually independent or perfectly dependent on each other. We follow Zhang (2017) to set H = 10, as the connectedness matrix may change when H is too small, or converge quickly to a stable value when H becomes higher, as discussed in Diebold and Yilmaz (2009) and Zhang (2017).

Diebold and Yilmaz (2014) also introduce three additional measures:

$$\text{From}_i = \sum_{j=1}^{K} \varphi_{ij}, \; for, \; i \neq j \tag{8}$$

$$\text{To}_i = \sum_{j=1}^{K} \varphi_{ji}, \; for, \; i \neq j \tag{9}$$

$$\text{Net}_i = \text{To}_i - \text{From}_i \tag{10}$$

where From_i describes how much one variable i gains from all others in the system; To_i describes how much variable i contributes to the system; Net_i calculates this variable's net contribution to the system, which can be positive or negative. To further account for the time variation in the system's interconnectedness, we follow Diebold and Yilmaz (2009) to use a rolling-window analysis to render a time-varying picture of intra-system connectedness, which estimates the VAR models recursively using overlapping sub-samples. The window size in this study is selected as a quarter of the total number of observations.

3.3. Accounting for the global common factor

A central task of this study is to explore the intrinsic integration among major East and Southeast Asian stock markets, which does not depend on the influences of the global stock market. The dynamics in the world stock market inevitably exert significant influences on local stock markets, especially during the progress of reducing barrier to foreign investment and liberalizing stock markets in recent years, or in an episode of risk contagion arising from a systemic event. This therefore gives rise to concerns that correlation-based approaches may generate biased conclusions on equity market integration, as returns used for calculating cross-market correlations encompass influences from both the global and non-global sources. Pukthuanthong and Roll (2009) and Carrieri et al. (2007) suggest the impropriety of directly inferring the real level of financial market integration by market-wide index return correlations, as there are cases where perfectly integrated markets can exhibit weak correlation in the presence of multiple global sources of return volatility and differing levels of sensitivities of markets to them.

Our filtering method is inspired by the international capital asset pricing model (ICAPM). Arouri and Foulquier (2012) introduce an augmented international asset pricing model to account for partial financial market segmentation and to reflect local risk that is not internationally diversifiable. Abid, Kaabia, and Guesmi (2014) and Boubakri

[3] We thank an anonymous reviewer for this suggestion. Results using the Akaike information criterion render generally the same results, omitted here for brevity but available upon request.

[4] We thank an anonymous reviewer for suggesting these possibilities.

and Guillaumin (2015) focus on South Asia and East Asia stock market integration, respectively, using the ICAPM. It has also been discussed in, for example, Yao, He, Chen, and Ou (2018).

To investigate whether the ASEAN5 + 4 stock markets are still strongly linked in the absence of common driving forces from the global stock market, we attempt to filter out the influences of the world stock market dynamics on local stock market returns, based on a simple market model expressed as:

$$y_{i,t} = \alpha_i + \beta_{i,t} y_{w,t} + \varepsilon_{i,t} \tag{11}$$

where $y_{i,\,t}$ denotes the return of market i at time t; α_i is the constant; $y_{w,\,t}$ is the return of the world stock market at time t with a coefficient $\beta_{i.\,t}$; $\varepsilon_{i,\,t}$ is the error term, showing the part of the ith market's idiosyncratic component from the total return, which is attributed to factors other than common global impacts. These filtered returns are then used to investigate the interrelationships among local stock market returns free from the disturbances of common global stock market impacts.

4. Data

Weekly stock market price indices for these ASEAN5 + 4 stock markets[5] and also for a world aggregate stock market are collected from Thomson Reuters Datastream, denominated in US dollars. Returns are calculated as the log difference of weekly stock market price indices. The sample period is selected between 23 June 1999 and 26 June 2019, with totally 1044 observations.

The descriptive statistics of stock market returns in the nine Asian stock markets and the world stock market are shown in Table 1. Over the sample period, Thailand has the highest mean return among all markets, followed by South Korea and the Philippines. Japan shows the lowest mean return, remarkably lower than its follower China. They are also the only two markets in the sample with lower mean returns than the world market. Comparing the ASEAN5 group to the East Asia group, the average return of ASEAN5 stock markets is higher than that of the four East Asian markets. Within the ASEAN5 group, Singapore has the lowest mean return, while Thailand has the highest. Among the East Asian markets, Japan has the lowest while South Korea has the highest mean returns, respectively.

Considering market volatility, the top three markets with highest levels of standard deviation are Indonesia, South Korea and Thailand, implying more volatility in these three markets than in others over the full sample period. The standard deviation for Malaysia is the lowest, followed by Japan and Hong Kong, but all higher than that of the world market, indicating that they are systematically more volatile than the global stock market. The average volatility of the ASEAN5 markets is lower than that of the East Asian markets, indicating that the latter are generally more volatile than the former. Among the ASEAN5 markets, Indonesia has the highest volatility, while Malaysia the lowest. Within the East Asian group, South Korean and Japanese markets are the most and least volatile ones, respectively.

We then plot each stock market's return series over the sample period in Fig. 1. The most volatile periods in all markets are seen during the 2008 financial crisis period. To address the significant impacts of the 2008 financial crisis, the whole sample is divided into pre- and post-crisis periods by the date 10 September 2008, as the Lehman Brothers filed its bankruptcy protection on 15 September 2008.[6]

[5] For brevity, the mainland China and China's Hong Kong stock markets will be respectively referred to as “China” and “Hong Kong” hereinafter in the main text, tables and figures.

