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Exchange rate volatility, stock prices and returns in BRICS: The moderating effect of inflation with wavelength analysis

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Abstract. This study aimed to evaluate the conditional effect of exchange rate volatility on stock prices and returns in the emerging markets of BRICS nations. Using daily data from 1 January 2000 to 30 December 2023, wavelet and quantile analysis were conducted. The Markov-regime model was estimated for robustness check. The wavelet scale W1 exhibited a variance of 574.7375 and a relative percentage of 20.95% in explaining stock price variability, whereas wavelet scale W3 had a variance of 288.5577 and a relative proportion of 15.54%, and wavelet scale W2 had a variance of 159.5644 and a relative proportion of 8.59%. The implication was that BRICS stock markets react significantly to cumulative economic trends over the short term and sudden movements in exchange rates. The variance contribution for returns was found to increase with short-term scales, ranging from 0.0156 for W1 to 0.0643 for W3. This increase indicated that stock returns in BRICS countries were moderately reactive to abrupt exchange rate fluctuations, immediate shifts in inflation, and money supply variations. The short-term scales capture the market's rapid responses to economic news and updates. Such sensitivity to transient economic changes aligns with the results of earlier studies. Stock prices rose in response to an increase in the inflation rate across the quantiles, while stock returns were inversely and considerably influenced by the inflation rate. Also, highly significant negative responses of stock returns to variations in the exchange rate were found under both floating and fixed exchange rate regimes. Overall, when internal inflation exerts a strong moderating influence in an economic environment marked by severe volatility, market performance becomes highly responsive to fluctuations in currency values. The findings of this research will aid in the planning and development of policies by all governments, as well as the financial industry

Keywords: variation in money supply; cumulative variance; variance spectrum distribution; quantile regression; Markov-switching regression

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Introduction

BRICS refers to Brazil, Russia, India, China, and South Africa, the five largest emerging economies. As a result, over the past several decades, these nations have seen a continuous increase in international commerce, strengthening their economic and commercial ties. Exchange rate volatility has become increasingly important in commerce as a topic for scholars, investors, and decisionmakers due to these global developments. This is because exchange rates affect a wide range of indicators, organisations, and economic entities, including financial markets at both macro and local levels. Additionally, exchange rates are essential to every economy because they directly influence capital flows, exports, and imports. This is particularly true concerning financial exchanges and international trade between a country and the rest of the world. Accordingly, variations in the value of a national currency relative to other currencies are now considered to have an immediate impact on the cost and price levels of imported and exported goods and services, which can affect the overall competitiveness of the economy.

Numerous studies have examined the link between exchange rates and stock market dynamics in the empirical literature. For instance, during the period 2005-2021, C.A.G. Da Silva (2023) investigated the dynamic interaction between exchange rate fluctuations and stock market returns in Brazil, Argentina, Mexico, and India using the Markov Switching Vector Autoregressive model with regime shifts. The study's findings indicated that, in every emerging economy under consideration, the impact of exchange rate fluctuations on stock returns was not statistically significant. This suggests that, both during calm and tumultuous times, changes in the value of the US dollar had no bearing on the trajectory of stock market returns.

M. Atif *et al*. (2022) investigated the relationship between oil price fluctuations and stock returns in countries that import and export oil. Their study used a panel vector autoregression model, and the results confirmed a growing correlation between changes in stock prices and oil prices, particularly during the period when oil prices fell sharply due to the devastating effects of the COVID19 pandemic. The impulse response and error variance decomposition produced results similar to Granger causality. There were no differences in how volatile market prices affected countries that imported and exported oil. W. Boukraine (2020) used quarterly data from 2011 to 2019 to study the behaviour of the Tunisian currency about inflation. The study used a smooth transition autoregressive model, a nonlinear approach. The results provided evidence of a substantial short-term impact of increases in foreign debt, the real effective exchange rate, and inflation on economic growth. The results of the non-linearity tests supported the logistic smooth transition autoregressive specification, which offered a more accurate account of exchange rate pass-through to inflation in Tunisia over a decade.

Scholars, however, disagree about whether exchange rate volatility and stock prices are related. Hence, empirical research has led to two prominent schools of thought: those who maintain that there is no correlation between exchange rates and the stock market (Sokhanvar *et al*., 2024) and those who argue that there is (Chancharat & Suwannapak, 2024). These differing viewpoints clearly indicate that there is still debate regarding the question of whether stock prices and currency exchange rates are related. There are no definitive answers to the question of how exchange rates impact stock prices in economic theory or empirical data. Considerable debate surrounds the relationship between stock prices and currency exchange rates. Despite extensive research, the conclusions of the empirical literature on the link between real exchange rates and stock prices remain inconclusive. This gap in the literature underscores the relevance of the present study, which aimed to contribute to the ongoing discussion on stock prices and exchange rate dynamics. The primary aim of this article was to investigate, how exchange rate volatility affects stock prices and returns in BRICS.

Literature Review

It is important to review theories and empirical studies on the effects of exchange rate instability on stock prices and returns. According to F. Gale *et al*. (2019) and the International Monetary Fund (2023), China's economy exceeded Japan's in 2010 to take second place, while Brazil overtook the UK in 2013 to take sixth place. Collectively, the BRICS countries make up 25% of the world's landmass, 40% of its population, 30% of global economic growth, and an estimated 8.7 trillion USD in GDP (Glauben & Duric, 2024). The recent economic crisis has affected final demand in major economies (the US, Europe, and Japan, or the G3), but consumption has been expanding faster in the BRICS. The BRICS nations are increasingly dominating the control of world trade. The WTO (World Trade Organization) and UNCTAD (United Nations Conference on Trade and Development) reported that export growth was 25% in China, 38% in Brazil, and 28% in India (Global trade..., 2024). By 2024, their total exports amounted to 3.2 trillion USD (UN Comtrade, n.d.). The BRICS facilitated up to 60% of trade among low-income countries (Blanga-Gubbay & Rubínová, 2023; Global trade..., 2024). Moreover, those who trade in the stock markets and international travellers are similarly impacted by changes in exchange rates. For decades, researchers have attempted to comprehend the connection between exchange rates and stock prices. Many theoretical and empirical studies have been conducted to ascertain the causal relationship between these two financial variables. For example, the conventional perspective, as exemplified by

floworiented models, proposes that exchange rates influence stock prices. This viewpoint asserts that fluctuations in exchange rates impact a company's competitive position. Consequently, this affects the firm's earnings, overall financial health, and, in turn, the general trend in stock prices, as noted by D. Carter *et al*. (2022). However, in both theory and practice, the direction of causality has remained unclear. Despite several empirical studies identifying some correlations and causal links, no definitive causal relationship has been established. Additionally, it is also observed that the direction of causation has been observed to vary across different economies.

Many theoretical models attempt to explain the connection between stock-oriented prices and exchange rate volatility. These theories include stock and flow-oriented models. According to the flow-oriented model proposed by R. Dornbusch & S. Fischer (1980), exchange rate fluctuations affect international trade, which subsequently influences the real income and production of enterprises. Given that the key factor influencing a company's stock price is its expected future cash flows and discounted present value, changes in the exchange rate will affect the company's balance sheet and, consequently, its stock price. As a result, the flow-oriented model proposes that stock prices and exchange rates are positively correlated. Conversely, the portfolio balance model asserts that there is a negative correlation between exchange rates and stock prices (Adekoya, 2020). According to this hypothesis, changes in stock prices impact capital account transactions, which are the key drivers of exchange rates. Under the principle, when the stock market performs well, foreign money flows into the country, boosting the market and, consequently, the value of the currency. The stock-oriented hypothesis does not share the same assumptions as the theories outlined above regarding the relationship between the stock market and the exchange rate market. This theory suggests that a similar element, such as interest rates, is what drives movements in both markets (Karimo, 2020; Atenga & Mougoue, 2021; Salachas *et al*., 2024). The flow model illustrated, how changes in exchange rates impact a company's trade balance position as well as its capacity to compete globally.

I. Ogunsanya & T.W. Adamson (2024) discovered empirical evidence supporting the portfolio adjustment theory's assertion regarding the correlation between exchange rate fluctuations and stock returns. By directly affecting aggregate demand through wealth and liquidity effects, changes in stock prices have an indirect effect on exchange rate movements. For instance, a drop in stock prices lowers local investors' wealth of local investors and reduces liquidity. A decline in liquidity leads to a further drop in interest rates, which in turn encourages capital flight and depreciates the value of the currency. According to this theory, supply and demand for financial assets like stocks and bonds are balanced by the exchange rate. As a result, expectations regarding relative currency fluctuations have a significant impact on the price variations of financially held assets. Thus, changes in exchange rates trigger changes in stock prices. If the value of the Nigerian Naira drops concerning the US dollar, the returns on dollar-denominated assets increase. This encourages investors to move their funds from domestic financial assets to dollar-denominated investments, thereby lowering the cost of local stocks.

Materials and Methods

To explore the impact of exchange rate volatility, inflation, and money supply variation on stock returns and prices within BRICS countries, and given the nature of the data and the potential for nonlinear interactions and time-frequency variations in financial time series, the research incorporated wavelet transformations to handle these complexities. Suppose $z = (z_1, ..., z_T)'$ is the series collected on exchange rate volatility, inflation, and money supply variation affecting stock returns. The long-memory wavelet model for Z is defined as:

$$Z = X\beta + W^{1}w + e, \tag{1}$$

where $X = (x_1, ..., x_T)'$ – the design matrix; β – the corresponding regression coefficient vector; and W' – the inverse wavelet transform matrix. For each time series, stock returns, and prices, the mean structure is described by $X\beta$, while the dependence structure is characterised by the variance of w. In particular, the parameters governing the variance behaviour are described by the following equation:

$$Var(z) = W^{1}M\begin{pmatrix}\sigma_{-1}^{2}I\\ \sigma_{-1}^{2}I\\ \sigma_{-c}^{2}\Gamma_c\end{pmatrix}W + \sigma_e^2 I. \tag{2}$$

Accordingly, w satisfies the variance structures in (3) and (4), and $e = (e_1, ..., e_T)'$ is regression errors with , which are independent of w:

$$r_t = \begin{cases}\omega_j^2, j = -1,\dots,-l\\ \omega_0^2(2^{1-2d}-1)2^{2dj}, j = -(l+1),\dots,-j.\\ \omega_0^2 2^{2dj}, j = f\end{cases} \tag{3}$$

For a given $L(0 \le l \le l-1)$, the correlation matrix $(n_f = T2^{-J})$ satisfies Φ_f, where:

$$\Phi_f = \begin{pmatrix}1\beta\beta^2\dots\\ \beta 1\beta\dots\\ \beta^2\dots\dots\beta^2\\ \dots\dots\dots\beta\\ \dots\dots\beta^2\beta 1\end{pmatrix}. \tag{4}$$

