FULafia Journal of Science & Technology
ISSN (print) 2449-0954 \ ISSN (online) 2636-4972
https://lafiascijournals.org.ng/index.php/fjst Sponsored By TERTIARY EDUCATION TRUST FUND
Manuscript => Received: June, 2025; Accepted: Sept, 2025; Published: Sept., 2025 https://doi.org/10.62050/fjst2025.v9n2.614

MODELLING TIMES SERIES VOLATILITY: A CASE STUDY OF NIGERIA ECONOMIC VARIABLES

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ABSTRACT
The profound vulnerability of the Nigerian economy to global oil price shocks necessitates a robust analysis of its macroeconomic volatility transmission mechanisms. This study employed the Dynamic Conditional Correlation Multivariate GARCH (DCC-MGARCH) model to investigate the interconnected volatility and time-varying spillovers among crude oil prices, exchange rates, inflation, and stock market performance using monthly data from January 2003 to December 2023. The results reveal significant volatility persistence and strong interdependencies among these variables, identifying oil price shocks and exchange rate fluctuations as primary drivers of volatility in inflation and stock returns. The analysis further uncovers distinct volatility regimes, including near-integrated GARCH processes for inflation and stock returns, and non-normal, fat-tailed distributions across all return series. While the model confirms high correlation persistence, it also exposes specification challenges, indicating that standard DCC frameworks may be inadequate for fully capturing the complex volatility dynamics inherent in Nigeria's oil-dependent economy. The study concludes that Nigeria remains acutely susceptible to oil-driven macroeconomic instability, underscoring the critical need for diversification policies and enhanced risk management strategies. These findings provide valuable insights for policymakers and investors while contributing to existing empirical literatures for analyzing multivariate financial-market interdependencies in resource-dependent emerging economies.

Keyword: Oil price volatility, volatility spillovers, DCC-MGARCH model, macroeconomic stability, resource-dependent economies

INTRODUCTION
The Nigerian economy is acutely vulnerable to global oil price fluctuations due to its heavy reliance on crude oil exports, which constitute over 90% of foreign exchange earnings and a significant share of government revenue (Central Bank of Nigeria [CBN], 2023). This dependence exposes critical macroeconomic variables, including stock market performance, exchange rates, and inflation, to heightened volatility during oil market instability (Adeoye & Saibu, 2021). Such volatility complicates economic planning and financial market stability, particularly in resource-dependent emerging economies like Nigeria, where structural constraints amplify transmission effects (Osinubi & Amaghionyeodiwe, 2022). The Dynamic Conditional Correlation (DCC) MGARCH model offers a robust framework to analyze these time-varying interdependencies, capturing how oil price shocks propagate across financial and macroeconomic variables (Alao & Alao, 2023). Understanding these dynamics is essential for policymakers and investors to mitigate risks and enhance resilience in Nigeria's oil-centric economy.

Existing studies highlight the asymmetric and nonlinear relationships between oil prices and macroeconomic variables in Nigeria. Adeoye and Saibu (2021) demonstrated that oil price shocks significantly destabilized exchange rates and inflation, while Adekunle and Aluko (2020) confirmed that exchange rate volatility exacerbates inflationary pressures through pass-through effects. Research on broader contexts, such as that by Agyei *et al*. (2023) and Aloui and Aïssa (2021), revealed that oil-exporting economies experience stronger volatility spillovers to financial market than importers, with crises intensifying these linkages. Similarly, Bala and Asemota (2020) and Tule *et al*. (2022) identified asymmetric effects in Nigeria, where negative oil shocks disproportionately impact inflation and exchange rates due to import dependence and fuel subsidies. In comparing multivariate GARCH models, Dantani *et al*. (2024) concluded that the BEKK specification was more robust than VECH in capturing volatility spillovers between key Nigerian financial variables, a finding attributed to its effectiveness with asymmetric transmissions. Internationally, studies like those by Zhang and Ji (2021) and Kang and Yoon (2023) underscored time-varying correlations between oil prices, currencies, and equities, emphasizing the role of global uncertainty in reshaping these dynamics.

Despite these contributions, critical gaps remain. First, few studies holistically examined the simultaneous volatility spillovers among oil prices, stock markets, exchange rates, and inflation in Nigeria, often analyzing pairwise relationships in isolation (e.g., Oloko *et al*., 2022; Iyke & Ho, 2021). Second, while some employed GARCH models, the DCC-MGARCH approach, which captures time-varying correlations, remains underexplored in Nigeria's context (Alao & Alao, 2023). Lastly, Nigeria's unique dual role as an oil exporter and refined product importer necessitates tailored analysis of how domestic policies (e.g., fuel subsidies) mediate these spillovers dimension overlooked in most studies (Tule *et al*., 2022).

