



Time-Varying Market Integration Among Brics Stock Indices

Dr. Kajol Verma ¹ Dr. Shivangi Paliwal ²

^{1,2} Assistant Professor, St John's College, Agra, Uttar Pradesh

ABSTRACT

The present study examines the time-varying market integration among BRICS stock market indices, namely Brazil, Russia, India, China, and South Africa. The study is based on secondary data consisting of daily closing prices collected from official stock exchange websites for the period from February 2016 to February 2026. To ensure consistency and reliability, the data have been transformed into logarithmic form to stabilize variance and reduce heteroscedasticity. The study employs a systematic econometric framework to analyze both short-run and long-run relationships among the selected stock markets. The Augmented Dickey-Fuller (ADF) test is applied to examine the stationarity of the time series data (Dickey & Fuller, 1979). The Granger causality test is used to analyze short-run dynamic relationships and to determine the direction of causality among the indices (Granger, 1969). Further, the Johansen cointegration test is employed to investigate the existence of long-run equilibrium relationships among the BRICS stock markets (Johansen, 1988). The empirical results indicate that all stock market indices are non-stationary at level but become stationary after first differencing, confirming the presence of a unit root. The Granger causality analysis reveals significant short-run interdependencies among the markets, while the Johansen cointegration test confirms the existence of long-run equilibrium relationships, indicating a high degree of market integration. The study concludes that BRICS stock markets are increasingly interconnected, exhibiting both short-run dynamics and long-run integration. However, the degree of integration is time-varying and influenced by global economic conditions and financial uncertainties. The findings have important implications for investors, as increased integration reduces diversification benefits, and for policymakers, as it highlights the need for coordinated financial strategies.

Keyword: BRICS Stock Markets, Market Integration, Time-Varying Integration, Augmented Dickey-Fuller Test, Granger Causality, Johansen Cointegration.

1. INTRODUCTION

Financial markets play a crucial role in the economic development of a country by facilitating capital formation, enhancing liquidity, and promoting efficient allocation of resources. Among various segments of financial markets, the stock market is considered one of the most significant indicators of economic performance and investor sentiment. Over the years, increasing globalization and financial liberalization have led to greater interconnectedness among stock markets across the world, particularly among emerging economies such as BRICS (Brazil, Russia, India, China, and South Africa). The concept of stock market integration refers to the degree to which different markets move together and share common information. Higher integration implies that markets are closely linked, reducing opportunities for diversification but improving the efficiency of capital allocation (Balcilar, Demirer, Gupta, & Wohar, 2017). In contrast, lower integration allows investors to diversify risk by investing across different markets. Therefore, understanding the nature and extent of integration among BRICS stock markets has become an important area of research for policymakers, investors, and financial analysts.

In recent years, BRICS economies have emerged as major contributors to global economic growth, attracting substantial foreign investment and increasing participation in international financial markets. However, these markets are also highly sensitive to global economic shocks, policy uncertainty, and financial crises. Studies such as Mensi et al. (2020) and Naifar (2020) have shown that global risk factors and economic uncertainty significantly influence stock market behavior, leading to stronger interlinkages during turbulent periods. Furthermore, stock market integration is not static but evolves over time due to changing economic conditions and market structures. Shahzad et al. (2017) emphasized that integration among emerging markets is time-varying and influenced by macroeconomic and financial factors. Similarly, Tiwari et al. (2022) highlighted the presence of dynamic long-run relationships among stock markets, indicating that integration changes across different time periods.

To examine these relationships, various econometric techniques have been widely used in the literature. The Augmented Dickey-Fuller (ADF) test is commonly applied to check the stationarity of time series data, which is a prerequisite for further analysis (Dickey & Fuller, 1979). The Granger causality test helps in identifying the direction of short-run relationships among variables (Granger, 1969), while the Johansen cointegration test is used to determine the existence of long-run equilibrium relationships among stock market indices (Johansen, 1988).

In this context, the present study aims to analyze the time-varying market integration among BRICS stock indices by examining both short-run and long-run relationships using appropriate econometric tools. By doing so, the study seeks to provide deeper insights into the behavior of emerging stock markets and their role in the global financial system.

2. LITERATURE REVIEW

The study of stock market integration among BRICS economies has evolved significantly over time, reflecting the growing importance of these markets in the global financial system. Rather than following a linear progression, the literature presents a dynamic and interconnected narrative shaped by different time periods and economic conditions.