[6] Using weekly data, the sample dates before and after the Lehman Brothers event are 10 and 17 September 2018, respectively. We therefore select the first date the divide the sample into two subsamples.

5. Empirical analysis

5.1. Correlation analysis

We first construct a correlation matrix by Pearson's rank correlation coefficients for the raw returns of the ASEAN5 + 4 stock markets using Eq. (1), without filtering the effects of the world stock market. Fig. 2 uses heat maps to visualize the pairwise dependences during the whole sample and two sub-periods, where a lighter color indicates a lower level of correlation and a darker color the otherwise. Diagonal elements represent self-correlations equaling one and are not shown in the figure.

Over the whole sample period, the color of China is on average the lightest, reflecting a lowest level of aggregated correlation with all other markets. By contrast, much darker colors are seen for the Singapore, Hong Kong and South Korea markets, indicating their high correlations with other markets. The highest pairwise correlations are seen exactly among them. Consistent with the coldest color of China, it also appears in all top three lowest correlations with Japan, South Korea, as well as Thailand and Indonesia (with equal magnitudes). The average correlation of the East Asia group is lower than that of the ASEAN5. Same rankings are seen in the subsample results. Each market's aggregate correlation with all others increases substantially by more than 40% during the post-crisis period, with China, Malaysia and Indonesia increasing the most, leading to a substantial increase in the system's aggregate correlation during this period.

The correlation results using filtered data are reported in Fig. 3. Singapore and Hong Kong are still among the top three most correlated markets, and their correlation is always the highest, irrespective of sample period or data type selected. South Korea is no longer among the top three, replaced by Thailand and Indonesia in each sub-period, respectively. The least correlated market is no longer China but Japan over the full sample and the post-crisis period, but China-Japan remains the least correlated pair over the full sample and post-crisis period. The filtering process not only changes these rankings, but also systemically and remarkably reduces magnitudes of pairwise correlations, leading to aggregate level of correlation declining by over 45% in each period. This finding may indicate that the previously high correlations computed by non-filtered returns are largely attributable to the common influences from the world stock market. Two seemingly highly correlated markets may not actually be that much related, if we manage to remove the influences from the global stock market dynamics, especially when both markets are commonly susceptible to these global factors. Furthermore, filtering leads the aggregate correlation for the post-crisis period to drop by 47.8%, slightly more than the pre-crisis period (46.7%), possibly implying that the post-crisis markets seem more susceptible to global stock market influences.

5.2. MST results

Given the correlation matrix, we proceed to calculate the distance matrix for all pairwise markets using Eq. (2) and construct an MST for the system. Fig. 4 shows the three trees presenting the full sample and two sub-periods, respectively, based on raw returns. Considering the significant impacts of the global stock market factors, we examine how the MSTs tend to change after filtering the effects of the world stock market. The results are shown in Fig. 5. The stock market with the highest degree centrality is highlighted as the most central node, where the degree centrality is defined as the number of edges incident to a given node. Also, the shorter the pairwise distance is, the thinner the edge between them will be.

Seen in Fig. 4(a), Singapore and Hong Kong are the two most central markets, each connecting together markets in its own region (except Japan). Clustering effects are therefore observed in both ASEAN5 and East Asia groups. The link between them is also the strongest, evidenced by their thinnest edge. The edges among ASEAN5 markets seem on average thinner than among the East Asia markets, indicating stronger

Table 1
Descriptive statistics.

	Mean	Median	Maximum	Minimum	Std.	Skewness	Kurtosis	Jarque-Bera
China	0.049	0.096	13.874	−24.906	3.408	−0.414	6.911	695.255***
Hong Kong	0.079	0.266	14.829	−14.437	2.988	−0.426	5.722	353.995***
Indonesia	0.076	0.282	21.790	−32.526	4.319	−0.828	10.734	2721.240***
Japan	0.023	0.139	12.984	−14.685	2.649	−0.271	5.006	187.714***
Korea	0.089	0.314	30.656	−26.901	4.224	−0.305	9.408	1802.453***
Malaysia	0.076	0.174	11.141	−17.964	2.368	−0.575	8.107	1192.176***
Philippines	0.080	0.139	24.596	−15.212	3.079	0.192	8.906	1523.848***
Singapore	0.066	0.124	14.346	−16.944	2.609	−0.308	7.553	918.082***
Thailand	0.120	0.285	19.372	−21.414	3.615	−0.393	6.265	490.526***
World	0.062	0.261	8.200	−17.894	2.288	−0.938	8.178	1319.273***

Note: Std. denotes standard deviation. Jarque-Bera denotes the statistics of Jarque-Bera test for normality.
*** 1% significance level.