This study addresses these gaps by employing the DCC-MGARCH model to analyze the interconnected volatility of oil prices, stock markets, exchange rates, and inflation in Nigeria. By capturing time-varying correlations and asymmetric responses, the research provides nuanced insights into risk transmission mechanisms during different market conditions. The findings will inform policymakers on stabilizing macroeconomic variables through targeted interventions (e.g., diversification strategies, buffer funds) and assist investors in optimizing portfolio allocations amid oil-driven volatility. Furthermore, the study contributes to the broader literature on commodity-dependent economies by offering a template for analyzing multivariate financial-market interdependencies in emerging markets.

The remainder of the article proceeds as follows: Section two describes the methodology employed. The data analysis and discussion are presented in section three, and section four concludes the study.

MATERIALS AND METHODS

Source of Data and Variables of the Study

This study utilised secondary data obtained from two authoritative sources: the Central Bank of Nigeria's official website (https://www.cbn.gov.ng/) and the World Bank's statistical database (https://data.worldbank.org/indicator/FP.CPI.TOTL.ZG). The research focused on analysing four critical macroeconomic indicators: exchange rates (EXR), inflation rates (INFLA), crude oil prices (OP), and stock exchange performance (SE). The dataset comprised monthly observations spanning a 21-year period from January 2003 to December 2023, ensuring robust temporal coverage for volatility analysis. All econometric computations and statistical tests were performed using EViews 10 software, which facilitated comprehensive examination of the time-series properties and dynamic relationships among the variables.

Statistical Technique for Data Analysis

Return series

To model the volatility of the variables, we first transform the raw monthly data into returns series. This transformation is performed using the natural logarithm of the current value divided by its previous value, as shown in Equations 1 through 4

$$REXR_t = \ln\left(\frac{EXR_t}{EXR_{t-1}}\right) \quad (1)$$

$$ROP_t = \ln\left(\frac{OP_t}{OP_{t-1}}\right) \quad (2)$$

$$RSE_t = \ln\left(\frac{SE_t}{SE_{t-1}}\right) \quad (3)$$

$$RINFLA_t = \ln\left(\frac{INFLA_t}{INFLA_{t-1}}\right) \quad (4)$$

where REXR - returns on exchange rate; ROP - returns on oil prices; RSE - returns on stock exchange; IINFLA - returns on inflation rate.

Unit Root Test

An augmented Dickey Fuller (ADF) (Dickey & Fuller, 1981) was employed to test the stationarity of the data. The ADF model for the exchange rate (EXR), oil prices (OP), stock exchange (SE) and inflation (INFLA) are given as follows:

$$\Delta EXR_t = aEXR_{t-1} + x_t'\delta + B_1\Delta EXR_{t-1} + B_2\Delta EXR_{t-2} + \cdots + B_p\Delta EXR_{t-p} + v_t \quad (5)$$

$$\Delta OP_t = aOP_{t-1} + x_t'\delta + B_1\Delta OP_{t-1} + B_2\Delta OP_{t-2} + \cdots + B_p\Delta OP_{t-p} + v_t \quad (6)$$

$$\Delta SE_t = aSE_{t-1} + x_t'\delta + B_1\Delta SE_{t-1} + B_2\Delta EXR_{t-2} + \cdots + B_p\Delta EXR_{t-p} + v_t \quad (7)$$

$$\Delta INFLA_t = aINFLA_{t-1} + x_t'\delta + B_1\Delta INFLA_{t-1} + B_2\Delta INFLA_{t-2} + \cdots + B_p\Delta INFLA_{t-p} + v_t \quad (8)$$

where x_t is an optional exogenous regression that may consist of a constant or a constant and a trend.

The ADF t-test of the null hypothesis states the following:

$\boldsymbol{H_0}: \theta = 0$, implying that the data need to be different to make them stationary. In contrast to the alternative hypothesis of $\boldsymbol{H_1}: \theta < 0$, the data tend to be stationary and need to be analysed by means of using a time trend in the regression model instead of differencing the data.

The test statistic is the conventional-to-t ratio for θ:

$$t_\theta = \frac{\widehat{\theta}}{se(\widehat{\theta})} \quad (9)$$

where $\widehat{\theta}$ is the estimate of a and where $se(\widehat{\theta})$ is the coefficient standard error.

Dynamic Conditional Correlation

The DCC-MGARCH model follows a two-step estimation procedure (Engle, 2002; Engle *et al*., 2011). In the first step, univariate GARCH(1,1) models are estimated separately for each time series to obtain conditional volatility estimates. For each asset return series, the variance equation is specified as:

$\sigma_{i,t}^2 = C_i + \alpha_i r_{i,t-1}^2 + \beta_i \sigma_{i,t-1}^2$, (for each variable) (4)

Where:

C_i= Constant term

α_i = ARCH term (response to shock)

β_i = GARCH term (Volatility persistence)

$i = REXR, RSE, ROP\ and\ RINFLA$

These estimates form the diagonal matrix $D_t = diag(\sigma_{1,t}, \sigma_{2,t}, \ldots, \sigma_{n,t})$, which contains the conditional standard deviations (Orskaug, 2009). The standardized residuals $\varepsilon_t = D_t^{-1} r_t$ are then used in the second step.