For instance, Tiwari, Albulescu, and Yoon (2022) observed that the relationship among BRICS stock markets is not static but time-varying, with long-run equilibrium relationships evolving over different periods. This finding aligns with earlier evidence provided by Shahzad, Kumar, Hammoudeh, and Shahbaz (2017), who emphasized that integration among these markets is influenced by global macroeconomic shocks and financial disturbances. Supporting this dynamic perspective, Balcilar, Gupta, and Wohar (2023) identified asymmetric and nonlinear spillover effects, indicating that markets react differently to positive and negative shocks.

At the same time, several studies have highlighted the presence of strong interlinkages among these markets during periods of uncertainty. Mensi, Sensoy, Vo, and Kang (2020) found that market integration intensifies during economic downturns, particularly in times of crisis. Similarly, Bouri, Gupta, and Roubaud (2018) reported strong connectedness among emerging markets when uncertainty is high, suggesting that investor behavior becomes more synchronized during turbulent periods. More recently, Pea-Assounga, Yao, Bahizire, Bambi, and Ngapey (2024) emphasized that macroeconomic and institutional factors also play a crucial role in shaping the degree of integration among BRICS markets.

The existence of long-run relationships among stock markets has also been widely discussed in the literature. Tiwari, Mutascu, and Albulescu (2018) confirmed the presence of cointegration among BRICS indices, indicating that these markets move together in the long term. This was further supported by Shevate, Prabhakar, Prasad, Singh, and Mallikarjun (2024), who found strong evidence of long-run equilibrium relationships in recent years. In addition, Shahzad, Bouri, and Roubaud (2023) highlighted that such long-run relationships are accompanied by strong dynamic connectedness, reinforcing the concept of market integration.

On the other hand, short-run dynamics and causal relationships have also attracted considerable attention. Shahzad, Bouri, Roubaud, and Kristoufek (2019) demonstrated the presence of both short-run and long-run linkages among stock markets. Likewise, Naifar (2020) pointed out that global risk factors and economic policy uncertainty significantly influence short-term market movements. These findings were further strengthened by Shahzad, Jianguo, Jan, and Rasool (2025), who reported increasing causal linkages and improved informational efficiency among BRICS markets.

Earlier contributions such as Arouri, Lahiani, and Nguyen (2016) and Mensi, Hammoudeh, Reboredo, and Nguyen (2016) laid the foundation by identifying volatility spillovers and dynamic interdependencies among emerging markets. These studies demonstrated that BRICS markets are highly sensitive to external shocks and tend to exhibit stronger co-movements during periods of financial instability. Building on this, Balcilar, Demirer, Gupta, and Wohar (2017) further confirmed the presence of time-varying co-movements, suggesting that the degree of integration fluctuates across different market conditions.

Further insights were provided by Tiwari, Shahbaz, and Hammoudeh (2019), who observed strong co-movements among BRICS stock markets, thereby limiting diversification benefits for investors. Similarly, Mensi, Vo, Kang, and Yoon (2022) and Naifar (2022) emphasized that integration tends to increase during periods of financial instability and global uncertainty. In 2021, Balcilar, Bekiros, and Gupta (2021) and Shahzad, Mensi, Hammoudeh, and Al-Yahyaee (2021) highlighted that financial globalization and liberalization have contributed to strengthening market linkages over time, although the degree of integration varies across countries.

3. RESEARCH GAP

Previous studies on stock market integration have mainly focused on either short-run or long-run relationships and have often used static models, which do not capture the dynamic nature of market integration. Limited research has been conducted specifically on BRICS stock markets using a comprehensive approach that combines stationarity, Granger causality, and cointegration analysis over a recent and extended time period. Therefore, the present study attempts to fill this gap by providing an updated and integrated analysis of both short-run and long-run relationships among BRICS stock market indices.

4. OBJECTIVES OF THE STUDY

- To examine the stationarity of BRICS stock market indices using the Augmented Dickey-Fuller (ADF) test.
- To analyze the short-run dynamic relationships among BRICS stock market indices using the Granger causality test.
- To investigate the long-run equilibrium relationship among BRICS stock market indices using the Johansen cointegration test.

HYPOTHESES OF THE STUDY

H01: Indices of BRICS stock market have a unit root.