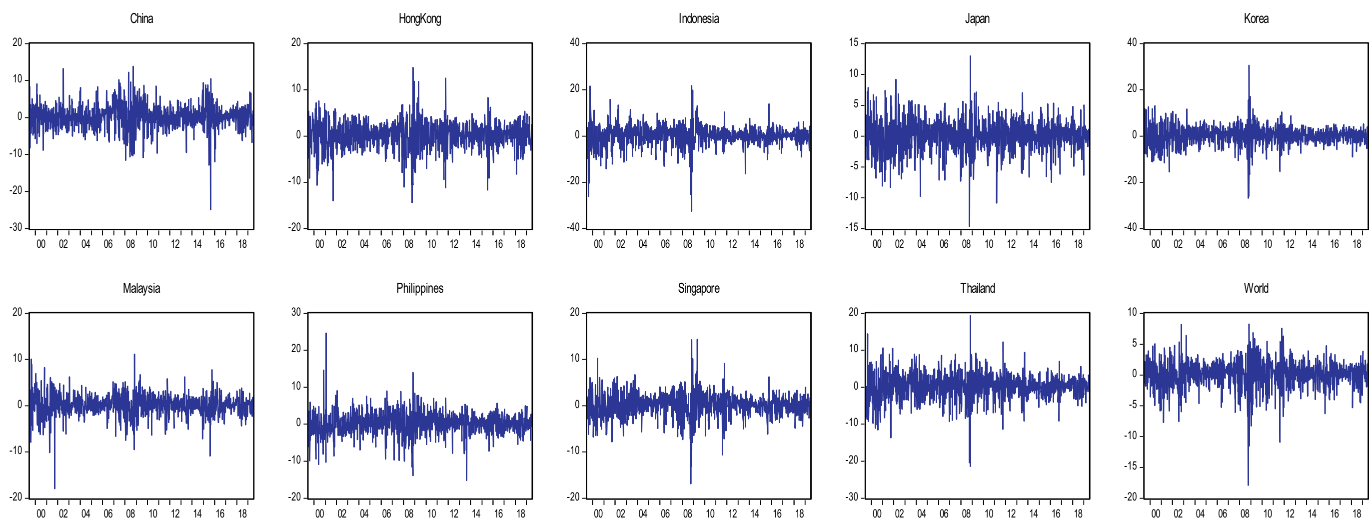
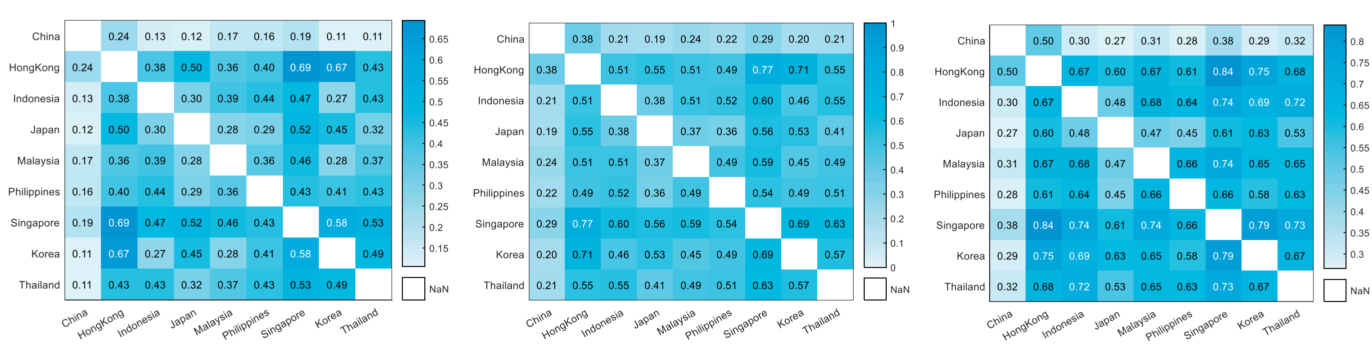


Fig. 1. Time series plots of return series.



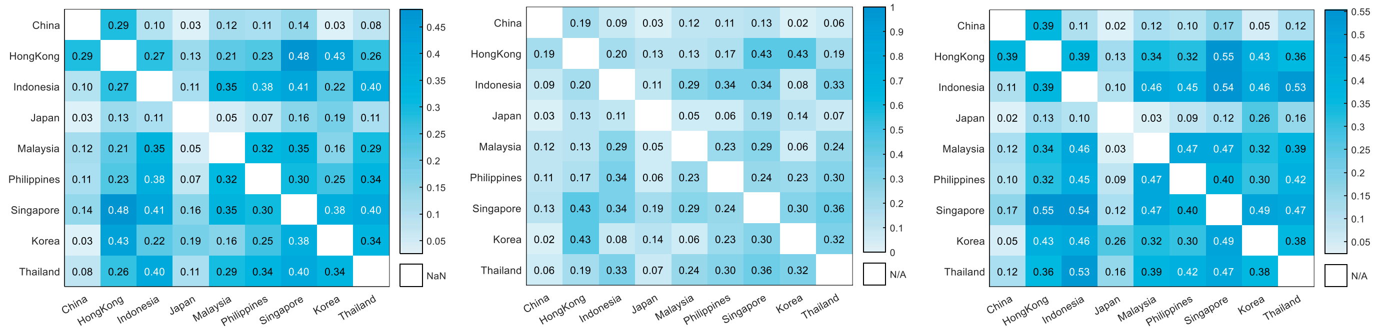
(a) Full sample (b) Pre-crisis period (c) Post-crisis period

Fig. 2. Correlation heat maps of raw returns for full sample, pre- and post-crisis periods.

cross-market links in the former group. China appears to be the least central node. Though these findings are consistent with the correlation results, disparities are, for example, South Korea which is among the top three most correlated appears not central in the MST. Also, the highly correlated Singapore-South Korea over the full sample are not directly linked in the MST.