In the second step, the model estimates time-varying correlations between the standardized residuals from the first step (Engle *et al*., 2011). The conditional covariance matrix H_t is decomposed as:

$$H_t = D_t R_t D_t \quad (5)$$

Where:

R_t = Dynamic correlation matrix

D_t = diagonal matrix from first step

The correlation matrix $R_t$is derived from a proxy process Q_t:

$$Q_t = (1 - m - n)\bar{Q} + m\epsilon_{t-1}\epsilon_{t-1}^{'} + nQ_{t-1} \quad (6)$$

Where:

$\bar{Q}$= Unconditional covariance of standardized residuals

m = reaction parameter (response to shock)

n = persistence parameter

To ensure R_t is a valid correlation matrix (with ones on the diagonal and off-diagonal element in [-1, 1]), Q_t is rescaled as:

$$R_t = diag(Q_t)^{\frac{-1}{2}} Q_t diag(Q_t)^{\frac{-1}{2}}$$

The parameters m and n must satisfy $m, n > 0$ and $a + b < 1$ for stationarity (Orskaug, 2009, Engle *et al.*, 2011)

RESULTS AND DISCUSSION

This section presents the empirical findings of the study and their subsequent discussion. The analysis begins by examining the descriptive statistics of the key variables, utilizing both graphical representations and summary statistics to illustrate their fundamental characteristics. Subsequently, the stationarity properties of the data are assessed using the Augmented Dickey-Fuller (ADF) unit root test. The core of the analysis then presents the outcomes of the Dynamic Conditional Correlation Multivariate GARCH (DCC-MGARCH) model, detailing both the first-step univariate estimations and the second-step dynamic correlation results. The discussion interprets these findings in the context of the existing literature and the study's overarching objectives.

Figure 1 showed a graphical representation of the study variables, revealing distinct patterns. The exchange rate displayed a steady increase over time, whereas the oil price, inflation rate, and stock exchange rates exhibited fluctuations, characterized by sharp increases and decreases, indicating volatility. The series also exhibited trends, such as an upwards trend in the inflation rate from 2022-2023, and in oil prices and stock exchanges from 2003-2008. Conversely, downwards trends are also observed in certain periods. These patterns suggest nonstationary, implying that the mean of the series is not constant over time.

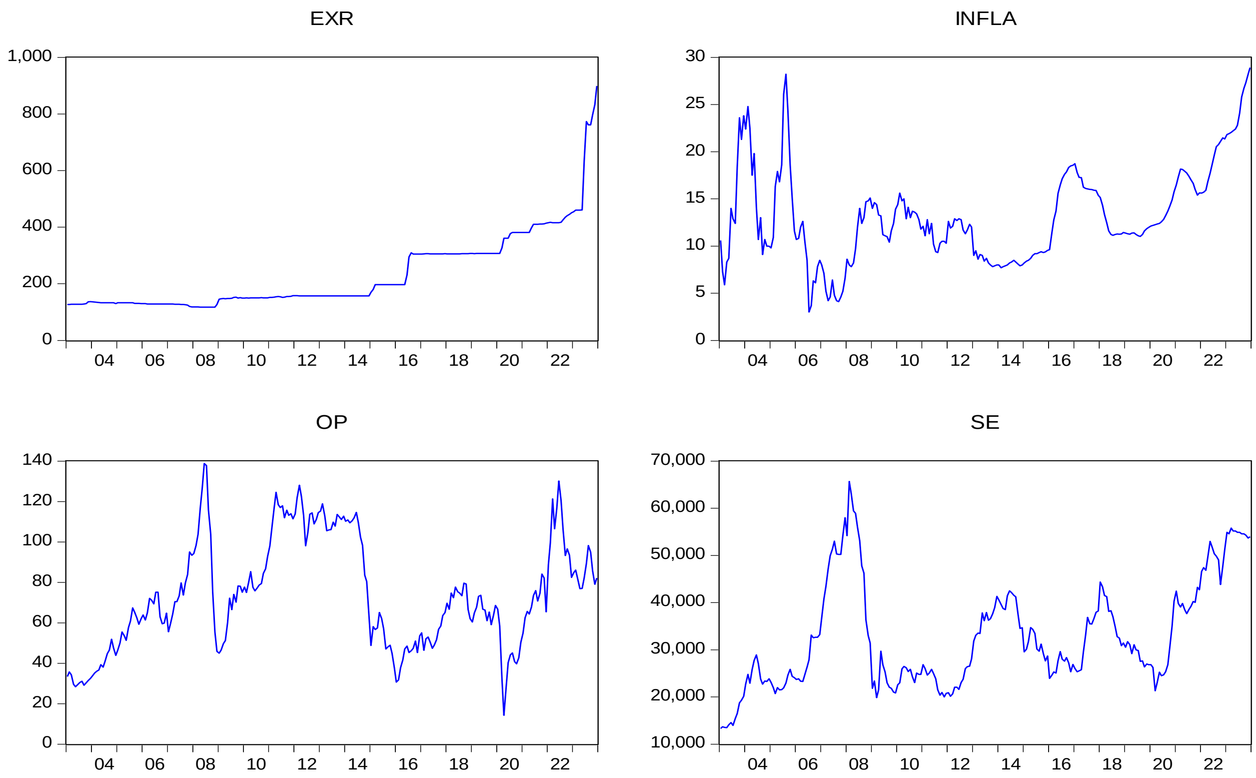

Figure 1: Time plots of the exchange rate (EXR), inflation rate (INFLA), oil price (OP) and Stoch exchange (SE)

