

STOCK MARKET INTERDEPENDENCE BETWEEN MALAYSIA, INDONESIA AND SINGAPORE DURING ECONOMIC STABILITY AND CRISES: A DCC-GARCH MODEL APPROACH

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ABSTRACT

Financial market integration has become increasingly important for investors and policymakers, particularly during economic turbulence, which amplifies systematic risks and reduces diversification opportunities. This study examines the integration and co-movements of Malaysia's stock market with its neighbouring ASEAN countries, Indonesia and Singapore, using weekly data from January 2004 to December 2023. A regime-based approach is adopted by dividing the analysis into pre-crisis, crisis, and post-crisis periods across two major global events: the Global Financial Crisis and COVID-19 pandemic. The analysis applies Dynamic Conditional Correlation Generalized Autoregressive Conditional Heteroskedasticity (DCC-GARCH) models to capture time-varying market interdependence. The findings reveal that stock market correlations intensified during crises periods, indicating stronger financial integration among the selected ASEAN markets. The results further demonstrate that the Global Financial Crisis exerted a more pronounced influence on market interdependence than the COVID-19 pandemic. These findings suggest that investors and portfolio managers should adopt dynamic and adaptive investment strategies in response to changing market conditions. This study also contributes to the understanding of regional financial integration and highlights its important role in supporting efficient capital allocation and sustainable economic cooperation within ASEAN.

Keywords: ASEAN, DCC-GARCH, market integration, co-movement, crisis, portfolio diversification

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1. INTRODUCTION

Understanding the relationship among financial markets is not merely academic but also important, especially for investors, portfolio managers, and policymakers. This is because the interdependencies between markets are crucial for effective portfolio diversification to mitigate the risk of investing in a single market. In addition, information on the relationship between financial markets is vital for forecasting the spillover effect shared among interdependent countries (El Khoury et al., 2023; Haddad, 2023).

The interrelationships between financial markets form the foundation of global economic systems. These connections are essential for supporting decision-making processes and formulating risk management strategies. Initially, scholars investigated the dynamics between markets across countries, often without distinguishing between normal and crisis conditions. This approach is evident in the non-crisis-related literature, such as Abbes & Trichilli (2015), Boubakri & Guillaumin (2015), Konradsson & Sjö (2019), Narayan & Rehman (2018). However, following a series of financial turmoil, researchers realized that market conditions play a significant role in determining the level of integration among countries. This suggests that the magnitude of systematic risk affects the dynamics of market relationships (Habiba et al., 2020; Lehkonen, 2015; Qizam et al., 2020; Robiyanto et al., 2023; Sehgal et al., 2017).

In this context, Malaysia, Indonesia, and Singapore, which represent a miniature version of Southeast Asia's economic diversity, serve as relevant cases for examining how interdependence responds to changing economic conditions. Malaysia is classified as an emerging and developing economy and is currently designated as an upper-middle-income country. Indonesia, the region's largest economy and population, is similarly categorised as an emerging middle-income country. In contrast, Singapore stands out as a high-income country supported by a business-friendly regulatory environment, strong investment infrastructure, education, healthcare, and public services (World Bank, 2024). These structural differences are also reflected in their financial market. The Singapore Exchange is the most mature and liquid exchange in Asia. Although Bursa Malaysia is classified as an emerging stock market, it is one of the fastest-growing exchanges in ASEAN and has established itself as a low-cost market for attracting investors. It is also one of the most important Islamic finance centers. Meanwhile, Indonesia's capital market has become one of the most active bourses in the ASEAN region, as demonstrated by the increasing number of listed companies and a robust sukuk and bond market (ASEAN Exchanges, 2025).

Additionally, these three countries are the founding members of ASEAN, which was established in 1967. All three were among the first to form ASEAN, which now has 11 member states. It is important to note that one of the main objectives of establishing ASEAN was to promote greater economic cooperation among member countries. Therefore, it is not surprising that Malaysia, Indonesia, and Singapore have become important trading partners. For example, Singapore is Malaysia's largest trading partner within ASEAN, while Malaysia and Indonesia are consistently among Singapore's most important trading partners. Singapore is also an important import and export destination for Indonesia. These close economic ties are due to geographical proximity and the trade-facilitating role of ASEAN as a regional organisation. Hutagalung (2025) even highlighted that Malaysia, Singapore, and Indonesia have successfully maintained a strategic balance between global trades and rivalries, thereby fostering regional unity.

Given the structural differences and similarities between Malaysia and its neighbours, Indonesia and Singapore, it is particularly noteworthy to examine these market relationships under different economic conditions. These three countries represent a mix of emerging and developed economies, providing valuable insights into the integration or interdependence of stock markets. Most existing studies have either focused on ASEAN countries as a whole or overlooked bilateral relationships, especially during the two major global crises. Therefore, this study aims to fill this gap by examining the time-varying stock market interdependence between Malaysia and its two closest neighbours.

The remainder of this paper is organised as follows: Section 2 provides a brief review of the relevant literature; Section 3 explains the research methodology used in this study; and Section 4 presents and discusses the empirical results. Finally, Section 5 concludes the study by discussing the implications, recognising any limitations, and identifying opportunities for future research.

2. LITERATURE REVIEW

Building on Modern Portfolio Theory, diversification benefits can be achieved through investments in assets or markets that are not perfectly correlated, thereby reducing exposure to risk arising from similar market reactions (Markowitz, 1952; Sharpe, 1964). Therefore, stock market integration has become an important aspect of understanding global financial interaction.

According to Stulz (2022), globalization is the primary driver of international financial market integration, leading to a single global capital market. Financial integration has strengthened linkages among neighbouring, regional, and global economies offering advantages such as greater economic growth, while also increasing asset return volatility and the risks of financial instability and contagion effects (Almanaseer, 2023; Mishra et al., 2022; Nițoi & Pochea, 2019; Wang et al., 2024). Given these mixed effects, examining stock market interdependence within ASEAN countries is highly important.

Previous studies generally report significant integration among ASEAN stock markets, although the degree of integration varies across countries and periods. Karim & Abdul-Rahman (2020) found high integration among ASEAN-5 markets, which were relatively resilient during the Global Financial Crisis. Similarly, Song et al. (2021) revealed that economic integration positively influences stock market co-movements in the region. Earlier studies by Ibrahim (2003), Majid & Kassim (2009), and Michael & Diskurse (2022), highlighted bilateral trade as an essential determinant of regional stock market integration, while Robiyanto et al. (2021) found stronger integration during and after the global crisis. However, several studies have highlighted the uneven integration across ASEAN markets. Mishra & Mishra (2020) and Saji (2022) noted that some Asian markets are segmented by national borders, leading to weak price convergence. Consistent with this view, Robiyanto (2017) identified the Philippines market as relatively segmented, while Jacob et al. (2021) reported weaker integration of Indonesia with its ASEAN peers. Ferli (2020) found stronger linkages among Indonesia, Malaysia, and Singapore, whereas Vietnam exhibited relatively weaker integration.