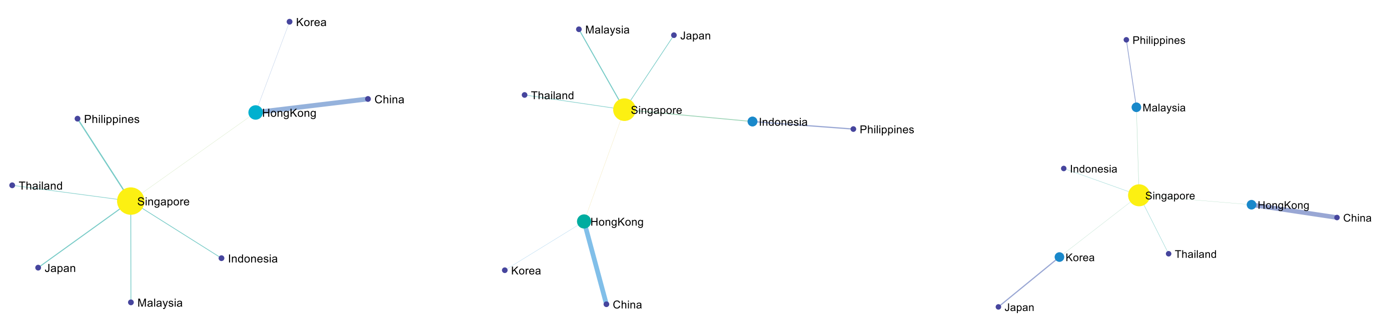
The main findings for the pre-crisis period are almost the same as for the full sample. The post-crisis MST maintains some of the pre-crisis characteristics, but presents substantial changes. The whole network seems more interconnected and centralized. Singapore remains central but is decoupled from Japan and the Philippines, despite their high post-crisis correlations. This implies that some other post-crisis correlations increase more than those pairs, making them less important in the post-crisis MST. Rather than only Hong Kong in the pre-crisis period, new sub-central nodes emerge.

After filtering the world stock market effects, the whole network is less compact but more stretched out over the full sample. The central role of Singapore is maintained but lessened. The filtering process causes the pre-crisis tree to change from a two-center to a three-center structure, as Indonesia and Hong Kong appear to be important, each linking to three markets. For the post-crisis MST, filtering process changes the location of Thailand, and the weakest link is no longer between Hong Kong and China, but between Japan and South Korea instead.



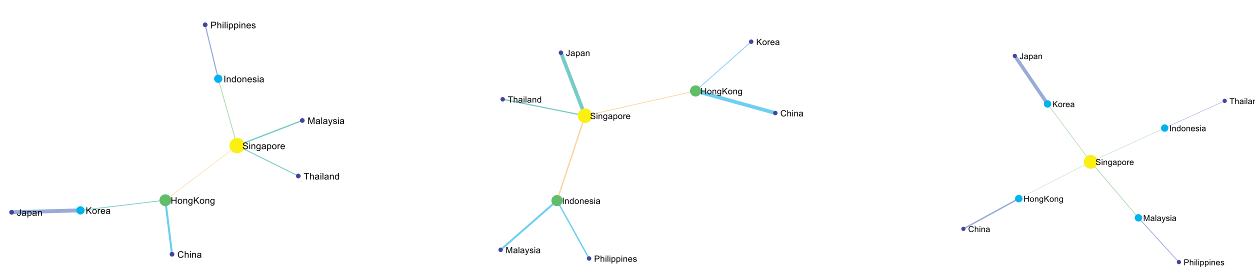
(a) Full sample (b) Pre-crisis period (c) Post-crisis period

Fig. 3. Correlation heat maps after filtering the world stock market effects.



(a) Full sample (b) Pre-crisis period (c) Post-crisis period

Fig. 4. MST for raw returns.



(a) Full sample (b) Pre-crisis period (c) Post-crisis period

Fig. 5. MST for filtered returns.

5.3. VAR-based results

To test the graphic evidence shown by the MSTs, we opt for using a multivariate time series approach proposed by Diebold and Yilmaz (2014) to further verify the interconnectedness among the ASEAN5 + 4 stock markets, accompanied by a rolling-window approach to capture the dynamics of the cross-market relationships, following extant literature (among others, Zhang, 2017; Wu et al., 2019; Zhang et al., 2018). We first fit the ASEAN5 + 4 returns into a VAR model, and then obtain a connectedness matrix by the GFEVD method, which shows the overall connectedness in the system as well as each market's gains and contributions to others. To account for the impacts of the world stock market dynamics on the system's interconnectedness, we compare the results generated by both raw and filtered returns, shown in Panels I and II of Table 2, respectively.

5.3.1. Interconnectedness by raw returns

Seen in Panel I of Table 2, the overall connectedness in the system without filtering the world stock market effects is 63.42% over the full sample, calculated as the average of the values of all non-diagonal elements. This indicates that the nine markets are highly interconnected using raw returns. To gauge each individual market's susceptibility and contribution to the dynamics of the whole system, the last column “From” and the row “To” are respectively calculated by Eqs. (8) and (9) to present the levels of each. While there is an upper bound for the measure “From” (100% maximum variation for any variable), “To” can exceed 100% (in theory, it can go to a maximum value of n). The figures of “From” are generally above 60%, indicating that most of the stock markets gain substantial information from the system, except China. The top receivers are Singapore, Hong Kong and South Korea. Compared to “From”, the contributions made by each

Table 2
Connectedness matrices before and after filtering the world stock market effects.

