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# Connecting the Dots: Crises' Influence on Persistence and Financial Integration in Southeast Asian Capital Markets

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**Abstract:** *This study aimed to assess risk diversification in the capital markets of nine Asian countries, including Hong Kong, Indonesia, Malaysia, South Korea, Japan, the Philippines, Thailand, China, and Taiwan. The research posed two main questions: (i) Did events in 2020 and 2022 create inefficiencies in these markets? (ii) If so, did autocorrelation of returns lead to increased linkages among these markets? The findings revealed the presence of autocorrelation, conditional heteroscedasticity, and nonlinear elements in the sample, suggesting persistence in returns during both tranquil and stressful periods. Consequently, the first research question was refuted, indicating that market (in)efficiencies were not significantly influenced by these events. Additionally, the analysis using the rhoDCCA method did not suggest integration between the markets, leading to the rejection of the second research question. These results have implications for investors, regulators, and supervisors in these markets, suggesting a need to consider measures that align with the random walk and martingale hypotheses in stock price creation.*

## 1. INTRODUCTION

During periods characterized by uncertainty, both individual and institutional investors exhibit a heightened desire to possess enhanced predictive capabilities regarding the returns on their investments. This is driven by their intention to identify market inefficiencies and potential valuation errors, thereby enabling the implementation of investment strategies that can yield returns surpassing the market average. Furthermore, this can assist regulators and policymakers in formulating policies that foster financial stability, mitigate systemic risk, and uphold the principles of fairness and transparency in markets (Dias, Pardal, et al., 2022; Dias, Pereira, et al., 2022; Pardal et al., 2022; Teixeira, Dias, & Pardal, 2022; Teixeira, Dias, Pardal & Horta, 2022).

In recent research investigations, it has been noted that during times of stress and global instability, there is a tendency for markets to exhibit a certain level of integration. Additionally, there is evidence of persistence in returns, suggesting that price changes are not independent or identically distributed. This implies that market prices may not fully reflect all the available information. When markets exhibit an overreaction to information, it signifies a delay in the adjustment of this information, granting investors the opportunity to obtain abnormal returns without assuming additional risk (Guedes et al., 2022; Zebende et al., 2022).

The objective of this study is to assess the risk diversification potential of two significant phenomena observed in recent years: the examination of (in)efficiency in its weak form and the investigation of financial integration in the capital markets of Southeast Asia. Specifically, this research focuses on the stock indexes of Hong Kong (HSI), Indonesia (JKSE), Malaysia (KLSE),

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South Korea (KOSPI), Japan (NIKKEI 225), the Philippines (PSEi), Thailand (SET), China (SSE), and Taiwan (TSEC). The study period spans from 2 January 2018 to 10 November 2022. The findings indicate the presence of persistence in returns. However, when employing the Detrended Fluctuation Analysis (DFA) model to quantify this persistence in two distinct subperiods, we observe that it is evident during the subperiod characterized by market stability, as well as during the events of 2020 and 2022. Consequently, we are compelled to reject the initial research question. To address the second research question regarding the impact of persistence on integration within regional markets, an examination of the *rhoDCCA* coefficients for two distinct subperiods was conducted. The analysis revealed a transition from anti-persistence to weak persistence in the majority of cases. Consequently, the findings prompt the rejection of the second research question.

In terms of contributions to existing research, this is the first study, as far as we know, to analyze the predictability of returns and tie it to the level of integration in Southeast Asian capital markets during the 2020 and 2022 events. Furthermore, we know that the authors' studies Pardal et al. (2022), Dias, Pardal, et al. (2022), Dias, Pereira, et al. (2022), and Teixeira, Dias, Pardal, and Horta (2022) evaluated the international financial markets during the events of 2020 and 2022, but the research issues, methodology used, and markets examined were fundamentally different from the following in this investigation.

This article is divided into five sections. The current section is the introduction. Section 2 includes a bibliographic review with references to empirical studies that investigated efficiency in its weak form and international financial market integration. Section 3 shows the sample data as well as the methods used. Section 4 details the discovered results. Section 5 summarizes the investigation's overall findings.

## 2. LITERATURE REVIEW

### 2.1. Market Efficiency, in Its Weak Form, in International Capital Markets

Many scholars contend that they encounter efficient financial markets wherein the prices of traded securities accurately reflect all pertinent information and promptly adjust to new information. Furthermore, this perspective assumes that the market's information is readily accessible without any associated costs (Fama, 1965a, 1965b, 1970, 1991). The efficient market theory posits that investors are unable to achieve abnormal returns when accounting for risk. However, previous research has presented contrasting findings, indicating that investors have the potential to achieve returns beyond the market average (Fama & French, 1988, 1993).

In the study conducted by Lin (2012), the efficient market hypothesis was examined on Asian stock exchanges from January 2003 to December 2011. The author employed Ljung-Box autocorrelation models and variance ratio tests for this purpose. The results indicate that the Hong Kong (Hang Seng) and India (BSE) markets exhibit efficiency in their weak form, whereas the Singapore (STI) market displays indications of (in)efficiency. Furthermore, Rizvi and Arshad (2016) employed the MF-DFA economic model to analyze weak-form efficiency in the capital markets of Malaysia, Indonesia, Singapore, and South Korea. Their study aimed to compare the Asian crisis with the subprime crisis. The obtained results suggest that there are indications of (in)efficiency in the markets, and the rejection of the random walk hypothesis differs depending on the economic structure of the countries in which the stock market operates.