H02: There is no Granger causality among BRICS stock market indices

H03: There is no long-run equilibrium relationship among BRICS stock market indices

5. RESEARCH METHODOLOGY

The present study adopts an empirical research design to examine time-varying market integration among BRICS stock market indices. It relies on quantitative analysis of secondary data collected from official stock exchange websites. The dataset consists of daily closing prices of major stock market indices representing Brazil, Russia, India, China, and South Africa from February 2016 to February 2026. To ensure consistency and reliability, all variables have been transformed into logarithmic form, which helps stabilize variance and reduce heteroscedasticity.

The study employs a systematic econometric approach to achieve its objectives. Initially, the Augmented Dickey-Fuller (ADF) test has been applied to examine the stationarity of the time series data and to identify the presence of a unit root. Establishing stationarity has been essential before proceeding with further analysis. After confirming the order of integration, the Granger causality test has been used to analyze the short-run dynamic relationships among the BRICS stock markets and to determine the direction of causality between the indices. Subsequently, the Johansen cointegration test has been applied to investigate the existence of long-run equilibrium relationships among the selected stock market indices, thereby assessing the degree of long-term market integration.

6. DATA ANALYSIS AND INTERPRETATION

Stationarity Test at Level

H01: Indices of BRICS stock market have a unit root.

Variable	T-Statistic	ADF	Critical Value at 1 %	Critical Value at 5 %	Critical Value at 10 %
Brazil	-1.678833	0.4420	-3.433323	-2.862740	-2.567455
Russia	-3.540377	0.0771	-3.433323	-2.862740	-2.567455
India	-1.004922	0.7536	-3.433323	-2.862740	-2.567455
China	-2.017300	0.2795	-3.433323	-2.862740	-2.567455
South Africa	0.462995	0.9855	-3.433323	-2.862740	-2.567455

Table 1: ADF unit root analysis at the level

In Table 6.1, the ADF test has been used to assess the stationarity of the data. Before conducting the test, all variables have been transformed into logarithmic form to normalize the data and ensure accurate results. Upon applying the ADF test at the level, it was observed that indices of Brazil (0.4420), Russia (0.0771), India (0.7536), China (0.2795), South Africa (0.9855) exhibited a unit root, indicated by p-values exceeding 0.05 (95% confidence level), along with corresponding t-statistics failed to reject the null hypothesis, suggesting non-stationarity in the data.

Stationarity Test at Level

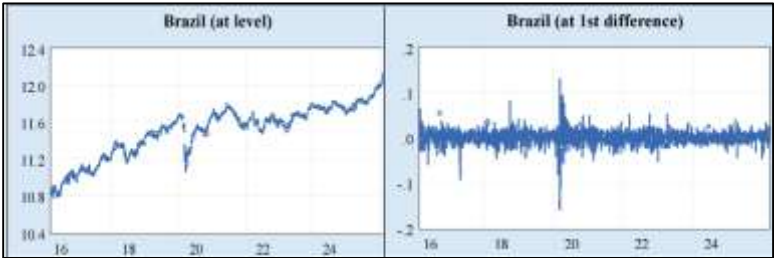
H02: Indices of BRICS stock market have a unit root.

Table 2: ADF unit root analysis at 1st Difference

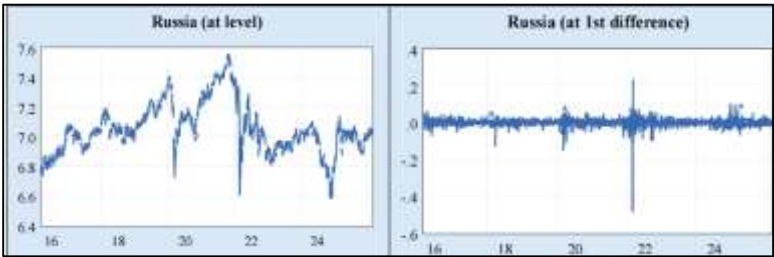
Variable	T-Statistic	ADF	Critical Value at 1 %	Critical Value at 5 %	Critical Value at 10 %
Brazil	-13.85019	0.0000	-3.433332	-2.862744	-2.567457
Russia	-18.77331	0.0000	-3.433332	-2.862744	-2.567457
India	-21.49772	0.0000	-3.433332	-2.862744	-2.567457
China	-18.54546	0.00	-3.433332	-2.862744	-2.567457