Thus, the wavelet model specification became:

$$srtn_{W_t} = \beta_0 + \beta_1 W[(exrvol)] + \beta_2 W[inflr] + \beta_3 W[mssvt] + e_{W1_t}; \tag{5}$$

$$sprc_{W_t} = \delta_0 + \delta_1 W[(exrvol)] + \delta_2 W[inflr] + \delta_3 W[mssvt] + e_{W2_t}, \tag{6}$$

where δ's and β's – the wavelet coefficients of stock returns, exchange rate volatility, inflation, and GDP,

respectively. Here, e_t – the error term, and $W[\cdot]$ denotes the wavelet transform applied to each variable, converting them from the time domain into the time-frequency domain. The wavelet coefficients for stock returns, exchange rate volatility, inflation, and GDP were then estimated using a wavelet-based regression technique. This method involves decomposing each series (exchange rate volatility, inflation rate, and money supply variation) into a set of wavelet coefficients using a discrete wavelet transform (DWT). With the transformed data, a regression analysis was performed at each level of decomposition to estimate the effect of variations in each variable on stock returns and prices at various frequencies, capturing both short-term and long-term effects. The Mallat algorithm was implemented for the maximum likelihood estimation of the discrete wavelet coefficients. The asymptotic variance of the MLE for (θ, β) is the inverse of the information matrix satisfying:

$$I = \begin{pmatrix} I_{\beta\beta} & 0 \\ 0 & I_{\delta\delta} \end{pmatrix} = \begin{pmatrix} 0.5tr[(\varphi \sum) \sum -1 (\varphi \sum / \varphi\theta_j)] & 0 \\ 0 & Z \sum -1 Z \end{pmatrix}. \quad (7)$$

The research also estimated the conditional covariance of the exchange rate as a measure of its volatility across BRICS countries. The study employs the variation in money supply and inflation rate as control variables, while exchange rate volatility is the foremost predictor whose impact on stock returns and prices was assessed. The daily returns are calculated using the equation:

$$r_t = ln[p_t / p_{t-1}], \quad (8)$$

where r_t – the daily return at time t, p_t, and p_{t-1} – the closing price at time t and the previous adjusted closing price. A decomposition of stock returns yields:

$$r_t = E[r_t / I_{t-1}] + e_t. \quad (9)$$

By definition, $E\ [r_t\ /\ I_{t-1}]$ – the conditional mean that follows an autoregressive process capturing the expected return at time t, given all previously available information I_{t-1}. On the other hand, e_t is defined by the equation as follows:

$$e_t = z_t \sigma_t, \quad (10)$$

where σ_t – the conditional standard deviation of e_t, while the sequence of z_t – identically distributed with a zero mean and unit variance (Kumar *et al*., 2019). Based on the conditional variance model, that is, the autoregressive conditional heteroskedasticity (ARCH) model proposed by R.F. Engle (1982), equation (3) was estimated accordingly. In the ARCH model, the variance of the error term depends on previous variances of the error term, as shown in equation (11):

$$\sigma_t^2 = \delta_0 + \sum_{i=1}^{q} \delta_i e_{t\text{-i}}^2. \quad (11)$$

T. Bollerslev *et al*. (2006) expanded the ARCH model by adding a moving average component to develop the generalised autoregressive conditional heteroskedasticity (GARCH) model. The GARCH (p, q) model was specified as:

$$\sigma_t^2 = \delta_0 + \sum_{i=1}^{q} \delta_i e_{t\text{-}}^2 + \sum_{j=1}^{p} \beta_j \sigma_{t\text{-}j}^2. \quad (12)$$

The process is stationary if $\delta + \beta < 1$. The fulfilment of the stationarity condition leads to the convergence of the conditional variance towards the unconditional variance. The δ_i coefficients explain the speed at which market participants in BRICS react to market news, while β_j captures volatility persistence over time. The study estimated the quantile regression model, which allows for greater flexibility in modelling the relationship between variables. The quantile model specification is given as:

$$Q_{\emptyset}(y|X) = Q_{\emptyset}(\alpha_0 + \alpha_x X_{it} + \alpha_z H_{it} + \gamma_i + \sigma), \quad (13)$$

where $Q_{\emptyset}(y|X)$ – the conditional quantile function of the response variable (exchange rate) given the vector of predictors X, $\alpha(\emptyset)$ – a vector of parameters that depend on the $\emptyset^{th}$ quantile. The quantile regression estimator for quantile $\emptyset$ minimises the loss function:

$$(\alpha_{\emptyset}) = \sum_{i:y \geq X_i' \alpha}^{N} \emptyset |y_i - X_i' \alpha_{\emptyset}| + \sum_{i:y \geq X_i' \alpha}^{N} (1 - \emptyset) |y_i - X_i' \alpha_{\emptyset}|. \quad (14)$$

Quantile regression estimates the median effect by minimising the sum of absolute deviation errors, as specified in equation (14). Such quantile estimation produced the coefficients $\alpha_{1\emptyset}$, $\alpha_{2\emptyset}$, $\alpha_{3\emptyset}$, and $\alpha_{k\emptyset}$ at the $\emptyset^{th}$ quantile, given the values of X_i. Thus, the estimation of coefficients for different quantiles ($\emptyset$) provides a measure of how the impact of each variable varies across different levels of stock returns and stock prices in each country covered by the research. The rationale for estimating quantile regression is that it enables the estimation of various quantiles of stock returns and prices, even in the presence of non-normal data distributions. The estimation process involves the minimisation of weighted absolute deviations through optimisation algorithms. Quantiles in the tables were calculated for $p = 0.25$ using the Rankit (Cleveland) method. A unit root test, the Pedroni cointegration test, and Markov-switching regression were used in the calculations. The unit root tests were conducted at both the level and first difference for the variables stock price (SPRC), exchange rate volatility (EXRVL), inflation (INFLR), money supply volatility (MSSVL) and stock return (SRTN). When comparing the alternative hypothesis – that a unit root does not exist – to the null hypothesis, which states that the series is non-stationary and has a unit root, the authors accepted the alternative hypothesis, suggesting the presence of a unit root. The purpose of the Pedroni cointegration test conducted in this research was to determine whether the variables exhibited signs of cointegration. Eviews 13 was also used for data processing. An asymmetric GARCH (AGARCH) model was used to describe the conditional standard deviation of stock prices. To conduct a comprehensive study on this topic, the analysis covered the period from 2019 to 2023. Daily data from 1 January 2000 to 30 December 2023 were sourced from the World Bank and the International Monetary Fund

databanks. In particular, the International Monetary Fund (2023) was a primary source.

Results and Discussion

Table 1 presented the descriptive statistics of the variables in the study. The mean values of the stock price (SPRC) are 22.61692, 4.797323, 355.5192, 156.487, and 40.00897 for Brazil, Russia, India, China, and South Africa, respectively. As shown in Table 1, India had the highest stock price during the period of the analysis. The standard deviation values from the mean values are 1341.48, 123.5870, 109.390, 10.2370, and 302.497 for the aforementioned countries, respectively. Kurtosis, a measure of the peakedness of a distribution, indicates that all values are greater than 3.0. The distribution is leptokurtic, meaning it is sharply peaked and heavy-tailed, as all other variables have kurtosis values exceeding 3. To determine the asymptotic properties of the test, the probability values for the distribution are compared to the results of the Jarque-Bera normality test. It can be inferred from the table that all variables exhibit low probability values, and since the means and medians are almost equal, it may be concluded that the residuals of the distribution follow a normal distribution.

Table 1. *Description statistics of the stock prices for BRICS*

Country	Mean	Max	Min	Quantiles	*SD*	Kurtosis
Brazil	22.61692	1,421.498	51.42061	1.13E+12	1,341.48	7.707
Russia	4.797323	8.488170	6.782594	3.47E+11	123.5870	15.938
India	355.5192	42,000.00	2,947.733	1.80E+13	109.390	59.949
China	156.487	1,899.589	-1.401473	1.308E+12	10.2370	22.962
South Africa	40.00897	6,133.375	262.0754	2.55E+12	302.497	6.814
All	480,215.3	1.13E+10	20,605,052	1.95E+27	1.155E+123	9.509

Source: *calculated by the authors*

Table 2 contained the descriptive statistics for stock returns in BRICS. According to the table, the mean return values for Brazil, Russia, India, China, and South Africa were 120, 162.21, 170.92, 1,726.24, and 3,027.18, respectively. The standard deviation of returns was lowest for Brazil, with a value of 11.32, while that of South Africa was the highest, at 134.6. Table 3 contained the descriptive statistics for exchange rate volatility in BRICS. According to the table, the mean volatility rate for the currencies was 1.2932 for the Brazilian real, 2.3271 for the Russian ruble, 3.0918 for the Indian rupee, 0.27345 for the Chinese yuan, and 2.03862 for the South African rand concerning the US dollar. The highest standard deviation of currency rates, 3.2309, was reported for the South African rand. The kurtosis coefficients for the volatility of these currencies show that the rand was leptokurtic, implying that the rand/dollar exchange rate exhibits significant deviations from the mean exchange rate.

Table 2. *Description statistics of the stock returns for BRICS*

Country	Mean	Max	Min	Quantiles	*SD*	Kurtosis
Brazil	120.89	1,672.298	120.379	1.10E+19	11.320	2.305
Russia	162.21	1,755.209	100.3297	2.17E+10	13.298	1.294
India	170.92	2,930.437	1,200.379	1.20E+14	181.237	9.282
China	1,726.24	29,387.100	1,345.301	1.89E+15	101.90	4.279
South Africa	3,027.18	3,875.279	142.3874	2.67E+14	134.548	19.287
All	3,259.389	1.14E+15	2,389.387	1.52E+20	1.121E+10	10.393

Source: *calculated by the authors*

Table 3. *Description statistics of the exchange rate volatility for BRICS*

Country	Mean	Max	Min	Quantiles	*SD*	Kurtosis
Brazil	1.2932	2.3208	0.00287	1.21E+12	0.29189	1.2039
Russia	2.3271	1.2389	1.02892	1.57E+10	2.38930	2.2087
India	3.0918	4.28102	0.19537	1.0E+12	1.02738	2.0314
China	0.27345	1.207400	0.01928	0.1262+10	0.13257	1.20328
South Africa	2.03862	5.38189	1.20383	1.56E+13	3.2309	3.10287
All	12.37947	2.393190	1.20893	1.05E+26	20.33618	1.3289

Source: *calculated by the authors*

Table 4 contained the descriptive statistics for stock returns in BRICS. According to the table, the mean inflation rate was highest in Russia at 190.4%, followed by China and South Africa at 176.4% and 109.4%, respectively. India had the highest standard deviation in inflation, followed by China and Russia. The kurtosis coefficients for the inflation rate in Russia and South Africa are 7.3893 and 12.349, respectively. This indicated that

the distribution of inflation rates in those two countries is leptokurtic, meaning it has fat tails, which suggested a higher frequency of extreme deviations from the average price level in those countries.

Table 4. *Description statistics of the inflation rate for BRICS*

Country	Mean	Max	Min	Quantiles	*SD*	Kurtosis
Brazil	10.3487	20.387	12.3837	1.13E+10	23.478	1.29832
Russia	190.387	35.5957	19.3562	5.40E+11	29.490	7.3893
India	27.3467	28.3834	10.289	1.20E+00	160.487	16.383
China	176.3874	25.487	19.2386	1.00E+05	60.336	3.2381
South Africa	109.386	27.1558	19.4253	1.56E+16	12.494	12.349
All	189.384	123.4310	20.3487	1.23E+47	1.10E+13	7.2194

Source: *calculated by the authors*

Table 5 belowed reports the summary statistics for variations in broad money supply in BRICS. The highest variation in money supply was recorded in South Africa, with a mean value of 12620.3%, while China, with a mean value of 1,435.3%, ranked second. Meanwhile, China and Russia, with values of 147.3% and 145.9%, respectively, exhibited the highest volatility in broad money supply. South Africa had the highest kurtosis coefficient, 20.395, while Russia ranked second with 19.289. This indicated that the distribution of money supply in these two countries is leptokurtic, with a tendency towards extreme outliers in money supply values. In other words, money supply changes in these countries have a high tendency to deviate significantly from the average.

