

# Stock Market Linkage between China and ASEAN-6 Countries: Integration Perspective

(*Hubungan Pasaran Saham antara China dan Negara ASEAN-6: Perspektif Integrasi*)

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## ABSTRACT

*This paper examines the integration process and time-varying characteristics of major stock markets in China and ASEAN-6 countries (Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam). Based on the DCC-GARCH model as related to the daily stock index return data of China and the ASEAN-6, from July 2000 to December 2022, our study showed that the dynamic correlation between the stock markets of China and the ASEAN-6 was significantly enhanced during the sample period. The level of stock market integration between China and Singapore, Malaysia, and Vietnam has increased significantly, and the correlation has become more stable. In addition, the integration process shows significant time-varying characteristics; the effect of major economic events, the development of domestic financial markets, and the opening process of capital markets have a significant impact on the integration process of regional stock markets. The study made recommendations to promote China-ASEAN financial cooperation and offers a reliable theoretical basis for investment portfolio decisions. This will assist policymakers in keeping up with economic trends and taking necessary policy measures and interventions in a timely and effective manner to control stock market risks, ensuring stable and healthy economic development.*

*Keywords: DCC-GARCH; ASEAN; stock market; integration; China*

## ABSTRAK

*Makalah ini mengkaji proses integrasi dan ciri-ciri perbezaan mengikut masa pasaran saham utama di China dan negara ASEAN-6 (Indonesia, Malaysia, Filipina, Singapura dan Vietnam). Berdasarkan model DCC-GARCH yang berkaitan dengan data pulangan indeks saham harian China dan ASEAN-6 dari Julai 2000 hingga Disember 2022, kajian kami menunjukkan bahawa korelasi dinamik antara pasaran saham China dan ASEAN-6 adalah meningkat secara signifikan semasa tempoh kajian. Tahap integrasi pasaran saham antara China dan Singapura, Malaysia, dan Vietnam telah meningkat dengan ketara, dan korelasi menjadi lebih stabil. Tambahan lagi, proses integrasi menunjukkan ciri-ciri perbezaan mengikut masa yang ketara; impak peristiwa ekonomi utama, pembangunan pasaran kewangan domestik dan proses pembukaan pasaran modal mempunyai kesan yang ketara ke atas proses integrasi pasaran saham serantau. Kajian ini memberikan beberapa cadangan khusus untuk menggalakkan kerjasama kewangan antara China-ASEAN dan menawarkan asas teori yang boleh dipercayai untuk membuat keputusan portfolio pelaburan. Hal ini dapat membantu penggubal dasar agar sentiasa mengikut arah aliran ekonomi dan mengambil langkah dasar dan campur tangan yang perlu dan tepat pada masanya serta berkesan dalam mengawal risiko pasaran saham bagi memastikan pembangunan ekonomi yang stabil dan sihat.*

*Kata kunci: DCC-GARCH; ASEAN; pasaran saham; integrasi; China*

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## INTRODUCTION

Despite the COVID-19 crisis, Asian emerging economies have been showing remarkable growth, especially in ASEAN economies. The rapid economic transformation and growth have facilitated the integration of the countries in the region and strengthened their role in the global economy (Jamil et al. 2023). Investors are also able to gain extensive diversification opportunities and higher returns from these economies (Asia & Pacific Department 2022). Furthermore, the economic integration of the Asian region (first proposed by the economist Friedrich Hayek in the early 20th century) would help create a more interconnected and coordinated economic system within this specific geographical area. This may include lowering tariffs and non-tariff barriers, which can help expand the market size, improve competitiveness, and continuously

stimulate economic growth (Feng et al. 2023). Based on data from the International Monetary Fund (IMF) in April 2021, the ASEAN region had a total GDP of approximating US\$3.32 trillion, making it the fifth-largest economy in the world. Based on standard deviations in GDP growth rates, it is expected to be the fourth-largest economy by 2050. Currently, ASEAN has become Asia's third-largest economy (ASEAN Investment Report 2022). As a result, China is undergoing industrial transformation and upgrade upon the end of the China Dividend and the emergence of the Engineer's Dividend. Within ASEAN, many Southeast Asian countries, which are represented by Malaysia, Indonesia, the Philippines, Vietnam, and Thailand, have begun to take over the transfer of China's labor-intensive industries (Esquivias et al. 2020).

In terms of Asian financial markets, it is presumed that the United States exerts influence through channels of funding costs, portfolio rebalancing, and risk appetite, whereas China exerts influence primarily through trade ties (Caporale et al. 2022). However, few studies have examined China's financial integration with other Asian economies (Fang & Bessler 2018) which may carry significant policy implications. Regional institutions such as the Association of Southeast Asian Nations (ASEAN) and the Asian Development Bank should monitor the degree of interdependence between China's stock market and those of other Asian economies in order to design macroprudential policies aimed at preserving financial stability. These countries need to maintain financial stability in the face of potential disruption from the region's larger economies, such as China. On the other hand, China seems to be very willing to seek financial integration with Southeast Asian countries, which is reflected in the deepening cooperation and integration in the financial field between China and the ASEAN member countries. Such cooperation often covers multiple areas, including trade, investment, monetary policy, and financial market development. The financial integration between China and the ASEAN will help promote economic cooperation inside and outside the region, strengthen trade and investment ties, improve the development and stability of financial markets, and promote economic growth and development in the region. This is of great significance to both China and ASEAN countries and will help strengthen regional cooperation and achieve common prosperity (Kim 2015). This present study provides new evidence on the financial ties between China and the six ASEAN economies.

On a micro level, Chinese trading enterprises and countries in the Southeast Asian region belong to a community of commercial interests. With the establishment of industrial parks in the latter region, the industrial agglomeration effect has become evident. At the same time, many local enterprises in the industrial parks have benefited and gained successful development through the provision of trade-supporting services and OEM production, including access to the market. Thus, China and Southeast Asian countries are cooperating in the upstream and downstream of the industrial chain, which mutually reinforces the business community. The improvement in the capital markets in Southeast Asia allows more local companies to be successfully listed that consequently increased the capitalization rate in these countries. Many of these listed companies involve trade, production, and processing links with Chinese companies. As a result, the operating conditions of Chinese companies affect Chinese stock prices, which subsequently affect the earnings of Southeast Asian companies that work closely with Chinese companies through the trade chain. This condition also impacts the country's stock market. From a macro perspective, the stock market is a macroeconomic barometer. Essentially, higher total trade between the two economies would further reinforce the economic ties between the two regions. As the trade between China and Asian countries continues to increase, the stock market's correlation will also increase. Moreover, the increasing economic interdependence between China and Asian countries and the expansion of openness to the outside world leads to a stronger link between the stock markets of China and developing Asian countries. Overall, the study of linkages has gradually become popular among scholars around the world.

