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STOCK MARKET PRICES AND FOREIGN EXCHANGE RATE INTERACTIONS IN NIGERIA: EVIDENCE FROM COINTEGRATED VAR MODEL

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ABSTRACT

The relationship between stock prices and foreign exchange rates has been a subject of ongoing academic debate, with empirical findings often yielding mixed results. This study investigates the dynamic link between stock market prices and the foreign exchange rate in Nigeria by analyzing secondary monthly time series data on the All Share Index, Naira/USD exchange rate, and money supply spanning January 2009 to December 2024. The analysis employs the Ng-Perron modified unit root test, Johansen Cointegration technique, Vector Autoregressive (VAR) model, impulse response function, variance decomposition and the Granger causality test using the modified Wald approach. Findings indicate that all variables are integrated of order one, yet no long-term cointegrating relationship exists among them. The VAR model reveals a degree of inertia in the behaviour of stock prices, exchange rates, and money supply in the short term. Stock market prices in Nigeria show a sluggish response to shocks in the exchange rate and money supply. Furthermore, neither exchange rate movements nor changes in money supply were found to significantly predict stock market prices, suggesting limited effectiveness of these variables as tools for stock market intervention. Granger causality tests also indicate the absence of causal relationships among the variables, implying that fluctuations in exchange rates and money supply do not significantly impact stock market performance in Nigeria. The study recommends that policymakers should not rely solely on exchange rate and money supply as tools for influencing stock market performance in Nigeria, but rather adopt broader macroeconomic and institutional strategies beyond exchange rate and money supply adjustments, while also enhancing market efficiency and investor confidence to improve the responsiveness of the stock market to economic fundamentals.

Keywords: Stock prices, Exchange Rate, Cointegration, VAR model, Modified Wald Test, Nigeria

INTRODUCTION

The relationship between stock market performance and foreign exchange rate dynamics has remained a central theme in international finance and macroeconomics, attracting substantial scholarly attention. This interest stems from the critical role both markets play in a country's economic development and financial integration. Exchange rates influence the competitiveness of domestic firms in international markets, while stock prices reflect investors' confidence and the valuation of corporate assets. Thus, the interplay between these two variables is crucial for portfolio management, macroeconomic stability, and policy formulation (Jebran and Iqbal, 2016).

Two major theoretical frameworks attempt to explain this interaction: the flow-oriented and stock-oriented models. The flow-oriented model, pioneered by Dornbusch and Fischer (1980), posits that exchange rate movements influence trade balances and, consequently, the profitability of firms, which in turn affects stock prices. Conversely, the stock-oriented model suggests that stock market developments affect investor wealth and expectations, thereby influencing capital flows and exchange rates (Branson, 1983). These theoretical views imply either unidirectional or bidirectional causality between stock prices and exchange rates. However, empirical evidence remains inconclusive and highly sensitive to country-specific factors, time frames, and methodological approaches (Phylaktis & Ravazzolo, 2005).

In emerging and developing economies, such as Nigeria, the stock market and the foreign exchange market are particularly volatile and susceptible to macroeconomic shocks, political instability, and external financial pressures. Nigeria's heavy dependence on oil exports and its exposure to global commodity price fluctuations often translate into exchange rate volatility and capital flow reversals. Simultaneously, the Nigerian stock market has experienced episodes of boom and bust, with limited investor confidence and low market capitalization relative to GDP (CBN, 2022; NSE, 2023). These factors have intensified the debate on whether movements in the exchange rate exert a significant influence on stock market behaviour in Nigeria or vice versa.

Although a number of studies have attempted to examine this relationship in the Nigerian context, the findings have been mixed and far from conclusive. For instance, Okwuchukwu and Ajayi (2019) reported a weak linkage between stock prices and exchange rates, while Akinlo and Apanisile (2016) found evidence of a long-run relationship. Conversely, Adaramola (2012) observed no significant impact of exchange rate fluctuations on stock market performance. These inconsistencies underscore the need for further investigation using more robust and updated econometric techniques capable of capturing both short-run dynamics and long-term equilibrium such as the Cointegrated Vector Autoregressive (VAR) model proposed by Johansen (1991).

Moreover, policy formulation in Nigeria has often lacked a clear understanding of the transmission mechanism between foreign exchange interventions and capital market responses. As a result, monetary authorities sometimes adjust interest rates or intervene in the currency market without a firm grasp of how such actions might impact the stock market or investor expectations. Inaccurate assumptions regarding this nexus may lead to suboptimal policies, especially in times of crisis or uncertainty. Therefore, an empirically grounded analysis of this relationship is vital to inform effective and coherent macroeconomic management.

This study aims to contribute to the body of knowledge by empirically investigating the direction, strength, and nature of the relationship between stock market prices and foreign exchange rates in Nigeria using monthly time series data spanning 2009 to 2024. By employing the Ng-Perron unit root test, Johansen cointegration, and Vector Autoregressive (VAR) methodology, the study seeks to fill the existing gap in literature and provide evidence-based insights that can guide policy formulation, investment decisions, and financial market regulation in Nigeria.

Several empirical studies have investigated the relationship between stock market returns and exchange rates across different countries, revealing mixed findings. Agrawal et al. (2010) found a unidirectional causality from stock market returns to exchange rates in India, while Sifunjo and Mwasaru (2012) observed the opposite in Kenya, with exchange rates significantly influencing stock prices. Similarly, Sahadudheen (2013) reported a negative impact of exchange rate volatility on Indian stock prices, emphasizing the sensitivity of stock markets to currency fluctuations.

Other studies further highlight the dynamic nature of this relationship. Umer et al. (2015), analyzing data from nine emerging markets, revealed that the direction of causality between stock prices and exchange rates varies depending on market conditions, shifting during crisis and tranquil periods. In Ghana, Korsah and Fosu (2016) identified a consistent negative long- and short-term effect of exchange rate depreciation on stock market capitalization. They recommended strengthening the real economy, especially agriculture, to enhance foreign exchange stability and stock market performance. Collectively, these studies underscore the complex and context-specific interactions between exchange rates and stock markets. Similarly, Zou et al. (2017) examined the link between commodity prices and exchange rates in Australia and New Zealand, finding a strong, predictive relationship where commodity prices improved the forecasting accuracy of exchange rates, outperforming conventional models.