Table 5. *Description statistics of the money supply variation for BRICS*

Country	Mean	Max	Min	Quantiles	*SD*	Kurtosis
Brazil	120.93	126,093.03	190.34879	1.22E+15	110.298	12.389
Russia	190.329	14,639.39	234.5658	4.567E+12	145.862	19.289
India	203.4855	3,562.186	187.5860	1.21E+14	123.4794	5.279
China	1,435.28	34,257.289	1,003.494	1.66E+23	147.300	16.081
South Africa	12,620.30	1,783.332	18,309.271	1.23E+10	111.289	20.395
All	24,755.358	4,566.6720	35,729.287	1.05E+23	1.03E+10	11.379

Source: *calculated by the authors*

Table 6 reported the unit root test results for BRICS. The results presented in Table 6 showed that the time series for stock returns and inflation rate indexes were both stationary at their levels.

However, the exchange rate and gross domestic product were non-stationary at their initial level but became stationary at the first difference, with a significance level of 5%.

Table 6. *Unit root test results for BRICS*

Variables	ADF		PP		Order of integration
	Level	1st Diff	Level	1st Diff	
SPRC (probability)	3.2910 (0.1567)	33.2497 (0.0027)	1.639 (0.1205)	49.5218 (0.0000)	1(1)
EXRVL (probability)	1.0968 (0.1613)	79.9526 (0.0000)	1.7042 (0.2723)	107.105 (0.0000)	1(1)
INFLR (probability)	0.4492 (0.3467)	60.3245 (0.0000)	2.5673 (0.458)	46.4431 (0.0001)	1(1)
SRTN (probability)	1.0987 (0.2465)	6.0987 (0.0000)	1.3721 (0.2861)	9.4431 (0.0001)	1(1)
MSSVT (probability)	2.43900 (0.9997)	82.3035 (0.0000)	1.91888 (0.9999)	135.056 (0.0000)	1(1)

Source: calculated by the authors

The results of the co-integration test were reported in Table 7. As shown in Table 7, the majority of tests yielded a probability of less than 0.05, which supported the acceptance of the hypothesis that co-integration exists.

Table 7. *Pedroni co-integration test results for BRICS*

Measure	Statistic	Probability
Panel v-statistic	3.812475	0.0001
Panel rho-statistic	-4.171151	0.0000

Table 2, Continued

Measure	Statistic	Probability
Panel PP-statistic	-4.905688	0.0000
Panel ADF-statistic	-2.103017	0.0177
Group rho-statistic	-1.728237	0.0420
Group PP-statistic	-4.454848	0.0000
Group ADF-statistic	-2.583454	0.0049

Source: *calculated by the authors*

Figure 1 illustrated the estimated relationship between the inflation rate, GDP, exchange rates, and stock returns. Table 4 reported the computed AGARCH (1.1) parameters. The results indicated a positive and dynamic relationship between the explanatory factors and stock returns, as evidenced by the positive correlations. This suggested that in BRICS, market turnover or trading volume responds positively to stock returns. Figure 2 showed the conditional variances of stock market returns for all BRICS countries.

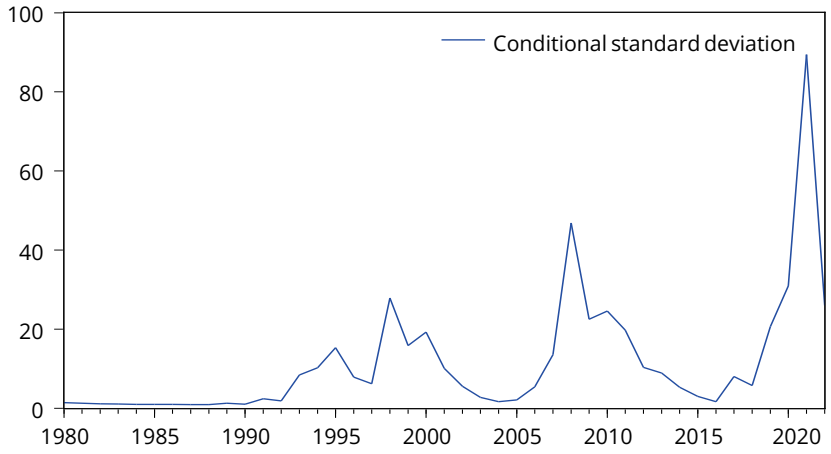

Figure 1. *Conditional standard deviation for stock prices*

Source: *calculated by the authors*

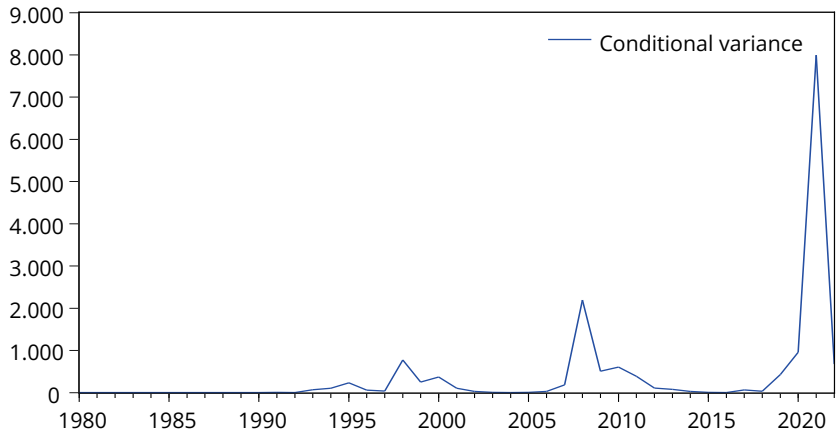

Figure 2. *Conditional variance for stock returns*

Source: *calculated by the authors*

Table 8 reported the wavelet results for BRICS stock returns. The wavelet analysis illustrated, how the variance of stock returns is influenced by exchange rates, inflation, and money supply fluctuations. The variance was distributed across different time scales for BRICS countries. This analysis employed a DWT using a Haar filter, which was well suited for detecting abrupt changes in financial time series data and extends over eight scales (W1 to W8). Short-term scales (W1 to W3) show an increasing variance contribution, rising from 0.0156 for W1 to 0.0643 for W3. This trend indicated that BRICS stock returns were moderately sensitive to short-term

fluctuations in exchange rates, inflation, and money supply. Short-term scales reflect the market's rapid responses to news and economic updates. This heightened sensitivity to short-term economic fluctuations aligns with the findings of H.R. Tejesh (2024). Conversely, K. Coretha *et al*. (2024) reported a short-term effect of exchange rate fluctuations on stock returns. Similarly, the GARCH (1.1) model estimation by D. ElDiftar (2023) revealed a significant positive long-term relationship between exchange rates and stock market returns in emerging markets (E7). Medium-term scales (W4 to W6) exhibit a sharp increase in variance, with W4 and W5 peaking at W6, where the variance reaches its highest relative contribution of 0.1628. These scales likely reflected the rapid adjustment processes in stock markets as they absorb the impacts of medium-term economic trends and policies. Long-term scales (W7 and W8) indicated that the relative proportion of variance remained significant, suggesting that long-term economic fundamentals and policy shifts continue to shape stock returns. W7 and W8 collectively account for over 48% of the total variance, highlighting the critical role of stable, long-term economic conditions in market valuations. This finding was supported by D. El-Diftar (2023), who concluded that positive long-term changes in capital markets can result from fluctuations in exchange rates.

Table 8. *Wavelet analysis of variance for stock returns of BRICS countries*

Scale	Variance	Relative proportion	Cumulative proportion
W1	398.2728	0.0156	0.0156
W2	1268.214	0.0496	0.0652
W3	1643.941	0.0643	0.1295
W4	3098.092	0.1212	0.2508
W5	2826.667	0.1106	0.3614
W6	4160.729	0.1628	0.5242
W7	3890.241	0.1522	0.6764
W8	8268.978	0.3236	1.0000

Source: *calculated by the authors*

The bar graph in Figure 3 illustrated the wavelet variance spectrum for BRICS stock returns. This graph was particularly useful for analysing how stock return volatility, influenced by factors such as exchange rate fluctuations, inflation volatility, and money supply variations, evolves across different frequency scales. Each bar represented the variance at a specific scale, demonstrating, how much of the total variability in stock returns can be attributed to fluctuations within that particular frequency band. The shorter bars on the left side of the graph indicated relatively lower variance contributions from high-frequency fluctuations, suggesting that in BRICS countries, immediate shortterm changes in exchange rates, inflation, and money supply variations contribute less to overall stock return volatility. By implication, when markets adjust quickly to transient changes, short-term economic shocks have minimal impact on stock markets. This finding aligned with the conclusions of S. Damiano (2020), who found that emerging markets can strengthen their resilience to global financial shocks through macroprudential regulation.

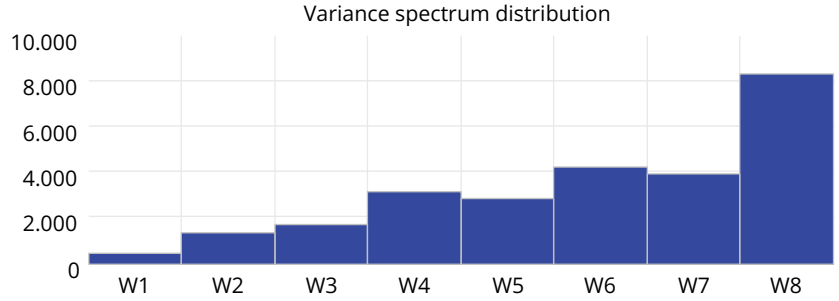

Figure 3. *Wavelet variance spectrum for stock returns of BRICS countries*

Source: *calculated by the authors*

Medium-term scales (middle bars) increased in height towards the centre of the graph, indicating a greater variance contribution from medium-term economic fluctuations. This increased variance at medium suggests the stock markets' reaction to more sustained economic trends and policies, which may take months to fully materialise in stock returns. According to the International Monetary Fund (2024), medium-term effects were significant because they reflect the market's adjustment period to new economic policies or changes in economic fundamentals. Long-term scales (rightmost bars) indicated that the largest share of variance in stock

returns stems from long-term factors. This highlighted the influence of long-term economic instability on stock markets. Such variances likely reflect deeper, structural economic changes occurring over several years, such as long-term trends in money growth, persistent inflationary conditions, and volatile exchange rate regimes. C. O'Sullivan & V.G. Papavassiliou (2021) emphasised that long-term economic trends exert a profound and lasting impact on stock market performance, particularly in emerging economies like those of the BRICS. This supported the argument that the greatest net volatility transmitters, according to the authors, were the longer-term benchmark stocks of core nations. Y.K. Qing & S. Kusairi (2019) also found that stock returns were significantly affected by changes in money growth, currency fluctuations, and interest rates in Malaysia.