In addition, Malaysia, located at the heart of ASEAN, provides a unique case study of its relationship with its neighbouring countries, Singapore and Indonesia. Several studies have shown that Malaysia has strong linkages with Singapore, highlighting the interrelationships between emerging and developed countries. Using the wavelet method, Kamaludin et al. (2021) found that the stock markets of Malaysia, Indonesia, and Singapore reacted to COVID-19 cases at the beginning of the pandemic. Wang et al. (2024) provide more robust evidence that Malaysia shows a short-term co-movement with most trading partners but a pronounced long-term synchronisation with Singapore (alongside Japan and Indonesia), highlighting its role as an important financial partner for Malaysia. Their DCC-GARCH results also confirm that Malaysia and Singapore are integrated in both the short and long run, reflecting stable and dynamic financial relations. In another study on the causes of greater integration of Asian stock markets over time, Wiesen et al. (2024) confirm that volatility (market instability) is a possible factor. Their study also shows that Malaysia has relatively little influence on the spread of financial instability, while Singapore and China play key roles in shaping regional market linkages. This finding confirms that of Aziz et al. (2022), who found that the stock market of Singapore primarily acts as the main transmitter of returns and volatility in their study of ASEAN+3.

The results of previous studies on the interdependence between Malaysia and Indonesia are consistent. Anhar et al. (2024) found that only Malaysia continued to exert a positive and lasting influence after the pandemic. This indicates a significant and lasting influence of Malaysia on the Indonesian capital market, especially during and after the COVID-19 pandemic. This is supported by Endri et al. (2024), who found that the Indonesian stock market exhibits unidirectional reciprocal lagged relationships with Malaysia, meaning that Malaysia leads and Indonesia follows with a time lag. Nevertheless, the researchers found that the Indonesian stock market and the markets of major trading partners (including Malaysia and Singapore) are integrated. In addition, the Islamic capital markets between the Jakarta Islamic Index of Indonesia and the Bursa Malaysia Emas Sharia of Malaysia remain highly integrated despite the 2008 Global Financial Crisis. These markets also have the greatest influence on the Islamic capital markets in the ASEAN-5 countries (Qizam et al., 2020). However, Mishra & Mishra (2020) and Robiyanto (2018) found that the Indonesian market became more connected to other Asian markets after the crises, suggesting that external shocks and global financial openness have strengthened these linkages. Similarly, Muharam et al. (2020), Qiu et al. (2022), and Robiyanto et al. (2021, 2023) confirm that stock markets are becoming more integrated, especially during economic crises and strong market shocks. In particular, Qin et al. (2022) emphasised that stock market integration accelerated notably after major financial crises, especially during the Asian financial crisis of 1999 and the 2008 subprime global financial crisis. These developments suggest that the global financial crisis transformed the structure and interdependence of international capital markets (Jordan et al., 2021).

Extending the scholarly work of previous researchers, this study aims to develop hypotheses to fill the observed gaps in understanding the interdependence of selected ASEAN stock markets. While previous literature predominantly examines the ASEAN region, this study focusses to a comparative analysis from Malaysia's perspective, examining its financial interdependence with Indonesia and Singapore. Furthermore, this study distinguishes itself by incorporating two significant global crises: the Global Financial Crisis and the COVID-19 pandemic. Therefore, the following hypotheses are proposed:

- H_1 : Stock market integration between Malaysia and its neighbouring countries intensifies during crisis periods compared to stable periods.
- H_2 : Stock market integration between Malaysia and Singapore is expected to be stronger and more stable during crisis periods than that between Malaysia and Indonesia.
- H_3 : Stock market integration between Malaysia and Singapore is expected to be stronger and more stable during crisis periods than that between Malaysia and Indonesia.

3. METHODOLOGY

This study analysed time series data from three ASEAN stock market indices: Malaysia, Indonesia, and Singapore. The FTSE Bursa Malaysia KLCI, IDX Composite, and Straits Times Index were used for the analysis. Following Nițoi & Pochea (2019), weekly closing price data were employed to address the challenges of non-synchronous trading hours in daily data. The study period, from January 2004 to December 2023, was deliberately selected to encompass two major global crises: the subprime crisis of 2007-2008 and the recent COVID-19 health crisis.

In this study, the DCC-GARCH approach is used to examine the time-varying correlation from Malaysia's perspective, specifically between Malaysia and its neighbouring countries, Indonesia and Singapore. The model is deemed suitable and appropriate for testing the above hypotheses as it captures the integration of stock markets over time under different economic conditions. Additionally, the time-varying correlation results are presented under various economic conditions, which contribute to addressing the three hypotheses of this study.

The 20-year study period was divided into sub-periods surrounding two major global crises. The Global Financial Crisis consists of pre-crisis (2005-2006), crisis (2007-2008), and post-crisis (2009-2010) phases, while the COVID-19 crisis includes pre-pandemic (2018-2019), pandemic (2020-2021), and post-pandemic (2022) phases. This classification is consistent with Lu & Zeng (2023), who identified the pandemic and post-pandemic phases from 2022 onwards. Dividing the sample into phases enables a more comprehensive analysis of stock market integration and co-movement during crises (Karim & Ning, 2013; Robiyanto et al., 2023).

To analyse the co-movements of pairs between Malaysia and its two neighbouring countries (the Indonesia and Singapore stock markets), data were retrieved from Refinitiv Eikon Datastream. Stock market returns are calculated using the following formula:

$$R_{i,t} = \ln \left(\frac{P_t}{P_{t-1}} \right) \quad (1)$$

where

- $R_{i,t}$ = stock return for market i on week t
- P_t = weekly price of an index
- P_{t-1} = weekly price of an index at week $t-1$

To achieve the research objectives, this study employs a multivariate model called the dynamic conditional correlation (DCC) model, which has the flexibility of a univariate generalized autoregressive conditional heteroscedasticity (GARCH) proposed by Engle (2002). This innovative multivariate GARCH is an extension of the constant correlation (CCC) estimator introduced by Bollerslev (1990). However, with the DCC estimator, the models differ by accommodating time-varying R . Specifically, this study follows the DCC-GARCH framework as follows:

$$r_{i,t} = \mu_{i,t} + \phi_i r_{i,t-1} + \varepsilon_{i,t} \varepsilon_{i,t-1} \Omega_{t-1} \square N_{i,t}(0, H_t) \quad (2)$$