Studies have also been conducted on the issue of stock market movements. To illustrate, the 2008 global financial crisis affected currency, stock market, and other asset prices in the global economy, especially in almost all Asian economies. Subsequently, many economists have focused on regional stock market integration. A particular focus is placed on whether the six ASEAN countries, are mutually integrating their economies into their stock market movements as trading partners and investment flows. Specifically, these countries ought to work simultaneously to maintain financial stability in the region rather than relying on other countries, such as the United States, thus allowing management to be carried out when a crisis strikes resurfaces. Nevertheless, this issue would not severely impact the ASEAN countries, allowing them to work concurrently. The long-term potential of ASEAN equity markets remains strong with the evolution of the supportive structural trends in the region from digitalization to deglobalization and the growing importance of sustainable development. Despite the increasing inflationary concerns in the US economic growth expectations, which lead to a decline in equity market performance, it is believed that ASEAN equity markets should be continuously supported by long-term growth themes. It is also suggested that these markets offer attractive long-term investment opportunities.

The objective of this study is to test the integration of the major stock markets of China and the ASEAN and examine the characteristics of the integration process of China-ASEAN stock markets over time. The study further analyzes the time-varying characteristics of China-ASEAN stock market integration, which were combined with major economic events. We use the time-varying dynamic correlation technology to carefully examine the stock markets of China and the six major ASEAN countries in the past two decades and found that the correlation between the stock markets of China and Singapore, Vietnam, and Malaysia has increased significantly, while the correlation between the stock markets of China and Thailand is relatively volatile.

This study shall contribute to the literature of ASEAN economic integration. Compared with related literature, we first used a dynamic correlation model to examine the correlation of the stock market from the perspective of China and ASEAN integration, and conducted an analysis of ASEAN and China's financial unique insights for policy advancement. Second,

the use of newer sample data allowed the research results to reflect the latest trend in the changing China-ASEAN stock market integration. Studying the integration process and time-varying characteristics of the stock markets of China and the ASEAN-6 countries will not only help investors truly grasp market risks and provide a reliable theoretical basis for investment portfolio decisions, but also help policymakers through capital flows between stock markets, information transmission and prediction of changes in investor psychology and expectations to keep abreast of economic trends. The study will assist the adoption of the necessary economic policies and administrative interventions in a timely and effective manner to control the risks of the stock market in preventing the occurrence, and spread of catastrophic financial events, and ensure the stable and healthy development of the economy.

## LITERATURE REVIEW

In the past 20 years, with the ever-increasing importance of emerging markets, the interaction between emerging and developed markets has gained attention from financial economists due to its definition of integration and financial liberalization. Stock market integration refers to the degree of interconnection and mutual influence between stock markets in different regions and countries. It reflects the degree of liquidity of information, capital, and investment between different stock markets. The higher the integration of the stock market, the closer the correlation between capital flows and price changes among various markets. Many articles empirically studied the co-movement of stock prices across international financial markets, such as those by Gopalan et al. (2023), Haini (2020), Le et al. (2023), Sriyana and Afandi (2020), Yap et al. (2020), and Yildirim et al. (2021).

The literature on financial integration has predominantly focused on the United States as a global actor. Despite this, several recent studies have begun to examine China's regional influence considering its increasing size and economic importance. Specifically, some of them have studied currency markets and highlighted the growing influence of the renminbi on Asian currencies (Vo & Ho 2023). By lowering barriers to portfolio flows and increasing the availability of market substitutes, financial market development and financial liberalization advancements substantially strengthen stock market integration (Wu 2020).

A range of studies employed different cointegration techniques focusing on the integration relationships within the ASEAN regions and between ASEAN and developed markets. For example, Mendez and Santos-Marquez (2021) conducted a bivariate cointegration test to examine the impact of the 1997/98 Asian currency crisis on the interdependence between the stock markets of the five ASEAN countries and developed stock markets (Australia, Germany, and the US). The study provided a small amount of evidence on the integration in the post-crisis period. Click and Plummer's (2005) result of the cointegration vector across five ASEAN stock markets implied that they are co-integrated, leading to an incomplete integration. Erkut and Sharma (2023) elaborated that during the post-1997 financial turmoil, ASEAN stock markets shifted towards further integration with each other or with the US and Japan. It further stated that the long-term diversification benefits of ASEAN stock markets tend to diminish.

Another group of researchers employed MGARCH models to estimate time-varying conditional correlations. This was followed with the adoption of the dynamic conditional correlations (DCCs)-MGARCH model to demonstrate the increase in the correlations during the Asian currency crisis. Ji et al. (2022) employed the model to demonstrate the correlations during the Asian currency crisis, which was subsequently shown to increase further due to the influence of investor herding behaviors. Cao et al. (2023) examined the impact of Asian currency crises on the correlations between eight East Asian stock markets.

Using the Granger causality tests and vector autoregression tests, Lim (2009) recorded evidence of increased integration and interdependence between the ASEAN-5 countries and the US stock market following the 1997 Asian currency crisis. Chen et al. (2009) applied Johansen cointegration tests and cointegration tests of moments (GMM) to demonstrate that the degree of integration within the ASEAN-5 markets was higher compared to the previous level. This situation indicated that the current benefits of financial risk reduction from diversification in the region were smaller than those of previous ones. Based on Rahman et al. (2017) application of roll cointegration analysis dynamic convergence of 11 Asian stock markets, cointegration was identified amongst Asian stock markets, which became more integrated during the Asian currency crisis. Lee and Shin (2012), who reported on the increase in the interdependence of East Asian stock markets with world markets after the 1997 currency crisis, established that regional financial integration was lower than global integration. Panjaitan and Saadah (2018) highlighted that while the regional financial integration between China and the ASEAN-5 countries had gradually increased, it however remained rather limited.