Figure 4 represented the cumulative variance distribution of stock returns influenced by exchange rate volatility, inflation volatility, and variations in the money supply across various time scales, using wavelet analysis for BRICS countries. The cumulative variance, as shown in the graph, increases progressively, indicating a stronger influence of longer time-scale fluctuations on stock return variance. The initial segment of the curve (early rise) suggested that short-term fluctuations in exchange rate volatility, inflation volatility, and money supply variations begin to impact stock returns, but their cumulative effect was initially modest. This part of the curve represented rapid market reactions to new information and immediate economic changes, which can trigger significant but short-lived volatility in stock markets, particularly in response to exchange rate fluctuations. This aligned with the findings of C. O'Sullivan & V.G. Papavassiliou (2021), who observed that the only net receivers of return spillovers were the short-end and the long-end segments of the yield curve periphery in core countries.

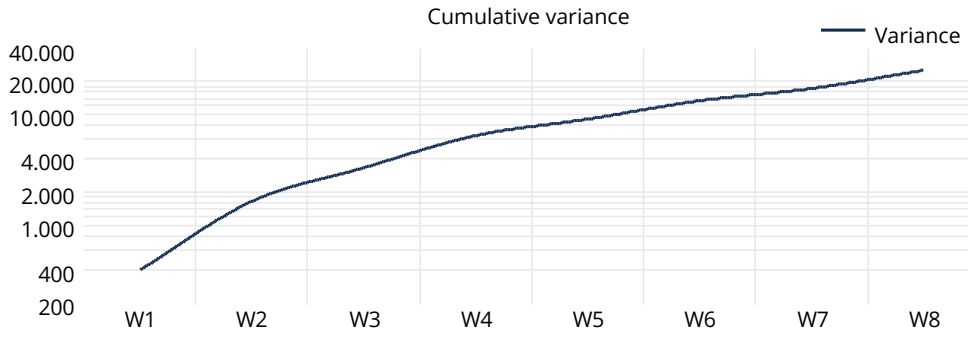

Figure 4. *Cumulative variance spectrum for stock returns of BRICS countries*
Source: *calculated by the authors*

The middle segment of the curve (steady ascent) rises more steadily; this suggested that mediumterm economic indicators begin to play a more significant role. This segment captures adjustments in stock returns to underlying economic trends such as sustained inflationary pressures or changes in money supply. The increasing cumulative variance in this section aligned with findings by R.K. Verma & R. Bansal (2021), who argued that in emerging markets, stock returns were particularly sensitive to macroeconomic variables such as GDP, FDI, and global institutional investment over the medium term. The later segment of the curve (plateauing trend) showed that towards the end of the curve, the rate of increase in cumulative variance slows and begins to plateau, indicating that the additional variance explained by the longest time scales is less pronounced. This plateau suggested that while long-term economic fundamentals, such as stable and consistent exchange rate policies, do influence stock returns, their incremental contribution to total variance was smaller than that of short- and medium-term factors.

Table 9 presented a wavelet analysis of BRICS stock prices. The wavelet analysis breaks down the variance of the time series using the DWT. According to the given equations, variables such as changes in the money supply, inflation volatility, and exchange rate fluctuations impact stock prices. Wavelet scale W1 had a relative percentage of 20.95% and a variance of 574.7375. Regarding stock price responses to short-term fluctuations in money supply, inflation, and exchange rates, this scale captured the highest frequency of fluctuations. The significant variation at this scale indicated that the stock prices of the BRICS nations were highly susceptible to market sentiment and short-term economic indicators. In particular, sharp fluctuations in exchange rates may cause stock market volatility immediately. When analysing the distinct effects of economic variables such as exchange rates, inflation, and money growth trends on stock market volatility over different time horizons, empirical research supported the wavelet analysis of BRICS stock prices, which examined the BRICS countries, broken down by variance across multiple scales. Studies by U.-F. Atipaga *et al*. (2024) and G.V.S. Chiranjivi & R. Sensarma (2023) have demonstrated that wavelet approaches are particularly useful in capturing the dynamic correlations between stock prices and exchange rates over a range of time scales. The continuous wavelet analysis reported by

U.-F. Atipaga *et al*. (2024) revealed negative co-movements within the short-term frequency, implying that African market asset investors preferred the short-term horizon during times of crisis. The results of G.V.S. Chiranjivi & R. Sensarma (2023) remained robust across variations in forecast timeframes, window sizes, data observation frequencies, and volatility analysis methods. These findings supported the high variance observed at W1, which reflected sharp market reactions to transient economic fluctuations.

Table 9. *Wavelet analysis of variance for stock prices of BRICS countries*

Scale	Variance	Relative proportion	Cumulative proportion
W1	574.7375	0.2095	0.2095
W2	159.5644	0.0859	0.2954
W3	288.5577	0.1554	0.4508
W4	793.2613	0.2272	0.6780
W5	35.82648	0.0193	0.6973
W6	20.879	0.0027	0.7000
W7	10.013	0.2501	0.9501
W8	6.2051	0.0499	1.0000

Source: *calculated by the authors*

According to the results, wavelet scales W2 and W3 have a variance of 159.5644 with an 8.59% relative proportion and a variance of 288.5577 with a 15.54% relative proportion. These scales represent medium-frequency components that capture the economic responses over a medium-term horizon. Scales W2 and W3 together account for adjustments in stock prices that correlate with more gradual economic developments, such as persistent inflation trends or steady GDP growth and decline. These components suggested that stock markets in BRICS countries exhibit significant responses not only to abrupt exchange rate fluctuations but also to the cumulative impact of economic trends over several months. Moreover, the medium-term adjustments (W2 and W3) found support in the research of M. Batondo & J. Uwilingiye (2022), who applied wavelet decomposition to stock return series to determine the multi-horizon pattern of joint movement as well as the dynamics of market integration. In terms of market episodes related to integration, short- and long-term interactions reinforced and extended the co-movement among stock markets. By extension, mediumfrequency components in financial time series often reflect the adjustment periods during which markets absorb and react to new economic data and policies over several months. Wavelet scale W4 had a variance of 793.2613 with a 22.72% relative proportion, representing lower frequency fluctuations. This scale indicated long-term trends in stock prices, potentially capturing underlying economic stability or significant economic shifts over multiple years, such as long-term GDP growth trends or prolonged inflationary pressures. The substantial variance explained by this component suggests that in BRICS countries, long-term economic fundamentals have a profound impact on stock prices, which may be influenced by persistent exchange rate policies or structural economic reforms.

The significant variance captured at lower frequencies (W4) aligned with research by F. Liu *et al*. (2022), T.C. Silva *et al*. (2023), and D.K. Khatri (2024), which suggested that lowerfrequency components indicate long-term economic trends and global pandemic-related shifts that gradually influence stock markets. This highlighted the profound impact of sustained economic developments on stock prices in BRICS countries over multiple years. Wavelet scale W5 had a variance of 35.82648 with a 1.93% relative proportion, while W6 had a variance of 4.922907 with a 0.27% relative proportion. These scales captured the lowest frequency variations, indicating very longterm trends in the economic data that have minimal impact on the variance of stock prices. These components represent generational shifts or extremely slow-moving economic processes whose impact on current stock prices is negligible compared to more immediate and medium-term economic factors. The negligible variance at the lowest scales (W5, W6, W7, and W8) is consistent with the findings of J.I. Samuels (2024), who noted that the longest-term trends of inflation, GDP growth, interest rates, foreign trade policies, cross-border capital flows, and market events often have minimal direct impact on current financial market dynamics. This is because these effects are so gradual that they become nearly indiscernible in the context of more immediate and medium-term economic processes.

In this wavelet variance spectrum, as shown in Figure 5, each bar represented the variance of stock returns at different scales, with the height of the bar indicating the magnitude of variance associated with that particular scale. From left to right, the scales transition from shorter to longer timeframes. Short time scales (leftmost bars), which were shorter in height, suggested that the immediate impact of exchange rate fluctuations, inflation, and variations in money supply on stock prices was relatively moderate. This aligned with studies such as M.I. Tabash *et al*. (2024), which found that stock markets in emerging economies often absorb short-term economic and financial shocks with moderate volatility, differing from the response of developed markets to financial shocks. This suggested that investors might

price in such fluctuations fairly quickly, leading to lower variance at these scales. Medium time scales (middle bars), which were the taller bars in the middle of the spectrum, indicate a higher variance, suggesting that stock prices were more sensitive to medium-term economic trends. This may indicate, how monetary policies and economic developments over several months to a year influence market perceptions and valuations. Studies such as M. Jibril *et al.* (2023) and K.K. Kumar *et al.* (2024) have discussed how long-term and medium-term economic indicators, such as inflation rates and GDP growth, significantly impact the financial markets of developing countries. This leads to higher volatility in stock returns as markets react to economic forecasts and policy shifts. Long-time scales (rightmost bars), which were the relatively shorter bars at the far right, suggested that the very long-term impacts of exchange rate volatility, inflation volatility, and money supply variations on stock prices exhibit lower variance, indicating stability. This may reflect the fact that long-term economic fundamentals tend to be more predictable or that long-term investors have already factored such elements into stock prices. According to T. Chun *et al*. (2022), long-term global financial market trends in emerging markets often showed resilience to short-term economic shocks, emphasising the role of fundamental economic health over extended periods. However, the wavelet variance spectrum indicated that stock returns in MENA countries were more influenced by mediumterm economic variables, with less emphasis on immediate and very long-term changes.

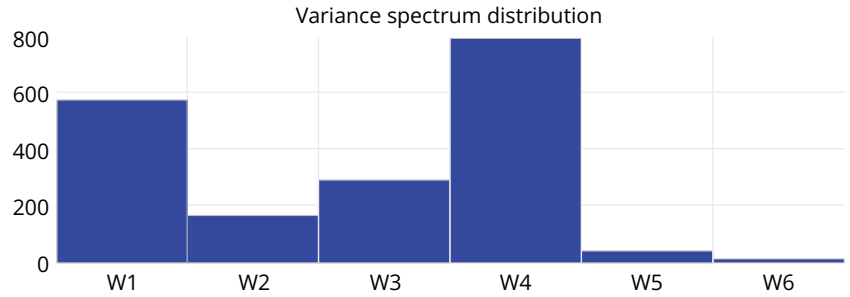

Figure 5. *Wavelet variance spectrum for stock prices of BRICS countries*
Source: *calculated by the authors*

The graph in Figure 6 depicted the cumulative variance of stock prices analysed over varying time scales using a wavelet transformation, focusing on the influence of exchange rate volatility, inflation volatility, and money supply variations on stock prices in BRICS countries. The curve illustrated a continuous increase in cumulative variance as the scale expands, stabilising at the longer time scales. Initial increase (left side of the curve): the steep ascent in the early part of the curve suggested that short-to-medium-term fluctuations in exchange rate volatility, inflation volatility, and money supply variations significantly contribute to stock price fluctuations. This indicated that stock prices were highly sensitive to immediate and medium-term economic changes. Empirical studies such as those by G. Korhan *et al*. (2021) on emerging markets demonstrated that stock market returns were notably impacted by exchange rate fluctuations in the short and medium term due to market conditions, whether bullish or bearish.