In this context, r signifies stock market returns, while $\varepsilon_{i,t}$ represents innovation conditioned on the information set at time $t-1$ and is denoted as $\varepsilon_{i,t} \Omega_{t-1}$. On the other hand, H_t represents the conditional variance-covariance matrix. This matrix can be expressed as

$$H_t = D_t R_t D_t \quad (3)$$

In the above equation, the conditional correlation estimator is represented as H_t . D_t is defined as an $(n \times n)$ diagonal matrix representing the time-varying conditional standard deviations of returns at time t in the equation of the univariate GARCH (1,1) model. Specifically, $D_t = \text{diag}(\sqrt{h_{1,t}}, \dots, \sqrt{h_{n,t}})$ where h_{it} represents the time-varying conditional volatility of returns for a particular stock market, as specified below:

$$h_{i,t} = \alpha_{oi} + \sum_{q=1}^q \alpha_{iq} \varepsilon_{i,t-q}^2 + \sum_{p=1}^p \beta_{ip} h_{i,t-p} \quad (4)$$

Within this framework, $i = 1, 2, 3, \dots, k$ (in this study referring to the stock market indices), the parameter α_{oi} represents a constant term, while α_{iq} and β_{ip} represent the ARCH and GARCH effects, respectively. A positive value of α_{iq} indicates the presence of volatility cluster. Meanwhile, β_{ip} captures the persistence of the volatility shock. The model subjects the ARCH and GARCH parameters to non-negativity constraints. As per Equation (3), R_t stands for a dynamically evolving conditional correlation matrix, derived by computing the standardised residuals obtained from GARCH (1,1) estimation.

$$R_t = \text{diag}(\sqrt{q_{11,t}}, \dots, \sqrt{q_{kk,t}}) Q_t \text{diag}(\sqrt{q_{11,t}}, \dots, \sqrt{q_{kk,t}}) \quad (5)$$

where Q_t is a symmetric positive definite matrix that captures the conditional covariance of the standardised residuals in the DCC model as follows:

$$Q_t = (1 - \alpha_{DCC} - \beta_{DCC}) \bar{Q} + \alpha_{DCC} \varepsilon_{t-1} \varepsilon_{t-1}' + \beta_{DCC} Q_{t-1} \quad (6)$$

In this context, $\bar{Q}$ represents the unconditional covariance matrix of the standardised residuals. Parameters α_{DCC} and β_{DCC} are non-negative with $\alpha_{DCC} + \beta_{DCC} < 1$. The estimation of the DCC-GARCH model is performed using the quasi-maximum likelihood method (QMLE), where the log-likelihood is the sum of two parts: one related to volatility and the other to correlation.

$$L = -\frac{1}{2} \sum_{t=1}^T (k \log(2\pi) + 2 \log|D_t| + \varepsilon_t' R_t^{-1} \varepsilon_t) \quad (7)$$

In our empirical estimation, the DCC-GARCH model is estimated using stock return data from Malaysia, Indonesia, and Singapore. In this two-step model, the first stage estimates the univariate GARCH model for each country's return series, where the conditional variance equation follows Equation (4) for $i = 1, 2$, and 3 , representing Malaysia, Indonesia, and Singapore, respectively. These equations capture volatility clusters and persistence within individual markets. The DCC component then estimates the conditional covariances matrix, Q_t as specified in Equation (6). This matrix reflects how shocks and movements in one stock market are associated with those in the other markets over time based on the standardised residuals obtained from the first stage. However, covariance values cannot be directly interpreted as degrees of market integration. Therefore, Equation (5) standardises Q_t to derive the conditional correlation matrix R_t which provides a comparable measure of the strength and direction of the relationship, allowing the extraction of dynamic correlation between markets over time. Finally, the DCC-GARCH parameters are estimated using the QMLE approach based on the log-likelihood function in Equation (7).

4. RESULTS AND DISCUSSION

The results are organised into several sections to facilitate interpretation. First, descriptive statistics provide an overview of the dataset, followed by a correlation analysis to examine the relationships among the variables and a trend analysis to assess stock return behaviour. The DCC-GARCH results are then presented in both tables and graphical form to capture stock market co-movements.

4.1. Descriptive Statistics

Table 1 presents the stock returns of KLSE (FTSE Bursa Malaysia Kuala Lumpur Composite Index), JKSE (Jakarta Composite Index), and STI (Straits Times Index) based on 1,043 weekly observations from 2004 to 2023. Among the three markets, the JKSE recorded the highest average weekly return (0.0022) compared to the KLSE and STI (0.0006), indicating superior return performance. This finding is consistent with data compiled by Bloomberg (2024), which reported that Indonesia's stock market outperformed Singapore's over the last decade. Indonesia's stock market achieved returns of 79.1%, compared to Singapore's, which recorded a 40.6% growth rate over the period.

However, JKSE also exhibited the highest standard deviation (0.0279), followed by STI (0.0230) and KLSE (0.0165), suggesting greater volatility and investment risk. This supports the Capital Asset Pricing Model (CAPM) principle that higher expected returns are associated with greater risk. In addition, KLSE recorded the lowest maximum returns (0.0665) relative to the JKSE (0.1159) and STI (0.1532), consistent with its lowest volatility profile. Therefore, the KLSE may

be more attractive to risk-averse investors, whereas the JKSE and STI may be more appealing to investors seeking higher returns despite increased risk.

Table 1: Descriptive Statistics

Variable	Obs	Min	Max	Mean	Std. dev.	Normality	ADF	ARCH (5)
KLSE	1,043	-0.0979	0.0665	0.0006	0.0165	0.0000*	-30.446 *	48.930*
JKSE	1,043	-0.2330	0.1159	0.0022	0.0279	0.0000*	-34.403*	83.081*
STI	1,043	-0.1647	0.1532	0.0006	0.0230	0.0000*	-31.337*	184.424*

Notes: *Significance at the 1% level; Normality was Shapiro-Wink Prob. with 5% level; ARCH (5) was Chi-squared values

In addition, a p-value of 0.0000 in the normality test means that the null hypothesis, which states that the data follows a normal distribution, is rejected at the 5% statistical significance level. In other words, the p-values indicate strong evidence against the assumption that the data follows a normal distribution. This indicates that the KLSE, JKSE, and STI data are not normally distributed, which is a common characteristic of financial time series data. Thus, it is confirmed that the GARCH family of models is suitable for this study to model time-varying volatility (Robiyanto et al., 2023). Table 1 also shows the results of the stationarity test for the level. The results indicate that KLSE, JKSE, and STI have ADF test statistics that are well below the critical values at the 1% significance level. This strongly rejects the presence of a unit root and implies that the three indices are stationary at the level. The ARCH test, which was conducted for the residuals of the individual index returns, aims to verify the existence of conditional heteroscedasticity in the return series. The ARCH test results indicate a statistically significant ARCH effect in all series, confirming the suitability of GARCH family models for capturing time-varying volatility. Therefore, this research can proceed with DCC-GARCH modelling, as the requirements for the time series data are met.