Recently, Zebende et al. (2022) used intraday data to quantify market efficiency in the G20 capital markets using the DFA and DCCA methods. The results of the DFA demonstrate that, in the pandemic times of COVID-19, stock exchanges tend to be efficient for deadlines less than 5 days but inefficient for terms more than 10 days. The DCCA data demonstrates a variety of patterns for each stock market. Furthermore, Guedes et al. (2022) investigated if the financial crises of the recent 20 years (2000–2021) impacted efficiency, in its weak form, in 19 G20 stock markets. The results of the study indicate (in)efficiency in each sliding window (1000 days), and the DFA exponents have values greater than 0.5, indicating long memories in their profitability.

## 2.2. International Capital Market Integration

According to conceptual understanding, financial integration in markets occurs when assets exhibiting equivalent levels of risk yield comparable returns and are exchanged within distinct market domains. The term "integration" can be described empirically as the phenomenon wherein non-stable individual series achieve stability when joined linearly (Pardal et al., 2020; Teixeira, Dias, & Pardal, 2022).

In their study, Qizam et al. (2015) investigated the long-term interconnectivity dynamics between the capital markets of Indonesia, Malaysia, the Philippines, Singapore, and Thailand. The authors discovered that these markets had a high level of integration from September 2007 to October 2012. Furthermore, they discovered that these links frequently involve bidirectional shocks, which make portfolio diversification efforts difficult. Gulzar et al. (2019) examined the integration of emerging capital markets in Asia, notably India, China, Pakistan, Malaysia, Russia, and South Korea, with the United States in their study. The study looked at the time before, during, and after the 2008 financial crisis. The study's findings demonstrated long-term financial integration between the US market and emerging stock markets, particularly in the post-crisis era.

The authors, Stevanius and Sukamulja (2020), emphasize the significant level of integration observed in 2020 between the Indonesian market and the capital markets of Malaysia, Thailand, South Korea, Japan, Singapore, and Hong Kong. Habiba et al. (2020) analyzed the co-integration of the stock markets in the United States and South Asia, specifically focusing on the markets of India, Pakistan, and Sri Lanka. The study examined the period before, during, and after the global financial crisis of 2008. The authors emphasize notable degrees of interconnectedness, hence raising doubts regarding the feasibility of portfolio diversification.

Subsequently, Song et al. (2021) conducted a study examining the effects of economic integration between India's stock market and prominent Asian markets, including China, Indonesia, Japan, South Korea, Malaysia, the Philippines, Singapore, and Thailand. The study encompassed the period from September 1999 to December 2017. The authors provide evidence and argue, based on their findings, that the potential for portfolio diversification may be undermined by the significant levels of financial integration observed in the examined capital markets.

In a recent study, Shi (2022) examined the integration and co-movement dynamics between China's stock market and 12 trading partners in the Asia-Pacific area subsequent to the global financial crisis of 2008. The empirical findings indicate that there has been an upsurge in the shocks experienced by China's stock markets and its trading partners, primarily attributed to recent occurrences like the Shanghai stock market crisis, the US-China tariff war, and the COVID-19 pandemic. The authors Teixeira, Dias, Pardal and Horta (2022) evaluated the synchronizations

between the capital markets of Germany, the USA, France, the United Kingdom, Italy, Russia, Japan, Canada, and China and the oil markets in the US, Asia, Canada, Emirates, China, Nigeria, and the United Kingdom during the events of 2020 and 2022, highlighting that long-term relations between the financial markets did not help to explain short-term movements, suggesting that the oil indexes can be considered safe ports for efficient portfolio diversification.

## 3. DATA AND METHODOLOGY

### 3.1. Data

The daily price index data for the capital markets of Hong Kong (HSI), Indonesia (JKSE), Malaysia (KLSE), South Korea (KOSPI), Japan (NIKKEI 225), the Philippines (PSEi), Thailand (SET), China (SSE), and Taiwan (TSEC) were collected from the Thomson Reuters Eikon platform. The data covers the period from January 2, 2018, to November 10, 2022. To enhance the robustness of the study, the sample was partitioned into two distinct subperiods: "Tranquil" (January 2, 2018, to December 31, 2019) and "Stress" (January 1, 2020, to November 10, 2022). In order to address exchange rate distortions and avoid distortions of achieved outcomes, quotes are expressed in the local currency.