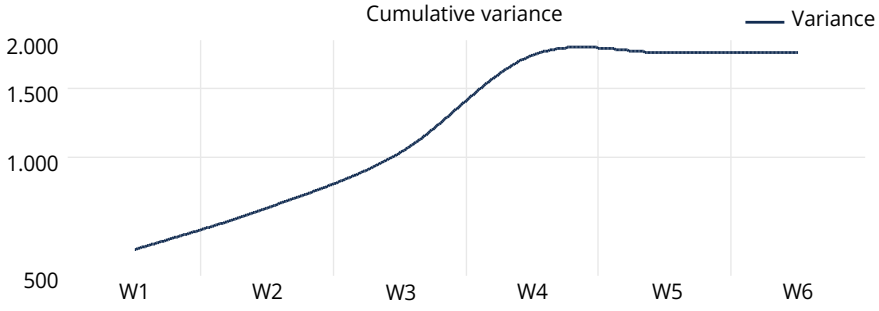

Figure 6. *Cumulative variance spectrum for stock prices of BRICS countries*
Source: *calculated by the authors*

Gradual plateau (middle to right side of the curve): as the curve extends towards the right and begins to plateau, this suggested that adding longer-term economic changes contributes incrementally less to the total vari-

ance. This plateauing effect implied that, while long-term economic trends (such as sustained exchange rate volatility or prolonged inflation instability) influence stock returns, their incremental impact was smaller compared to short- and medium-term volatility. This aligned with findings by M. Mroua & L. Trabelsi (2020), H. Qian *et al*. (2021), and R.K. Singh *et al*. (2024). Using the Lagrange multiplier principle, H. Qian *et al*. (2021) reported significant stock market effects arising from exchange rate changes in BRICS, examining the mechanisms underlying exchange rate shocks. M. Mroua & L. Trabelsi (2020) investigated the dynamic links between exchange rates and stock returns in BRICS countries using the panel GMM and ARDL methods as analytical frameworks. They found that these relationships were positive in the short, medium, and long term, suggesting that in Brazil and Russia, exchange drives lead stock returns, while in India, they were negative. In contrast, China exhibits bidirectional causality.

R.K. Singh *et al*. (2024) analysed the transmission of risk, return, and volatility in the BRICS stock markets between 2008 and 2023 using both linear and non-linear GARCH models. The results demonstrated that there was a significant unilateral and reversible spillover effect in BRICS market performance. The research findings also corroborate those obtained by S. Kumar (2019), U.A. Sheikh *et al*. (2020), and R.K. Suri *et al*. (2024). R.K. Suri *et al*. (2024) identified a complex interaction between stock markets and exchange rates in G20 countries, highlighting a strong positive long-run relationship and negative nexus between these variables. For instance, S. Kumar (2019) and U.A. Sheikh *et al*. (2020) argued that there was an asymmetrical correlation between stock prices and currency exchange rates. S. Mahapatra & S.N. Bhaduri (2019) used a two-factor arbitrage pricing model to study the spillover effects of exchange rate and stock return volatility in Indian financial markets. The findings showed that fluctuations in exchange rates affect stock returns. Some authors also suggested that there was a nonlinear relationship between stock prices and exchange rates.

Furthermore, the far-right side of the cumulative variance curve at longer scales indicated a saturation point, where additional economic information does not significantly alter the understanding of stock return variability. This reflected the market's efficiency in integrating long-term economic expectations into stock prices, a phenomenon discussed by W. Breuer & S. Ruiz de Vargas (2021) in their analysis of key issues in international financial investment management. According to the results of the conditional mean equation shown in Table 10, exchange rate volatility had a positive effect on equities in BRICS. The results of the conditional variance equation demonstrated the presence of statistically significant bidirectional shock transmissions among the study's key variables. However, bond rates influence market returns due to high volatility and shock transmissions. Furthermore, evidence suggested the presence of shock spillovers between returns and currency exchange rate fluctuations. The findings implied that shocks and volatility had a substantial impact on stock prices. While stock prices responded positively to exchange rate volatility, returns exhibited a negative response to volatility in exchange rates and inflation rates.

Table 10. *GARCH results for BRICS*

GARCH results for stock prices			
Mean equation			
Variable	Coefficients	*z* statistic	Prob.
SPRC(-1)	1.01732	120.0036	0.0000
EXRVL	1.33513	500.4028	0.0000
INFLR	0.11499	40.7893	0.0000
MSSV	0.03811	70.6146	0.0000
C	0.20745	110.1038	0.0000
Variance equation			
C	0.301204	10.00941	0.0000
Arch	0.154353	60.36250	0.0000
Tarch/Leverage	0.04306	111.52538	0.0000
GARCH	0.51360	924.8814	0.0000
Persistence	0.728052	118.06938	0.0000
Adjusted R^2 = 0.674978	Durbin-Watson	2.034225	0.0000

Table 10, Continued

GARCH results for stock returns			
Mean equation			
Variable	Coefficients	*z* statistic	Prob.
SRTN(-1)	0.97455	160.393	0.0000
EXRVL	-1.09346	-120.48094	0.0000
INFLR	-1.23490	-176.3983	0.0000
MSSV	1.70586	400.58632	0.0000
C	0.19209	100.38634	0.0000
GARCH results for stock prices			
Variance equation			
C	0.032864	140.58975	0.0000
Arch	-0.548190	133.48794	0.0000
Tarch/Leverage	0.035870	114.5125	0.0000
GARCH	0.621093	50.409187	0.0000
Persistence	0.982610	1,635.089	0.0000
Adjusted R^2 = 0.745900	Durbin-Watson	2.10004	0.0000

Source: *calculated by the authors*

Exchange rate volatility had a significant impact on stock prices, while it had a negative impact on stock returns. Investors in the BRICS stock markets must exercise caution due to the ongoing volatility of currency exchange rates. Such persistent volatility in the stock market reflects ongoing uncertainty. The conditional variance equation also demonstrated the presence of volatility transmissions between the foreign exchange and stock markets of the BRICS nations, suggesting that exchange rate shocks have a long-lasting effect on the stock market. Overall, there was a substantial positive spillover from shocks and volatility, providing empirical support for the theory that shocks and fluctuations in currency exchange rates affect stock market prices and returns.

These findings aligned with those of B. Subburayan & A. Aruldoss (2020) and R. Aydin *et al*. (2023). Using an AGARCH model, they examined the volatility spillovers between exchange rates and stock prices in South Africa and other BRICS and Association of Southeast Asian Nations (ASEAN) financial markets. Their research supported the existence of bidirectional spillovers in South Africa's financial markets. Furthermore, the findings were consistent with those reported by W.M.A. Ahmed (2019) and T. Lakshmanasamy (2021). According to T. Lakshmanasamy (2021), exchange rates had a significant positive impact on stock returns in India. The robustness of these results was consistent with those earlier reported by W.M.A. Ahmed (2019). Using the non-linear autoregressive distributed lag method, the researcher reported the presence of asymmetry in the effect of exchange rates on stock returns.

I. Anyikwa & A. Phiri (2023) employed the Quantile-VAR technique to establish the interconnectedness of returns between African stock markets and global commodity and financial asset markets. Using the EGARCH model, K. Agyarko *et al*. (2023) researched on the correlation between volatility in the Ghanaian stock market and exchange rate volatility, advising market investors to rely on the generalised error distribution as the most suitable model, when making decisions regarding the volatility of the Ghanaian stock market. Additionally, Y. Kassouri & H. Altıntaş (2020) studied the dynamic co-movements between Turkish market stock prices, interest rates, money supply, and currency exchange rates from January 2003 to December 2018. Using the threshold autoregressive model, they discovered that a decline in Turkish stock prices corresponds to an increase in the value of the Turkish lira relative to the US dollar.

Stock returns were both positively and negatively influenced by changes in the money supply, with significant coefficients of 1.70586 and -1.23490, respectively. This finding supported the conclusion of S.E. Effiong *et al*. (2023), who demonstrated econometrically that a positive money supply shock significantly increased stock returns, regardless of the exchange rate policy regime in place. The authors also found that devaluation policies in emerging economies resulted in declining returns. Conversely, the rate of inflation and fluctuations in the money supply, with significant coefficients of 0.11499 and 0.03811, respectively, had a positive effect on stock prices. These findings were consistent with those of S. Hirota (2023), who observed that as the money supply grows, the demand for equities rises, which in turn positively affects their pricing. Furthermore, the findings aligned with those reported by C.C. Anyanwu & D.U. Ohurogu (2024), empirically determined that variations in money supply enhance stock market liquidity.

The results of this research also supported those of L. Liu *et al*. (2024). The GMM results reported by L. Liu *et al*. (2024) indicated a positive relationship between bank stock returns and changes in the money stock, as well as between stock prices of deposit money banks and

money supply variability. These findings suggested that investors may choose equities markets if substantial returns outweigh the significant currency rate risks. Across all of the countries under study, there were significant spillovers of market volatility. Exchange rate volatility generated ripple effects that transmitted from the foreign exchange market to the BRICS stock markets. The main hypothesis asserted that financial markets in emerging economies are usually more volatile, meaning that exchange rate changes occur more frequently and have an immediate impact on stock prices. Table 11 presented the quantile results for stock prices across different quantiles: Q0.1, Q0.2, Q0.3, Q0.4, Q0.5, Q0.6, Q0.7, Q0.8, and Q0.9.

Table 11. *Quantile regression results for BRICS stock prices*

Variable	OLS	Q0.1	Q0.2	Q0.3	Q0.4	Q0.5	Q0.6	Q0.7	Q0.8	Q0.9
EXRVL	0.3884	0.551	0.1536	-0.0193	0.489	0.1328	0.1342	0.1921	0.6312	0.2510
	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
INFLR	0.5480	0.713	0.5546	0.4880	0.394	0.3486	0.3296	0.4139	0.4357	0.4739
	0.002	0.001	0.013	0.001	0.012	0.000	0.000	0.004	0.000	0.000
C	0.0320	-0.313	-0.0797	-0.0479	-0.029	0.0263	0.0462	0.0692	0.0820	0.3427
	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
MSSVL	0.0320	-0.124	0.011	0.0129	0.035	0.136	0.114	0.183	0.651	0.051
	0.00	0.00	0.020	0.01	0.01	0.00	0.001	0.00	0.00	0.00
Quantile slope equality 39 tests		Wald test: 63.45(.00)		Stability test Ramsey reset test: QLR lambda stat: 0.0068(.93)						

Source: *calculated by the authors*

Exchange rate variation negatively affected stock prices only at the Q0.3 quantile, with a 0.0193 effect. The coefficients for exchange rate volatility in the stock price equation were positive and highly significant across the quantiles, except for the third quantile. These coefficients for the 10th, 20th, 40th, 50th, 60th, 70th, 80th, and 90th quantiles were 0.551, 0.1536, 0.489, 0.1328, 0.1342, 0.1921, 0.6312, and 0.2510. The positive coefficients indicated that volatility in the exchange rate stimulates stock prices. The rate of inflation also had a significant positive influence on stock prices. Specifically, a 1% increase in exchange rate volatility led to a 0.551%, 0.1536%, 0.489%, 0.1328%, 0.1342%, 0.1921%, 0.6312%, and 0.2510% increase in stock prices at the 10th, 20th, 40th, 50th, 60th, 70th, 80th, and 90th quantiles for BRICS markets.