The empirical research on the above literature on China-ASEAN stock market integration under the framework of East Asian stock market integration offers a useful exploration in gaining an objective understanding of the issue. However, there are several limitations. First, most of the studies were static analysis, which were mainly limited to determining whether an integration occurred among various markets and whether time-varying level of integration became a concern among decision-makers and investors. However, the study was relatively constrained and the subsection test and dynamic cointegration conducted were not able to describe the dynamic changes of stock market integration in detail. Second, while some studies applied time-varying correlation techniques to study the dynamic changes of China-ASEAN stock market integration, the data used were relatively dated and not able to reflect the latest trend of China-ASEAN market integration changes. The Shanghai-Hong Kong Stock Connect in 2014 for example illustrated that China's financial market had

undergone unprecedented reform and opening-up, which should be reflected through the changes in the integration level of regional stock markets.

Given this perspective the paper provides new evidence of financial linkages between China and the ASEAN-6 economies in threefold. First, it examines the time-varying characteristics of China's stock market linkages with those of Malaysia, Singapore, Indonesia, the Philippines, Thailand, and Vietnam from 2000 to 2022 from an integration viewpoint. Secondly, it enriches the research scope of regional financial integration not least that it is one of the few research projects that includes the stock market of Vietnam. Finally, the article advances innovative suggestions, starting from the construction of the China-ASEAN financial cooperation mechanism and accelerating the construction of the China-ASEAN financial infrastructure, to designing the macro-prudential policies aimed at ensuring financial stability in the event of a possible shock to the region's larger economies, such as China.

## METHODOLOGY AND DATA

There is currently no universal definition of stock market integration, but it is generally accepted that higher correlations between stock market returns generally imply a higher level of integration between markets (Tran 2022). The DCC-GARCH model proposed by Engle (2002), is particularly suitable for examining the dynamic correlation between assets. This method has the flexibility of univariate GARCH. Since the parameters to be estimated in the correlation term are independent of the number of series to be correlated many series can accordingly be considered in a single estimate. Compared with the assumed constant correlation coefficient of the CCC-GARCH model, the DCC-GARCH model presumes that the correlation coefficient between sequences changes dynamically over time, which can thus better reflect the interaction of fluctuations between sequences. Due to these advantages, the DCC approach is widely used to examine the dynamics of stock market integration in developed countries although only a few studies have used the model to examine common movements and interdependencies in Asian financial markets. This paper thus adopts the DCC-GARCH model to analyze the change characteristics of China-ASEAN major stock markets over a longer period.

Several studies (Cho & Parhizgari 2008; Do et al. 2020) showed that the DCC (1,1)-GARCH (1,1) model can better describe the dynamic correlation, which consists of two parts; GARCH (1,1) and DCC (1,1). There are two parts of the mean and variance equations. Engle (2002) used a two-step method to estimate the DCC-GARCH model. The first step was to estimate the univariate GARCH equation and the variance parameters of each asset separately, and calculate the variance. In the second step the parameter values were estimated and the standardized return sequence was subsequently used to estimate the correlation coefficient parameters with the dynamic correlation coefficient calculated.

The mean equation is expressed as:

$$r_{t,1} = \theta_{t,1} + a_{t,1} \quad (1)$$

$$r_{t,2} = \theta_{t,2} + a_{t,2} \quad (2)$$

Where,  $r_{t,1}$  and  $r_{t,2}$  respectively represent the t-period returns of China and one of the ASEAN countries,  $\theta_{t,1}$  and  $\theta_{t,2}$  respectively represent the t-period average returns of China and one of the ASEAN countries,  $a_{t,1}$  and  $a_{t,2}$  respectively represent the t-period error terms of the stock market of China and one of the ASEAN countries.

Among them,  $a_{t,1}$  and  $a_{t,2}$  are the error terms under the conditions of the previous information set, and the previous information will have an impact on the current period's return, and obey the binary distribution with the mean value of 0 and the variance of the covariance matrix  $A_t$ :

$$\begin{pmatrix} a_{t,1} \\ a_{t,2} \end{pmatrix} \left| \pi_{t-1} \sim N \left[ \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{11,t}^2 & \sigma_{12,t}^2 \\ \sigma_{21,t}^2 & \sigma_{22,t}^2 \end{pmatrix} \right] \quad (3)$$

The variance equation is expressed as:

$$\sigma_{t,1}^2 = \gamma_1 + \alpha_1 a_{t-1,1}^2 + \beta_1 \sigma_{t-1,1}^2 \quad (4)$$

$$\sigma_{t,2}^2 = \gamma_2 + \alpha_2 a_{t-1,2}^2 + \beta_2 \sigma_{t-1,2}^2 \quad (5)$$

Among them,  $\sigma^2$  is the respective variance of the stock markets of the two countries,  $\gamma_i$ ,  $\alpha_i$ , and  $\beta_i$  are the coefficients that need to be obtained through data simulation,  $\alpha_i$  represents the impact of information on this period, and  $\beta_i$  represents the change in previous conditional variance. The impact of the situation on the return of the current period, the size of  $\alpha_i + \beta_i$  can represent the concentration of time series fluctuations. Both  $\alpha$  and  $\beta$  are greater than 0, and  $\alpha + \beta < 1$ ; the larger the value, the stronger the volatility persistence, and vice versa.

The DCC (1,1) model can be expressed as:

$$A_t = D_t R_t D_t \quad (6)$$

$$D_t = \text{diag}(\sigma_{11,t}, \sigma_{22,t}, \dots, \sigma_{nn,t}) \quad (7)$$

$$R_t = \text{diag}(Q_t)^{-1} Q_t \text{diag}(Q_t)^{-1} \quad (8)$$

$$Q_t = (q_{t,ij}) = (1 - \alpha - \beta)\bar{Q} + \alpha e_{t-1} e'_{t-1} + \beta Q_{t-1} \quad (9)$$

$$e_t = D_t^{-1} \varepsilon_t \quad (10)$$

$$\bar{Q} = \frac{1}{T} \sum_{t=1}^T e_t e_t' \quad (11)$$

$$\rho_{t,12} = \frac{q_{t,12}}{\sqrt{q_{t,11}} \cdot \sqrt{q_{t,22}}} \quad (12)$$

$R_t$  is the  $n \times n$  dynamic conditional correlation coefficient matrix,  $D_t$  is the  $n \times n$  diagonal matrix composed of the time-varying standard deviation obtained by the univariate GARCH model and  $Q_t$  is the conditional variance covariance;  $\rho_{t,12}$  is the dynamic correlation coefficient between the stock markets of China and one of the ASEAN countries at time  $t$  to be finally obtained in this paper.