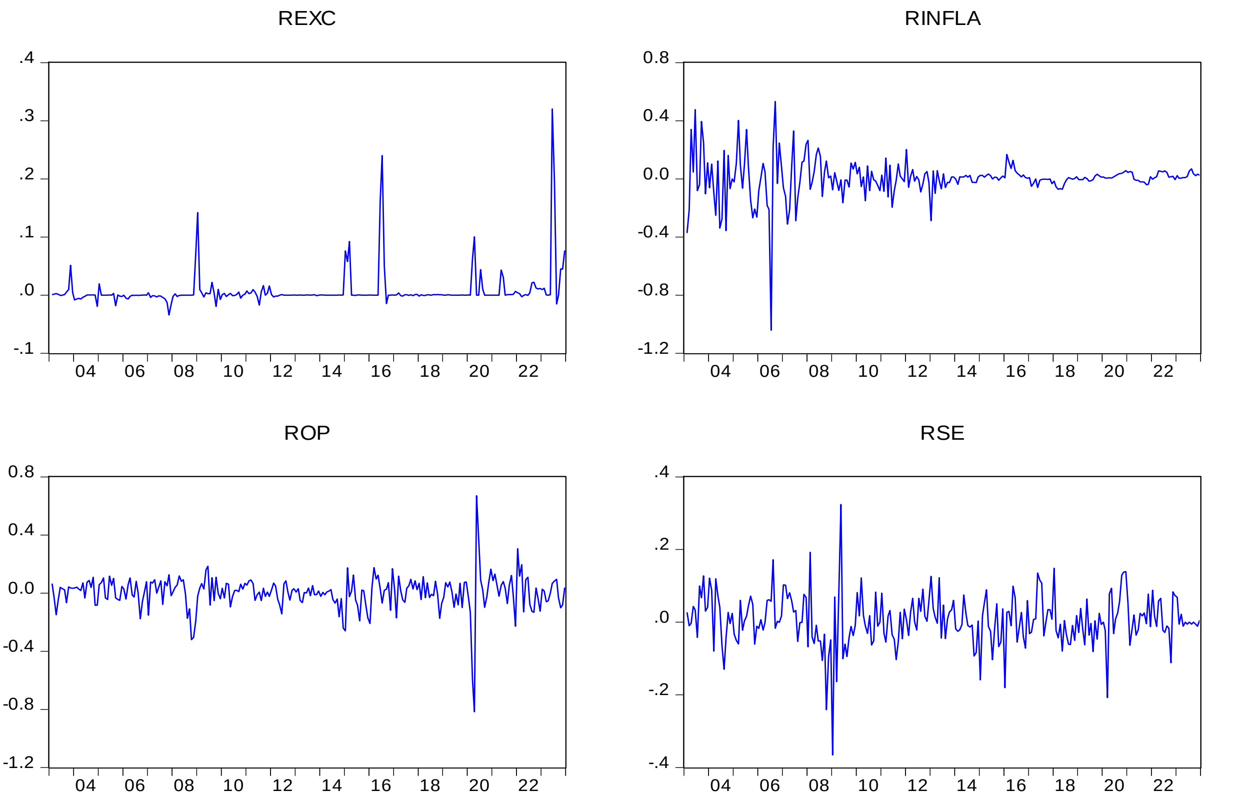

Figure 2: Time plot of return on exchange rate (REXR), return on inflation rate (RINFLA), return on oil price (ROP) and return on stock exchange (RSE)

Figure 2 displays the graphical representation of returns on the exchange rate, inflation rate, oil price, and stock exchange. The graph revealed two key features: volatility clustering, where large changes are followed by periods of similar volatility, and mean reversion, where volatility consistently returns to zero. These characteristics suggested that the series exhibited stationary behaviour, accompanied by volatility clustering and mean reversion.

The histogram in Figure 3 presents the distribution of standardized residuals for exchange rate returns from February 2003 to December 2023. The series displays pronounced leptokurtosis (kurtosis = 90.38) and positive skewness (skewness = 8.22), reflecting a concentration of observations near zero alongside fat tails with extreme positive deviations. Roughly 76% of residuals fall within the first bin near zero, consistent with volatility clustering a hallmark of financial time series where volatility persists over time. The Jarque-Bera test (82,676.21, p ≈ 0) overwhelmingly rejected normality, confirming the expected non-Gaussian properties of exchange rate returns, including heavy tails and frequent outliers that deviated sharply from a normal distribution.