The coefficients for inflation also demonstrated a positive relationship betwe en stock prices and the inflation rate in BRICS economies. These coefficients were 0.7153, 0.5546, 0.4880, 0.3948, 0.3486, 0.3296, 0.4139, 0.4357, and 0.4739 for the 10th, 20th, 30th, 40th, 50th, 60th, 70th, 80th, and 90th quantiles, respectively. Consequently, stock prices rose following an increase in the inflation rate throughout the period of analysis. The estimated effects across different quantiles of the regression model were largely consistent for all the BRICS countries: negative for exchange rate volatility and inflation in terms of their impact on stock returns, but positive regarding their impact on stock prices. However, the magnitudes of these effects vary considerably. The coefficients for money supply variation were significant but negative at the 10th quantile and continue to be negative through the 20th quantile; beyond this, however, money supply variation positively impacted stock prices. Table 12 presented the quantile results for stock returns across different quantiles, namely Q0.1, Q0.2, Q0.3, Q0.4, Q0.5, Q0.6, Q0.7, Q0.8, and Q0.9.

Table 12. *Quantile regression results for BRICS stock returns*

Variable	OLS	Q0.1	Q0.2	Q0.3	Q0.4	Q0.5	Q0.6	Q0.7	Q0.8	Q0.9
EXRVL	-0.0269	-0.0235	-0.0254	0.0231	-0.0208	-0.0211	-0.0226	-0.0246	-0.0291	-0.0319
	0.02	0.544	0.001	0.02	0.361	0.005	0.001	0.001	0.002	0.002
INFLR	-0.016	-0.013	-0.020	-0.0135	-0.0254	-0.0144	-0.0190	-0.0381	-0.0525	-0.0646
	0.09	0.02	0.05	0.02	0.05	0.04	0.05	0.06	0.09	0.02
C	0.0212	-0.0297	-0.0242	-0.0213	-0.0201	0.0203	0.0211	0.0228	0.0265	0.0327
	0.02	0.02	0.02	0.02	0.08	0.02	0.02	0.02	0.02	0.02
MSSVL	0.090	1.032	1.0387	1.0289	0.002	0.1928	0.0981	0.1286	1.001	1.0837
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Quantile slope equality tests		Wald test: 56.82(.00)		Stability test Ramsey reset test: QLR Lambda stat: 1.5899(.20)						

Source: *calculated by the authors*

As shown in Table 13, the coefficients for exchange rate volatility and stock returns were -0.0269, -0.0235, -0.0254, 0.0231, -0.0208, -0.0211, -0.0226, -0.0246, 0.0291, and -0.0319. Based on *p*-values, stock returns were found to be significantly affected by exchange rate volatility at the 20th, 30th, 50th, 60th, 70th, 80th, and 90th quantiles. In contrast, stock returns at the 10th and 40th quantiles were found to be insignificantly affected by exchange rate volatility. The findings suggested that stock returns responded to exchange rate volatility by increasing by 0.0231 percentage points for every 1% rise in exchange rate volatility at the third quantile. Quantile regression estimations showed that the inflation rate was negatively correlated with stock returns, with *p*-values below 0.05 across all quantiles for BRICS. Specifically, stock returns were inversely and considerably affected by the inflation rate, with coefficients of -0.013, -0.020, -0.0135, -0.0254, -0.0144, -0.0190, -0.0381, -0.0525, and -0.0646 for the 10th, 20th, 30th, 40th, 50th, 60th, 70th, 80th, and 90th quantiles, respectively. A 1% increase in the variation of the money supply resulted in stock returns rising by 0.090%, 1.032%, 1.0387%, 1.0289%, 0.002%, 0.1928%, 0.0981%, 0.1286%, 1.001%, and 1.0837%, in each quantile, i.e., Q0.1, Q0.2, Q0.3, Q0.4, Q0.5, Q0.6, Q0.7, Q0.8, and Q0.9, with *p*-values of each being less than 5%. The outputs of the Markov-switching regression for BRICS, as illustrated in Table 13 below, revealed the joint effects across different regimes during the study period for both stock prices and stock returns, respectively. The equation specification comprised two regimes, namely, Regime 1 and Regime 2 with switching mean regressors of exchange rate volatility, inflation rate, and variations in money supply, and four AR terms identified as non-switching.

Table 13. *Markov-switching regression results for BRICS stock prices and returns*

Regimes	Stock prices			Stock returns				
	EXRVL	INFLR	C	MSSVL	EXRVL	INFLR	C	MSSVL
Regime 1 (floating)	0.517** (0.0956)	0.519* (0.079)	0.025 (0.029)	1.013** (0.002)	-1.350** (0.0970)	-2.318* (0.086)	0.302* (0.000)	1.921* (0.000)
Regime 2 (fixed)	0.2916 (0.000)	0.5360** (0.0005)	0.427** (0.304)	0.113* (0.000)	-0.015** (0.026)	-0.063** (0.078)	0.021** (0.022)	0.216* (0.000)
AR(1)	-0.0549 (0.8007)			0.1387	0.329*(0.0000)			0.002
AR(2)	0.2331**(0.0020)			0.0029	0.015**(0.0010)			0.016*
AR(3)	0.0421*(0.0008)			0.0073	0.5132*(0.0054)			0.019*
AR(4)	0.0169**(0.0016)			0.059	0.1125**(0.0020)			0.002*
LOG(SIGMA)	-2.677**	3.0200*	0.289	2.389**	-4.964*	1.000	1.0200	6.000*
Transition parameters								
P11-C	0.0315**(0.0005)			0.1208*(0.0000)				
P21-C	0.0058**(0.0000)			0.0453**(0.0005)				
S.E. of regression	0.00059			0.00040				
Durbin-Watson stat	2.7631			2.7550				

Source: *calculated by the authors*

The results for BRICS showed that fluctuations in the currency exchange rates positively and significantly impacted stock prices in both regimes of floating and fixed exchange rates, with coefficients of 0.517 and 0.2916, respectively. A percentage rise in currency fluctuations induced a 0.517% and 0.2916% increase in stock prices under the floating and fixed exchange rate regimes, respectively. Within the same model and economic setting, a rise in the variation of the money supply resulted in a 1.013% increase in stock prices under the floating exchange rate regime, whereas, under the fixed exchange rate regime, a rise in money supply variation resulted in a 0.113% increase in stock prices. The impact of money supply variation on stock prices was greater under the floating exchange rate system. This suggested that in an economic environment characterised by extreme volatility, stock price fluctuations become more sensitive to variations in currency values and money circulation. The Markov-switching results showed that fluctuations in currency exchange rates and inflation rates both impacted stock returns negatively in both the floating and fixed exchange rate regimes. A percentage rise in exchange rate volatility led to a 1.350% and 0.015% decline in stock returns under the floating and fixed exchange rate regimes, respectively.

These results were also consistent in line with the findings of P.O. Junior & G. Tweneboah (2020), where the link between exchange rates and the stock markets of Morocco and Tunisia was researched through the application of quantile-in-quantile regression techniques on daily data. Accordingly, the research reinforced the findings of W.M.A. Ahmed (2019), who used a nonlinear ARDL (NARDL) model to ascertain significant negative variations in the Egyptian exchange rate's impact on stock returns. Specifically, the conditional volatility of currency exchange rates positively impacts stock prices, while negatively impacting stock returns. During the same period, the researcher focused on the returns of the Egyptian stock market and employed a NARDL to identify both short- and long-term asymmetries, as well as the impact of exchange rate fluctuations on stock returns across two regimes. They found that fluctuations

in the value of the Egyptian pound negatively affected stock returns significantly. They also found that an increase in the value of the home currency positively affects stock prices, but this influence is less pronounced than that of currency depreciation, which significantly affects stock returns.

The findings of A.A. Salisu & X.V. Vo (2021) and A.A. Salisu *et al*. (2021) also corroborated the asymmetric nature and regime effects of the present research findings. A.A. Salisu *et al*. (2021) used historical monthly data that included exchange rates and stock returns of the BRICS countries in question to analyse the relationship between exchange rates and stock returns within the BRICS countries. The research developed a forecasting model that connected changes in exchange rates to the difference in stock returns between the US and overseas markets. According to the data, three BRICS countries – Brazil, India, and South Africa – had positive correlations between stock return differentials and exchange rate returns. However, after accounting for the asymmetry impact, contradictory findings for China and Russia emerged. Both in-sample and out-of-sample forecasts demonstrated how useful and reliable stock returns are in predicting changes in exchange rates within the BRICS framework. Additionally, taking observable asymmetry and common (global) variables into consideration improves forecast accuracy even further.

The results of this study have significant implications for portfolio diversification techniques and foreign exchange management. A.A. Salisu & X.V. Vo (2021) used a dataset covering a period of 513 weeks, from 2011 to 2020, to investigate the relationship between exchange rates and stock returns in fast-growing emerging economies with high interest rates, such as Brazil, China, Colombia, India, and Indonesia, and advanced industrialised countries with low interest rates, such as Canada, Denmark, Israel, Japan, South Korea, Poland, Sweden, and the UK. For its analysis, the study used a panel data approach. The results indicated differences in the interactions between the two environments: economies with a low interest rates regime have positive interactions over the long term, whereas economies with a high interest rates regime have negative associations in the short term.

The role of money supply variation was consistent across both models. Hence, an increase in money supply variation stimulated a 1.921% rise in stock returns under the floating exchange rate, whereas, under the fixed exchange rate, it led to a 0.216% increase in stock returns. However, it was sufficient to report that the impact of money supply variation on stock returns was greater under the floating exchange rate system than under the fixed exchange rate regime. The plot of the AR/MA polynomial inverse roots was shown in Figure 7. These plots confirmed that all root locations for both the stock price and stock return equations are contained within the circle, as shown in Figures 7 and 8 below, implying that all AR coefficients were relatively stable. Furthermore, the validity of both models was confirmed by the significance of the transition probabilities.