ASEAN countries including Singapore, Malaysia, Thailand, Indonesia, and the Philippines have relatively mature capital markets, while Vietnam has developed a strong economic momentum in the past four years. For this reason, the Vietnamese market was also included in this study. This article adopts China's Shanghai Composite Index and the empirical analysis of national stock market significant index returns; specifically, China's Shanghai Composite Index (SSEC), Singapore Straits Times Index (STI), Malaysia's FTSE Kuala Lumpur Composite Index (KLSE), Thailand's SET Index (SET), Indonesia's Jakarta Composite Index (JKSE), the Philippines' Manila Composite Index (EPSI), and Vietnam's VN index (VN). The Shanghai Composite Index was chosen since the Shanghai Stock Exchange is the earliest stock exchange in China and one of the most important exchanges in the country. It is an important index reflecting the performance of the domestic blue chip stock market. The Shanghai Composite Index includes many companies with significant influence, such as Pingan and Sinopec of China. They represent an important part of the domestic economy and provided an important guiding role in economic development situation. The Shanghai Composite Index is thus widely regarded as the benchmark for the Chinese stock market. The sample period consists of the daily closing price data from July 8, 2000, to December 15, 2022, excluding the data with different transaction dates. The sample size comprised 3838 observations which were obtained from the Wind database. To minimize the heteroskedasticity inherent in the data, the log return on the closing price was calculated using the formula  $R_t = \ln P_t - \ln P_{t-1}$ .

## EMPIRICAL RESULT AND DISCUSSION

Based on the descriptive statistics in Table 1, the China and ASEAN equity markets showed positive mean returns, with the highest return of 0.001 recorded in the Indonesian market. The Vietnam market recorded the most significant standard deviation at 0.016, followed by the China market at 0.015. Overall, all variables were significantly skewed, as indicated by the left skew shown by all markets except for the Singapore stock market. In addition, all variables presented kurtosis values of higher than 3, which are represented by a 'pointy peaks and thick tail' pattern. For the normality test based on the Jarque-Bera test statistics, the p-values for all seven stock markets are 0 and statistically significant at the 1% level thus rejecting the null hypothesis of normal distribution.

TABLE 1. Descriptive statistics

|              | SSEC   | JKSE   | KLSE    | PSEI   | SETI   | STI    | VN     |
|--------------|--------|--------|---------|--------|--------|--------|--------|
| Mean         | 0.000  | 0.001  | 0.000   | 0.000  | 0.000  | 0.000  | 0.000  |
| Median       | 0.000  | 0.000  | 0.000   | 0.000  | 0.000  | 0.000  | 0.000  |
| Maximum      | 0.090  | 0.136  | 0.199   | 0.155  | 0.110  | 0.215  | 0.142  |
| Minimum      | -0.132 | -0.136 | -0.192  | -0.143 | -0.203 | -0.155 | -0.265 |
| Std. Dev.    | 0.015  | 0.013  | 0.009   | 0.014  | 0.013  | 0.011  | 0.016  |
| Skewness     | -0.437 | -0.622 | -0.891  | -0.160 | -1.359 | 0.462  | -0.876 |
| Kurtosis     | 12.280 | 25.416 | 103.786 | 23.083 | 32.136 | 46.204 | 27.192 |
| Jarque-Bera  | 20863  | 121009 | 2439508 | 96865  | 205592 | 448351 | 141255 |
| Probability  | 0.000  | 0.000  | 0.000   | 0.000  | 0.000  | 0.000  | 0.000  |
| Observations | 3838   | 3838   | 3838    | 3838   | 3838   | 3838   | 3838   |

Note: China's Shanghai Composite Index (SSEC), Singapore Straits Times Index (STI), Malaysia's FTSE Kuala Lumpur Composite Index (KLSE), Thailand's SET Index (SET), Indonesia's Jakarta Composite Index (JKSE), the Philippines' Manila Composite Index (EPSI), and Vietnam's VN index (VN)

Prior to further analysis, it is important to ensure the stationarity of the variables to prevent the occurrence of spurious regression. In this case, the ADF unit root test was employed to test the stationarity of the variables, and the results are presented in Table 2.

TABLE 2. ADF unit root test

|      | 1% critical value | 5% critical value | t-statistic | P-value  | Stationary? |
|------|-------------------|-------------------|-------------|----------|-------------|
| SSEC | -2.565            | -1.941            | -76.862     | 0.000*** | Yes         |
| JKSE | -2.565            | -1.941            | -72.818     | 0.000*** | Yes         |
| KLSE | -2.565            | -1.941            | -52.574     | 0.000*** | Yes         |
| PSEI | -2.565            | -1.941            | -75.645     | 0.000*** | Yes         |
| SETI | -2.565            | -1.941            | -74.148     | 0.000*** | Yes         |
| STI  | -2.565            | -1.941            | -77.373     | 0.000*** | Yes         |
| VN   | -2.565            | -1.941            | -37.174     | 0.000*** | Yes         |

Note: \*\*\* represent significance at the 1% level.

It was indicated from the results of the ADF unit root test that the null hypothesis for the presence of a unit root was rejected for all variables at the 1% level of significance. Therefore, all variables are stationary and did not exhibit a unit root.

The heteroscedasticity test was also conducted on the suitability of the sample data for an autoregressive conditional heteroscedasticity (ARCH) model. Therefore, another prerequisite for the use of a GARCH model was the presence of an ARCH effect in the series. The ARCH test was conducted on eight groups of variables, followed by the selection of a lag order of five groups of data based on the AIC criterion. Subsequently, ARCH-LM tests were carried out on the residuals (lag 4). Accordingly, the results of the ARCH-LM tests are summarized in Table 3.