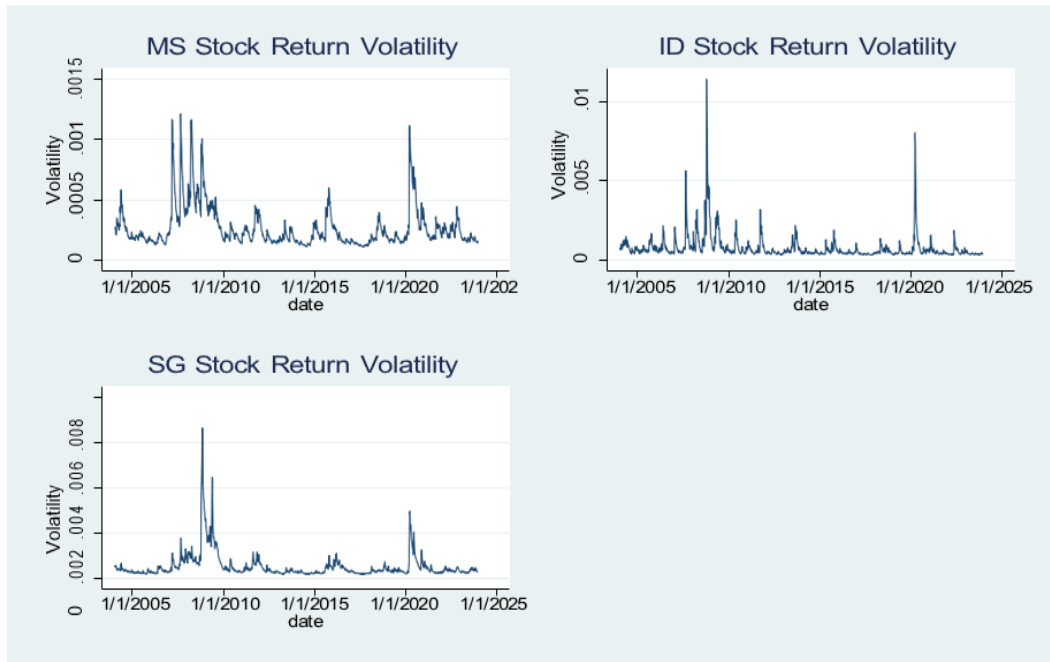
Table 2, on the other hand, shows the Pearson correlation coefficients between the three indices, which are all statistically significant at the 1% level. The correlation between KLSE and JKSE is approximately 0.5761, indicating a moderately positive linear relationship between the two stock indices over the last decade. KLSE exhibited a stronger correlation with the STI (0.6036) than with the JKSE. Although the correlation between the STI and JKSE (0.6064) is marginally the highest among the pairs, the KLSE and STI correlations are similarly strong, suggesting that Singapore maintains close linkages with both Malaysia and Indonesia. Despite the overall positive correlation that these three markets experienced, which implies that they move together in the same direction, KLSE seems to be the least correlated with the other two markets, as shown by the lowest pairwise correlation coefficients. This is evidenced by data from Bloomberg (2023), which shows that the KLSE has historically lagged slightly behind other ASEAN countries, but current trends show a reversal of this pattern, with the KLSE experiencing upward and positive trends in the early 2024. This trend could be due to KLSE being a relatively untapped market within the ASEAN-5 region, as other neighbouring countries have reached market saturation in the same period. Furthermore, the KLSE rally was bolstered by the recent stabilisation of the political landscape following a period of uncertainty due to the rapid change in three Prime Ministers over the past five years. Political stability is an important factor in instilling investors' confidence, leading to increased market performance in terms of volume and amount invested (Liu et al., 2022).

Table 2: Correlation Analysis

Variables	KLSE	JKSE	STI
KLSE	1		
JKSE	0.5761*	1	
STI	0.6036*	0.6064*	1

*Notes: *Significance at the 1% level; Pearson correlation coefficient with 5% level*

To further understand the behaviour of the data utilised in this study, the stock return trends of the three ASEAN countries were analysed. The ups and downs of the stock returns of KLSE, JKSE, and STI indicate volatility in stock returns, which is important for stability and for risk management. With reference to Figure 1, fluctuations in stock returns over the 20 years of the study (2004-2023) are almost similar. However, JKSE seems to be more volatile than the other two markets and experienced the highest spike among the rest of the markets. These extreme spikes likely corresponded to the Global Financial Crisis of 2008/2009 and the pandemic COVID-19 of 2020/2021. Apart from these periods, the volatility of the Indonesian stock market seems to be stabilised, except for several volatile situations that occur occasionally, which could be due to local events and economic announcements.

Figure 1: Stock return volatility of Malaysia, Indonesia and Singapore

Source: Refinitiv Eikon Datastream, processed

As shown by the graphs, the Malaysian stock market exhibits patterns similar to those of the Indonesian market. Both markets experienced significant volatility during global crises. However, the spikes in Malaysia are less severe than those in Indonesia, suggesting that the Malaysian equity

market is more resilient and less vulnerable to global economic shocks. Apart from these spikes, the KLSE has experienced periods of volatility linked to local economic events such as central bank announcements, earnings releases, and policy changes. The declining volatility of the Malaysian stock market after 2020 indicates that the market has recovered from the pandemic, possibly due to effective stabilisation measures implemented by the authorities.

In comparison, the STI of Singapore is the most stable market among the three, as demonstrated by fewer and lower peaks throughout the 20-year study. The heightened volatility is due to the 2008 Global Financial Crisis and the COVID-19 pandemic. However, the spikes were not as intense as those in Indonesia. A more stable STI may indicate a relatively more mature market, efficient and effective governance, a proactive approach to economic policy, and a stable political environment (Wijeratne, 2018).

All three markets showed increased volatility during crises, with Indonesia's reaction being the highest and Singapore's the lowest, reflecting the STI as the most stable market. Following heightened volatility, all markets revert to their mean volatility levels, with the STI showing the fastest reversion, indicating that it is an efficient market. This reversion is critical for long-term investment strategies, as it indicates that the impact of shocks is not perpetual but rather dissolves over time. Singapore's consistently lower level of volatility is most likely due to its status as a global financial hub that imposes stringent financial regulations to reduce the market volatility.

4.2. DCC-GARCH Results

The main objective of this study is to analyse the integration or co-movement between Malaysia and its neighbouring countries. The pairing of Malaysia and Indonesia reveals the relationship between two developing countries, whereas Malaysia and Singapore represent the relationship between a developing and a developed country. Although the behaviour of individual markets has been discussed in the previous section, DCC-GARCH is still required as a methodology to investigate the patterns of volatility between market pairs. This provides information on whether these market pairs move together or are diverse.