### 3.2. Methodology

To address the research questions, the approach employed will be established through a series of sequential steps. To initially assess the stationarity of the time series, a panel unit root test of Levin et al. (2002) will be employed. This test aims to determine if the series adheres to a white noise process characterized by a means of zero and constant variance. In order to assess the potential occurrence of structural breaks as a consequence of the heightened volatility observed over the periods of 2020 and 2022, the methodology proposed by Clemente et al. (1998) will be employed. To address the initial research question, an assessment will be conducted to determine if the time series exhibit autocorrelation in their returns. To achieve this objective, we will use autocorrelation econometric tests, namely the Ljung and Box (1978), ARCH-LM test proposed by Engle (1982), to estimate the presence of conditional heteroscedasticity. Furthermore, the BDS test developed by Brock and de Lima (1996) will also be used to evaluate the linearity of the time series. However, it should be noted that this particular model artifact lacks the ability to accurately measure the degree of autocorrelation. As a result, we will need to employ the Detrended Fluctuation Analysis (DFA), which is an econophysical model, in order to estimate and analyze this aspect. To address the second research question, the methodology employed will involve the application of the Detrended Cross-Correlation Coefficient *ρDCCA* (*rhoDCCA*). This method will enable the assessment of whether there exists a discernible tendency towards financial integration during periods characterized by stress and uncertainty in the capital markets of Southeast Asia, which are the focus of the analysis. The objective is to examine the plausibility of portfolio diversification in light of these findings.

The explanation of the exponents $\alpha_{DFA}$ and *ρDCCA* can be found in Tables 1 and 2.

**Table 1.** Detrended Fluctuation Analysis αDFA

| Exponent | Signal Type |
|---|---|
| $\alpha_{DFA} < 0.5$ | long-range anti-persistent |
| $\alpha_{DFA} \simeq 0.5$ | uncorrelated, white noise |
| $\alpha_{DFA} > 0.5$ | long-range persistent |

**Source:** Own elaboration

**Table 2.** Detrended Cross-Correlation Coefficient pDCCA

| Weak | Medium | Strong |
|---|---|---|
| ≦ 0.000 → ≦ 0.333 | ≦ 0.333 → ≦ 0.666 | ≦ 0.666 → ≦ 1.000 |

**Source:** Own elaboration

## 4. RESULTS AND DISCUSSION

Figure 1 depicts the evolution of levels in the nine capital markets under consideration over the whole study period. The investigated stock indexes clearly indicate structural breaks in the time series, indicating the volatility to which these stock markets were subjected, particularly in the first months of 2020, which coincides with the occurrence of the first wave of the COVID-19 pandemic. Fluctuations in the time series can be seen as early as 2022, primarily in the first and third quarters of the year, implying structural breaks, a situation that may eventually be explained by the impact of Russia's invasion of Ukraine and subsequent concerns about rising associated inflation.

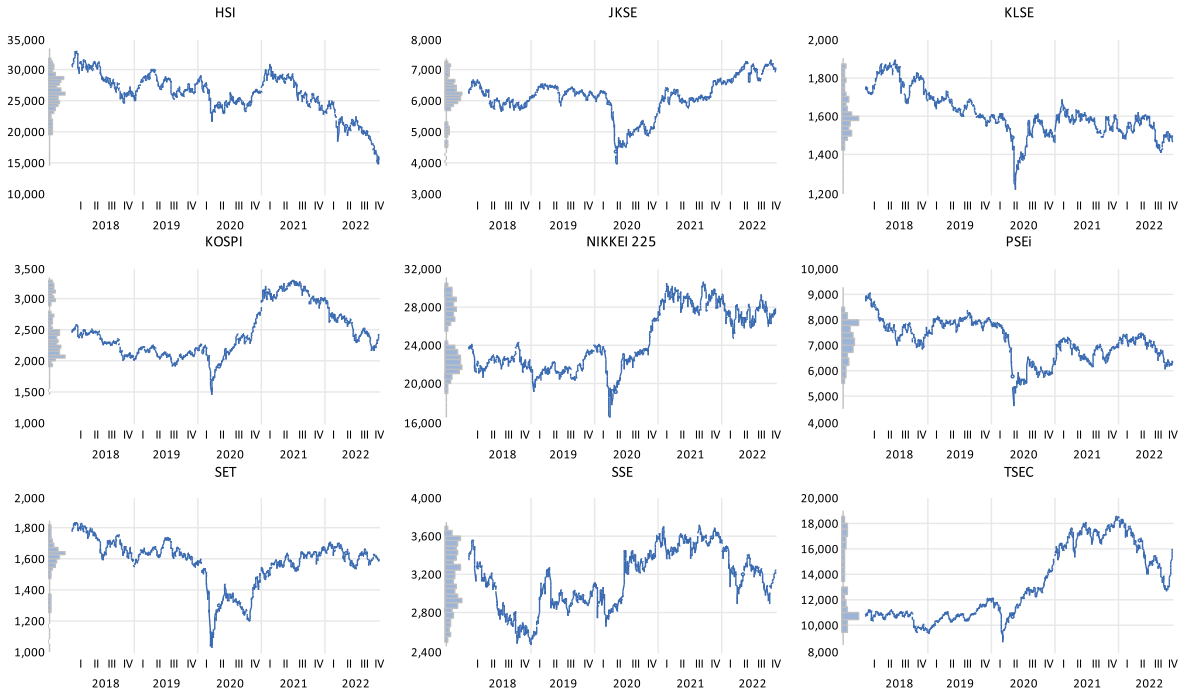


**Figure 1.** Evolution, in levels, for the 9 capital markets under analysis from January 2, 2018, to November 10, 2022

**Source:** Own elaboration

The evaluation of time series concerning their stationarity is significant as it enables the comprehension of underlying trends and patterns in the data while also facilitating the identification of potential fluctuations. Table 3 presents the outcomes derived from the LLC (2002) test, which examines the null hypothesis that posits the existence of a unit root (inconsistent variance) inside the panel data's time series. Based on the information supplied, it can be inferred that throughout the specified period, at a significant level of 1%, there is an absence of a unit root, indicating the rejection of the null hypothesis in the first differences.