In Sri Lanka, Koperunthevy et al. (2017) assessed the relationship between stock prices and exchange rates using monthly data and found no evidence of long-run cointegration or causality in either direction. Conversely, Turgut (2017), studying Turkey's financial market, confirmed a robust long-run relationship between stock prices and real exchange rates using ARDL and ECM methods, further supported by a combined cointegration test. The study also revealed long-run bidirectional and short-run unidirectional causality from exchange rates to stock prices, highlighting context-dependent interactions across countries.

Mostafa and Gang (2017) explored the dynamic relationship between stock prices and exchange rates using daily data across Bangladesh, Pakistan, and India from 2009 to 2015. While no meaningful relationship was found in Bangladesh, Pakistan exhibited a unidirectional causality from stock prices to exchange rates, and India showed a long-run negative impact of exchange rates on stock prices, along with short-run causality from stock prices to exchange rates. Moore and Wang (2014) also identified a negative relationship between these variables in both developed and emerging markets. Expanding on previous research, Bhutto and Chang (2019) examined the effects of exchange rate fluctuations on stock prices in China using linear and nonlinear ARDL models across different timeframes. Their findings revealed symmetric effects before the global financial crisis and asymmetric effects during and after, indicating the crisis introduced structural shifts in the exchange rate–stock price relationship.

Van-Hop (2019) studied six countries-Japan, the UK, Hong Kong, China, India, and Brazil-between 2007 and 2013 to assess how exchange rates interact with stock market prices in the short and long term. The study used cointegration and multivariate Granger causality tests and found that the 2007-2009 global financial crises significantly altered the nature of the relationship. During the crisis and over the full sample period, exchange rates were negatively associated with stock prices in emerging economies and positively in developed countries. Post-crisis, the relationship turned positive across all countries except the UK. These findings suggest that exchange rate movements are important predictors of stock market performance and highlight the influence of economic shocks on financial variable interactions.

Ahmed and Oladotun (2019) examined the impact of monetary policy on the nexus between exchange rates and stock market prices in Nigeria, South Africa, and Egypt from 2005 to 2017. Using a panel ARDL model and annual data on key monetary and financial indicators, the study confirmed a negative and significant relationship between exchange rates and stock prices in the full sample and post-crisis period, thereby validating the trade balance approach (TBA) for those periods. However, the TBA was not supported during the pre-crisis phase. Notably, while South Africa displayed a synchronized movement between exchange rates and stock prices, Nigeria and Egypt exhibited divergent trends.

Dang et al. (2020) explored the asymmetric impact of exchange rate fluctuations on stock prices in Vietnam using a nonlinear ARDL model with monthly data from January 2001 to May 2018. By decomposing the exchange rate into appreciation and depreciation components, the study examined both short- and long-run asymmetries. The findings revealed that exchange rate changes influence stock prices asymmetrically in both time horizons, with currency appreciation exerting a stronger long-term effect than depreciation. Even in the absence of asymmetry, the study noted a significant short-run impact of exchange rate fluctuations on stock market behaviour.

Similarly, Cakir (2021) examined whether exchange rate movements have symmetric or asymmetric effects on three major Turkish stock indices-BIST All Shares, BIST National 100, and BIST National 30 using four ARDL models from January 2003 to December 2018. The study confirmed that exchange rates exert asymmetric influences on all three indices in both the short and long term. Long-run results indicated that currency appreciation positively affects stock markets, while depreciation does not, a reflection of Turkey's import-dependent economy. Additionally, economic activity had a positive and significant long-run effect on all indices, whereas interest rates and volatility had negative effects. Gokmenoglu et al. (2021) further extended this discourse by using a quantile-on-quantile approach to study the nuanced relationship between exchange rates and stock returns in selected emerging markets. Their results revealed that the impact of exchange rate changes is conditional upon prevailing market conditions (bearish or bullish), underlining the importance of exchange rate flexibility. Collectively, these studies underscore the asymmetric and context-specific nature of exchange rate–stock market dynamics, offering valuable insights for policymakers and investors.

A review of the empirical literature reveals ongoing debate over the nature and direction of the relationship between stock prices and exchange rates, with inconsistent findings across regions and methodologies. While some studies have identified a positive linkage suggesting that currency appreciation boosts investor confidence and stock performance others report a negative association, implying

that depreciation erodes stock market value. These conflicting results underscore the need for further investigation, especially in countries like Nigeria where market inefficiencies and macroeconomic volatility are pronounced. This study responds to such gaps by using a robust dataset from 2009 to 2024 and applying advanced econometric techniques to uncover both short- and long-run dynamics. The goal is to provide clearer insights that will inform monetary policy, guide investor strategy, and contribute meaningfully to academic discourse on financial market interactions in emerging economies.

MATERIALS AND METHODS

Source of Data

The data used in this research work are monthly secondary data on All Share Index (ASI) used as proxy for stock market prices, Naira/US Dollar Exchange Rate (USD) used as proxy for foreign exchange rate, and Broad money supply (M2). The data was obtained from CBN website (www. cbn.gov.ng) and spanned from January, 2009 to December, 2024. All the plots and statistical analysis were implemented using E-views version 10 software.

Methods of Data Analysis

The following methods are employed in the statistical analysis of this research work:

Ng and Perron (NP) Modified Unit Root Test

To check the unit root and stationarity properties of the series, Ng and Perron modified unit root test is employed because of its good power property. Ng and Perron (2001) constructed four test statistics which are based on the Generalized Least Squares detrended series Y_t^d. The four test statistics are the modified forms of Phillips & Perron Z_α and Z_t statistics, the Bhargava (1986) R_1 statistic, and the Elliot, Rothenberg & Stock Point Optimal statistic (Elliot *et al.*, 1996). First, define the term:

$$k = \sum_{t=2}^{T} (Y_{t-1}^d)^2 / T^2 \quad (1)$$

The four modified statistics are then written as,

$$\left.\begin{array}{c} MZ_\alpha^d = (T^{-1}(Y_T^d)^2 - f_0)/(2k) \\ MZ_t^d = MZ_\alpha \times MSB \\ MSB^d = (k/f_0)^{0.5} \\ MP_T^d = \begin{cases} (-7^2 k + 7T^{-1}(Y_T^d)^2)/f_0\,, & \text{if } x_t = \{1\} \\ (-13.5^2 k + (1+13.5)T^{-1}(Y_T^d)^2)/f_0, & \text{if } x_t = \{1, t\} \end{cases} \end{array}\right\} \quad (2)$$

where MZ_α^d is the modified detrended Z_α transformation of the standardized estimator given by:

$$T(\hat{\alpha} - 1) = \{T^{-1}\sum_{t=1}^{T} y_{t-1}(y_t - y_{t-1})\}/\{T^{-1}\sum_{t=1}^{T} y_{t-1}^2\} \quad (3)$$