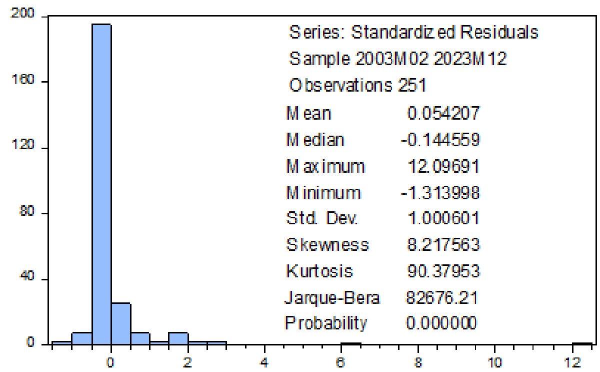

Figure 3: Histogram of returns on exchange Rate

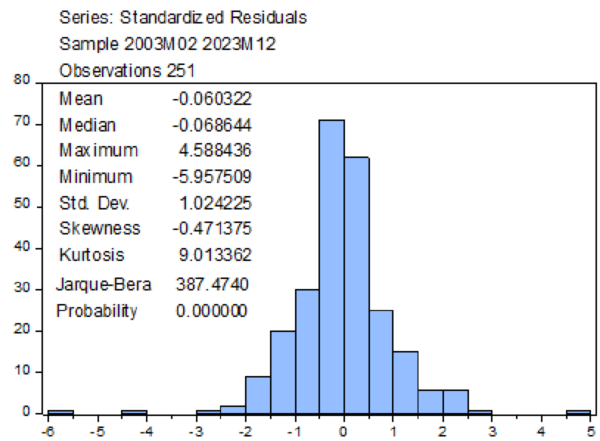

Figure 4: Histogram of returns on inflation rate

The histogram in Figure 4 presents the distribution of standardized residuals for inflation rate changes from February 2003 to December 2023. The series exhibited moderate negative skewness (-0.47), suggesting slightly more pronounced downward movements than upward onesa pattern occasionally observed in inflation dynamics. The significant excess kurtosis (9.01) indicated fatter tails than a normal distribution, implying an elevated frequency of extreme inflation shocks. While the distribution appears more symmetric and bell-shaped than the previous case, the Jarque-Bera test (387.47, p ≈ 0) firmly rejected normality. This confirmed that inflation rate changes retained characteristic financial-style non-normalities, including volatility clustering and an increased likelihood of tail events, though with less severity than typical asset returns.

This histogram illustrates the distribution of standardized residuals for oil price returns from February 2003 to December 2023. While the distribution appeared closer to normality than typical exchange rate series, it still deviated significantly from a Gaussian distribution. The moderate negative skewness (-0.91) revealed a longer left tail, reflecting oil markets' tendency to experience sharp declines during crashes or supply disruptions more often than comparable upward spikes. With a Kurtosis of 4.72, the series exhibited fat tails, though less extreme than exchange rate data, suggesting oil prices are somewhat less prone to severe outliers (Figure 5). The more evenly spread, bell-shaped distribution indicated weaker volatility clustering compared to currency markets. Nevertheless, the Jarque-Bera test (65.59, p ≈ 0) decisively rejected normality, confirming that oil returns share the asymmetric risks and fat-tailed properties characteristic of commodity markets, albeit in a less pronounced form than financial assets like exchange rates.

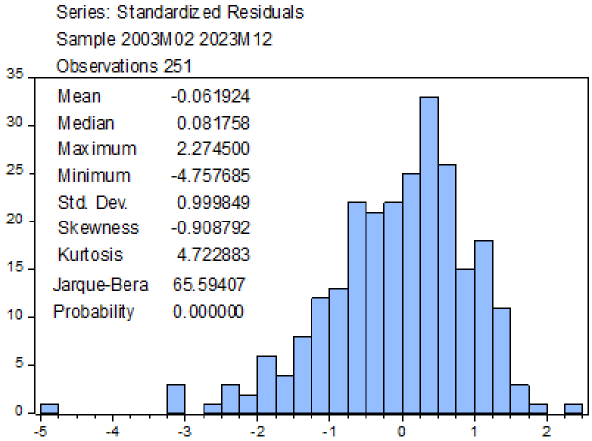

Figure 5: Histogram of returns on oil price

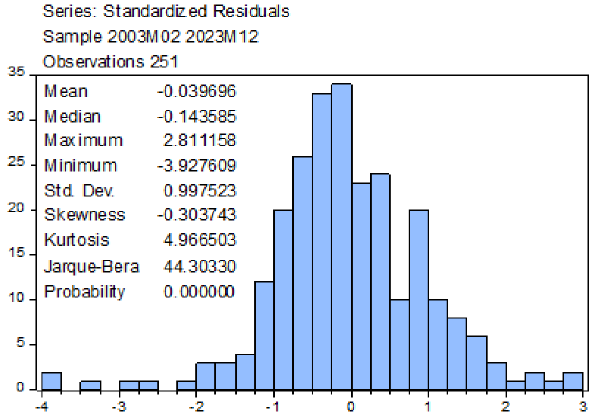

Figure 6: Histogram of returns on stock exchange

The histogram in Figure 6 presents the distribution of standardized residuals for stock exchange returns from February 2003 to December 2023, capturing key features of equity market behaviour. The series displayed mild negative skewness (-0.30), reflecting the asymmetric tendency for sharp downward movements characteristic of panic-driven sell-offs to be more abrupt than gradual upward trends. With a kurtosis of 4.97, the distribution exhibited fat tails, confirming that extreme returns occur more frequently than predicted by a normal distribution, consistent with the volatility clustering and regime shifts typical of equity markets. While the data appears relatively symmetric and less concentrated around the mean compared to exchange rates, the Jarque-Bera test (44.30, p ≈ 0) decisively rejected normality, underscoring the prevalence of non-Gaussian properties such as tail risk and return asymmetry fundamental traits of stock market dynamics.