	China	Hong Kong	Indonesia	Japan	Malaysia	Philippines	Singapore	Korea	Thailand	From
Panel I. Connectedness matrix for raw returns										
China	65.51%	10.17%	3.10%	2.48%	3.73%	3.49%	5.91%	2.71%	2.90%	34.49%
Hong Kong	4.20%	27.66%	7.34%	8.10%	7.18%	6.83%	16.64%	13.87%	8.19%	72.34%
Indonesia	1.60%	9.15%	34.75%	4.99%	8.98%	9.45%	12.78%	7.85%	10.44%	65.25%
Japan	1.56%	11.57%	5.91%	39.64%	5.21%	5.34%	12.55%	11.30%	6.91%	60.36%
Malaysia	1.91%	9.71%	9.30%	4.91%	36.28%	8.36%	13.29%	7.56%	8.67%	63.72%
Philippines	1.74%	9.03%	9.87%	5.00%	8.44%	36.17%	11.03%	8.70%	10.02%	63.83%
Singapore	2.13%	15.58%	9.09%	8.22%	9.05%	7.50%	26.07%	12.19%	10.17%	73.93%
Korea	1.21%	15.25%	6.65%	8.77%	6.13%	7.24%	14.46%	30.45%	9.86%	69.55%
Thailand	1.44%	9.80%	9.67%	5.91%	7.82%	8.73%	13.18%	10.71%	32.73%	67.27%
To	15.80%	90.27%	60.93%	48.38%	56.54%	56.93%	99.84%	74.89%	67.16%	63.42%
Net	−18.69%	17.93%	−4.32%	−11.98%	−7.18%	−6.89%	25.91%	5.33%	−0.11%	
Panel II. Connectedness matrix for filtered returns										
China	85.96%	7.75%	1.03%	0.15%	1.26%	1.28%	1.79%	0.11%	0.68%	14.04%
Hong Kong	4.85%	55.28%	5.43%	0.87%	2.79%	3.37%	13.23%	9.89%	4.29%	44.72%
Indonesia	0.90%	4.14%	56.90%	0.58%	7.15%	8.36%	9.88%	3.21%	8.87%	43.10%
Japan	0.40%	1.54%	2.43%	87.39%	0.25%	1.08%	2.57%	2.86%	1.49%	12.61%
Malaysia	0.89%	3.23%	8.08%	0.12%	64.59%	6.58%	8.83%	1.98%	5.70%	35.41%
Philippines	0.79%	3.62%	9.07%	0.35%	6.20%	61.85%	6.01%	4.18%	7.93%	38.15%
Singapore	1.07%	11.83%	8.75%	1.35%	6.53%	4.86%	50.05%	7.28%	8.28%	49.95%
Korea	0.11%	10.91%	4.17%	1.87%	1.94%	4.20%	8.67%	60.62%	7.52%	39.38%
Thailand	0.58%	3.96%	8.93%	0.70%	5.08%	7.15%	9.48%	6.69%	57.43%	42.57%
To	9.59%	46.98%	47.90%	5.99%	31.18%	36.87%	60.46%	36.20%	44.76%	35.55%
Net	−4.45%	2.26%	4.79%	−6.62%	−4.23%	−1.28%	10.51%	−3.18%	2.19%	

Note: "From" denotes the aggregation of horizontal elements for each variable in the matrix, while "To" is the aggregation of vertical elements for each variable, both excluding the diagonal elements which represent self-connectedness. "Net" is calculated as the difference between the values of "To" and "From", measuring the net contribution made by this variable to the whole system.

market vary significantly, with the three top receivers also being the top contributors. All markets contribute more than 50% to the system, except China and Japan. Combining these results, China is found to receive and also contribute the least, while Singapore is the opposite, which are consistent with the non-filtered graphic evidence of the MST.

The last row "Net", computed as the difference between the magnitudes of "To" and "From", measures each market's net contribution to the system. It simultaneously considers each market's contributions and gains, and is therefore more informative and comparable to the MST findings, relative to either "From" or "To". Most markets have negative values of "Net", indicating that they receive more than they contribute over the sample period, and are thus net receivers. Among them, China "net" receives the most from the system. There are only three net contributors to the system, Singapore, Hong Kong and South Korea. These results, again, correspond to the MST findings.

Pairwise connections are plotted in Fig. 6 to visualize the connectedness and overall interaction among all markets. The nine stock markets are connected by 36 edges, arranged radially around a circle and represented by nodes on the out part of the circular layout. Directional arrows are drawn to show pairwise relationships. If market *i* explains more than is explained by market *j* ($i \neq j$), an outward edge (arrow) is drawn pointing from *i* towards *j*, or otherwise an inward edge is drawn. Singapore as the top net contributor is highlighted by a red diamond. With eight outgoing edges and "net" contributing to all other markets, it should be considered the most influential in the system. China, by contrast, is highlighted by a blue square. It net receives from all other markets with zero outward edges, affected by all others while influencing none.