The DCC-GARCH estimation results are shown in Table 3. The conditional variance parameters for all countries are statistically significant and positive, confirming the appropriateness of the GARCH model used in this study. Specifically, the ARCH parameters (α_1) for Malaysia, Indonesia, Singapore are 0.0905, 0.1879, and 0.0997 respectively, while the corresponding GARCH parameters (β_1) are 0.8554, 0.6810, and 0.9039. Importantly, the dynamic conditional correlation (DCC) parameters, lambda 1 (α_{dcc}) is 0.0376 and lambda 2 (β_{dcc}) is 0.8485 are both statistically significant, and their sum is less than one, satisfying the stationarity condition.

Table 3: Results of DCC-GARCH estimation

Parameter	Coefficient	Std. Error	z/t-stats
α_{01}	0.000013	0.000004	3.51*
α_{02}	0.000092	0.000019	4.93*
α_{03}	0.000010	0.000003	3.39*
α_{11}	0.090536	0.018953	4.78*
α_{12}	0.187865	0.031159	6.03*
α_{13}	0.099704	0.028078	3.55*
β_{11}	0.855379	0.028724	29.78*
β_{12}	0.680978	0.045960	14.81*
β_{13}	0.903862	0.020829	43.39*
α_{dcc}	0.037577	0.010290	3.65*
β_{dcc}	0.848519	0.042822	19.82*

Notes: *p<0.01.

As the DCC-GARCH method captures time-varying correlations, the analysis is further conducted across predefined sub-periods to examine changes in stock market integration under different economic conditions. Consistent with the subperiod classification described earlier, the results are presented for the full sample period (2004–2023), as well as the periods before, during, and after the Global Financial Crisis and COVID-19 pandemic (see Table 4 and Table 5).

Table 4: Malaysia - Indonesia DCC-GARCH Results

	Global Financial Crisis				COVID-19 Health Crisis		
	All Sample	Pre Crisis	Crisis Period	Post Crisis	Pre Crisis	Crisis Period	Post Crisis
Min	0.0681	0.3806	0.4023	0.4767	0.4050	0.3562	0.4297
Max	0.7953	0.6556	0.7953	0.6661	0.6047	0.7675	0.6056
Mean	0.5553	0.5321	0.6151	0.5798	0.5452	0.5627	0.5320

Source: Refinitiv Eikon Datastream, processed

Table 5: Malaysia - Singapore DCC-GARCH Results

	Global Financial Crisis				COVID-19 Health Crisis		
	All Sample	Pre Crisis	Crisis Period	Post Crisis	Pre Crisis	Crisis Period	Post Crisis
Min	0.0715	0.4267	0.4790	0.5317	0.4325	0.3207	0.4103
Max	0.8188	0.6746	0.7987	0.6903	0.6825	0.8188	0.6609
Mean	0.5868	0.5673	0.6479	0.6088	0.5835	0.5827	0.5594

Source: Refinitiv Eikon Datastream, processed

Table 4 shows the DCC-GARCH results for the Malaysia–Indonesia pair over the 20 years of the study. The results examine the impact of crises on the co-movement between the two stock markets. Throughout the sample period, the correlation between the KLSE and JKSE ranged from a minimum of 0.0681 to a maximum of 0.7953. On average, the correlation was 0.5553, indicating

a moderately positive linear relationship between these two markets. It is observed that the correlation between KLSE and JKSE varied during the global financial crisis. Before the global financial crisis, the average correlation was 0.5321, while during the crisis, it ranged between 0.4023 and 0.7953, with an average of 0.6151. In the post-crisis period, the correlations remained at approximately 0.4767 and 0.6661, respectively. These results suggest that the correlation between the two indices tended to increase during the global financial crisis, signifying stronger co-movement.

During the COVID-19 crisis, variations in the co-movement between the KLSE and JKSE were observed. Before the crisis, the correlation ranged from 0.4050 to 0.6047, with an average of 0.5452. During the crisis, the correlation fluctuated between 0.3562 and 0.7675, with an average of 0.5627. In the post-crisis period, the correlation ranged from 0.4297 to 0.6056, with an average of 0.5320. The increased correlation during the COVID-19 pandemic indicates that the two markets were more integrated during the crisis than in the non-crisis period.

Apart from Malaysia's relationship with Indonesia, a developing country, the relationship between Malaysia and Singapore, a developed country in ASEAN, is examined. The correlation between the two was moderately positive, with results ranging from 0.0715 to 0.8188. On average, the correlation was 0.5868, indicating that when one market increases, the other tends to follow to some extent. During the global financial crisis, interdependence became stronger than before. The correlation between the KLSE and STI varied around the global financial crisis. Before the crisis, the average correlation coefficient was 0.5673. However, during the crisis, co-movement intensified, ranging from 0.4790 to 0.7987, with an average of 0.6479. In the post-crisis period, the correlation remained between 0.5317 and 0.6903. These results suggest that during difficult times, the two markets reacted more closely to each other as investors in both markets responded similarly to global uncertainty.

The co-movement between the KLSE and STI during the COVID-19 pandemic also generated similar results. Before the pandemic, the correlation ranged from 0.4325 to 0.6825, with an average value of 0.5835. During the crisis period, the correlation widened significantly from 0.3207 to higher value of 0.8188, with an average of 0.5827. After the pandemic, the correlation weakened slightly to 0.5594, with the range tightening from 0.4103 to 0.6609. The findings explain how closely connected the Malaysian and Singaporean markets are, especially during times of crisis. This information is helpful for Malaysian investors in designing their portfolios, particularly during periods of market instability and uncertainty. Investors might reduce their investments in ASEAN countries and look at other markets or other classes of investment assets as the benefit of regional portfolio diversification declines.