The findings of the unit root test of Clemente et al. (1998), with structural breaks, applied to the 9 capital markets under analysis for the two subperiods under examination are provided in table

4. During the tranquil subperiod, it is feasible to see that the Asian markets had the most significant structural breakdown in 2018. There were concerns that year that the US Fed would raise interest rates more than expected, producing a collapse trend in international markets, with the Asian region bearing the brunt of the impact. The most severe structural breaks in the Stress subperiod are due to the global pandemic of 2020, except the HSI stock index, which has its most substantial fall in 2022, coinciding with Russia's invasion of Ukraine. These conclusions are supported by the authors Pardal et al. (2022), Dias, Pardal, et al. (2022), Dias, Pereira, et al. (2022), highlighting structural breaks caused by events in 2020 and 2022.

**Table 3.** Panel unit root test, applied to 9 capital markets under analysis for the full-time period sample

| **Method** | | | | | **Statistics** | **Probability**** |
|---|---|---|---|---|---|---|
| **Levin, Lin & Chu t*** | | | | | -132.424 | 0.0000 |
| | **Coefficient** | ***t*-Stat** | **SE Reg** | **mu*** | **sig*** | **Observations** |
| Pooled | -0.99857 | -100.558 | 1.001 | -0.500 | 0.707 | 10736 |

**Note:** ** Probability is assumed as asymptomatically normal.

**Source:** Own elaboration

**Table 4.** Unit root test from Clemente et al. (1998), with structural breaks, concerning the capital markets of Southeast Asia

| | **Tranquil Period** | | **Stress Period** | |
|---|---|---|---|---|
| | **02/01/2018 a 31/12/2019** | | **01/01/2020 a 10/11/2022** | |
| **Stock Exchange** | ***t*-stat** | **Break Date** | ***t*-stat** | **Break Date** |
| **HSI** | -22.45790 (0)*** | 06/02/2018 | -27.58790 (0)*** | 23/03/2022 |
| **JKSE** | -22.56739 (0)*** | 18/09/2018 | -27.15514 (0)*** | 12/05/2020 |
| **KLSE** | -22.06478 (0)*** | 27/07/2018 | -28.60787 (0)*** | 15/05/2020 |
| **KOSPI** | -21.88841 (0)*** | 29/01/2018 | -27.06296 (0)*** | 19/03/2020 |
| **NIKKEI 225** | -23.80133 (0)*** | 02/02/2018 | -27.63558 (0)*** | 01/04/2020 |
| **PSEi** | -38.03594 (0)*** | 10/01/2018 | -42.20247 (0)*** | 14/01/2020 |
| **SET** | -21.80880 (0)*** | 20/06/2018 | -50.70630 (0)*** | 18/12/2020 |
| **SSE** | -22.59823 (0)*** | 24/04/2019 | -27.13685 (0)*** | 17/01/2020 |
| **TSEC** | -24.53457 (0)*** | 06/02/2018 | -25.41780 (0)*** | 20/10/2020 |

**Notes:** Lag Lenght (Automatic Length based on SIC). Break Selection: Minimize Dickey-Fuller t-statistic. The lateral values between parentheses relate to lags. The asterisks ***, **, * represent the significance of the statistics at 1%, 5% and 10% respectively.

**Source:** Own elaboration

The findings of the Ljung-Box test, applied to the 9 capital markets examined for the entire sample period, are presented in Table 5. To assess the level of autocorrelation, the original returns were examined for 4 and 12 lag days. The analysis revealed that when the lags increase, the autocorrelation exhibits a higher level of persistence. In order to verify the findings, an identical model was employed, incorporating squared returns as well as lagged values at intervals of 4 and 12. The analysis demonstrated an increase in the persistence of autocorrelation, except for the Hong Kong Index (HSI), which exhibited a comparatively smaller rise in autocorrelation, particularly to the original returns.

In order to verify the findings of the Ljung-Box test, an assessment of conditional heteroscedasticity in temporal data was conducted using Engle's Lagrange Multiplier test (ARCH-LM test) as proposed in 1982. The ARCH-LM tests were conducted on residuals from a first-order autoregressive process for a lag of 10 days. Table 6 presents evidence indicating that the residuals

of autoregressive processes in the capital markets of Southeast Asia exhibit conditional heteroscedasticity, which aligns with the common occurrence of this characteristic in financial assets. The findings of this study confirm the validity of the Ljung-Box tests conducted on squared returns with lag periods of 4 and 12, as presented in Table 5.