MZ_t^d is the modified detrended Z_t transformation of the conventional regression t statistic defined by:

$$t_\alpha = (\sum_{t=1}^{T} y_{t-1}^2)^{1/2}(\hat{\alpha} - 1)\,/s \quad (4)$$

where $s^2 = T^{-1}\sum_{t=1}^{T}(y_t - \hat{\alpha} y_{t-1})^2 \quad (5)$

MSB is the modified Bhargava R_1 statistic (Stock, 1990). The R_1 statistic is given by:

$$R_1 = \sum_{t=2}^{T}(y_t - y_{t-1})^2 / \sum_{t=1}^{T}(y_t - \bar{y})^2\,; \quad \bar{y} = \frac{1}{T}\sum_{t=1}^{T} y_i \quad (6)$$

MP_T^d is the ERS modified detrended point optimal statistic (Elliot *et al.*, 1996). The point optimal statistic is given as:

$$P_T = \frac{[S(\bar{\alpha}) - \bar{\alpha} S(1)]}{s^2} \quad (7)$$

Y_T^d is the trended series, x_t is a series of observations at time t, f_0 is the frequency zero spectrum define as:

$$f_0 = \sum_{j=-(T-1)}^{T-1} \hat{\gamma}(j).K\left(\frac{j}{l}\right) \quad (8)$$

Where l is a bandwidth parameter, T is the sample size, K is a kernel function and $\hat{\gamma}(j)$ is the j-th sample autocovariance of the residuals $\hat{u}_t$ and is given by:

$$\hat{\gamma}(j) = \sum_{t=j+1}^{T}(\hat{u}_t \hat{u}_{t-j})/T \quad (9)$$

The MZ_α, MZ_t, MSB and MP_T statistices are collectively referred to as M tests and are used in detecting the presence of unit root in a series (Ng & Perron, 2001). In addition to the MZ_α and MZ_t statistics, Ng and Perron also investigated the size and power properties of the MSB statistic. Critical values for the demeaned and detrended case of this statistic were taken from (Stock, 1990).

Johansen Cointegration Test

Two or more non-stationary series, I(1), are said to be cointegrated if their linear combination gives a stationary series, I(0). Johansen (1991, 1995) developed a methodology for testing for cointegration as follows:

Let $\boldsymbol{Y_t} = (y_{1t}, y_{2t}, \dots, y_{nt})'$ denote an $(n \times 1)$ vectorof non-stationary I(1) time series variables. The basic Vector Autoregressive Model of order p, denoted VAR(p) is defined as

$$Y_t = \alpha + \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \cdots + \phi_p Y_{t-p} + BX_t + \varepsilon_t, t = 1, 2, \dots, T \quad (10)$$

where α is an $(n \times 1)$ vector of intercept, ϕ_i $(i = 1, 2, \dots, p)$: is $(n \times n)$ coefficient matrices, X_t is d-vector of deterministic variables, ε_t is an $(n \times 1)$ vector of unobservable error term with zero mean (white noise).

We may rewrite this VAR as:

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + BX_t + \varepsilon_t \quad (11)$$

where

$$\Pi = \sum_{i=1}^{p} \phi_i - I\,;\ \Gamma_i = -\sum_{j=i+1}^{p} \phi_j \quad (12)$$

Granger's representation theorem asserts that if the coefficient matrix Π has reduced rank $r < k$, then there exist $k \times r$ matrices α and β each with rank r such that $\Pi = \alpha\beta'$ and $\beta' Y_t$ is I(0). r is the number of cointegrating relations (the cointegrating rank) and each column of β is the cointegrating vector.Johansen cointegration test computes two statistics: trace statistic and maximum eigenvalue statistic. We only employ both the trace test and maximum eigenvalue test statistics in this study. The trace statistic for the null hypothesis of r cointegrating relations is computed as:

$$LR_{tr}(r|k) = -T\sum_{i=r+1}^{k} \log(1 - \lambda_i) \quad (13)$$

The maximum eigenvalue test statistic is computed as:

$$LR_{max}(r|r+1) = -Tlog(1 - \lambda_{r+1}) = LR_{tr}(r|k) - LR_{tr}(r+1|k) \quad (14)$$

where λ_i is the i-th largest eigenvalue of the $\boldsymbol{\Pi}$ matrix in (3.6), $r = 0, 1, 2, \dots, k-1$ (Johansen, 1995).

Cointegrating regression model specification

To specify a model describing a long-term relationship existing among the study variables, we specify ASI as a function of exchange rate and money supply. It is expressed mathematically as:

$$ASI = f[USD, M2] \quad (15)$$

Since the three variables have different units of measurement, we transform them to natural logarithms. This converts them to a common unit and stabilizes their variances as well. Our model now becomes:

$$\ln(ASI)_t = \beta_0 + \beta_1 \ln(USD)_t + \beta_2 \ln(M2)_t + \varepsilon_t \quad (16)$$

Where $\ln(ASI)_t$ represents natural log of ASI at time t proxied for stock market prices, $\ln(USD)_t$ represents natural log of exchange rate at time t, $\ln(M2)_t$ represents natural log of money supply at time t, ε_t is the error term assumed to be normally and independently distributed with zero mean and constant variance, which captures all other explanatory

variables that influence stock market prices but are not captured in the model, β_0 is the intercept of the regression model which represents the predictive value of the dependent variable when all the independent variables are kept constant, β_1, β_2 are the partial elasticity of stock market prices with respect to USD and M2 respectively.

Vector Autoregressive (VAR) Model

The Vector Autoregressive (VAR) model is a statistical model used in econometrics and time series analysis to capture the linear interdependencies among multiple time series.

Let $Y_t = (y_{1t}, y_{2t}, \dots, y_{nt})'$ denote an $(n \times 1)$ vector of time series variables. The basic autoregressive model of order p, denoted VAR(p) is defined as

$$Y_t = C + A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_p Y_{t-p} + \varepsilon_t, t = 1, 2, \dots, T \quad (17)$$

Where C is an $(n \times 1)$ vector of intercept, A_i $(i = 1, 2, \dots, p)$ is $(n \times n)$ coefficient matrices, ε_t is an $(n \times 1)$ vector of unobservable error term with zero mean (white noise).