These results reflect the average level of connectedness in the system over the full sample of 20 years, rendering a static snapshot of the connections among ASEAN5 + 4 stock markets. The complex and multifaceted equity markets, however, are prone to unpredictable exogenous shocks, evolving market practices and sentiments, and ongoing legal and institutional updates, from both domestic and international sources (Wu, 2018). We well expect that interconnectedness among these stock markets tends to change over time. To depict the dynamics of how the intra-system connectedness evolves, we apply a

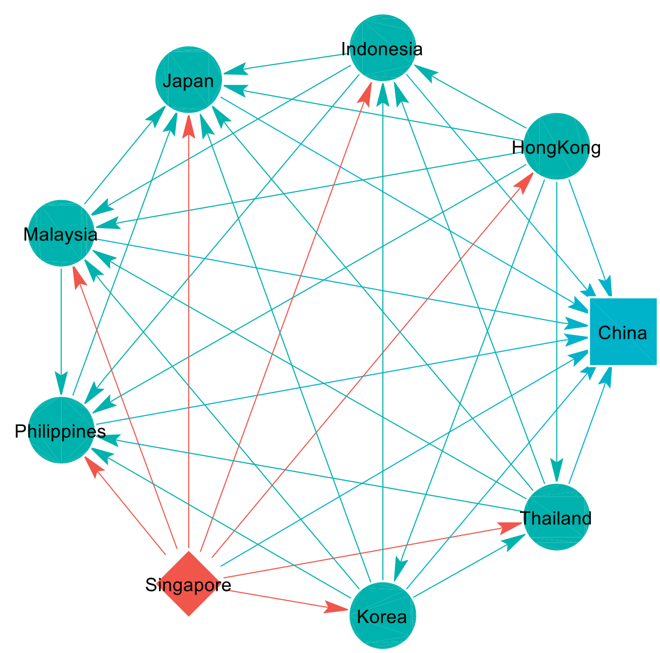


Fig. 6. Full-sample pairwise connectedness for raw returns.

simple rolling-window approach to the VAR model, following extant literature (Diebold & Yilmaz, 2009, 2012; Ji et al., 2018; Zhang, 2017; Zhang et al., 2018).

There, however, has been no consensus on window length selection (Ji & Fan, 2016). With totally 1044 observations from 23 June 1999 to 26 June 2019, we select a quarter of this number (which is 261 weeks, approximately five years) as our window size. Moving along the time scale with one window step length, there are totally 784 windows to be recursively estimated. The VAR model is estimated for each window, implying that the full sample connectedness should not be simply calculated as the average of the connectedness of rolling windows, though

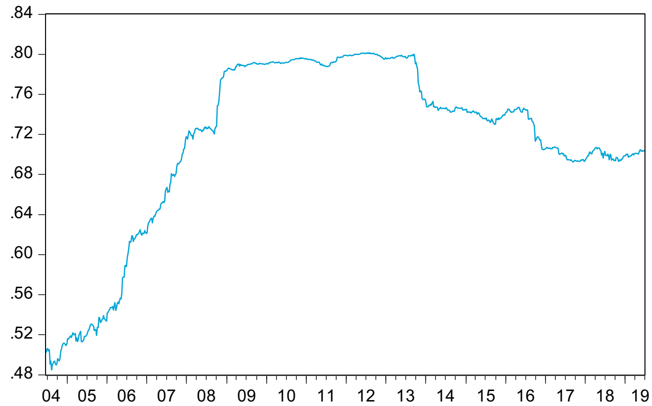


Fig. 7. Rolling-window total connectedness using raw returns.

they are mutually comparable (Zhang, 2017).

A rolling-window version of connectedness is shown in Fig. 7. The total connectedness among the ASEAN5 + 4 stock markets of each window is plotted corresponding to the end of that particular window. The interconnectedness of the whole system clearly exhibits a time-varying trend. The lowest point, which is less than 50%, is seen at the beginning of the timeline corresponding to the window ending in 2004. It then climbs up steadily to the around 72% when the window ends in early 2008, and levels until the third quarter of 2008, when it starts rising sharply as the global financial crisis unfolds. The connectedness maintains at its peak (around 79%) from the beginning of 2009 to the middle of 2013, covering the global financial crisis and its aftermath, as well as the European sovereign debt crisis. After that, systemic interconnectedness shows a declining trend and decreases to around 70% in early 2017 and levels off till the end of the sample period.

5.3.2. *Interconnectedness by filtered returns*

Substantial changes in the full sample connectedness matrix are seen after filtering the world stock market effects, as shown in Panel II, Table 2. Most notably, the full-sample total connectedness in the system decreases from 63.42% before filtering to 35.55% after filtering the world stock market effects, dropping by 44%. This indicates that the previously estimated high interconnectedness among ASEAN5 + 4 stock markets seems largely driven by the global market influences that all markets are commonly exposed to. After filtering out the contribution by world stock market impacts, cross-market interconnection significantly decreases.

Each market's gains from and contributions to others decrease remarkably. The top three receivers are Singapore, Hong Kong and Indonesia, who are also the top three contributors, albeit different rankings. The values of "Net" show that Singapore, Indonesia, Hong Kong and Thailand are four net contributors. Interestingly, Indonesia and Thailand, considered as net receivers when using non-filtered data, become net contributors. Conversely, South Korea changes from a net contributor in the non-filtering case to a net receiver. Though in both cases Singapore and Hong Kong are recognized as net contributors, their net contributions drop substantially in magnitude after filtering, especially Hong Kong. Considering which market receives and contributes the least, China is replaced by Japan using filtered data. These results, again, correspond to our findings from the MST analysis. The implication is that the ASEAN5 + 4 stock markets are actually not that highly prone to information spillovers from each other, after removing the component of returns contributed by their common susceptibility to the global market information spillover. The full sample pairwise connections using filtered returns are plotted in Fig. 8. The most noticeable difference from Fig. 6 is that Japan becomes the top net receiver and is highlighted as a blue square.