**Table 5.** Ljung and Box's (1978) test results applied to the time series residues pertaining to the financial markets under study from January 2, 2018, to November 10, 2022

| Stock Exchange | LB (4) | LB (12) | $LB^2$ (4) | $LB^2$ (12) |
|---|---|---|---|---|
| **HSI** | 4.8393 | 16.041 | 222.63*** | 279.59*** |
| **JKSE** | 11.720** | 28.847*** | 312.79*** | 789.85*** |
| **KLSE** | 12.056** | 22.067** | 311.69*** | 623.91*** |
| **KOSPI** | 8.0097* | 21.881** | 511.98*** | 621.29*** |
| **NIKKEI 225** | 9.7543** | 23.065** | 249.58*** | 557.53*** |
| **PSEi** | 11.887** | 15.807 | 118.01*** | 476.94*** |
| **SET** | 15.906*** | 69.989*** | 196.83*** | 696.98*** |
| **SSE** | 9.8237** | 21.939** | 23.826*** | 49.090*** |
| **TSEC** | 11.704** | 18.187 | 305.28*** | 392.01*** |

**Note:** The asterisks *, **, and *** indicate the statistical significance at 1%, 5%, and 10%, respectively.

**Source:** Own elaboration

**Table 6.** ARCH-LM test applied to the residues of the time series, relating to the financial markets under review, from 2 January 2018 to 10 November 2022

| Stock Exchange | ARCH-LM (10 lags) |
|---|---|
| **HSI** | 18.22159*** |
| **JKSE** | 28.31304*** |
| **KLSE** | 44.95503*** |
| **KOSPI** | 45.79618*** |
| **NIKKEI 225** | 183.4122*** |
| **PSEi** | 5.501505** |
| **SET** | 40.08408*** |
| **SSE** | 3.352062*** |
| **TSEC** | 20.94755*** |

**Note:** The asterisks *, **, and *** indicate the statistical significance at 1%, 5%, and 10%, respectively.

**Source:** Own elaboration

To verify the outcomes of the Ljung-Box tests conducted on the squared returns, specifically for lag days of 4 and 12, and the ARCH-LM tests performed on the residuals of first-order autoregressive processes, specifically for a lag day of 10, the Brock and de Lima (1996) BDS test was employed to detect the existence of nonlinear components. The results of the BDS test can be seen in Table 7, indicating that the hypothesis of independent and identically distributed (i.i.d) returns is rejected at a statistical significance level of 1% from dimension 2. These findings provide more support for the assumption that stock index returns exhibit nonlinearity or possess a substantial nonlinear element. The present findings provide support for the outcomes obtained by Ljung-Box's autocorrelation test and the ARCH-LM's examination of conditional heteroscedasticity. The above evidence has been substantiated by Revez et al. (2022) and Guedes et al. (2022), indicating the existence of persistent trends in returns throughout global capital markets.

Table 8 validates the results of the Detrended Fluctuation Analysis (DFA) exponents applied to the time series of the 9 capital markets under consideration for the two subperiods: Tranquilo and Stress. Long memories may be observed in the stock indexes KLSE (0.59), SSE (0.56), KOSPI (0.57), SET (0.55), Nikkei 225 (0.54) and TSEC (0.54) during the Tranquil subperiod, while markets

in the Philippines (PSEi - 0.48), Indonesia (JKSE - 0.47) show signs of anti-persistence, i.e., short-term memories, and Hong Kong (0.51) shows signs of some balance. Already in the stress subperiod, it can be observed that the stock markets of SET (0.65), KOSPI (0.59), JKSE (0.58), KLSE (0.58, TSEC (0.56) and Nikkei 225 (0.55), show signs of (in) efficiency quite significant, while the HSI stock index (0.47) shows some anti persistence, as the markets in the Philippines (PSEi - 0.51) and China (SSE - 0.49), suggest some balance during the events of 2020 and 2022. These findings highlight that the global pandemic of 2020 and the Russian invasion of Ukraine in 2022 did not increase the persistence of returns in these regional markets, even though this autocorrelation was already present in the Peaceful subperiod. As a result of these findings, the first research question is rejected, namely, that the events in 2020 and 2022 did not accentuate the persistence of returns.

**Table 7.** The BDS test applied to the residues of the time series relating to the financial markets under review from January 2, 2018, to November 10, 2022

| Stock Exchange | Dimension (2) | Dimension (3) | Dimension (4) | Dimension (5) | Dimension (6) |
|---|---|---|---|---|---|
| **HSI** | 1.789176* | 2.625399*** | 3.561366*** | 4.373404*** | 5.171091*** |
| **JKSE** | 9.231350*** | 10.91309*** | 11.30731*** | 11.69457*** | 12.16552*** |
| **KLSE** | 7.213532*** | 7.765237*** | 8.265813*** | 9.186513*** | 10.05533*** |
| **KOSPI** | 7.997180*** | 10.11833*** | 11.31711*** | 12.18097*** | 13.03395*** |
| **NIKKEI 225** | 5.188243*** | 7.292188*** | 8.474536*** | 9.414761*** | 9.974192*** |
| **PSEi** | 4.284193*** | 4.981881*** | 5.974118*** | 6.797873*** | 7.490943*** |
| **SET** | 6.037695*** | 8.130050*** | 9.433205*** | 10.01199*** | 10.58819*** |
| **SSE** | 2.823340*** | 4.585408*** | 5.409197*** | 6.001483*** | 6.322955*** |
| **TSEC** | 5.146626*** | 7.339224*** | 8.658569*** | 9.853241*** | 10.71121*** |

**Note:** The method considered in the BDS test was the fraction of pairs, for a value of 0.7. The second to last column relates to the size of the diving (embedding dimension). The values shown in the table refer to z-Statistic. The asterisks ***, **, *, represent the significance of statistics at 1%, 5%, 10%, respectively.