If Y_1, Y_2 and Y_3 are three different time series variables, a VAR(2) model includes the lagged values of all the three variables up to two time periods and has the form:

$$Y_{1t} = c_{11} + a_{11}Y_{1,t-1} + a_{12}Y_{2,t-1} + a_{13}Y_{3,t-1} + b_{11}Y_{1,t-2} + b_{12}Y_{2,t-2} + b_{13}Y_{3,t-2} + \varepsilon_{1t}$$

$$Y_{2t} = c_{21} + a_{21}Y_{1,t-1} + a_{22}Y_{2,t-1} + a_{23}Y_{3,t-1} + b_{21}Y_{1,t-2} + b_{22}Y_{2,t-2} + b_{23}Y_{3,t-2} + \varepsilon_{2t}$$

$$Y_{3t} = c_{31} + a_{31}Y_{1,t-1} + a_{32}Y_{2,t-1} + a_{33}Y_{3,t-1} + b_{31}Y_{1,t-2} + b_{32}Y_{2,t-2} + b_{33}Y_{3,t-2} + \varepsilon_{3t}$$

The VAR(2) model with three variables in matrix form can be written as:

$$\begin{bmatrix} Y_{1t} \\ Y_{2t} \\ Y_{3t} \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \\ c_3 \end{bmatrix} + \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \begin{bmatrix} Y_{1,t-1} \\ Y_{2,t-1} \\ Y_{3,t-1} \end{bmatrix} + \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{bmatrix} \begin{bmatrix} Y_{1,t-2} \\ Y_{2,t-2} \\ Y_{3,t-2} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{bmatrix} \quad (18)$$

Granger Causality Test Based on Modified Wald Test

We employ Granger causality test procedure due to Toda and Yamamoto (1995) to determine the direction of causality among the study variables. Toda and Yamamoto procedure uses a Modified Wald (MWALD) test for restrictions on the parameters of the VAR (k) model. The model is specified as follows:

$$(ASI)_t = \alpha_1 + \sum_{i=1}^{k+d} \phi_{1i}(ASI)_{t-i} + \sum_{t-i}^{k+d} \phi_{2i}(USD)_{t-i} + + \sum_{t-i}^{k+d} \phi_{3i}(M2)_{t-i} + \varepsilon_{xt} \quad (19)$$

$$(USD)_t = \alpha_2 + \sum_{i=1}^{k+d} \beta_{1i}(USD)_{t-i} + \sum_{t-i}^{k+d} \beta_{2i}(ASI)_{t-i} + + \sum_{t-i}^{k+d} \beta_{3i}(M2)_{t-i} + \varepsilon_{yt} \quad (20)$$

$$(M2)_t = \alpha_3 + \sum_{i=1}^{k+d} \varphi_{1i}(M2)_{t-i} + \sum_{t-i}^{k+d} \varphi_{2i}(ASI)_{t-i} + + \sum_{t-i}^{k+d} \varphi_{3i}(USD)_{t-i} + \varepsilon_{zt} \quad (21)$$

where $k$is the optimal lag order; $d$is the maximal order of integration of the series in the system; $\varepsilon_{xt}, \varepsilon_{yt}$ and ε_{zt} are error terms which are assumed to be white noise. The usual Wald test is then applied to the first k coefficient matrices using the standard χ^2-statistics. The test checks the following pairs of hypotheses: $(ASI)_t$ "Granger causes" $(USD)_t$ if $\phi_{1i} \neq 0$ in equation (19) against $(USD)_t$ "Granger causes" $(ASI)_t$ if $\beta_{2i} \neq 0$ in equation (20) and vice versa.

RESULTS AND DISCUSSION

Summary Statistics of the Study Variables

In other to understand the distributional characteristics of all share index, exchange rate and money supply, we compute the summary statistics such as the mean, standard deviation and range as well as normality measures like skewness, kurtosis and Jarque-Bera statistics. The result of summary statistics is presented in Table 1.

Table 1: Summary Statistics of the Study Variables

Statistics	Variables in Level			Log Returns of the Variables		
	ASI	USD	M2	ASI	USD	M2
Mean	31315.61	209.3636	13542746	0.170076	0.466991	1.417128
Median	28044.37	159.7350	13212381	-1.115166	0.000000	0.883278
Maximum	65652.40	494.7000	28724166	53.81141	14.47508	39.53757
Minimum	19851.90	118.7000	1917503.	-37.23692	-14.13763	-28.67307
Standard Dev.	9554.612	99.01069	7932573.	20.63041	3.489780	5.020247
Skewness	1.307594	1.151548	0.162649	0.666794	0.540832	1.391163
Kurtosis	4.382981	2.834096	1.877251	3.205341	7.921321	25.84466
Jarque-Bera	70.01475	42.65421	10.93107	14.48913	202.0573	4214.891
P-value	0.000000	0.000000	0.004230	0.000714	0.000000	0.000000
No. of Obs.	192	192	192	191	191	191

The summary statistics presented in Table 1 indicate that the average monthly values for the All Share Index, exchange rate, and money supply are 31,315.61, 209.36, and 13,542,746 respectively, with corresponding standard deviations of 9,554.61, 99.01, and 7,932,573. These large standard deviations suggest substantial fluctuations around the mean values, reflecting high volatility in the Nigerian financial indicators during the study period. Furthermore, the considerable differences between the maximum and minimum values for each variable underscore the extent of variability within the dataset. Tests for normality reveal significant departures from normal distribution, as the null hypotheses of zero skewness and a kurtosis coefficient of 3 are rejected at the 1% significance level. This is further corroborated by the large Jarque-Bera statistics and their associated p-values, confirming that the variables are not normally distributed.

Graphical Examination of the Study Variables

The initial step in time series analysis involves plotting the original data series at their levels against time to visually examine their graphical characteristics. This approach aids in identifying underlying trends and movement patterns within the data. In this study, the original series have been plotted over time, and the resulting graphs are displayed in Figure 1.