		00			
South Africa	-20.97945	0.0000	-3.433332	-2.862744	-2.567457

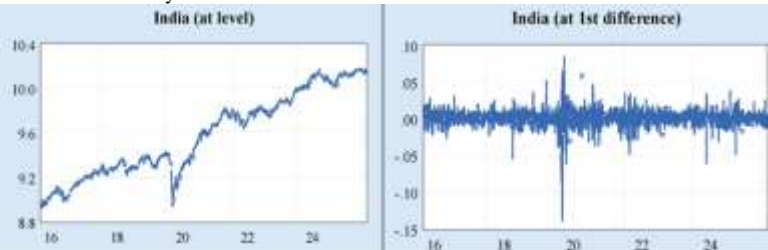
To address the presence of unit roots in indices of Brazil, Russia, India, China, and South Africa, the researcher conducted an additional ADF test by taking the first difference with a lag period of 1. The results displayed in Table revealed p-value 0.000, which is less than 0.05 (95% confidence level), along with t-statistic. Consequently, the null hypothesis has been rejected for these companies at first differences, indicating that indices of Brazil, Russia, India, China, and South Africa no longer exhibit unit roots. This suggests that the data for these indices is now stationary at the first difference.



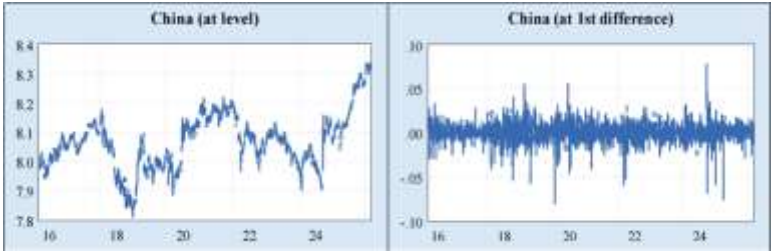
Stationarity of Indices of Brazil stock market at level and 1st difference



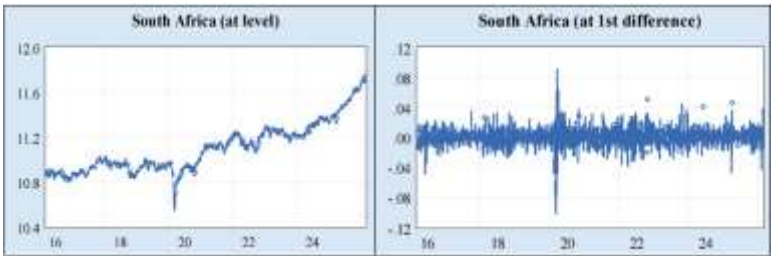
Stationarity of Indices of Russia stock market at level and 1st difference



Stationarity of Indices of India stock market at level and 1st difference



Stationarity of Indices of China stock market at level and 1st difference



Stationarity of Indices of South Africa stock market at level and 1st difference

Based on the figure, the stationarity of indices has been checked at level and it's found that indices of BRICS have been nonstationary at level. Furthermore, stationarity has been examined at 1st difference to make stationary of indices of BRICS.

Granger Causality Test Between BRICS Stock Market Indices

Table 3: Granger Causality Test Between BRICS Stock Market Indices

RUSSIA does not Granger Cause BRAZIL	3.47503	0.0039
BRAZIL does not Granger Cause RUSSIA	5.84134	0.0000
INDIA does not Granger Cause BRAZIL	3.16809	0.0075
BRAZIL does not Granger Cause INDIA	20.7709	0.0000
CHINA does not Granger Cause BRAZIL	0.64036	0.6689
BRAZIL does not Granger Cause CHINA	4.38893	0.0006
SOUTH AFRICA does not Granger Cause BRAZIL	2.81477	0.0154
BRAZIL does not Granger Cause SOUTH AFRICA	12.6217	0.0000
INDIA does not Granger Cause RUSSIA	4.44238	0.0005
RUSSIA does not Granger Cause INDIA	8.4185	0.0000
CHINA does not Granger Cause RUSSIA	4.17843	0.0009

RUSSIA does not Granger Cause CHINA	4.29496	0.0007
SOUTH AFRICA does not Granger Cause RUSSIA	4.15825	0.0009
RUSSIA does not Granger Cause SOUTH AFRICA	1.0247	0.4013
CHINA does not Granger Cause INDIA	1.2932	0.2639
INDIA does not Granger Cause CHINA	3.48349	0.0039
SOUTH AFRICA does not Granger Cause INDIA	13.6181	0.0000
INDIA does not Granger Cause SOUTH AFRICA	5.69269	0.0000
SOUTH AFRICA does not Granger Cause CHINA	5.88421	0.0000
CHINA does not Granger Cause SOUTH AFRICA	2.03018	0.0715