**Source:** Own elaboration

**Table 8.** Detrended Fluctuation Analysis (DFA) results

| Indexes | DFA Exponent (Tranquil) 02/01/2018 a 31/12/2019 | DFA Exponent (Stress) 01/01/2020 a 10/11/2022 |
|---|---|---|
| **HSI** | 0.51 ≅ 0,0013 ($R^2$ = 0,98) | 0.47** ≅ 0,0048 ($R^2$ = 0,99) |
| **JKSE** | 0.47** ≅ 0.0075 ($R^2$ = 0,99) | 0.58*** ≅ 0.0018 ($R^2$ = 0,98) |
| **KLSE** | 0.59*** ≅ 0,0020 ($R^2$ = 0,98) | 0.58*** ≅ 0,0081 ($R^2$ = 0,98) |
| **KOSPI** | 0.57*** ≅ 0.0010 ($R^2$ = 0,98) | 0.59*** ≅ 0.0010 ($R^2$ = 0,98) |
| **NIKKEI 225** | 0.54*** ≅ 0,0088 ($R^2$ = 0,99) | 0.55*** ≅ 0,0011 ($R^2$ = 0,98) |
| **PSEi** | 0.48** ≅ 0.0022 ($R^2$ = 0,97) | 0.51 ≅ 0.0219 ($R^2$ = 0,97) |
| **SET** | 0.55*** ≅ 0,0012 ($R^2$ = 0,98) | 0.65*** ≅ 0,0023 ($R^2$ = 0,97) |
| **SSE** | 0.56*** ≅ 0.0029 ($R^2$ = 0,99) | 0.49 ≅ 0.0207 ($R^2$ = 0,97) |
| **TSEC** | 0.54*** ≅ 0,0011 ($R^2$ = 0,98) | 0.56*** ≅ 0,0063 ($R^2$ = 0,99) |

**Note:** The hypotheses are $H_0 = 0.5$ and $H_1 \neq 0.5$. The asterisks ***, **, *, represent the significance of the statistics at 1%, 5%, 10%, respectively.

**Source:** Own elaboration

Table 9 shows the Detrended Cross-Correlation Coefficient ($\rho DCCA$) coefficients for the 9 capital markets studied over two subperiods: Tranquil and Stress. The $\rho DCCA$ coefficients for the Tranquil subperiod reveal 19 anti-persistent (negative autocorrelation) correlation components, 8 mean correlations (≅ 0.333 → ≅ 0.666), 6 weak correlating factors (≅ 0.000 → ≅ 0.333), and 3 cross-correlation factors without strong trends (0.666 → ≅ 1.000). These findings indicate that the markets under consideration are not integrated, implying that risk mitigation through diversification may

be a smart approach for investors operating in these Southeast Asian regional markets. During the Stress subperiod, there are 18 weak correlation coefficients (≦ 0.000 → ≦ 0.333), 10 mean correlations (≦ 0.333 → ≦ 0.666), 7 anti-persistent correlated coefficients (negative autocorrelation), and 1 strong correlating coefficient (0.666 → ≦ 1.000). When the two subperiods were compared, it was discovered that the *ρDCCA* climbed from anti-persistent to weak and medium non-trend correlation coefficients in the majority of cases. To answer the second research question, which is whether the persistence of returns drove the integration of these regional markets, the answer is no, which means that the second investigation question is rejected due to a lack of evidence.

**Table 9.** A summary of the *ρDCCA* coeficients, applied to the 9 Asian capital markets, regarding the Tranquilo and Stress subperiods