Table 1 summarized the descriptive statistics of the study variables. The results show that the exchange rate averaged 232.85 USD/Naira, ranging from 117.72-989.90. The average inflation rate was 13.18%, with a range of 3 to 28.92%. The average oil price was 73.66, fluctuating between 14.28 and 138.74. The stock exchange averaged 32,757.40, with a range of 13,298.80 -65,652.38. Additionally, the Jarque–Bera test revealed that none of the series followed a normal distribution ($p < 0.05$).

Table 1: Descriptive statistics results

Parameter	EXR	Inflation rate	Oil price	Stock exchange
Mean	232.8503	13.17611	73.66464	32757.40
Median	157.3100	12.32000	70.43000	29641.32
Maximum	898.8976	28.92000	138.7400	65652.38
Minimum	117.7200	3.000000	14.28000	13298.80
Std. Dev.	139.2620	5.028307	27.21496	11254.56
Skewness	1.973230	0.775813	0.299422	0.725632
Kurtosis	7.990965	3.521780	2.171789	2.715679
Jarque-Bera	425.0850	28.13785	10.96774	22.96355
Probability	0.000000	0.000001	0.004153	0.000010
Sum	58678.28	3320.380	18563.49	8254864.
Sum Sq. Dev.	4867873.	6346.252	185904.2	3.18E+10
Observations	252	252	252	252

Source: Authors' compilation

Table 2: Augmented dickey fuller (ADF) unit root test results

Variables	Test Critical Values 1%	5%	10%	Test Statistic	P value	Remark
EXR	-3.4568	-2.8731	-2.5730	2.7304	1.0000	Not stationary
REXR	-3.4566	-2.8730	-2.5730	-7.3085	0.0000	Stationary
INLA	-3.4580	-2.8736	-2.5733	-0.3080	0.9204	Not stationary
RINFLA	-3.4576	-2.8734	-2.5732	-6.9550	0.0000	Stationary
OP	-3.4564	-2.8729	-2.5729	-2.9037	0.0463	Stationary
ROP	-3.4565	-2.8730	-2.5730	-11.7153	0.0000	Stationary
SE	-3.4567	-2.8730	-2.5730	-2.3610	0.1540	Not stationary
RSE	-3.4567	-2.5730	-2.5730	-7.2104	0.0000	Stationary

Source: Authors' compilation

Table 2 displayed the results of the ADF unit root test for the study variables. The findings indicated that the exchange rate, inflation rate, and stock exchange were non-stationary in their raw form ($p > 0.05$). However, their return series were found to be stationary ($p < 0.05$). In contrast, both the oil price and its return series were determined to be stationary ($p < 0.05$).

The first-step univariate GARCH results in Table 3 showed significant volatility persistence across variables, with return on oil prices and exchange rate displaying strong ARCH effects (α=0.6389 and 0.5598 respectively, both significant at 5% level), while return on stock exchange and inflation showed weaker ARCH terms. The GARCH persistence (β) varies considerably, with stock exchange and inflation showing highly persistent volatility (β=0.7139 and 0.9269, both significant), while exchange rate shows an unusual negative coefficient (β=-0.0469, insignificant). The sum $\alpha+\beta$ approaches or exceeds 1 for oil prices and inflation, suggesting integrated or near-integrated GARCH processes. ARCH-LM tests indicated no remaining ARCH effects in residuals (all p-values >0.05), validating the GARCH specifications. However, Jarque-Bera tests strongly rejected normality for all series (p=0.0000), suggesting fat-tailed distributions that may require Student-t or other non-normal error specifications for more accurate modelling.