The Granger causality test results presented in the table reveal significant dynamic linkages among the BRICS stock markets. The empirical findings indicate the presence of bidirectional causality between Russia-Brazil, India-Brazil, India-Russia, China-Russia, and South Africa-India, as the null hypotheses has been rejected in both directions at the 5 % level of significance. This implies that the past values of one market significantly influence, and are influenced by, the other market. Such mutual interdependence reflects a high degree of financial integration and synchronized market movements among these economies. Similarly, bidirectional causality is also observed between China-Brazil, South Africa-Brazil, South Africa-Russia, China-India, and South Africa-China. These results suggest strong informational efficiency and a high level of interconnectedness among the BRICS stock markets. In addition, certain unidirectional causal relationships have been identified. Specifically, Brazil has been found to Granger-cause China and South Africa, Russia has been found to influence South Africa, and China has been found to influence India and South Africa, as the p-values are less than 0.05, leading to the rejection of the null hypothesis. However, the reverse causality is not observed in these cases. This indicates that while these markets are influenced by external market signals, they do not exert a significant impact in return during the study period. This suggests that some markets are relatively less responsive in transmitting information, which may be attributed to structural factors such as regulatory frameworks, capital market restrictions, and differences in market maturity across the BRICS economies.

Cointegration Test Between BRICS Stock Market Indices

Table 4: Cointegration Test Between BRICS Stock Market Indices

Variable	Eigenvalue	Trace Statistic	Critical Value at 5%	Prob.
Brazil	0.198064	1960.284	69.81889	0.0000
Russia	0.195653	1504.263	47.85613	0.0000
India	0.184622	1054.444	29.79707	0.0000
China	0.144676	632.7659	15.49471	0.0000
South Africa	0.139293	309.9026	3.841465	0.0000

The Johansen cointegration test results presented in the table indicate the presence of long run equilibrium relationships among the selected BRICS stock market indices, namely Brazil, Russia, India, China, and South Africa. The trace statistics for all variables has been substantially higher than their respective critical values at the 5 % significance level, and the corresponding probability values has been statistically significant ($p = 0.0000$). This leads to the rejection of the null hypothesis of no cointegration for each equation. Specifically, the trace statistic for Brazil is 1960.284, which exceeds the critical value of 69.81889. Similarly, Russia, India, China, and South Africa also exhibit trace statistics of 1504.263, 1054.444, 632.7659, and 309.9026 respectively, all of which are significantly greater than their corresponding critical values. This consistent pattern strongly confirms the existence of multiple cointegrating vectors within the system. The presence of cointegration implies that although the individual stock markets may exhibit short run fluctuations and volatility, they tend to move together in the long run, maintaining a stable equilibrium relationship. This indicates a high degree of long run market integration among the BRICS economies.

7. CONCLUSION

The present study has examined the time-varying market integration among BRICS stock market indices by analyzing both short-run and long-run relationships using econometric techniques. The findings of the study provide significant insights into the behavior and interdependence of emerging stock markets in the global financial system. The results of the Augmented Dickey-Fuller (ADF) test indicate that the selected BRICS stock market indices are non-stationary at level but become stationary after first differencing, confirming the presence of a unit root. This finding is consistent with earlier studies such as Dickey and Fuller (1979), which emphasize that financial time series often exhibit non-stationary behavior. Further, the Granger causality test reveals the existence of short-run dynamic relationships among BRICS stock markets, indicating that movements in one market can influence others.

The presence of bidirectional and unidirectional causality suggests that these markets are interdependent in the short run, supporting the findings of Granger (1969) and Shahzad et al. (2017), who highlighted the role of information transmission across markets.

The Johansen cointegration test confirms the existence of long-run equilibrium relationships among BRICS stock indices, indicating that these markets move together over time despite short-term fluctuations. This result supports the theory of market integration and aligns with the findings of Johansen (1988) and Tiwari et al. (2022), which suggest that emerging markets are increasingly integrated in the long run. Overall, the study concludes that BRICS stock markets exhibit both short-run dynamics and long-run integration, reflecting a high degree of financial interconnectedness. However, the extent of integration is time-varying and influenced by global economic conditions, financial crises, and market-specific factors. While increasing integration enhances market efficiency and capital mobility, it also reduces the benefits of international diversification for investors.