TABLE 3. ARCH-LM test

| Variables | F-statistic | P-value  | Does it have an ARCH effect? |
|-----------|-------------|----------|------------------------------|
| SSEC      | 35.563      | 0.000*** | Yes                          |
| JKSE      | 83.306      | 0.000*** | Yes                          |
| KLSE      | 1127.408    | 0.000*** | Yes                          |
| PSEI      | 28.967      | 0.000*** | Yes                          |
| SETI      | 192.438     | 0.000*** | Yes                          |
| STI       | 12.232      | 0.001*** | Yes                          |
| VN        | 40.202      | 0.000*** | Yes                          |

Based on the results of the ARCH-LM test, the concomitant probability of the seven series amounted to 0 and significant at the 1% level. Thus, significant heteroscedasticity and volatility clustering in the seven series and an ARCH effect were indicated. Therefore, the GARCH model was applicable.

In this article, a DCC-GARCH model was developed for each of the SSEC index markets and six stock markets in the ASEAN-6 to analyze the dynamic correlation between the Chinese market and the Southeast Asian market. This was in accordance with the two-stage method of DCC-GARCH model estimation proposed by Engle (2002) with the first stage being the univariate GARCH regression. The second stage was estimated after the standardization of the residuals, and the DCC coefficient was used to determine the strength of the dynamic correlation between the Chinese and Southeast Asian markets. The model estimation results are shown in Table 4.

TABLE 4. Estimation results

|           | Variable | Coefficient | Std. Error | z-Statistic | Prob.    |
|-----------|----------|-------------|------------|-------------|----------|
| SSEC      | $\omega$ | 0.000       | 0.000      | 1.938       | 0.052**  |
|           | $\alpha$ | 0.031       | 0.005      | 5.396       | 0.000*** |
|           | $\beta$  | 0.963       | 0.007      | 132.287     | 0.000*** |
| JKSE      | $\omega$ | 0.000       | 0.000      | 1.880       | 0.060**  |
|           | $\alpha$ | 0.070       | 0.024      | 2.869       | 0.004*** |
|           | $\beta$  | 0.926       | 0.024      | 38.314      | 0.000*** |
| SSEC-JKSE | $\omega$ | 0.230       | 0.027      | 8.537       | 0.000*** |
|           | $\alpha$ | 0.022       | 0.006      | 3.286       | 0.001*** |
|           | $\beta$  | 0.860       | 0.044      | 19.172      | 0.000*** |
| KLSE      | $\omega$ | 0.000       | 0.000      | 0.582       | 0.560    |
|           | $\alpha$ | 0.019       | 0.006      | 3.041       | 0.002*** |
|           | $\beta$  | 0.972       | 0.007      | 129.756     | 0.000*** |
| SSEC-KLSE | $\omega$ | 0.232       | 0.024      | 9.659       | 0.000*** |
|           | $\alpha$ | 0.002       | 0.001      | 2.702       | 0.006*** |
|           | $\beta$  | 0.985       | 0.004      | 220.553     | 0.000*** |
| PSEI      | $\omega$ | 0.000       | 0.000      | 0.857       | 0.391    |
|           | $\alpha$ | 0.041       | 0.029      | 1.375       | 0.016**  |
|           | $\beta$  | 0.954       | 0.034      | 27.425      | 0.000*** |
| SSEC-PSEI | $\omega$ | 0.190       | 0.022      | 8.669       | 0.000*** |
|           | $\alpha$ | -0.004      | 0.054      | 7.925       | 0.000*** |
|           | $\beta$  | 0.788       | 0.082      | 9.968       | 0.000*** |
| SETI      | $\omega$ | 0.000       | 0.000      | 1.229       | 0.218    |
|           | $\alpha$ | 0.034       | 0.014      | 2.374       | 0.017**  |
|           | $\beta$  | 0.964       | 0.016      | 58.396      | 0.000*** |
| SSEC-SETI | $\omega$ | 0.228       | 0.024      | 9.251       | 0.000*** |
|           | $\alpha$ | 0.192       | 0.023      | 8.313       | 0.000*** |
|           | $\beta$  | 0.046       | 0.028      | 1.675       | 0.013**  |

|          |          |       |       |        |          |
|----------|----------|-------|-------|--------|----------|
| STI      | $\omega$ | 0.000 | 0.000 | 1.895  | 0.058*   |
|          | $\alpha$ | 0.043 | 0.009 | 4.648  | 0.000*** |
|          | $\beta$  | 0.953 | 0.011 | 90.068 | 0.000*** |
| SSEC-STI | $\omega$ | 0.303 | 0.025 | 11.909 | 0.000*** |
|          | $\alpha$ | 0.001 | 0.024 | 8.996  | 0.000*** |
|          | $\beta$  | 0.998 | 0.021 | 9.250  | 0.000*** |
| VN       | $\omega$ | 0.000 | 0.000 | 2.935  | 0.003*** |
|          | $\alpha$ | 0.078 | 0.013 | 5.950  | 0.000*** |
|          | $\beta$  | 0.911 | 0.014 | 64.795 | 0.000*** |
| SSEC-VN  | $\omega$ | 0.192 | 0.026 | 7.335  | 0.000*** |
|          | $\alpha$ | 0.002 | 0.001 | 4.625  | 0.000*** |
|          | $\beta$  | 0.996 | 0.001 | 74.484 | 0.000*** |

Note: \*\*\*, \*\*, and \* denote significance at the 1%, 5%, and 10% levels, respectively.

All DCC parameters are significant at the 5% level (Table 4). The DCC coefficients of the Chinese market and Indonesian Jakarta Composite Index (SSEC-JKSE), Kuala Lumpur Composite Index (SSEC-KLSE), Philippines (SSEC-PSEI), Singapore (SSEC-STI) and Vietnam VN Index (SSEC-VN) were significant and satisfied the constraint of  $\alpha + \beta < 1$ . The small value of  $\alpha$  indicates that the standardized residual product with a lag of one period has minimal influence on the dynamic correlation coefficient. The large value of  $\beta$  shows that the correlation coefficient between variables is greatly affected by the previous period, and its correlation changes have strong characteristic of persistence.

The dynamic conditional correlation coefficient reflects the degree of convergence of the stock market return changes between the two countries. A large dynamic conditional correlation coefficient indicates a high degree of convergence of stock market yield changes and a high degree of market integration. Conversely, it may signify that there is a clear segmentation in the stock market. To measure the dynamic correlation between variables over time, the following figure shows the time path diagram of the dynamic correlation coefficient of the six data sets.