Table 3: First step DCC MGARCH model results

Parameter	ROP	REXR	RSE	RINFLA
α	0.6389	0.5598	0.1372	0.0635
	(0.0140)	(0.0059)	(0.0533)	(0.1714)
β	0.3633	-0.0469	0.7139	0.9269
	(0.1200)	(0.1841)	(0.0000)	(0.0000)
$\alpha+\beta$	1.0022	0.7439	0.8511	0.9904
ARCH LM	1.0802	0.0023	0.8516	0.6726
	(0.2997)	(0.9624)	(0.3570)	(0.4129)
Jarque Bera	65.5941	82676.21	44.3033	387.47409
	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Source: Authors' compilation

Table 4: Second step DCC MGARCH model results

Parameters	DCC with Correlation targeting	DCC without Correlation targeting
θ_1	0.1000 (NA)	0.1000(NA)
θ_2	0.8500(NA)	0.8500(NA)
$\theta_1+\theta_2$	0.9500	0.9500
θ_3	0.000(NA)	0.000(NA)
θ_4		0.0525(NA)
θ_5		-0.0421(NA)
θ_6		0.0218(NA)
θ_7		-0.1192(NA)
θ_8		-0.0109(NA)
θ_9		0.2772(NA)

Source: Authors' compilation

The second-step DCC results build upon the first-step univariate GARCH findings by examining time-varying correlations between the series. Both DCC specifications (with and without correlation targeting) show high persistence in conditional correlations ($\theta_1+\theta_2$=0.95), consistent with the strong GARCH effects found in the first step, particularly for return on stock exchange and inflation. However, the lack of significance (NA p-values) for all parameters suggested potential estimation problems, possibly related to the non-normality detected in the first step's Jarque-Bera tests. The absence of asymmetric effects (θ_3=0) aligns with the first-step results where no leverage effects were modelled. The additional parameters in the non-targeted model (θ_4-θ_9) appear unstable, with some negative values that violate GARCH positivity constraints, mirroring the problematic negative β coefficient found for exchange rates in the first step. The results collectively suggest that while the data shows strong volatility persistence, the DCC modelling encounters specification challenges, likely due to the non-normal, highly persistent volatility characteristics identified in the univariate analysis.

CONCLUSION

This study concludes that Nigeria's oil-dependent economy exhibits complex volatility transmission patterns among oil prices, exchange rates, inflation, and stock markets, as evidenced by the DCC-GARCH analysis. The findings confirm strong interdependencies between these variables, with oil price shocks and exchange rate fluctuations driving persistent volatility in inflation and stock returns. While the model reveals high correlation persistence and near-integrated GARCH processes for inflation and stock returns, the estimation challenges including insignificant DCC parameters and non-normality issues highlight the need for alternative approaches like regime-switching models. The results underscore Nigeria's vulnerability to oil-driven volatility and the importance of diversification policies, while also demonstrating that standard DCC specifications may be inadequate for capturing the full complexity of volatility dynamics in oil-dependent emerging markets. These insights contribute to the broader literature on commodity-exporting economies by providing empirical evidence of Nigeria's unique volatility transmission mechanisms and identifying critical gaps for future methodological refinements.

Conflict of interest: The authors declare no conflict of interest.

REFERENCES

Adedoyin, F. F., Bekun, F. V. and Etokakpan, M. U. (2022). Oil price shocks and inflation in oil-importing versus exporting countries. *Energy*, 239, 122301. https://doi.org/10.1016/j.energy.2021.122301

Adekoya, O. B. and Oliyide, J. A. (2021). How COVID-19 drives connectedness between commodity and financial markets. *Resources Policy*, 74, 102247. https://doi.org/10.1016/j.resourpol.2021.102247

Adekunle, W. and Aluko, O. A. (2020). Exchange rate volatility and inflation in Nigeria. *African Journal of Economic and Management Studies*, 11(2), 275–290. https://doi.org/10.1108/AJEMS-03-2019-0111

Adeoye, B. W. and Saibu, O. M. (2021). Oil price shocks and macroeconomic performance in Nigeria: A dynamic multivariate approach. *Energy Economics*, 93, 104985. https://doi.org/10.1016/j.eneco.2020.104985

Agyei, S. K., Adam, A. M. and Bossman, A. (2023). Dynamic connectedness between oil prices and African stock markets. *International Review of Economics & Finance*, 84, 1–18. https://doi.org/10.1016/j.iref.2022.11.015

Ahmad, W. and Rais, S. (2021). Gold, oil, and stocks: Dynamic correlations in times of crisis. *Finance Research Letters*, 38, 101496. https://doi.org/10.1016/j.frl.2020.101496

Akanni, L. O. and Akinlo, A. E. (2020). Oil price shocks and stock market returns in Nigeria. *Energy Reports*, 6, 1477–1486. https://doi.org/10.1016/j.egyr.2020.05.028

Alao, R. O. & Alao, O. F. (2023). Volatility spillovers and dynamic correlations between oil prices and stock markets in Nigeria: Implications for risk management. *J. of Afr. Business*, 24(1), 45-62. https://doi.org/10.1080/15228916.2022.2046231

Aloui, R. and Aïssa, M. S. B. (2021). Dynamic linkages between oil and stock markets in the Gulf. *Energy Economics*, 96, 105176. https://doi.org/10.1016/j.eneco.2021.105176

Apergis, N. and Miller, S. M. (2020). Do structural oil-market shocks affect stock prices? *Energy Economics*, 85, 104529. https://doi.org/10.1016/j.eneco.2019.104529

Asteriou, D. and Bashir, F. (2023). Oil prices, exchange rates, and stock markets. *Journal of Economic Studies*, 50(1), 1–18. https://doi.org/10.1108/JES-05-2022-0273