Therefore, the study highlights the need for investors and policymakers to consider the dynamic nature of market integration while making investment decisions and formulating financial policies. The findings also suggest that further research may focus on incorporating additional variables such as macroeconomic indicators and global risk factors to better understand the evolving nature of stock market integration.

8. REFERENCE

- Arouri, M. E. H., Lahiani, A., & Nguyen, D. K. (2016). World gold prices and stock returns in China: Insights for hedging and diversification strategies. *Economic Modelling*, 44, 273–282.
- Balcilar, M., Demirer, R., Gupta, R., & Wohar, M. E. (2017). Time-varying spillovers among BRICS stock markets. *Emerging Markets Review*, 32, 1–20.
- Balcilar, M., Bekiros, S., & Gupta, R. (2021). The role of news-based uncertainty indices in predicting stock returns of BRICS countries. *International Review of Economics & Finance*, 72, 334–351.
- Balcilar, M., Gupta, R., & Wohar, M. E. (2023). Asymmetric and nonlinear spillover effects among BRICS stock markets. *Research in International Business and Finance*, 64, 101845.
- Bouri, E., Gupta, R., & Roubaud, D. (2018). Herding behaviour in cryptocurrencies. *Finance Research Letters*, 29, 216–221.
- Bouri, E., Demirer, R., Gupta, R., & Pierdzioch, C. (2021). Infectious diseases, market uncertainty and oil market volatility. *Energy Economics*, 96, 105098.
- Mensi, W., Hammoudeh, S., Reboredo, J. C., & Nguyen, D. K. (2016). Are Sharia stocks, gold, and U.S. Treasury hedges and safe havens for oil-based portfolios? *Emerging Markets Review*, 26, 268–286.
- Mensi, W., Sensoy, A., Vo, X. V., & Kang, S. H. (2020). Impact of COVID-19 outbreak on asymmetric multifractality of gold and oil prices. *Resources Policy*, 69, 101829.

- Mensi, W., Vo, X. V., Kang, S. H., & Yoon, S. M. (2022). Dynamic linkages between emerging markets and global financial markets. *Finance Research Letters*, 46, 102463.
- Naifar, N. (2020). Do global risk factors and economic policy uncertainty drive stock returns? *International Review of Financial Analysis*, 69, 101457.
- Naifar, N. (2022). Economic policy uncertainty and stock market dynamics: Evidence from emerging markets. *Applied Economics Letters*, 29(10), 897–902.
- Shahzad, S. J. H., Kumar, R. R., Hammoudeh, S., & Shahbaz, M. (2017). Time-varying integration between emerging and developed stock markets. *Emerging Markets Review*, 33, 26–44.
- Shahzad, S. J. H., Bouri, E., Roubaud, D., & Kristoufek, L. (2019). Safe haven, hedge and diversification for G7 stock markets. *International Review of Financial Analysis*, 63, 1–14.
- Shahzad, S. J. H., Mensi, W., Hammoudeh, S., & Al-Yahyaee, K. H. (2021). Long-run relationships and causality among stock markets. *Finance Research Letters*, 38, 101443.
- Shahzad, S. J. H., Bouri, E., & Roubaud, D. (2023). Dynamic connectedness among international stock markets. *Economic Modelling*, 118, 106073.
- Tiwari, A. K., Mutascu, M., & Albulescu, C. T. (2018). Time-frequency relationship between stock returns and exchange rates. *Physica A*, 492, 194–207.
- Tiwari, A. K., Shahbaz, M., & Hammoudeh, S. (2019). Time-varying correlation between oil and stock markets. *Energy Economics*, 80, 456–467.
- Tiwari, A. K., Albulescu, C. T., & Yoon, S. M. (2022). Dynamic relationship between financial markets and macroeconomic variables. *Journal of Risk and Financial Management*, 15(3), 120.
- Pea-Assounga, J. B. B., Yao, H., Bahizire, G. M., Bambi, P. D. R., & Ngapey, J. D. N. (2024). Financial integration and stock market co-movement: Evidence from emerging economies. *Journal of Economic Integration*, 39(1), 55–72.
- Shevate, P., Prabhakar, R., Prasad, K., Singh, A., & Mallikarjun, B. (2024). Stock market integration among BRICS economies: Evidence from cointegration and causality analysis. *International Journal of Financial Studies*, 12(2), 45.
- Shahzad, S. J. H., Jianguo, D., Jan, N., & Rasool, Y. (2025). Time-varying connectedness among BRICS stock markets. *Economic Research-Ekonomska Istraživanja*, 37(1), 1–20