A rolling-window version of the filtered connectedness is shown in

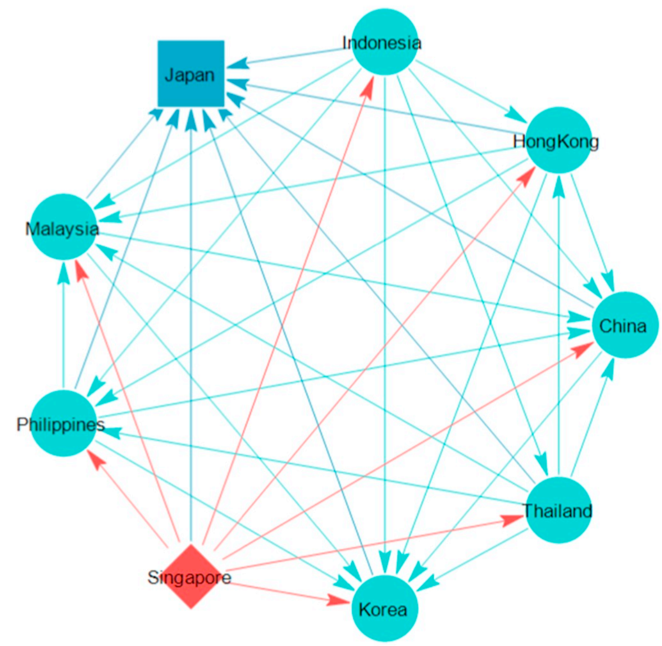


Fig. 8. Full-sample pairwise connectedness using filtered returns.

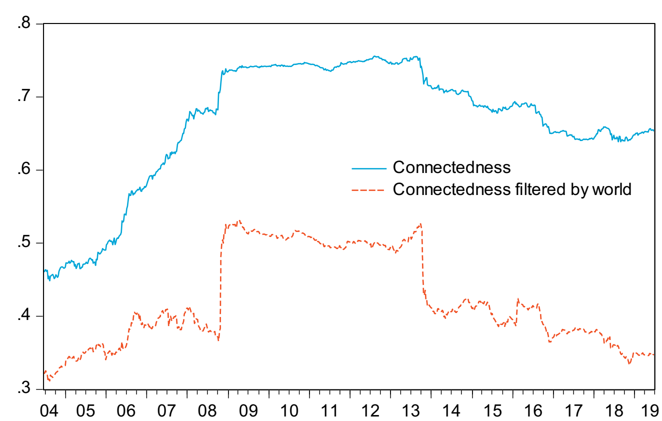


Fig. 9. Rolling-window connectedness using filtered and non-filtered returns.

Fig. 9, alongside its non-filtered counterpart. These two lines exhibit similar general trends over time, despite different movements at each point of time. It should be noted that though using filtered returns removes the direct influences from the global stock market, regional and local markets are still exposed to information and risk spillover from the global market, especially with increasing participation of international investors in regional and local markets, who are more susceptible to global market dynamics relative to regional or local investors and adjust their investment behavior accordingly.[7] The global influences on local markets are thus by no means eliminated, but rather can indirectly drive the co-movement among local markets.

The filtered connectedness, however, is consistently much lower than the non-filtered one over the full sample period. It can be noticed that as time goes by, the gap between their magnitudes tends to enlarge, especially since the 2008 financial crisis. This implies that the bias caused by failure of filtering out the world stock market influences becomes increasingly pronounced over time, evident by the increasingly overestimated interconnectedness. A plausible explanation can be that connections between the Asian and world markets have been

[7] We thank an anonymous reviewer for this insightful comment.

deepened over the past decade (Chowdhury et al., 2019), and local markets are becoming more sensitive to world events (Arouri & Foulquier, 2012), especially since the prominent global crisis. Thinking globally and learning from the experiences of financial contagion, local stock markets are increasingly prudent and alert to information and risk spillover from foreign markets, especially from neighbor markets or those once closely linked markets, leading to more segmented rather than integrated markets in this region. Failing to rule out the disturbances of world market dynamics thus tends to increasingly harm the accuracy of estimating the intrinsic cross-market connectedness over time.

Notably, financial market integration has been a long-standing goal of ASEAN countries, as shown in several official ASEAN documents.[8] To facilitate freer cross-border capital flow and multi-jurisdiction offerings, wide-ranging reforms have been implemented in ASEAN countries to enhance corporate standards, increase transparency, address the gaps in financial reporting, promote mutual recognition and harmonized disclosure regime, and benchmark with international standards. The ASEAN Common Exchange gateway was created, which is an electronic trading link that enables cross-market trading and thus increases overall trading liquidity (Singh, 2009).