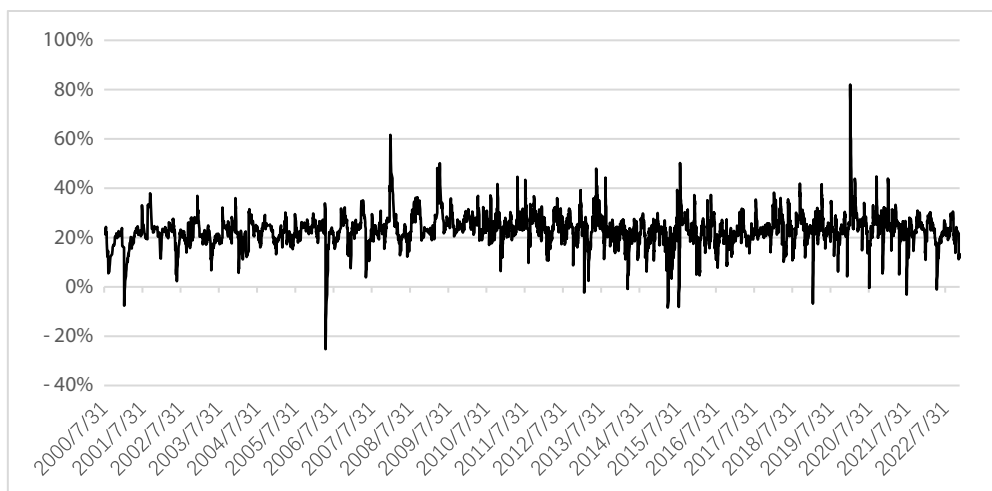


FIGURE 1. Coefficients related to stock market dynamics between China and Indonesia

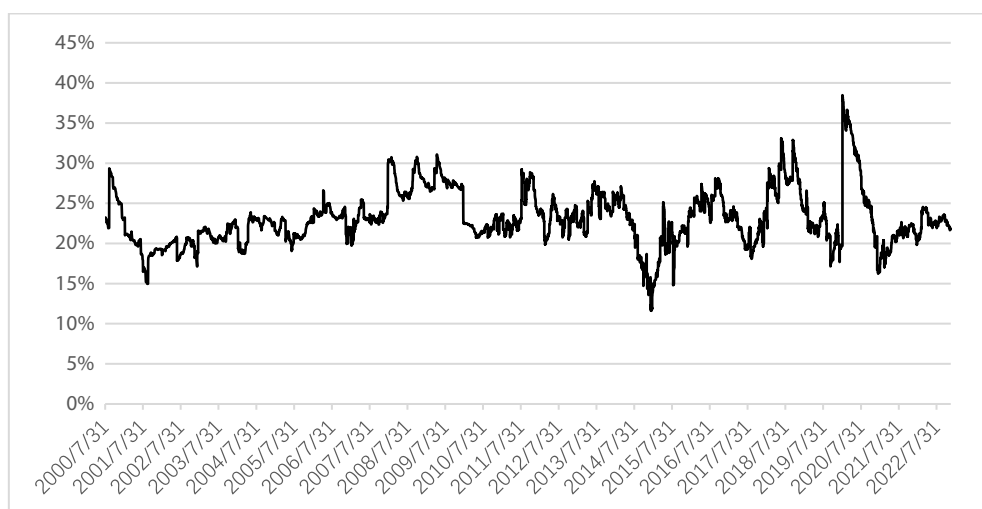


FIGURE 2. Coefficients related to stock market dynamics between China and Malaysia

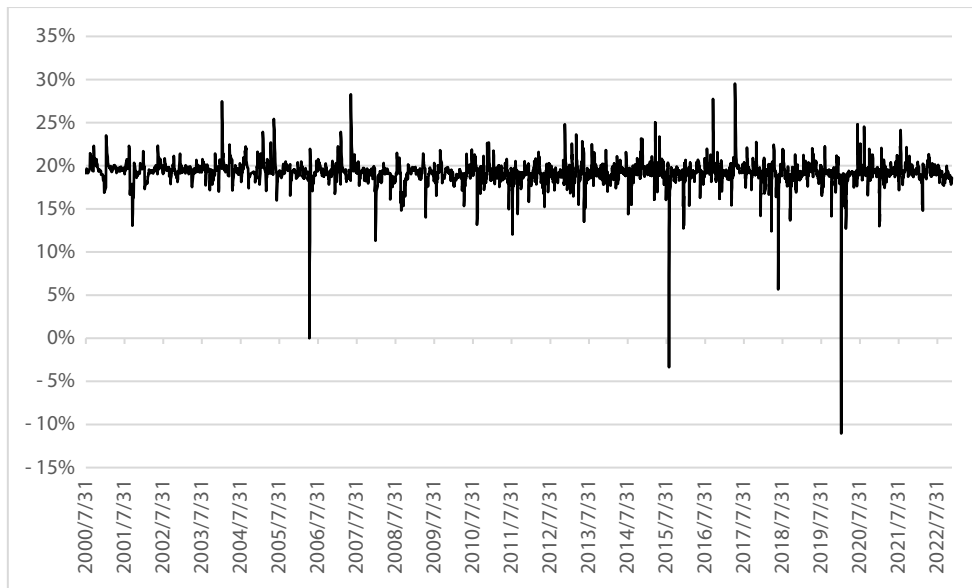


FIGURE 3. Coefficients related to stock market dynamics between China and the Philippines