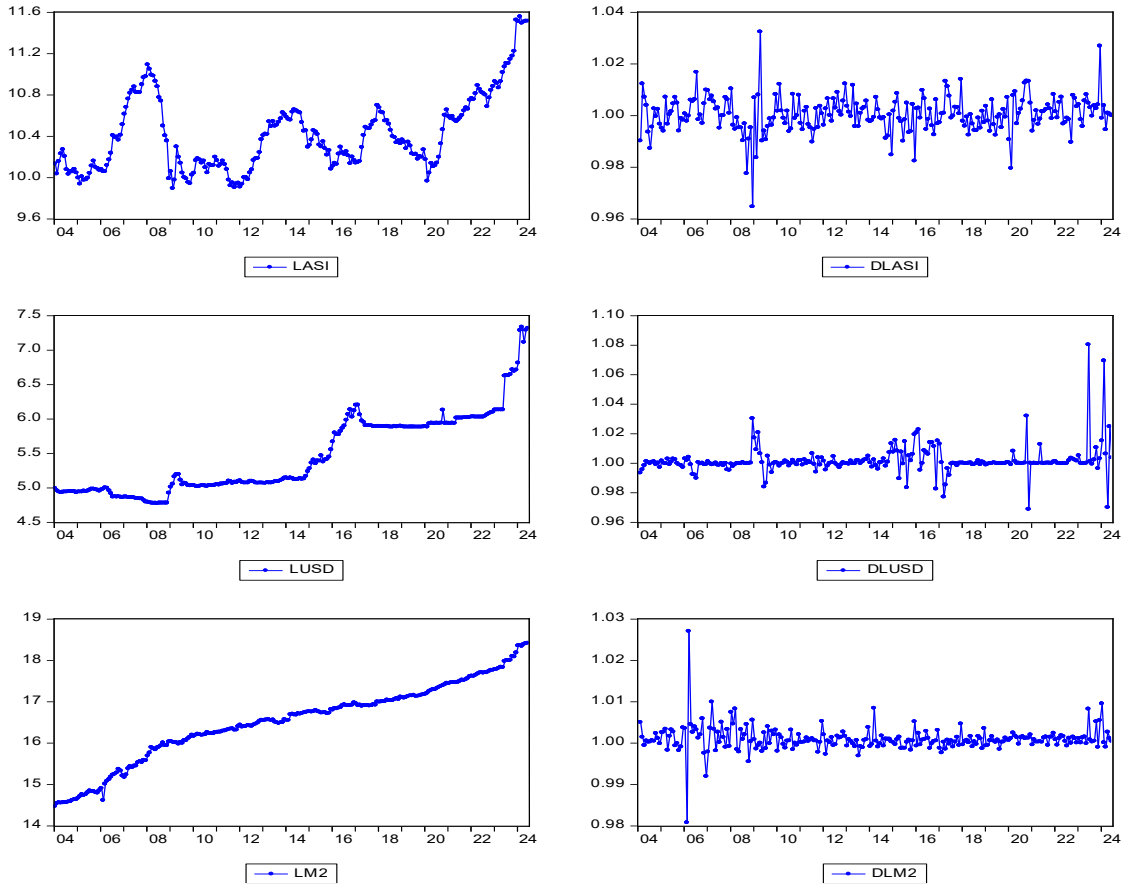

Figure 1: Time Plots of Monthly ASI, Exchange Rate and Money Supply

The time plots of the monthly All Share Index, exchange rate, and money supply in Nigeria, as shown in Figure 1 (left), reveal irregular and unsmooth trend movements, suggesting that the mean and variance of these series change over time- an indication of non-stationarity. In contrast, the plots of the first differenced series presented in Figure 1 (right) display more stable and consistent patterns, implying that the differenced series are covariance stationary.

Ng-Perron (NP) Modified Unit Root Test Result

To assess the presence of unit roots and determine the stationarity properties of the study variables, the Ng-Perron (NP) modified unit root test is utilized. The test is performed under two specifications: one with intercept only, and the other with both intercept and linear trend. The results of the NP test are presented in Table 2.

Table 2: Ng-Perron (NP) Modified Unit Root Test Result

Variable	Option	MZ_α	MZ_t	MSB	MPT
ln smp	Intercept only	-5.5974	-2.7684	0.1775	1.6640
	Intercept & trend	-4.2049	-1.8391	0.1554	1.1164
Δ ln smp	Intercept only	-139.153	-7.1812	0.0536	0.6211
	Intercept & trend	-144.320	-8.4939	0.0589	0.6341
ln usd	Intercept only	0.4318	0.2729	0.6322	28.9493
	Intercept & trend	-3.6982	-1.3338	0.3607	24.2534
Δ ln usd	Intercept only	-69.9728	-7.8431	0.0264	0.6319
	Intercept & trend	-78.6111	-6.2658	0.0797	1.1746
ln $m2$	Intercept only	1.0444	2.2053	2.1116	290.312
	Intercept & trend	-1.1735	-0.8749	0.4915	50.2666
Δ ln $m2$	Intercept only	-94.6121	-6.8749	0.0727	0.9789
	Intercept & trend	-95.2182	-8.9072	0.0719	0.9274
Critical values					
1%	Intercept only	-13.8000	-2.5800	0.1740	1.7800
	Intercept & trend	-23.8000	-3.4200	0.1430	4.0300
5%	Intercept only	-13.8000	-2.5800	0.1740	1.7800
	Intercept & trend	-23.8000	-3.4200	0.1430	4.0300
10%	Intercept only	-13.8000	-2.5800	0.1740	1.7800
	Intercept & trend	-23.8000	-3.4200	0.1430	4.0300

The Ng-Perron modified unit root test results presented in Table 2 show that the null hypothesis of a unit root cannot be rejected for the level forms of the monthly stock market prices, exchange rates, and money supply-both under the intercept-only specification and the model with intercept and linear trend. This is evidenced by the Ng-Perron M-statistics exceeding the critical values at the 1%, 5%, and 10% significance levels. However, when the test is applied to the first differenced series; the null hypothesis is rejected under both model specifications, as the M-statistics fall below the corresponding critical values. These findings indicate that the original series are non-stationary in levels but become stationary after first differencing, implying that all the study variables are integrated of order one, I(1).

Johansen Cointegration Test Results

Johansen cointegration analysis is applicable to variables that share the same order of integration. Since this condition is met by our study variables, we proceed to investigate their long-run equilibrium relationships using the Johansen cointegration testing approach. The results of both the Trace and Maximum Eigenvalue tests are presented in Table 3.