4.3. Time-varying correlation of DCC-GARCH

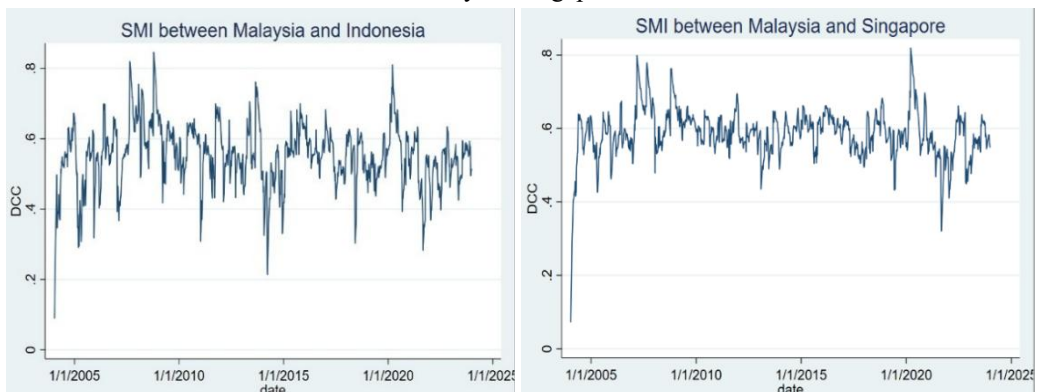
Figure 2 shows a graph of the time-varying DCC-GARCH between the stock market index pairs of Malaysia and Indonesia, as well as Malaysia and Singapore. Based on the graph, the correlation is not constant but fluctuates over time in response to economic events and other factors. The graph shows that the range of correlations lies between 0.1 and 0.8, with an average of 0.60 (as presented in Table 4 and Table 5), suggesting that both pairs are correlated, but neither moves in perfect unison (correlation of +1) nor in the completely opposite direction (correlation of -1). Throughout the 20-year study period, there are significant correlation peaks, indicating that both country pairs

respond similarly to the global shocks. During periods of low correlation, these markets may have been influenced by local events, leading to low correlations between country pairs. Thus, Malaysian investors seeking to diversify their portfolios in the Indonesian and Singaporean stock markets must be vigilant in their timing, as diversification is a time variant. Therefore, investors must continuously monitor market trends to adapt to the prevailing market conditions.

A closer examination of the countries reveals that both pairs exhibit strong correlations during the two major economic downturns: the Global Financial Crisis and the COVID-19 pandemic. This observation emphasises that global crises are systematic risks in which numerous countries cannot entirely evade their impact. Consequently, the period of economic crisis led to greater market integration, as shown in Figure 2. This phenomenon is consistent with existing research, which suggests that crises tend to strengthen market interdependence. Aziz et al. (2022) found that the COVID-19 pandemic significantly affected the returns and volatility of ASEAN+3 equity markets. The authors also highlighted that Singapore is the main transmitter of returns and volatility, which is consistent with our findings, as the correlation between Malaysia and Singapore is higher than that between Malaysia and Indonesia.

Other studies showing that financial crises act as a catalyst for closer integration of stock markets include Robiyanto et al. (2021), who observe a higher level of integration during and after the global financial crisis. Rahman et al. (2017) found that markets moved towards better integration, especially during the post-crisis period around the Asian financial crisis in 1997/1998. Behera and Sahoo (2022) show that, on average, 47.06% of a shock to one index spills over to all other indices, suggesting strong interconnectedness associated with COVID-19 uncertainty in ASEAN countries. It is also believed that contagion occurred more frequently during the pandemic, and markets reacted differently at different stages of the pandemic (Kamaludin et al., 2021; Zhang et al., 2022). Specifically, Wang et al. (2024) found that Malaysia exhibited short-term co-movement with all emerging markets and OECD countries during the COVID-19 pandemic. However, the Malaysian stock market demonstrated synchronized movements with the stock markets of Indonesia and Singapore at both high and low frequencies, suggesting the existence of co-movements across both short- and long-term horizons.

Figure 2: Time-varying stock market integration between Malaysia-Indonesia and Malaysia-Singapore.



Source: Refinitiv Eikon Datastream, processed

Although the present study does not aim to identify the determinants of the heightened correlation observed during crises, the existing literature suggests that crises often act as triggering events that cause an increase in co-movement. This is stated in the influential work of Pretorius (2002), who argued that one of the factors of stock market co-movements is the 'contagion effect', which refers to spillover effects that cannot be explained by economic fundamentals. Furthermore, Burdekin and Tao (2025) found that external market influences, particularly from the United States, play an important role in driving co-movements during crises. When volatility is low, regional influences become more prominent and significant. Similarly, Yiu & Tsang (2021) concluded that the COVID-19 pandemic had a greater impact on ASEAN-5 equity market returns and volatility than local situations.

As illustrated in Figure 2, the dynamic correlations fluctuate over time rather than remain constant, suggesting that stock market integration within the region is time-varying in nature. Although the overall integration remained at a moderate level, periods of economic turbulence were associated with noticeably stronger co-movements, particularly during major crises. These findings imply that the benefits of international portfolio diversification tend to diminish during periods of uncertainty as regional markets become increasingly interconnected. This evidence reinforces the view that ASEAN stock market, in this study referring to Malaysia, Indonesia, and Singapore linkages, are dynamic rather than static, with crises acting as catalysts that intensify regional financial integration.

5. CONCLUSION

This study provides a comprehensive understanding of stock market integration between Malaysia and its regional counterpart, Singapore. The DCC-GARCH results reveal that the stock markets exhibit a moderate positive correlation over the study period, with integration strengthening during periods of economic turbulence, particularly during the Global Financial Crisis. These findings support H_1 , confirming that stock market integration intensified during crisis periods, and further validate H_3 by demonstrating that the Global Financial Crisis exerted a stronger influence on market integration than the COVID-19 pandemic. In addition, graphical analysis shows that the Malaysia-Singapore market pair experienced relatively fewer fluctuations in dynamic correlations than the Malaysia-Indonesia pair, suggesting greater stability and resilience in integration with a developed market. These findings support H_2 , which highlights the role of market maturity in shaping the stability of regional stock market linkages.

This study provides empirical evidence of stock market integration between Malaysia and its ASEAN neighbours, Indonesia and Singapore. The findings show that market integration is moderate but dynamic, with stronger co-movements occurring during periods of financial turbulence. These patterns suggest that the benefits of cross-market diversification are more limited during crises, especially for the Malaysia and Singapore market pair. By examining integration across several countries during various crisis episodes, this study contributes to the literature by highlighting the time-varying stock market integration between developing and developed countries within the ASEAN region, an area that remains underexplored.

From a practical perspective, the findings suggest that investors and portfolio managers should adopt more adaptive asset allocation strategies that consider changing market conditions. Given

the tendency of regional equity markets to move more closely during crises, diversification into alternative asset classes may provide additional risk management benefits. At the policy level, the findings offer empirical support for strengthening regional financial resilience and managing potential contagion risks through closer financial cooperation and market monitoring mechanisms. The findings also play a broader role in regional market integration by promoting efficient capital allocation and stronger regional financial cooperation, which indirectly supports the United Nations Sustainable Development Goals (SDGs), particularly SDG 8 (Decent Work and Economic Growth) and SDG 17 (Partnership for the Goals). Future research should extend this study to a wider range of ASEAN economies to further enhance understanding of regional market integration in an increasingly interconnected financial environment.