Bala, D. A. and Asemota, J. O. (2020). Oil price shocks, exchange rate, and inflation volatility in Nigeria: A GARCH-MIDAS approach. *Resources Policy*, 68, 101772. https://doi.org/10.1016/j.resourpol.2020.101772

Bashir, U. and Khan, M. A. (2022). Inflation volatility and economic growth: Evidence from emerging markets. *J. of Economic Studies*, 49(3), 456–472. https://doi.org/10.1108/JES-07-2021-0336

Bouri, E., Gupta, R. and Roubaud, D. (2019). Oil volatility and sovereign risk of oil-exporting countries. *Energy Economics*, 78, 96–115. https://doi.org/10.1016/j.eneco.2018.11.011

Central Bank of Nigeria (CBN) (2023). *Annual Economic Report*. https://www.cbn.gov.ng

Central Bank of Nigeria (2023). *Monetary Policy and Exchange Rate Volatility in Nigeria* (Economic Report No. Q2/2023). https://www.cbn.gov.ng

Emenike, K. O. and Adeleke, A. I. (2020). Oil price shocks and inflation in oil-exporting countries: A Markov-switching approach. *Energy Reports*, 6, 1477–1486. https://doi.org/10.1016/j.egyr.2020.05.027

Engle, R. F. (2002). Dynamic conditional correlation: A simple class of multivariate generalized autoregressive conditional heteroskedasticity models. *Journal of Business & Economic Statistics*, 20(3), 339–350. https://doi.org/10.1198/073500102288618487

Engle, R. F., Ledoit, O. and Wolf, M. (2011). Large dynamic covariance matrices. *Journal of Business & Economic Statistics*, 39(3), 1–14. https://doi.org/10.1080/07350015.2019.1617153

Guesmi, K. and Fattoum, S. (2021). Return and volatility spillovers between oil and MENA stock markets. *Emerging Markets Review*, 47, 100789. https://doi.org/10.1016/j.ememar.2021.100789

Iyke, B. N. and Ho, S. Y. (2021). Exchange rate volatility and inflation in Nigeria. *Journal of Economic Studies*, 48(5), 987–1002. https://doi.org/10.1108/JES-04-2020-0161

Kang, S. H. and Yoon, S. M. (2023). Dynamic spillovers between oil prices and exchange rates. *Economic Modelling*, 118, 106089. https://doi.org/10.1016/j.econmod.2022.106089

Mensi, W., Hammoudeh, S. and Kang, S. H. (2021). Hedging strategies of oil price and exchange rate risks. *Energy Economics*, 94, 105070. https://doi.org/10.1016/j.eneco.2021.105070

Nusair, S. A. and Al-Khasawneh, J. A. (2022). The impact of oil price shocks on stock markets in GCC countries. *Energy Economics*, 112, 106151. https://doi.org/10.1016/j.eneco.2022.106151

Nwosa, P. I. and Oseni, I. O. (2022). Oil price volatility and macroeconomic performance in Nigeria. *OPEC Energy Review*, 46(1), 3–22. https://doi.org/10.1111/opec.12233

Oloko, T. F., Ogunronbi, J. and Adesoye, B. A. (2022). Dynamic linkages between oil prices, exchange rates, and stock markets in Nigeria. *International Journal of Energy Economics and Policy,* 12(1), 1–12. https://doi.org/10.32479/ijeep.12654

Olowe, R. A. (2020). Modeling Naira/Dollar exchange rate volatility: Evidence from GARCH models. *CBN Journal of Applied Statistics,* 11(1), 1–25. https://www.cbn.gov.ng

Orskaug, E. (2009). *Multivariate DCC-GARCH model: With application to financial risk* [Unpublished master's thesis]. Norwegian University of Science and Technology.

Osinubi, T. S. and Amaghionyeodiwe, L. A. (2022). Exchange rate volatility and stock market performance in Nigeria: A multivariate GARCH analysis. *Afri. Development Review,* 34(2), 210-225. https://doi.org/10.1111/1467-8268.12645

Salisu, A. A. and Adediran, I. A. (2020). Uncertainty due to infectious diseases and oil price volatility. *Energy,* 213, 118777. https://doi.org/10.1016/j.energy.2020.118777

Salisu, A. A. and Isah, K. O. (2023). Revisiting the oil price-stock market nexus. *International Review of Financial Analysis,* 85, 102456. https://doi.org/10.1016/j.irfa.2022.102456

Tule, M. K., Salisu, A. A. and Chiemeke, C. C. (2022). Oil price shocks and inflation in Nigeria. *Energy Policy,* 161, 112712. https://doi.org/10.1016/j.enpol.2021.112712

Umar, Z. and Gubareva, M. (2021). A time-frequency analysis of the impact of oil shocks on exchange rates. *Energy Economics,* 99, 105276. https://doi.org/10.1016/j.eneco.2021.105276

Zhang, D. and Ji, Q. (2021). Dynamic correlation between oil and stock markets. *Energy Economics,* 94, 105063. https://doi.org/10.1016/j.eneco.2021.105063