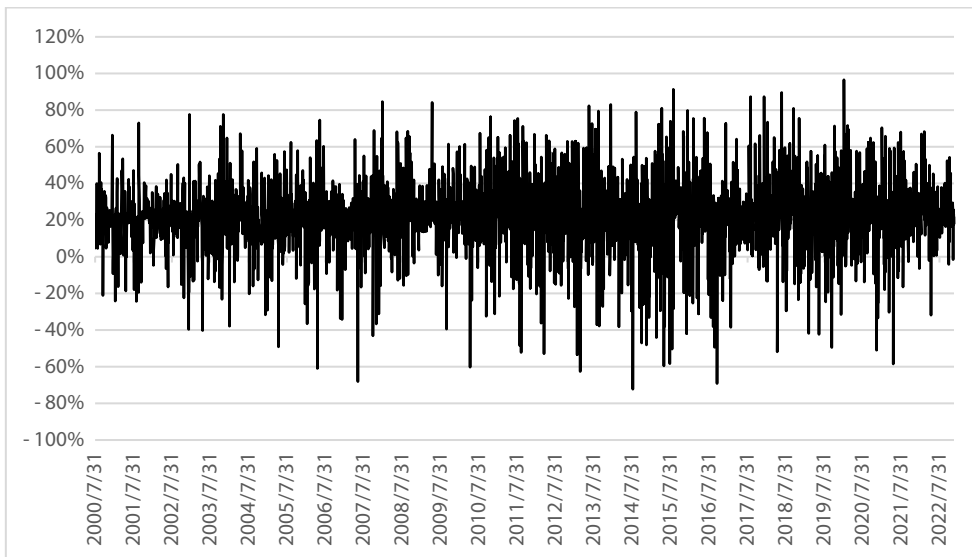


FIGURE 4. Coefficients related to stock market dynamics between China and Thailand

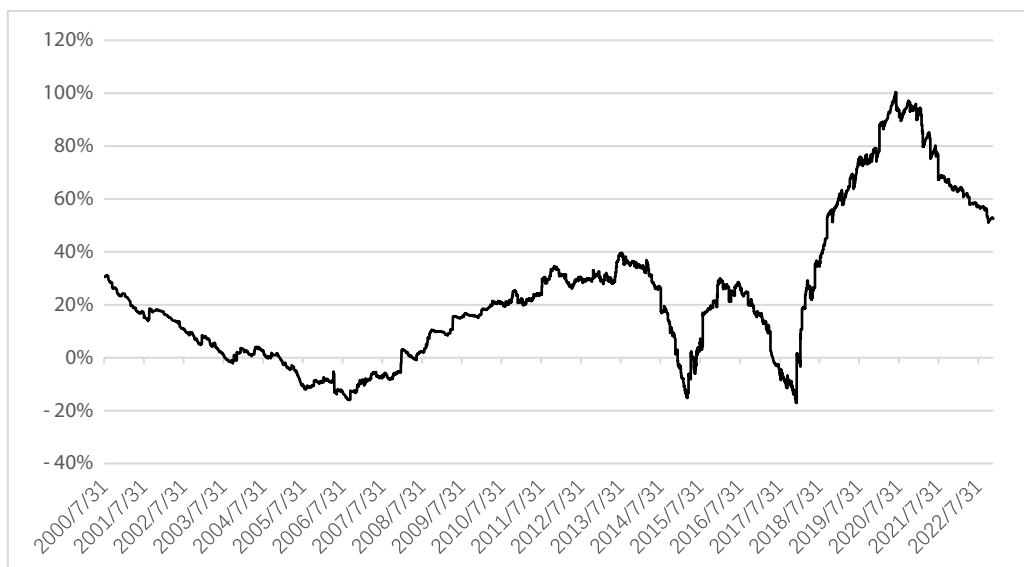


FIGURE 5. Coefficients related to stock market dynamics between China and Singapore





FIGURE 6. Coefficients related to stock market dynamics between China and Vietnam

Figures 1-6 present the pairwise dynamic correlation coefficients between the stock markets of the six major ASEAN members and the Chinese stock market during the selected period. It can be shown that most of the correlation coefficients between the stock markets of China and Malaysia, Singapore, the Philippines, and Vietnam are variously positive (above the 0-point line). This again indicates that there is a positive correlation between them, and that there is a linkage effect which varies with time and is dynamic. By comparing the pairwise dynamic correlation coefficient diagrams, it can be further established that the linkage between the stock markets of China and Singapore during the investigation period has gradually increased.

From 2000 to 2006, the integration level of the Chinese market and the stock markets of ASEAN-6 countries showed fluctuation. The subsequent period from 2007 to 2014 showed an integration level for most markets, except for Thailand which showed a significant upward trend. Following the outbreak of the subprime mortgage crisis in the United States in 2007, the US stock market declined. As a result of the significant global influence of the US financial market, the stock markets of various countries were jointly affected and the trend of change was consistent. Subsequent to the financial crisis, China began the process of RMB internationalization with an increasingly open domestic capital market. Qualified foreign institutional investors (QFII) were expanded, and the pilot program of RMB qualified foreign institutional investors (RQFII) was initiated along with the implementation of "Shanghai-Hong Kong Stock Connect".

The reduction of barriers in the cross-border RMB financial asset allocation system improved the degree of integration between the A-share market and the stock markets of the five ASEAN countries. In 2015, the dynamic correlation coefficient between the Shanghai Composite Index and the stock markets of the five ASEAN countries, excepting Thailand, almost experienced a decline which was the strongest in recent years. The main reason for this phenomenon was the severe turmoil in China's stock market in 2015, followed by its sharp decline that damaged investors' confidence. Notably too, an important factor affecting investors' cross-border RMB asset allocation has reduced the level of integration between the stock markets of China and major ASEAN countries.

From 2016 to 2018, the dynamic correlation coefficient between the stock markets of China and the significant ASEAN countries rebounded from the bottom. At this time, the trend of A-shares stabilized, the capital market continued to open, QFII and RQHI continued to expand, and the Shenzhen-Hong Kong Stock Connect was launched. The RMB exchange rate stabilized at the end of 2016, followed by its continuous rise. The demand for assets has also increased, and the affirmative information generated by these significant economic events has brought a positive impact in the integration process of the stock markets of China and the ASEAN countries.

Due to the full-scale outbreak of the new crown epidemic in 2020, the correlation between the stock markets of Indonesia, Malaysia, Singapore, and Vietnam and the Chinese stock market reached an all-time high. However, Thailand and the Philippines performed very differently during this period. The correlation between the Philippines and Chinese stock markets once reached the lowest level in history, showing a negative correlation. It was also volatile and fluctuate frequently. The correlation between Thailand and China's stock market experienced a state of instability and violent shocks. These changes showed that the degree of integration between Thailand and the Philippines with China's stock market has not been significantly enhanced.