Table 3: Summary of Johansen Cointegration Test Results

Hypothesized No. of CE(s)	H_0	H_1	**Trace Statistic**	**Critical Value**	**P-value****
		Trace Test			
None	$r = 0$	$r \geq 1$	19.63018	35.01090	0.7299
At most 1	$r \leq 1$	$r \geq 2$	9.065432	18.39771	0.5734
At most 2	$r \leq 2$	$r = 3$	2.742716	3.841466	0.0977
		Maximum Eigenvalue Test			
Hypothesized No. of CE(s)	H_0	H_1	$\lambda_{\max}$ Statistic	Critical Value	P-value**
None	$r = 0$	$r = 1$	10.56475	24.25202	0.8707
At most 1	$r \leq 1$	$r = 2$	6.322716	17.14769	0.7846
At most 2	$r \leq 2$	$r = 3$	2.742716	3.841466	0.0977

Note: Both Trace test and Max-eigenvalue test indicate no cointegrating eqn(s) at the 0.05 level. * denotes rejection of the null hypothesis at the 0.05 level. **MacKinnon-Haug-Michelis (1999) p-values

The results of the Johansen cointegration Trace and Maximum Eigenvalue tests, as reported in Table 3, fail to reject the null hypotheses of no cointegration at ranks $r = 0, r \leq 1$ and $r \leq 2$. At the 5% significance level, both tests indicate the absence of cointegrating equations. This suggests that there is no long-run cointegrating relationship among stock market prices, foreign exchange rates, and money supply. Consequently, the variables do not exhibit a stable long-run equilibrium and do not share a common stochastic trend, implying that they are not inherently linked and may drift apart from one another over time.

VAR Lag Order Selection Criteria

Before estimating a Vector Autoregressive (VAR) model, it is crucial to determine the appropriate number of lags to include in the system. The selection of an optimal lag length ensures that the model adequately captures the dynamic relationships among variables without over-fitting or losing degrees of freedom. To this end, several statistical criteria are commonly used, including the Log-Likelihood (LogL), Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Criterion (SC), and Hannan-Quinn Criterion (HQ). Table 4 presents the results from the lag length selection test applied to the study variables.

Table 4: VAR Lag Order Selection Criteria

Lag	**LogL**	**LR**	**FPE**	**AIC**	**SIC**	**HQC**
0	468.9713	NA	1.59e-06	-4.835676	-4.629850	-4.752291
1	736.7237	515.6712	1.03e-07	-7.573796	-7.213602	-7.427873
2	760.7302	45.47252*	8.80e-08*	-7.73259*	-7.21803*	-7.52413*
3	831.7612	66.93721	7.94e-09	-7.935663	-7.7628858	-7.9754293
4	863.7092	74.95832	5.93e-10	-8.753626	-7.6713822	-7.8627813

Note: *indicates lag order selected by the criterion

Table 4 shows that while the log-likelihood (LogL) improves with additional lags, the majority of model selection criteria including the Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Criterion (SC), and Hannan-Quinn (HQ) consistently identify lag 2 as the optimal lag length. Despite slightly better values at higher lags, lag 2 is preferred because it strikes a balance between model fit and simplicity, and it is the only lag where all five criteria unanimously align. Hence, lag 2 is selected for the VAR model estimation.

Parameter Estimates of VAR Coefficients

To further investigate the interrelationships among stock market prices, foreign exchange rates, and money supply in Nigeria, a Vector Autoregressive (VAR) model in levels with a constant term is estimated. The regression results from this model are presented in Table 5.

Table 5: VAR Parameter Estimates for Study Variables

	$\ln asi$	$\ln usd$	$\ln m2$
$\ln asi(-1)$	0.821381	-0.001771	0.002271
	(0.07278)	(0.01265)	(0.01876)
	[11.2852]	[-0.14007]	[0.12104]
$\ln asi(-2)$	-0.176378	0.002352	0.015352
	(0.07299)	(0.01268)	(0.01881)
	[-2.41644]	[0.18546]	[0.81609]
$\ln usd(-1)$	-0.321219	1.325030	-0.072441
	(0.40220)	(0.06988)	(0.10366)
	[-0.79866]	[18.9622]	[-0.69884]
$\ln usd(-2)$	0.253180	-0.337786	0.073326
	(0.39973)	(0.06945)	(0.10302)
	[0.63338]	[-4.86383]	[0.71174]
$\ln m2(-1)$	0.437862	-0.003007	0.770864
	(0.27883)	(0.04844)	(0.07186)
	[1.57037]	[-0.06208]	[10.7269]
$\ln m2(-2)$	-0.396937	0.010934	0.217466
	(0.27663)	(0.04806)	(0.07130)
	[-1.43489]	[0.22749]	[3.05013]
C	3.352471	-0.063815	0.019756
	(0.60750)	(0.10555)	(0.15657)
	[5.51850]	[-0.60462]	[0.12618]
R-squared	0.740696	0.993781	0.996119
Adj. R-squared	0.625637	0.993578	0.995991
F-statistic	35.90478	4874.151	7827.603

Note: Standard errors in ( ) & t-statistics in [ ]

The Vector Autoregressive model of order 2 (VAR(2)) reported in Table 5 involving the three variables: log of stock market prices (lnASI), log of exchange rate (lnUSD), and log of money supply (lnM2) can be represented in a single matrix Equation (22) as follows:

$$\begin{bmatrix} \ln(ASI)_t \\ \ln(USD)_t \\ \ln(M2)_t \end{bmatrix} = \begin{bmatrix} 3.252471 \\ -0.063815 \\ 0.019756 \end{bmatrix} + \begin{bmatrix} 0.821381 & -0.001771 & 0.00227 \\ -0.321219 & 1.325030 & -0.072441 \\ 0.437862 & -0.003007 & 0.770864 \end{bmatrix} \begin{bmatrix} \ln(ASI)_{t-1} \\ \ln(USD)_{t-1} \\ \ln(M2)_{t-1} \end{bmatrix} + \begin{bmatrix} -0.176378 & 0.002352 & 0.015352 \\ 0.253180 & -0.337786 & 0.073326 \\ -0.396937 & 0.010934 & 0.217466 \end{bmatrix} \begin{bmatrix} \ln(ASI)_{t-2} \\ \ln(USD)_{t-2} \\ \ln(M2)_{t-2} \end{bmatrix} + \begin{bmatrix} \varepsilon_{ASI,t} \\ \varepsilon_{USD,t} \\ \varepsilon_{M2,t} \end{bmatrix} \quad (22)$$

From the results of VAR (2) parameter estimates reported in Table 5 and Equation (22), the lagged coefficients of stock market prices, exchange rates, and money supply (at both one- and two-period lags) are statistically significant at the 5% level, accompanied by high t-statistics. However, the results suggest that in the short run, these variables do not provide predictive information about one another. Specifically, money supply and exchange rate movements do not offer meaningful insights into stock price fluctuations in Nigeria. The most substantial predictive power for each variable comes from its own past values, indicating strong self-dependence and reinforcing the presence of inertia in all three variables. This finding further implies that stock prices in Nigeria react slowly to changes in exchange rates and money supply. Consequently, exchange rate and money supply shocks do not provide sufficient information for policymakers to rely on them as effective monetary policy tools for influencing stock market behavior in the Nigerian context.