| Índices | Tranquilo 02/01/2018 a 31/12/2019 | | | Stress 01/01/2020 a 10/11/2022 | | |
|---|---|---|---|---|---|---|
| | *ρDCCA* | Period (days) | Trend | *ρDCCA* | Period (days) | Trend |
| **KOSPI \| HSI** | 0.68 | n > 35 | Strong | 0.36 | n > 29 | Médio |
| **KOSPI \| JKSE** | -0.18 | n > 43 | Anti-persistent | 0.16 | n > 136 | Weak |
| **KOSPI \| SSE** | 0.33 | n > 29 | Medium | 0.21 | n > 112 | Weak |
| **KOSPI \| TSEC** | 0.64 | n > 4 | Medium | 0.39 | n > 112 | Medium |
| **KOSPI \| NIKKEI** | -0.01 | n > 53 | Anti-persistent | 0.63 | n > 92 | Medium |
| **KOSPI \| SET** | 0.67 | n > 63 | Strong | 0.58 | n > 63 | Medium |
| **KOSPI \| PSEi** | 0.13 | n > 76 | Weak | 0.18 | n > 43 | Weak |
| **KOSPI \| KLSE** | -0.13 | n > 63 | Anti-persistent | -0.02 | n > 63 | Anti-persistent |
| **HIS \| JKSE** | -0.11 | n > 43 | Anti-persistent | -0.07 | n > 76 | Anti-persistent |
| **HIS \| SSE** | 0.33 | n > 29 | Medium | 0.17 | n > 112 | Weak |
| **HIS \| TSEC** | 0.39 | n > 29 | Medium | 0.15 | n > 112 | Weak |
| **HIS \| NIKKEI** | 0.44 | n > 35 | Medium | 0.38 | n > 35 | Medium |
| **HIS \| SET** | 0.67 | n > 52 | Strong | 0.21 | n > 52 | Weak |
| **HIS \| PSEi** | 0.11 | n > 76 | Weak | 0.05 | n > 24 | Weak |
| **HIS \| KLSE** | -0.11 | n > 63 | Anti-persistent | 0.03 | n > 29 | Weak |
| **JKSE \| SSE** | -0.11 | n > 24 | Anti-persistent | -0.01 | n > 24 | Anti-persistent |
| **JKSE \| TSEC** | -0.23 | n > 43 | Anti-persistent | 0.07 | n > 43 | Weak |
| **JKSE \| NIKKEI** | 0.19 | n > 35 | Weak | 0.06 | n > 35 | Weak |
| **JKSE \| SET** | -0.11 | n > 52 | Anti-persistent | -0.29 | n > 76 | Anti-persistent |
| **JKSE \| PSEi** | 0.42 | n > 24 | Medium | 0.67 | n > 136 | Strong |
| **JKSE \| KLSE** | -0.10 | n > 29 | Anti-persistent | 0.47 | n > 112 | Medium |
| **SSE \| TSEC** | 0.43 | n > 20 | Medium | 0.39 | n > 76 | Medium |
| **SSE \| NIKKEI** | -0.18 | n > 29 | Anti-persistent | 0.18 | n > 112 | Weak |
| **SSE \| SET** | 0.35 | n > 52 | Weak | 0.16 | n > 52 | Weak |
| **SSE \| PSEi** | \| 0.07 | n > 24 | Anti \| persistent | 0.19 | n > 76 | Weak |
| **SSE \| KLSE** | \| 0.05 | n > 29 | Anti \| persistent | 0.04 | n > 92 | Weak |
| **TSEC \| NIKKEI** | \| 0.11 | n > 29 | Anti \| persistent | 0.22 | n > 112 | Weak |
| **TSEC \| SET** | 0.38 | n > 35 | Medium | 0.50 | n > 112 | Medium |
| **TSEC \| PSEi** | \| 0.11 | n > 16 | Anti \| persistent | 0.16 | n > 136 | Weak |
| **TSEC \| KLSE** | \| 0.07 | n > 52 | Anti \| persistent | \| 0.12 | n > 92 | Anti \| persistent |
| **NIKKEI \| SET** | \| 0.03 | n > 16 | Anti \| persistent | 0.48 | n > 92 | Medium |
| **NIKKEI \| PSEi** | 0.16 | n > 17 | Weak | 0.02 | n > 13 | Weak |
| **NIKKEI \| KLSE** | \| 0.03 | n > 52 | Anti \| persistent | \| 0.15 | n > 76 | Anti \| persistent |
| **SET \| PSEi** | 0.12 | n > 52 | Weak | 0.02 | n > 52 | Weak |
| **SET \| KLSE** | \| 0.13 | n > 63 | Anti \| persistent | \| 0.38 | n > 112 | Anti \| persistent |
| **PSEi \| KLSE** | \| 0.12 | n > 43 | Anti \| persistent | 0.39 | n > 136 | Medium |

**Source:** Own elaboration

## 5. CONCLUSION

The objective of this research was to examine the phenomenon of risk diversification within the capital markets of various Asian nations, namely Hong Kong, Indonesia, Malaysia, South Korea, Japan, the Philippines, Thailand, China, and Taiwan. The study focused on the period spanning from 2 January 2017 to 31 December 2017. The findings of the analysis indicate that the occurrences in 2020 and 2022 did not exert a noteworthy influence on the persistent nature of returns within these markets. This suggests that the state of market efficiency was already established during times characterized by relative tranquility. Moreover, the findings of the study indicate that the existence of persistence and long-term memories did not result in increased financial integration across the regional capital markets. On the contrary, these markets appeared to remain separate and distinct from one another. In conclusion, investors, regulatory authorities, and supervisors have the potential to use these findings to influence their supervisory policies and actions, thereby maintaining stability and efficiency within capital markets. In conclusion, this study provides significant insights for all parties involved in Asian financial markets, offering assistance for their future decision-making and strategic endeavors.

## References

Brock, W. A., & de Lima, P. J. F. (1996). 11 Nonlinear time series, complexity theory, and finance. *In Handbook of Statistics* (Vol. 14). https://doi.org/10.1016/S0169-7161(96)14013-X

Clemente, J., Montañés, A., & Reyes, M. (1998). Testing for a unit root in variables with a double change in the mean. *Economics Letters, 59*(2), 175–182. https://doi.org/10.1016/S0165-1765(98)00052-4

Dias, R., Pereira, J. M., & Carvalho, L. C. (2022). Are African Stock Markets Efficient? A Comparative Analysis Between Six African Markets, the UK, Japan and the USA in the Period of the Pandemic. *Naše Gospodarstvo/Our Economy, 68*(1), 35–51. https://doi.org/10.2478/ngoe-2022-0004

Dias, R. T., Pardal, P., Teixeira, N., & Horta, N. R. (2022). Tail Risk and Return Predictability for Europe's Capital Markets: An Approach in Periods of the 2020 and 2022 Crises. Advances in Human Resources *Management and Organizational Development*, 281-298. https://doi.org/10.4018/978-1-6684-5666-8.ch015