TABLE 5. Descriptive statistics for dynamic correlation coefficients

|         | China-Indonesia | China-Malaysian | China-Philippines | China-Thailand | China-Singapore | China-Vietnam |
|---------|-----------------|-----------------|-------------------|----------------|-----------------|---------------|
| Mean    | 0.231           | 0.233           | 0.191             | 0.225          | 0.276           | 0.194         |
| Median  | 0.231           | 0.228           | 0.192             | 0.228          | 0.233           | 0.172         |
| Maximum | 0.819           | 0.384           | 0.295             | 0.965          | 1.004           | 0.484         |
| Minimum | -0.252          | 0.116           | -1.002            | -0.722         | -0.171          | 0.018         |

Note: Descriptive statistical table of the dynamic correlation coefficient between the stock markets of China and the six ASEAN countries.

It is apparent from Table 5, on the descriptive statistics of dynamic correlation coefficients, the stock markets between China and Southeast Asian countries showed positive dynamic correlations. Notably, the highest correlation coefficient was recorded between the China and Singapore markets, with an average of 27.6%, while the Philippine stock market recorded the lowest correlation with an average of 19.1%. To illustrate this point, Singapore is an international financial centre in Asia second only to Hong Kong and is also the most open financial market with a high level of financial development. Further, the country is the first to launch A-share index futures with its QFII quota the highest among ASEAN countries and is in the process of RMB internationalization.

Singapore is the largest RMB offshore market in the ASEAN region and with the closest financial connection with mainland China. The degree of integration of the China-Singapore stock market is the highest and in line with expectations. Conversely, the level of integration with the Philippines is the lowest since the country has the smallest capital market among the six ASEAN countries. It is also adversely affected by the South China Sea dispute on economic and trade exchanges and financial cooperation.

Results in Figure 1-6 and Table 5 indicate the dynamic correlation of the stock markets of the six ASEAN countries which is mostly positively correlated but with negative correlation recorded over short period of time. By comparing the average and extreme values of the dynamic correlation between their stock markets at various stages, it can be shown that although the degree of integration between Malaysia and Vietnam and the Chinese stock market is not the highest, there are no negative extreme values. This suggests that the relationship between China, Malaysia and Vietnam has been continuously strengthened in the past two decades, and the process of integration has produced stability. It also shows that the One Belt One Road strategy has deepened the economic and trade relations between Malaysia, Vietnam, and China to a large extent that has resulted in the "two-way rush" of advantages and needs.

## CONCLUSION

This study documented several important findings. First, the dynamic correlation coefficient between the stock markets of China and the six ASEAN countries has increased during the sample period. The result indicates the increasing level of regional stock market integration. Among them, the correlation between Singapore and China's stock market is the most obvious, followed by that of Malaysia and Vietnam. Their correlation with China's stock market is also relatively consistent and stable, which gives investors new inspiration. Increased interconnectedness leads to closer and more accessible financial cooperation, but it also brings potential financial risk contagion. Secondly, in addition to Thailand, the stock markets of China, Singapore, Malaysia, Indonesia, the Philippines, Vietnam, and other countries also showed significant time-varying characteristics during the integration process. Third, major economic events such as the outbreak of the US financial crisis, the development and opening of China's domestic financial market, and emergencies such as the outbreak of the new crown epidemic continue to affect the integration of the stock markets of mainland China and the ASEAN countries. With the steady advancement of China's financial market reform, the implementation of financial opening towards ASEAN, and the regionalization of RMB in the region, the degree of integration between the stock markets of China and major ASEAN countries will continue to increase in the foreseeable future.

For policymakers and regulators, the China-ASEAN regions will apply the "2030 Vision of China-ASEAN Strategic Partnership" as a guide under the framework of the Belt and Road Initiative to actively build a closer China-ASEAN community of shared future. Following the full effect of the "Protocol between the People's Republic of China and the Association of Southeast Asian Nations on Amending the China-ASEAN Comprehensive Economic Cooperation Framework Agreement" and some of the agreements under it, China-ASEAN economic and trade cooperation will continue to be more solid and with more depth thus strengthening the relationship between the two parties. Stock market cooperation will also accelerate the pace of cooperation, providing capital support for China-ASEAN economic and trade cooperation and infrastructure construction.

Currently, a series of mechanisms have been established for China-ASEAN financial cooperation due to the increasingly complex financial needs of both parties. However, there is an urgent need for the two sides to continuously deepen the construction of financial cooperation mechanisms to provide a basis for accelerating the integration of stock markets of China and major ASEAN countries. Therefore, it is necessary to continuously conduct the regular high-level meeting mechanism between China and ASEAN financial institutions and establish a normalized multilateral consultation mechanism at the working level of financial management institutions between the two regions. Furthermore, it is also important to strengthen the two-way communication and early warning information-sharing mechanism between China and ASEAN on financial risk prevention. However, as the risk of contagion in the securities market becomes intensified with the increase in the degree of integration, the risk of cross-border financial contagion has also intensified. For these

reasons, it is critical for countries to strengthen institutional cooperation in financial supervision and maintain their vigilance against systemic financial risks to maintain regional financial stability. In addition, the accelerated construction of China-ASEAN financial infrastructure and the provision of material guarantees, and technical support are necessary for a solid promotion for the integration of the stock markets of China and major ASEAN countries. By encouraging China's securities market cooperation with relevant countries and the opening China's A-share market to foreign investors, the infrastructure construction and technical requirements for international financial cooperation would increase.

Active exploration and continuous efforts, including the provision of references, are crucial for the solid promotion of the integration process of the stock markets of China and major ASEAN countries. Considering the varying degrees of financial openness and security market maturity in ASEAN countries, the conditions for a comprehensive promotion of this integration are yet to materialize. Being a mature and developed stock market, Singapore is notably the largest offshore RMB market in the ASEAN region. It features the foundation for interconnection with the mainland stock market that can explore the launch of the "Shanghai-Singapore (Singapore) Connect". Accordingly, efforts should be reinforced to promote the market connection of domestic and foreign exchanges, including the mutual recognition of the different varieties of stock exchanges present in the ASEAN region.

Although this article is one of the few that explores the integration of China's stock market and the ASEAN stock market in recent years, there is a large scope for further research to explore the important events and their impact on the regional integration. Future research may also extend the analysis through using a multivariate GARCH model and expand the scope to examine the impact of China-U.S. integration on ASEAN stock markets.

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