The coefficient of determination (R^2) values indicate that the overall fit of the VAR model is strong, with the model accounting for approximately 74.07% of the variation in stock market prices, 99.38% in foreign exchange rates, and 99.61% in money supply. The adjusted R-squared values and F-statistics reinforce the robustness of the estimated VAR model. Overall, the results suggest that stock prices, exchange rates, and money supply in Nigeria are largely self-determined in the short run, with limited interdependence among them.

Impulse response function (IRF) analysis

Figure 2 presents Impulse Response Functions (IRFs), derived from VAR models, illustrate how each variable-stock market prices (ASI), exchange rate (USD), and money supply (M2)-responds over time to a one-time standard deviation shock in itself or another variable. In this study, the IRFs track these dynamic responses over a 10-period horizon in Nigeria, with blue lines showing the estimated effects and red dashed lines representing 95% confidence intervals used to determine statistical significance.

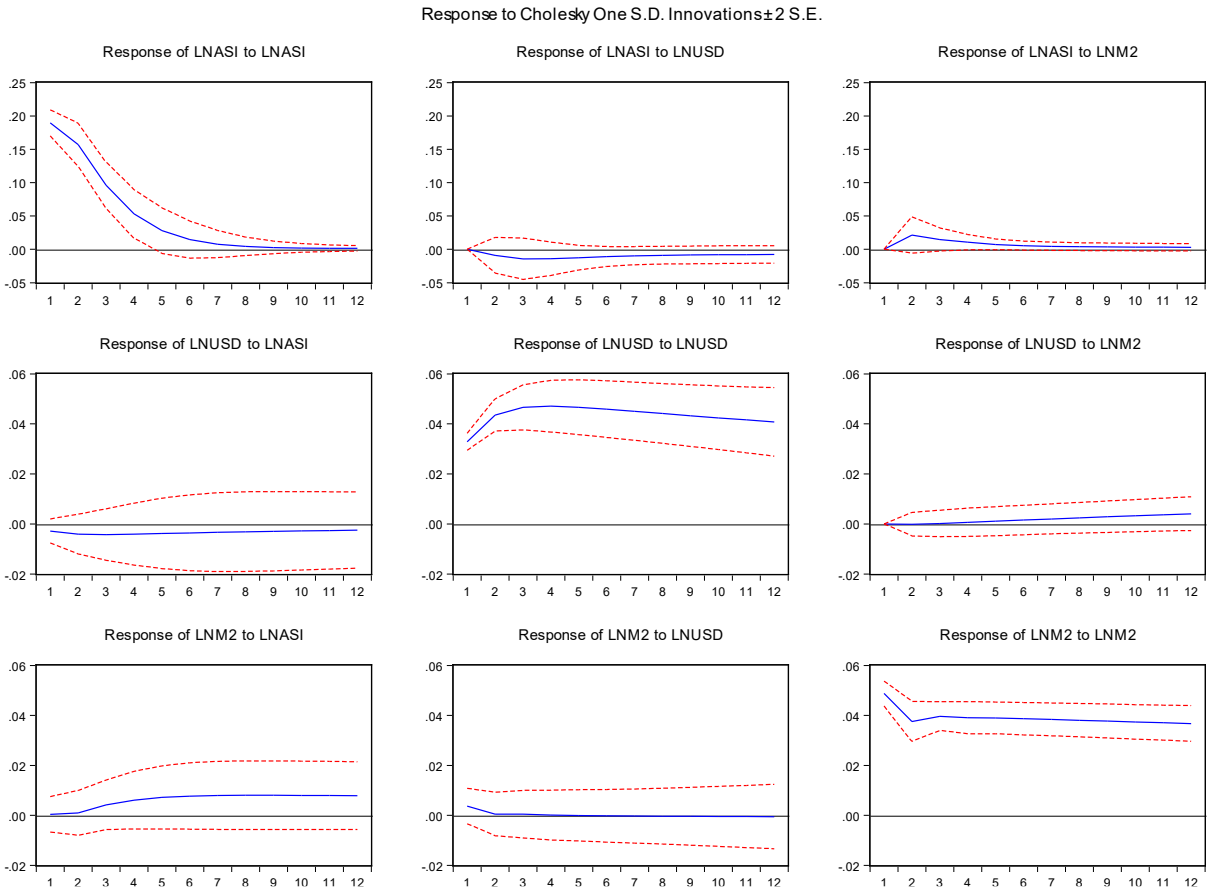

Figure 2: Plots of Impulse Response Function (IRF)

The impulse response analysis reported in Figure 2 reveals that stock market prices (ASI) exhibit strong persistence to their own shocks, gradually declining over time-an indication of inertia in the capital market. However, ASI shows negligible and statistically insignificant responses to shocks in both exchange rate (USD) and money supply (M2), suggesting that neither foreign exchange fluctuations nor monetary expansion significantly influence stock prices in the short run. This aligns with earlier VAR results, which indicated limited interdependence among the variables.

Similarly, the exchange rate (USD) responds strongly and positively to its own shocks, demonstrating self-dependence and persistence. However, it reacts weakly and insignificantly to shocks from stock prices and money supply, indicating minimal short-run influence from these variables. The money supply (M2) also shows strong persistence to its own shocks, reflecting continuity in monetary policy behaviour. Yet, like the other variables, M2 reacts insignificantly to shocks from both ASI and USD, reinforcing the conclusion that these three macroeconomic indicators largely operate independently in Nigeria over the short term.

Variance decomposition results

To further examine the relationships among the study variables, the variance decomposition results of stock market prices, foreign exchange rate and money supply are presented in Tables 6, 7 and 8.

Table 6: Variance Decomposition of ln *asi*

Period	Std. Error	ln *asi*	ln *usd*	ln *m2*
1	0.189729	100.0000	0.000000	0.000000
2	0.247301	99.12478	0.130027	0.745192
3	0.266170	98.65353	0.398771	0.947702
4	0.272008	98.28931	0.650356	1.060334
5	0.273826	98.03057	0.850737	1.118696
6	0.274482	97.84093	1.005090	1.153982
7	0.274800	97.69314	1.128823	1.178035
8	0.275008	97.56970	1.233790	1.196507
9	0.275176	97.46079	1.327272	1.211935
10	0.275324	97.36117	1.413326	1.225502
11	0.275460	97.26810	1.494130	1.237772
12	0.275589	97.18013	1.570843	1.249023

The variance decomposition results for stock market prices, as shown in Table 6, reveal that at the 4-period horizon, just 0.65% of the variation in stock prices is attributed to shocks from the foreign exchange rate, while 1.06% is explained by shocks from money supply. In contrast, a substantial 98.29% of the variance is explained by shocks originating from the stock market itself. This suggests that in the short run, neither exchange rate fluctuations nor changes in money supply provide meaningful predictive information about stock market behaviour in Nigeria.