REFERENCES

- Abbes, M. B., & Trichilli, Y. (2015). Islamic stock markets and potential diversification benefits. *Borsa Istanbul Review*, 15(2), 93–105. <https://doi.org/10.1016/j.bir.2015.03.001>
- Almanaseer, S. R. (2023). The relationship between financial integration and financial stability: An application of panel smooth transition model. *International Journal of Professional Business Review*, 8(5), 1–22.
- Anhar, M., Maronrong, R., Burda, A., & Sumail, L. O. (2024). Dynamics of Indonesian stock market interconnection: Insights from selected ASEAN countries and global players during and after the COVID-19 pandemic. *Investment Management and Financial Innovations*, 21(2), 180–190. [https://doi.org/10.21511/imfi.21\(2\).2024.14](https://doi.org/10.21511/imfi.21(2).2024.14)
- ASEAN Exchanges. (2025). *ASEAN capital markets — 2024 recap and 2025 outlook*. <https://doi.org/https://www.aseanexchanges.org/content/asean-capital-markets-2024-recap-and-2025-outlook/>
- Aziz, M., Ahmad, N., Zichu, J., & Nor, S. M. (2022). The impact of COVID-19 on the connectedness of stock index in ASEAN+3 Economies. *Mathematics*, 10(9). <https://doi.org/10.3390/math10091417>
- Behera, J., & Sahoo, D. (2022). Asymmetric relationships between information and communication technology (ICT), globalization, and human development in India: evidence from non-linear ARDL analysis. *Journal of Economic Structures*, 11(1). <https://doi.org/10.1186/s40008-022-00269-5>
- Bloomberg. (2023). *Stock market performance returns (% in MYR), year-to-date as at end-July 2023*. <https://www.publicmutualonline.com.my/Portfolio.aspx>
- Bloomberg. (2024). *Foreign Stock Market Performance*. Public Mutual Online. <https://www.publicmutualonline.com.my/Portfolio.aspx>
- Bollerslev, T. (1990). Modelling the coherence in short-run nominal exchange rates: A multivariate generalized ARCH model. *The Review of Economics and Statistics*, 72(3), 498–505.
- Boubakri, S., & Guillaumin, C. (2015). Regional integration of the East Asian stock markets: An empirical assessment. *Journal of International Money and Finance*, 57, 136–160. <https://doi.org/10.1016/j.jimonfin.2015.07.011>
- Burdekin, R. C. K., & Tao, R. (2025). Chinese vs. US Stock Market Transmission to Australasia, Hong Kong, and the ASEAN Group. *Journal of Risk and Financial Management*, 18(3), 162. <https://doi.org/10.3390/jrfm18030162>
- El Khoury, R., Mensi, W., Alshater, M. M., & Kang, S. (2023). Extreme risk spillovers and hedging strategies between Indonesia sectorial stocks and commodity markets.

- International Journal of Emerging Markets*. <https://doi.org/10.1108/IJOEM-11-2022-1721>
- Endri, E., Fauzi, F., & Effendi, M. S. (2024). Integration of the Indonesian Stock Market with Eight Major Trading Partners' Stock Markets. *Economies*, 12(12), 1–22. <https://doi.org/10.3390/economies12120350>
- Engle, R. (2002). Dynamic conditional correlation: A simple class of multivariate generalized autoregressive conditional heteroskedasticity models. *Journal of Business and Economic Statistics*, 20(3), 339–350. <https://doi.org/10.1198/073500102288618487>
- Ferli, O. (2020). How Asean Economic Community (AEC) progress from equity market correlation. *Jurnal Riset Manajemen Dan Bisnis*, 5(1), 1–12. <http://jrmb.ejournal-feuniat.net/index.php/JRMB/article/view/326>
- Habiba, U. E., Peilong, S., Zhang, W., & Hamid, K. (2020). International stock markets integration and dynamics of volatility spillover between the USA and South Asian markets: evidence from Global financial crisis. *Journal of Asia Business Studies*, 14(5), 779–794. <https://doi.org/10.1108/JABS-03-2019-0071>
- Haddad, S. (2023). Global Financial Market Integration: A Literature Survey. *Journal of Risk and Financial Management*, 16(12). <https://doi.org/10.3390/jrfm16120495>
- Hutagalung, S. (2025). Beyond borders: How Singapore, Malaysia, and Indonesia sustain regional and global stability. *Eurasia Review*. <https://doi.org/https://www.eurasiareview.com/02052025-beyond-borders-how-singapore-malaysia-and-indonesia-sustain-regional-and-global-stability-oped/>
- Ibrahim, M. (2003). Macroeconomic forces and capital market integration: A VAR analysis for Malaysia. *Journal of the Asia Pacific Economy*, 8(1), 19–40. <https://doi.org/10.1080/1354786032000045228>
- Jacob, T., Raphael, R., & Stebiya, M. V. (2021). Capital market integration of ASEAN-5 countries: an empirical analysis. *Hasanuddin Economics and Business Review*, 5(2), 30. <https://doi.org/10.26487/hebr.v5i2.2796>
- Jordan, C., By, E., & Golden, J. (2021). *Part I International capital markets in context, 1 Introduction*. International Capital Markets: Law and Institutions (2nd Edition). <https://doi.org/10.1093/law/9780198849001.003.0001>.
- Kamaludin, K., Sundarasan, S., & Ibrahim, I. (2021). Covid-19, Dow Jones and equity market movement in ASEAN-5 countries: Evidence from wavelet analyses. *Heliyon*, 7(1). <https://doi.org/10.1016/j.heliyon.2020.e05851>
- Karim, B. A., & Abdul-Rahman, A. (2020). Market integration in ASEAN-5: Evidence of islamic and conventional stock markets. *Polish Journal of Management Studies*, 21(1), 186–198. <https://doi.org/10.17512/pjms.2020.21.1.14>
- Karim, B. A., & Ning, H. X. (2013). Driving forces of the ASEAN-5 stock markets integration. *Asia Pacific Journal of Business Administration*, 5(3), 186–191.
- Konradsson, R., & Porss, T. (2019). *Stock market integration between the BRIC countries - Long-term investment opportunities*. Master's thesis, Linköping University
- Lehkonen, H. (2015). Stock market integration and the global financial crisis. *Review of Finance*, 19, 2039–2094. <https://doi.org/10.1093/rof/rfu039>
- Liu, B., Hamdan, M., Whiteley, C., & Aminu, N. (2022). The Effect of Political Instability on the UK Stock Returns: Evidence from 2016 eferendum and the Major Events that Followed. *Theoretical Economics Letters*, 12(06), 1648–1672. <https://doi.org/10.4236/tel.2022.126091>
- Lu, R., & Zeng, H. (2023). VIX and major agricultural future markets: Dynamic linkage and time-frequency relations around the COVID-19 outbreak. *Studies in Economics and Finance*, 40(2), 334–353. <https://doi.org/10.1108/SEF-02-2022-0121>