Among the ASEAN5 + 4 stock markets, however, barriers to financial market integration are far beyond geographic distance between two markets. Capital account restrictions, exchange restrictions and capital control are still believed to play a role, despite a contrasting view of adopting freer policies to deregulate and liberalize markets. There also exist huge disparities in the level of socio-economic and institutional development, trade openness, regulatory and legal environments across these economies (Abid et al., 2014; Bekaert & Harvey, 1995). With the presence of these heterogeneities, the objectives, perceived costs and benefits from integration vary significantly across jurisdictions. Vast differences also exist in terms of tax regimes, market practice, market size and infrastructure, costs, product range, technology investment, liquidity and so on. It is not likely that these markets can achieve parity with each other in these regards. All these factors pose direct and indirect investment barriers to global investors and impede freer flow of capital. To expedite regional integration and translate these initiatives into each government's policy framework, it requires not only alignment of objectives, and also strong political will as well as accommodating and well-tailored plans of implementation.

5.4. Robustness test

To test the robustness of our main results based on the VAR approach, we conduct a Granger causality test to find the extent of convergence of these stock markets during the full sample and two subperiods. The results are generally consistent with our main results, suggesting similar patterns of the interconnectedness among the ASEAN5 + 4 markets using both raw and filtered returns. For brevity, the results are not reported here but are available upon request.

6. Conclusion and implications

While evidence in extant literature shows that stock markets in Asia have been increasingly integrated in recent years (for example, Chien et al., 2015), we find that the interconnection among the ASEAN5 + 4 stock markets substantially decreases after we filter out the influences from the global stock market. This indicates that the seemingly high level of cross-market connection is largely caused by the pervasive influences from the global equity market. After the financial crisis, we find that the gap between the levels of interconnectedness estimated by filtered and non-filtered data tends to enlarge over time, implying Asian markets' increasing common exposure to international market factors.

Our findings therefore answer the question of whether Asian stock markets are really getting more integrated, or whether it is mainly a result of unaccounted information? Or in other words, are the enhanced cross-market linkages simply be driven by some common international forces? Our results show that the high interconnectedness among the local stock markets in East and Southeast Asia is largely caused by common global market factors, consistent with findings in for example, Chen (2018). From a portfolio perspective, failure to filter the systematic factor originated from the global stock market is very likely to lead to overestimation of the intrinsic pairwise correlations in the portfolio. By filtering the effects of the international stock market, we manage to avoid overstating the level of cross-market linkages, and capture the real cross-market correlations not subject to a precondition of pervasive influences from the global market.

Comparing the results from the VAR approach using non-filtered versus filtered data, interconnectedness in the system exhibits similar general trends, but using filtered data consistently and remarkably reduces the level of interconnectedness over the full sample. This implies that failure of filtering out the global market factors can cause an overestimated stock market integration, leading to the empirical fallacy that these markets are becoming more tightly linked and mutually influential, but in fact their interconnectedness remains at a low level in the absence of common shocks from the broader world market. Without the influences from the international stock market, the real cross-market linkages during calm times in the East and Southeast Asian region are rather weak, suggesting potential diversification benefits for potential international investors.

Our empirical results show that the interconnection among the ASEAN5 + 4 stock markets tends to vary over time. It rises sharply when the crisis unfolds, as all markets are commonly prone to risk spillovers from the international market. During the crisis period, cross-market connection peaks, implying diminishing diversification benefits in these markets when they are simultaneously experiencing turbulences caused by a systemic event. In the post-crisis period, market interconnectedness declines to a quite low level. A plausible explanation is that these markets, after undergoing the financial crisis, become more alert to information and risk spillover from external sources, especially neighbor markets, making them more prudent and independent from other markets in the region.

We also find a time-variant network structure, with changing importance of individual markets (nodes) and time-varying links, based on both MST and VAR results. On average, Singapore and Hong Kong exert the strongest influences on others, while they are also more prone to shocks and information spillovers from other markets, irrespective of data used. The key roles of these markets are also found before and after the 1997–98 Asian financial crisis in Huyghebaert and Wang (2010). The biggest capital market Japan appears to be the most segmented among all, implying that market size may not matter much for a market's level of integration. China, despite its large market size and strikingly rapid growth over the past decade, is among the least affected or influential markets. We also find the rising role of Indonesia in the network after filtering the world stock market effects, as opposed to South Korea based on non-filtered data. The divergence in the degrees of integration among individual markets can be attributed to their different levels of stock market development (Singh, 2009), and political, economic and institutional differences across jurisdictions in this region (Yu et al., 2010).

Some practical implications from our findings can aid and nourish potential users in the process of policy making and asset allocation. For policy makers, our results indicate that there is still a long way to go to achieve a high level of capital market integration within ASEAN5 + 4 markets and the broader Asian market. Integration efforts should be jointly made on multiple aspects to foster and bolster regional integration, through for example, bilateral agreements, establishing

[8] For example, the ASEAN Vision 2020 (1997), the Bali Concord II (2003), the ASEAN Economic Community (AEC) 2015 Blueprint (2006), the ASEAN Capital Market Forum (ACMF) Implementation Plan 2015 (2009), etc.

exchange linkages, facilitating cross-border trading of stocks, etc. From the financial stability perspective, by identifying these key stock markets in the region, we provide strong policy recommendations with respect to carefully watching and regulating these markets with *ex ante* inoculation plans in places, so as to protect not only those core markets but more importantly, a substantial part of the network during crises. For international investors seeking for potential investment opportunities in the Asian market, our results suggest that international portfolio diversification benefits are still highly relevant in these Asian markets. We hope this study can also provide a new perspective in understanding and analyzing the trends and patterns of stock market integration, not only in East and Southeast Asia but also generalizable to other markets and regions.

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