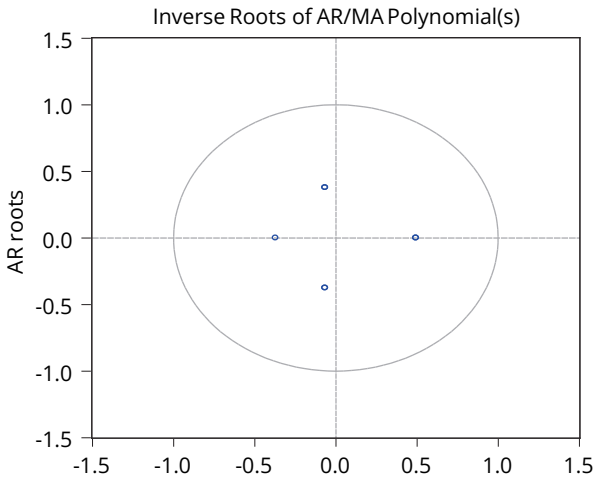

Figure 7. *Inverse root plot for stock returns*
Source: *calculated by the authors*

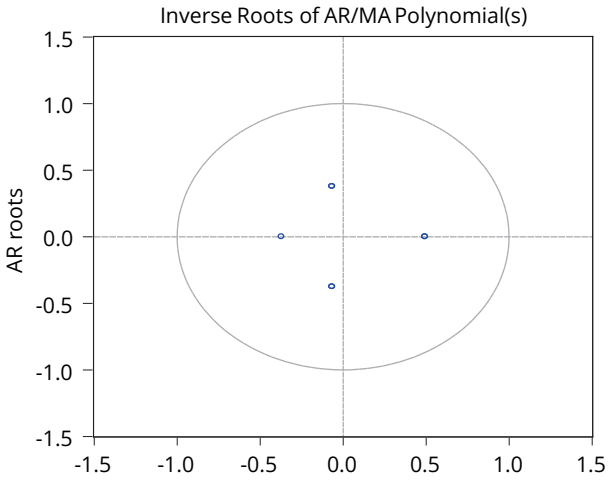

Figure 8. *Inverse root plot for stock pricese*
Source: *calculated by the authors*

Apart from the AR(1) autoregressive term, all other autoregressive terms – namely, AR(2), AR(3), and AR(4) – were significant at the 1% and 5% levels in the stock price model. This validated that previous stock prices have a substantial influence on current stock prices. For the stock returns model, all the autoregressive coefficients – 0.329 for AR(1), 0.015 for AR(2), 0.5132 for AR(3), and 0.1125 for AR(4) – were significant at the 1% level. This also provided the required validation that previous stock returns have a significant impact on current stock returns. Given the non-switching behaviour of the autoregressive terms, the Markov-switching estimations clearly indicated that only stock prices from the previous two, three, and four days significantly and positively predict current stock prices.

The non-switching behaviour of the autoregressive terms also indicated that past stock returns largely and positively predict current stock returns. The coefficient of the transition parameter for stock prices was larger in Regime 1 than in Regime 2, whereas, in the stock returns model, the transition probability was significant only for Regime 1. Taken together, these findings suggested that under the floating exchange rate regime, volatility in exchange rates, money supply variation, and inflation were more likely to occur and persist for a longer period than under the fixed exchange rate regime. Moreover, the floating exchange rate regime was the most likely to endure. The Durbin-Watson statistics for both stock price and stock return regressions deviate from 2. Thus, autocorrelated errors were detected in the estimated models for both stock prices and stock returns. This was likely due to the significance of the autoregressive terms.

Conclusions

The study's findings demonstrated a clear correlation between stock market activities and exchange rate volatility. The study also found heightened variance at medium scales, implying that stock markets in BRICS react to more sustained economic trends and policies, which may take months to yield earnings. The influence of long-term economic instability on the stock markets reflects deeper, structural economic changes induced by long-term money growth trends, sustained inflationary pressures, and unstable exchange rate regimes. It was found that stock prices in BRICS were highly sensitive to short-term economic indicators and market sentiment, where immediate volatility in stock markets was triggered by rapid changes in exchange rates. More specifically, the findings aligned with empirical research that highlights the differentiated impact of economic variables such as exchange rates, inflation, and changes in money growth trends on stock price volatility over varying time horizons. Long-term economic fundamentals have a profound impact on stock prices, which may be influenced by persistent exchange rate policies or structural economic reforms.

The results indicated that stock prices were highly sensitive to immediate and medium-term economic changes. The estimated impacts of different quantiles of the regression line were largely the same – negative for exchange rate volatility and inflation in terms of their effect on returns, and positive in terms of their effect on stock prices. However, the magnitudes of these impacts vary significantly. Volatility spillovers in the foreign exchange market were considerable in all the studied nations. Exchange rate volatility spread from the foreign exchange market to stock markets. According to the results, volatility in the exchange rate stimulates stock prices. Inflation also had a significant positive influence on stock prices. Quantile regression estimations showed that the inflation rate was negatively correlated with stock returns. The Markov-switching regression results indicated that variations in currency exchange rates positively and significantly impact stock prices in both floating and fixed exchange rate regimes.

Variations in currency exchange rates and inflation rates both impact stock returns negatively in floating and fixed exchange rate regimes. Businesses need to implement more effective hedging strategies in stock markets to mitigate negative impacts. Additionally, policymakers must deepen capital markets and create a resilient stock market that can endure over time. To enhance future research, scholars could utilise daily-to-annual panel datasets for other regions, such as the ASEAN nations, while also accounting for the effects of interest rate variations on stock markets in each country. Examining the asymmetric effects of exchange rate fluctuations could also yield further insightful research findings.

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Conflict of Interest

None.

References

[1] Adekoya, O.B. (2020). Portfolio balance approach to asymmetries, structural breaks and financial crisis: Testing a model for Nigeria. *CBN Journal of Applied Statistics*, 11(1), 87-110. doi: 10.33429/Cjas.11120.4/5.

[2] Agyarko, K., Wiah, E.N., Frempong, N.K., & Odoi, B. (2023). Modelling the volatility of the Ghana stock market: A comparative study. *International Journal of Statistics and Applied Mathematics*, 8(3), 125-132. doi: 10.22271/maths.2023.v8.i3b.998.

[3] Ahmed, W.M.A. (2019). Asymmetric impact of exchange rate changes on stock returns: Evidence of two *de facto* regimes. *Review of Accounting and Finance*, 19(2), 147-173. doi: 10.1108/RAF-02-2019-0039.

[4] Anyanwu, C.C., & Ohurogu, D.U. (2024). Stock market liquidity in Nigeria: The effects of interest rate and money supply. *Nigerian Journal of Management Sciences*, 25(1), 114-126.

[5] Anyikwa, I., & Phiri, A. (2023). Connectedness and spillover between African equity, commodity, foreign exchange and cryptocurrency markets during the COVID-19 and Russia-Ukraine conflict. *Future Business Journal*, 9, article number 48. doi: 10.1186/s43093-023-00227-y.

[6] Atenga, E.M.E., & Mougoue, M. (2021). Return and volatility spillovers to African currencies markets. *Journal of International Financial Markets, Institutions and Money*, 73, article number 101348. doi: 10.1016/j.intfin.2021.101348.

[7] Atif, M., Raza Rabbani, M., Bawazir, H., Hawaldar, I.T., Chebab, D., Karim, S., & AlAbbas, A. (2022). Oil price changes and stock returns: Fresh evidence from oil exporting and oil importing countries. *Cogent Economics & Finance*, 10(1), article number 2018163. doi: 10.1080/23322039.2021.2018163.

[8] Atipaga, U.-F., Alagidede, I., & Tweneboah, G. (2024). On the connectedness of stock returns and exchange rates in emerging and frontier markets in Africa. *Economic Notes*, 53(3), article number e12249. doi: 10.1111/ecno.12249.
[9] Aydin, R., Lögün, A., & Aydin, B. (2023). The relationship between exchange rates and stock prices: Comparative example of ASEAN and BRICS countries. *Romanian Journal of Economic Forecasting*, 26(4), 128-142.
[10] Batondo, M., & Uwilingiye, J. (2022). Comovement across BRICS and the US stock markets: A multitime scale wavelet analysis. *International Journal of Financial Studies*, 10(2), article number 27. doi: 10.3390/ijfs10020027.
[11] Blanga-Gubbay, M., & Rubínová, S. (2023). *Is the global economy fragmenting?* Retrieved from https://www.wto.org/english/res_e/reser_e/ersd202310_e.htm.
[12] Bollerslev, T., Litvinova, J., & Tauchen, G. (2006). Leverage and volatility feedback effects in high-frequency data. *Journal of Financial Econometrics*, 4(3), 353-384. doi: 10.1093/jjfinec/nbj014.
[13] Boukraine, W. (2020). *Asymmetric behavior of exchange rate in Tunisia: A nonlinear approach*. Retrieved from https://mpra.ub.uni-muenchen.de/102037/1/MPRA_paper_102037.pdf.
[14] Breuer, W., & Ruiz de Vargas, S. (2021). Some key developments in international financial management. *Journal of Business Economics*, 91, 595-615. doi: 10.1007/s11573-021-01039-8.
[15] Carter, D., Mazumder, S., Simkins, B., & Sisneros, E. (2022). The stock price reaction of the COVID-19 pandemic on the airline, hotel, and tourism industries. *Finance Research Letters*, 44, article number 102047. doi: 10.1016/j.frl.2021.102047.
[16] Chancharat, S., & Suwannapak, S. (2024). The dynamic relationship between ASEAN+6 exchange rates and stock markets: Application of the ARDL model. *Journal of Asian Business and Economic Studies*, 31(5), 365-377. doi: 10.1108/JABES-01-2024-0026.
[17] Chiranjivi, G.V.S., & Sensarma, R. (2023). The effects of economic and financial shocks on private investment: A wavelet study of return and volatility spillovers. *International Review of Financial Analysis*, 90, article number 102936. doi: 10.1016/j.irfa.2023.102936.
[18] Chun, T., Xiaoxing, L., & Donghai, Z. (2022). Financial market resilience and financial development: A global perspective. *Journal of International Financial Markets, Institutions and Money*, 80, article number 101650. doi: 10.1016/j.intfin.2022.101650.
[19] Coretha, K., Sobe, P.A., & Mwakujonga, J. (2024). Effects of interest and exchange rate volatility on stock returns: Evidence from the financial sector of Tanzania. *NG-Journal of Social Development*, 13(1), 215-225. doi: 10.4314/ngjsd.v13i1.16.
[20] Da Silva, C.A.G. (2023). The regime changing behavior of exchange rates and stock market prices of selected emerging countries: An application of the Markov switching vector autoregressive model (MS-VAR). *American Journal of Economics and Business Innovation*, 2(1), 22-28. doi: 10.54536/ajebi.v2i1.993.
[21] Damiano, S. (2020). *Dampening the impact of global financial shocks on emerging market economies*. Retrieved from https://surl.li/ldazom.
[22] Dornbusch, R., & Fischer, S. (1980). Exchange rates and the current account. *The American Economic Review*, 70(5), 960-971.
[23] Effiong, S.E., Benson, O.J., & Umoru, D. (2023). Stock returns and state-dependent effects of changes in exchange rate and money supply from central banks. *Asian Journal of Economics, Business and Accounting*, 23(18), 117-130. doi: 10.9734/ajeba/2023/v23i181062.
[24] El-Diftar, D. (2023). The impact of exchange rates on stock market performance of the Emerging 7. *Journal of Capital Markets Studies*, 7(2), 125-139. doi: 10.1108/JCMS-03-2023-0005.
[25] Engle, R.F. (1982). Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. *Econometrica*, 50(4), 987-1007. doi: 10.2307/1912773.
[26] Gale, F., Valdes, C., & Ash, M. (2019). *Interdependence of China, United States, and Brazil in soybean trade*. Retrieved from https://ers.usda.gov/sites/default/files/_laserfiche/outlooks/93390/OCS-19F-01.pdf?v=55425.
[27] Glauben, T., & Duric, I. (2024). BRICS: World heavyweight in agricultural trade. *Intereconomics*, 59(3), 160-166. doi: 10.2478/ie-2024-0033.
[28] Global trade outlook and statistics. April. (2024). Retrieved from https://surl.li/pwazvm.
[29] Hirota, S. (2023). Money supply, opinion dispersion, and stock prices. *Journal of Economic Behavior & Organization*, 212, 1286-1310. doi: 10.1016/j.jebo.2023.06.014.
[30] International Monetary Fund. (2023). *World economic outlook: Navigating global divergences*. Washington: International Monetary Fund.
[31] International Monetary Fund. (2024). *World economic outlook*. Washington: International Monetary Fund.
[32] Jibril, M., Mairafi, S.L., Mahmud, A.A., & Bello, M.B. (2023). Effect of gross domestic product and inflation on stock returns of quoted companies in Nigeria. *Fulafia International Journal of Business and Allied Studies*, 1(1), 293-309.
[33] Junior, P.O., & Tweneboah, G. (2020). Are there asymmetric linkages between African stocks and exchange rates? *Research in International Business and Finance*, 54, article number 101245. doi: 10.1016/j.ribaf.2020.101245.