- Majid, M. S. A., & Kassim, S. H. (2009). Impact of the 2007 US financial crisis on the emerging equity markets. *International Journal of Emerging Markets*, 4(4), 341–357.
- Markowitz, H. (1952). Portfolio selection. *The Journal of Finance*, 7(1), 77–91. <https://doi.org/10.1111/jofi.13000>
- Michael, C., & Diskurse, O. (2022). The BRI : Trade integration and stock market synchronization . A review of empirical findings. *Ordnungspolitische Diskurse*, No. 2022-3.
- Mishra, A. K., Theertha, A., Amoncar, I. M., & R L, M. (2022). Equity market integration in emerging economies: a network visualization approach. *Journal of Economic Studies*. <https://doi.org/10.1108/JES-07-2021-0343>
- Mishra, P. K., & Mishra, S. K. (2020). Integration of ASEAN-5 equity markets: Implications. *SCMS Journal of Indian Management*, 17(2), 20–29.
- Muharam, H., Robiyanto, R., Pangestuti, I. R. D., & Mawardi, W. (2020). Measuring asian stock market integration by using orthogonal generalized autoregressive conditional heteroscedasticity. *Montenegrin Journal of Economics*, 16(1), 121–137. <https://doi.org/10.14254/1800-5845/2020.16-1.8>
- Narayan, S., & Rehman, M. U. (2018). Portfolio diversification opportunities within emerging and frontier stock markets: Evidence from ten Asian countries. *Buletin Ekonomi Moneter Dan Perbankan*, 21(1), 1–22. <https://doi.org/10.21098/bemp.v21i1.893>
- Nițoi, M., & Pochea, M. M. (2019). What drives European Union stock market co-movements? *Journal of International Money and Finance*, 97, 57–69. <https://doi.org/10.1016/j.jimonfin.2019.06.004>
- Pretorius, E. (2002). Economic determinants of emerging stock market interdependence. *Emerging Markets Review*, 3(1), 84–105. [https://doi.org/10.1016/S1566-0141\(01\)00032-2](https://doi.org/10.1016/S1566-0141(01)00032-2)
- Qin, W., Cho, S., & Hyde, S. (2022). Measuring market integration during crisis periods. *Journal of International Financial Markets, Institutions and Money*, 78(2009). <https://doi.org/10.1016/j.intfin.2022.101555>
- Qiu, Y., Ren, Y., & Xie, T. (2022). Global factors and stock market integration. *International Review of Economics and Finance*, 80(March), 526–551. <https://doi.org/10.1016/j.iref.2022.02.031>
- Qizam, I., Ardiansyah, M., & Qoyum, A. (2020). Integration of Islamic capital market in ASEAN-5 countries: Preliminary evidence for broader benefits from the post-global financial crisis. *Journal of Islamic Accounting and Business Research*, 11(3), 811–825. <https://doi.org/10.1108/JIABR-08-2019-0149>
- Rahman, M. S., Othman, A. H. A., & Shahari, F. (2017). Testing the validation of the financial cooperation agreement among ASEAN+3 stock markets. *International Journal of Emerging Markets*, 12(3), 572–592. <https://doi.org/10.1108/IJoEM-05-2016-0127>
- Robiyanto, R. (2017). The analysis of capital market integration in ASEAN region by using OGARCH approach. *Jurnal Keuangan Dan Perbankan*, 21(2), 169–175.
- Robiyanto, R. (2018). Indonesian stock market's dynamic integration with Asian stock markets and world stock markets. *Jurnal Pengurusan*, 52, 181–192. <https://doi.org/10.17576/pengurusan-2018-52-15>
- Robiyanto, R., Frensidy, B., Setyawan, I. R., & Huruta, A. D. (2021). A different view on ASEAN capital market integration. *Economies*, 9(4), 1–9. <https://doi.org/10.3390/economies9040141>
- Robiyanto, R., Nugroho, B. A., Handriani, E., & Frensidy, B. (2023). Measuring the effectiveness of ASEAN-5 initiatives from emerging market portfolio's perspective. *Cogent Business and Management*, 10(1). <https://doi.org/10.1080/23311975.2023.2167292>
- Saji, T. G. (2022). Revisit financial integration in Asia: New time-series evidence from stock

- markets. *The Indian Economic Journal*, 70(2), 209–228. <https://doi.org/10.1177/00194662221082197>
- Sehgal, S., Gupta, P., & Deisting, F. (2017). Assessing time-varying stock market integration in Economic and Monetary Union for normal and crisis periods. *European Journal of Finance*, 23(11), 1025–1058. <https://doi.org/10.1080/1351847X.2016.1158727>
- Sharpe, W. F. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk capital asset prices. *The Journal of Finance*, 19(3), 425–442. <https://doi.org/10.1111/j.1540-6261.1964.tb02865.x>
- Song, Y., Huang, R., Paramati, S. R., & Zakari, A. (2021). Does economic integration lead to financial market integration in the Asian region? *Economic Analysis and Policy*, 69, 366–377. <https://doi.org/10.1016/j.eap.2020.12.003>
- Stulz, R. M. (2022). Globalization, corporate finance, and the cost of capital. *Journal of Applied Corporate Finance*, 34(1), 8–23.
- Wang, X., Guo, H., Waris, M., & Din, B. H. (2024). Risk and causality co-movement of Malaysia’s stock market with its emerging and OECD trading partners. Evidence from the wavelet approach. *PLoS ONE*, 19(1), 1–33. <https://doi.org/10.1371/journal.pone.0296712>
- Wiesen, T. F. P., Adekoya, O. B., Oliyide, J., & Afatsao, R. (2024). Does high volatility increase connectedness? A study of Asian equity markets. *International Review of Financial Analysis*, 96(PB), 103735. <https://doi.org/10.1016/j.irfa.2024.103735>
- Wijeratne, D. (2018). *The Future of Asean - Time to Act*. (Issue May). <https://www.pwc.com/sg/en/publications/assets/healthcare-future-asean-2018.pdf>
- World Bank. (2024). *World Bank Country and Leading Groups*. <https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups>
- Yiu, M. S., & Tsang, A. (2021). *Impact of COVID-19 on ASEAN-5 Stock Markets* (WP/21-01, Issue January).
- Zhang, Y., Zhou, L., Chen, Y., & Liu, F. (2022). The contagion effect of jump risk across Asian stock markets during the Covid-19 pandemic. *North American Journal of Economics and Finance*, 61(March), 101688. <https://doi.org/10.1016/j.najef.2022.101688>