Table 7: Variance Decomposition of ln usd

Period	Std. Error	ln asi	ln usd	ln $m2$
1	0.032963	0.735067	99.26493	0.000000
2	0.054735	0.822762	99.17652	0.000718
3	0.072018	0.829147	99.16976	0.001096
4	0.086135	0.806377	99.18777	0.005856
5	0.098023	0.775145	99.20814	0.016713
6	0.108292	0.743555	99.22231	0.034139
7	0.117339	0.714196	99.22758	0.058224
8	0.125431	0.687548	99.22354	0.088913
9	0.132750	0.663387	99.21049	0.126122
10	0.139430	0.641324	99.18891	0.169766
11	0.145569	0.620991	99.15925	0.219761
12	0.151243	0.602088	99.12189	0.276023

The variance decomposition results for the exchange rate, as presented in Table 7, indicate that at the 8-period horizon, only 0.69% of its variation is explained by shocks from stock market prices and just 0.09% by shocks from money supply. In contrast, 99.22% of the variation in the exchange rate is driven by its own innovations. This implies that, in the short run, movements in the exchange rate are largely self-determined, with stock market prices and money supply contributing negligibly to its fluctuations, and thus lacking predictive power over exchange rate dynamics in Nigeria.

Table 8: Variance Decomposition of ln $m2$

Period	Std. Error	ln asi	ln usd	ln $m2$
1	0.048899	0.006895	0.580934	99.41217
2	0.061683	0.027980	0.371500	99.60052
3	0.073439	0.343247	0.265474	99.39128
4	0.083402	0.794959	0.205931	98.99911
5	0.092327	1.251034	0.168131	98.58084
6	0.100393	1.646266	0.142681	98.21105
7	0.107768	1.970525	0.124645	97.90483
8	0.114569	2.232308	0.111353	97.65634
9	0.120886	2.444142	0.101244	97.45461
10	0.126789	2.617322	0.093368	97.28931
11	0.132333	2.760769	0.087120	97.15211
12	0.137563	2.881203	0.082098	97.03670

The variance decomposition results for money supply, as shown in Table 8, indicate that money supply does not exhibit any meaningful predictive influence on stock market prices or exchange rates in Nigeria. By the twelfth month, approximately 97.04% of the variation in money supply is attributed to its own shocks. The contribution of stock market prices to money supply fluctuations is minimal, accounting for only about 2.88%, while exchange rate shocks explain just 0.08%. These findings suggest that changes in money supply are predominantly driven by its own internal dynamics, with negligible influence from the other variables in the model.

Granger Causality Test Results

To examine the direction of causality among the study variables, Granger causality test based on modified Wald test procedure is employed and the result is presented in Table 9.

Table 9: Granger Causality Test Result based on Modified Wald Test

Excluded	Chi-sq	Df	P-value
	Dependent variable: ln asi		
ln usd	2.193742	2	0.3339
ln $m2$	2.211283	2	0.2108
All	4.701582	4	0.3193
	Dependent variable: ln usd		
ln asi	0.034597	2	0.9829
ln $m2$	2.924985	2	0.2317
All	3.255118	4	0.5161
	Dependent variable: ln $m2$		
ln asi	1.609096	2	0.4473
ln usd	0.509695	2	0.7750
All	2.198208	4	0.6994

The Granger causality test results presented in Table 9 do not reject the null hypothesis of no causality between the foreign exchange rate and stock market prices. There is no statistical evidence supporting either unidirectional or bidirectional causality between these two variables, indicating that changes in the exchange rate do not Granger-cause stock market prices, nor do stock market prices Granger-cause exchange rate movements. This implies that fluctuations in the foreign exchange rate have no discernible effect on stock market performance in Nigeria.

Similarly, the test fails to reject the null hypothesis of no causality between money supply and stock market prices. The findings reveal no evidence of a one-way or reciprocal causal relationship between the two variables, meaning that money supply changes do not Granger-cause stock market price movements, and vice versa. This suggests that variations in the money supply do not significantly impact stock market prices in the Nigerian context.

CONCLUSION

This study set out to investigate the dynamic relationship between stock market prices and the foreign exchange rate in Nigeria, incorporating the role of money supply using monthly time series data from January 2009 to December 2024. Through a robust methodological framework involving the Ng-Perron unit root test, Johansen Cointegration technique, Vector Autoregressive (VAR) model, impulse response analysis, variance decomposition, and Granger causality tests based on the modified Wald approach, the analysis provides significant insights into the interdependencies among these macroeconomic variables.

The findings reveal that while all three variables-stock market prices (ASI), exchange rates (USD/Naira), and money supply (M2) are non-stationary in levels but stationary in their first differences (i.e., integrated of order one), they do not share a common long-run equilibrium relationship, as evidenced by the absence of cointegration. The short-run dynamics captured by the VAR model demonstrate that stock market prices, exchange rates, and money supply exhibit inertia, with limited predictive interdependence. Specifically, shocks to exchange rates and money supply do not significantly influence stock prices, and vice versa, in both the impulse response and variance decomposition frameworks. The Granger causality tests further reinforce the absence of any statistically significant causal linkages among the variables, implying that neither exchange rate fluctuations nor money supply variations serve as effective tools for forecasting or influencing stock market behaviour in Nigeria.

These findings carry important policy implications. The ineffectiveness of exchange rate and money supply shocks in driving stock market performance suggests that policymakers should not rely on these variables in isolation as levers for capital market intervention. Instead, there is a need for more comprehensive macroeconomic strategies that incorporate fiscal policy coordination, institutional reforms, and structural improvements in financial infrastructure. In addition, efforts to enhance market efficiency, regulatory transparency, and investor confidence are essential to improve the responsiveness of the Nigerian stock market to broader economic fundamentals. Overall, this study contributes to the growing literature on financial market linkages in developing economies and underscores the importance of adopting multidimensional approaches for effective monetary and financial policy formulation in Nigeria.

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