[34] Karimo, T.M. (2020). Impact of interest rate differential and exchange rate movement on the dynamics of Nigeria's international private capital flows. *CBN Journal of Applied Statistics*, 11(2), 29-63. doi: 10.33429/Cjas.11220.2/8.
[35] Kassouri, Y., & Altıntaş, H. (2020). Threshold cointegration, nonlinearity, and frequency domain causality relationship between stock price and Turkish Lira. *Research in International Business and Finance*, 52, article number 101097. doi: 10.1016/j.ribaf.2019.101097.
[36] Khatri, D.K. (2024). Analysing the impact of major financial crisis on macroeconomic variables and stock prices: An empirical study of stock market of United Kingdom. *Asian Journal of Economics, Business and Accounting*, 24(5), 412-432. doi: 10.9734/ajeba/2024/v24i51319.
[37] Korhan, G., Baris, M.E., & Siamand, H. (2021). Exchange rates and stock markets in emerging economies: New evidence using the quantile-on-quantile approach. *Quantitative Finance and Economics*, 5(1), 94-110. doi: 10.3934/QFE.2021005.
[38] Kumar, K.K., Stalin, G.A., & Rajeswari, B. (2024). An empirical study: Long run and short run impact of macroeconomic variables on Indian stock market prices. In R. El Khoury (Ed.), *Technology-driven business innovation. Studies in systems, decision and control* (Vol. 223, pp. 273-281). Cham: Springer. doi: 10.1007/978-3-031-51997-0_23.
[39] Kumar, S. (2019). Asymmetric impact of oil prices on exchange rate and stock prices. *The Quarterly Review of Economics and Finance*, 72, 41-51. doi: 10.1016/j.qref.2018.12.009.
[40] Kumar, S., Tiwari, A.K., Chauhan, Y., & Ji, Q. (2019). Dependence structure between the BRICS foreign exchange and stock markets using the dependence-switching copula approach. *International Review of Financial Analysis*, 63, 273-284. doi: 10.1016/j.irfa.2018.12.011.
[41] Lakshmanasamy, T. (2021). The relationship between exchange rate and stock market volatilities in India: ARCH-GARCH estimation of the causal effects. *International Journal of Finance Research*, 2(4), 244-259. doi: 10.47747/ijfr.v2i4.443.
[42] Liu, F., Kong, D., Xiao, Z., Zhang, X., Zhou, A., & Qi, J. (2022). Effect of economic policies on the stock and bond market under the impact of COVID-19. *Journal of Safety Science and Resilience*, 3(1), 24-38. doi: 10.1016/j.jnlssr.2021.10.006.
[43] Liu, L., Bashir, T., Abdalla, A.A., Salman, A., Ramos-meza, C.S., Jain, V., & Shabbir, M.S. (2024). Can money supply endogeneity influence bank stock returns? A case study of South Asian economies. *Environment, Development and Sustainability*, 26, 2775-2787. doi: 10.1007/s10668-022-02867-6.
[44] Mahapatra, S., & Bhaduri, S.N. (2019). Dynamics of the impact of currency fluctuations on stock markets in India: Assessing the pricing of exchange rate risks. *Borsa Istanbul Review*, 19(1), 15-23. doi: 10.1016/j.bir.2018.04.004.
[45] Mroua, M., & Trabelsi, L. (2020). Causality and dynamic relationships between exchange rate and stock market indices in BRICS countries: Panel/GMM and ARDL analyses. *Journal of Economics, Finance and Administrative Science*, 25(50), 395-412. doi: 10.1108/JEFAS-04-2019-0054.
[46] O'Sullivan, C., & Papavassiliou, V.G. (2021). A high-frequency analysis of return and volatility spillovers in the European sovereign bond market. *The European Journal of Finance*. doi: 10.1080/1351847X.2021.1910057.
[47] Ogunsanya, I., & Adamson, T.W. (2024). Exchange rate movement and stock returns in most capitalised economies in Sub-Saharan Africa. *Ilorin Journal of Economic Policy*, 11(1), 18-37. doi: 10.4314/ijep.v11i1.2.
[48] Qian, H., Xiangning, W., & Shuguang, Z. (2021). The effects of exchange rate fluctuations on the stock market and the affecting mechanisms: Evidence from BRICS countries. *The North American Journal of Economics and Finance*, 56, article number 101340. doi: 10.1016/j.najef.2020.101340.
[49] Qing, Y.K., & Kusairi, S. (2019). The effect of money supply, exchange rate, and interest spread toward the performance of stock market in Malaysia. *Widyakala Journal*, 6(2), 142-149. doi: 10.36262/widyakala.v6i2.217.
[50] Salachas, E., Kouretas, G.P., Laopodis, N.T., & Vlamis, P. (2024). Stock market spillovers of global risks and hedging opportunities. *European Journal of Political Economy*, 83, article number 102533. doi: 10.1016/j.ejpoleco.2024.102533.
[51] Salisu, A.A., & Vo, X.V. (2021). The behavior of exchange rate and stock returns in high and low interest rate environments. *International Review of Economics & Finance*, 74, 138-149. doi: 10.1016/j.iref.2021.02.008.
[52] Salisu, A.A., Cunado, J., Isah, K., & Gupta, R. (2021). Stock markets and exchange rate behavior of the BRICS. *Journal of Forecasting*, 40(8), 1581-1595. doi: 10.1002/for.2795.
[53] Samuels, J.I. (2024). *Understanding the dynamics of financial markets: A comprehensive analysis*. doi: 10.13140/RG.2.2.32665.60008.
[54] Sheikh, U.A., Asad, M., Ahmed, Z., & Mukhtar, U. (2020). Asymmetrical relationship between oil prices, gold prices, exchange rate, and stock prices during global financial crisis 2008: Evidence from Pakistan. *Cogent Economics & Finance*, 8(1), article number 1757802. doi: 10.1080/23322039.2020.1757802.
[55] Silva, T.C., Wilhelm, P.V.B., & Tabak, B.M. (2023). The effect of interconnectivity on stock returns during the global financial crisis. *The North American Journal of Economics and Finance*, 67, article number 101940. doi: 10.1016/j.najef.2023.101940.
[56] Singh, R.K., Singh, Y., Kumar, S., Kumar, A., & Alruwaili, W.S. (2024). Mapping risk-return linkages and volatility spillover in BRICS stock markets through the lens of linear and non-linear GARCH models. *Journal of Risk and Financial Management*, 17(10), article number 437. doi: 10.3390/jrfm17100437.

[57] Sokhanvar, A., Çiftçioğlu, S., & Hammoudeh, S. (2024). Comparative analysis of the exchange rates-stock returns nexus in commodity-exporters and -importers before and during the war in Ukraine. *Research in International Business and Finance*, 67, article number 102152. doi: 10.1016/j.ribaf.2023.102152.
[58] Subburayan, B., & Aruldoss, A. (2020). Volatility spillover of exchange rate on stock market: Evidence from South Africa. *Asian Journal of Economics, Finance and Management*, 2(1), 131-139.
[59] Suri, R.K., Gauba, S., & Chandran, A.P. (2024). Co-movements between stock markets and exchange rates: Empirical evidence from the G20 nations. *International Journal of Finance Research*, 5(3), 252-269. doi: 10.47747/ijfr.v5i3.1934.
[60] Tabash, M.I., Chalissery, N., Nishad, T.M., & Al-Absy, M.S.M. (2024). Market shocks and stock volatility: Evidence from emerging and developed markets. *International Journal of Financial Studies*, 12(1), article number 2. doi: 10.3390/ijfs12010002.
[61] Tejesh, H.R. (2024). Impact of inflation and exchange rate on stock market returns in India: An ARDL approach. *Theoretical and Applied Economics*, 31(2), 25-36.
[62] UN Comtrade. (2023). Retrieved from https://comtradeplus.un.org.
[63] Verma, R.K., & Bansal, R. (2021). Impact of macroeconomic variables on the performance of stock exchange: A systematic review. *International Journal of Emerging Markets*, 16(7), 1291-1329. doi: 10.1108/IJOEM-11-2019-0993.

Коливання обмінного курсу, цін акцій та прибутковості у країнах BRICS: модераторний вплив інфляції за допомогою аналізу хвильових довжин

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Анотація. Метою цього дослідження було оцінити умовний вплив волатильності обмінного курсу на ціни акцій і прибутковість у країнах, що розвиваються, з групи BRICS. Використовуючи щоденні дані за період з 1 січня 2000 року по 30 грудня 2023 року, було проведено хвильовий та квантильний аналіз. Для перевірки надійності результатів було оцінено модель Маркова. Хвильова шкала W1 виявила дисперсію 574,7375 і відносну частку 20,95 % у поясненні мінливості цін на акції, тоді як хвильова шкала W3 мала дисперсію 288,5577 і відносну частку 15,54 %, а хвильова шкала W2 – дисперсію 159,5644 і частку 8,59 %. Це свідчило про те, що фондові ринки країн BRICS суттєво реагують на сукупні економічні тренди у короткостроковій перспективі та на раптові коливання обмінного курсу. Внесок дисперсії для прибутковості зростав на короткострокових шкалах, коливаючись від 0,0156 для W1 до 0,0643 для W3. Це вказало на те, що прибутковість акцій у країнах BRICS є помірно чутливою до раптових коливань обмінного курсу, миттєвих змін інфляції та варіацій грошової маси. Короткострокові шкали фіксували швидкі ринкові реакції на економічні новини та оновлення, що відповідало результатам попередніх досліджень. Ціни акцій зростали у відповідь на збільшення рівня інфляції на всіх квантилях, тоді як прибутковість акцій демонструвала значну обернену залежність від рівня інфляції. Крім того, було виявлено значний негативний вплив волатильності обмінного курсу на прибутковість акцій як у режимі плаваючого, так і у фіксованого валютного курсу. Загалом, коли внутрішня інфляція чинить значний модераторний вплив у середовищі з високою волатильністю, ринкова ефективність стає дуже чутливою до коливань валютного курсу. Результати цього дослідження сприятимуть розробці політик як урядами, так і фінансовим сектором

Ключові слова: варіація грошової маси; сукупна дисперсія; спектральний розподіл дисперсії; квантильна регресія; регресія з перемиканням режимів Маркова