Engle, R. F. (1982). Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation. *Econometrica, 50*(4), 987. https://doi.org/10.2307/1912773

Fama, E. F. (1965a). Random Walks in Stock Market Prices. *Financial Analysts Journal, 21*(5). https://doi.org/10.2469/faj.v21.n5.55

Fama, E. F. (1965b). The Behavior of Stock-Market Prices. *The Journal of Business, 38*(1). https://doi.org/10.1086/294743

Fama, E. F. (1970). Efficient Capital Markets: A Review of Theory and Empirical Work. *The Journal of Finance, 25*(2). https://doi.org/10.2307/2325486

Fama, E. F. (1991). Efficient Capital Markets: II. *The Journal of Finance, 46*(5). https://doi.org/10.2307/2328565

Fama, E. F., & French, K. R. (1988). Dividend yields and expected stock returns. *Journal of Financial Economics, 22*(1). https://doi.org/10.1016/0304-405X(88)90020-7

Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics, 33*(1). https://doi.org/10.1016/0304-405X(93)90023-5

Guedes, E. F., Santos, R. P. C., Figueredo, L. H. R., Da Silva, P. A., Dias, R. M. T. S., & Zebende, G. F. (2022). Efficiency and Long-Range Correlation in G-20 Stock Indexes: A Sliding Windows Approach. *Fluctuation and Noise Letters*. https://doi.org/10.1142/S021947752250033X

Gulzar, S., Mujtaba Kayani, G., Xiaofeng, H., Ayub, U., & Rafique, A. (2019). Financial cointegration and spillover effect of global financial crisis: a study of emerging Asian financial markets. *Economic Research-Ekonomska Istraživanja, 32*(1), 187-218. https://doi.org/10.1080/1331677x.2018.1550001

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). https://doi.org/10.1108/JABS-03-2019-0071

Levin, A., Lin, C. F., & Chu, C. S. J. (2002). Unit root tests in panel data: Asymptotic and finite-sample properties. *Journal of Econometrics, 108*(1). https://doi.org/10.1016/S0304-4076(01)00098-7

Lin, F. (2012). Extreme Dependence Across East Asian Financial Markets: Evidence in Equity and Currency Markets. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2173390

Ljung, G. M., & Box, G. E. P. (1978). On a measure of lack of fit in time series models. *Biometrika, 65*(2). https://doi.org/10.1093/biomet/65.2.297

Pardal, P., Dias, R., Šuleř, P., Teixeira, N., & Krulický, T. (2020). Integration in Central European capital markets in the context of the global COVID-19 pandemic. Equilibrium. *Quarterly Journal of Economics and Economic Policy, 15*(4), 627-650. https://doi.org/10.24136/eq.2020.027

Pardal, P., Dias, R. T., Teixeira, N., & Horta, N. R. (2022). The Effects of Russia's 2022 Invasion of Ukraine on Global Markets: An Analysis of Particular Capital and Foreign Exchange Markets. *Advances in Human Resources Management and Organizational Development,* 262-280. https://doi.org/10.4018/978-1-6684-5666-8.ch014

Qizam, I., Qoyum, A., & Ardiansyah, M. (2015). Global Financial Crisis and Islamic Capital Market Integration among 5-ASEAN Countries. *Global Review of Islamic Economics and Business, 2*(3). https://doi.org/10.14421/grieb.2015.023-04

Revez, C., Dias, R., Horta, N., Heliodoro, P., & Alexandre, P. (2022). Capital Market Efficiency in Asia: An Empirical Analysis. 6th EMAN Selected Papers (Part of EMAN Conference Collection), 49–57. https://doi.org/10.31410/eman.s.p.2022.49

Rizvi, S. A. R., & Arshad, S. (2016). How does crisis affect efficiency? An empirical study of East Asian markets. *Borsa Istanbul Review, 16*(1). https://doi.org/10.1016/j.bir.2015.12.003

Shi, Y. (2022). What influences stock market co-movements between China and its Asia-Pacific trading partners after the Global Financial Crisis? *Pacific Basin Finance Journal, 72*. https://doi.org/10.1016/j.pacfin.2022.101722

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

Stevanius, S., & Sukamulja, S. (2020). Co-integration and Co-movement Between Asian Stock Price Index and Jakarta Composite Index. *Indonesian Capital Market Review, 12*(1). https://doi.org/10.21002/icmr.v12i1.12175

Teixeira, N., Dias, R., & Pardal, P. (2022). The gold market as a safe haven when stock markets exhibit pronounced levels of risk : evidence during the China crisis and the COVID-19 pandemic. April, 27–42.

Teixeira, N., Dias, R. T., Pardal, P., & Horta, N. R. (2022). Financial Integration and Comovements Between Capital Markets and Oil Markets: An Approach During the Russian Invasion of Ukraine in 2022. *Advances in Human Resources Management and Organizational Development,* 240-261. https://doi.org/10.4018/978-1-6684-5666-8.ch013

Zebende, G. F., Santos Dias, R. M. T., & de Aguiar, L. C. (2022). Stock market efficiency: An intraday case of study about the G-20 group. *Heliyon, 8*(1), e08808. https://doi.org/10.1016/j.heliyon.2022.e08808