FOREIGN RESERVE LEVELS AND EXCHANGE RATE VOLATILITY: EVIDENCE IN NIGERIA

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ABSTRACT

Globally, foreign reserves are crucial for determining the exchange rate. Nigeria's foreign reserves have been volatile due to the country's oil-dependency economic structure. At an all-time high of $62.1 billion in November 2008, supported by high global oil prices, it fell to a low of $23 billion in October 2016, caused by a decrease in foreign reserve accretion due to lower global oil prices. Thus, this paper explores how foreign reserve levels influence exchange rate determination in Nigeria. The study employs monthly foreign reserve and foreign exchange rate data sourced from the Central Bank of Nigeria's statistical bulletin, covering the period from 2015 to 2024. The study applied the Vector Autoregressive Model for the analysis. Findings from model one (1) suggest that historical values of the official exchange rate significantly influence current and future official exchange rate movements. Additionally, a decrease in foreign exchange reserves in the previous period is associated with a depreciation of the official exchange rate. Findings from model two (2) suggest that past values of the interbank foreign exchange market rate significantly influence current and future interbank foreign exchange market rate. While a decrease in foreign exchange reserves in the previous period appears to be associated with an appreciation of the interbank foreign exchange market rate, this relationship is not statistically significant in model two. The study demonstrates that Nigeria's foreign exchange reserves play an important yet time-lag and asymmetric role in exchange rate determination. The study underscores the limitations of relying solely on foreign reserve management for exchange rate stability and highlights the need for complementary structural reforms to mitigate systemic vulnerabilities. The study recommends that the Nigerian apex bank adopts forward-looking reserve management strategies like the Guidotti-Greenspan rule and stress testing for foreign reserve management to assess resilience against shocks like commodity price collapses and geopolitical crises.

Keywords: Foreign Reserves, Exchange Rate, Foreign Exchange Market, Exchange Rate Volatility

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INTRODUCTION

Foreign reserves are critical to influencing the exchange rate around the world. Nigeria's foreign reserves have witnessed steady fluctuations due to the country's oil-dependent economic structure (Okonjo-Iweala, Osafo-Kwaako, & Husssen, 2016). It reached an all-time high of $62.1 billion in November 2008, boosted by high global oil prices, before falling to a low of $23 billion in October 2016, due to a decline in foreign reserve accretion as global oil prices fell. The foreign reserves were $ 28.3 billion in 2015, $30.3 billion in 2017, $ 42.5 billion in 2018, $38.1 in 2019, $35.4 billion in 2020, $40.5billion in 2021, $37.1 billion in 2022, $34.2 billion in 2023 and $33.1 billion in June 2024 (Central Bank of Nigeria, 2020; 2024; IMF, 2017). In 2023, Nigeria adopted the unified exchange rate regime. Prior to that, Nigeria had adopted a plethora of exchange rate policies ranging from a fixed exchange rate regime (pre-1986) to a dual exchange rate system (SFEM) (1986-1999), a managed float exchange rate regime (2000s-2015), forex restrictions, and multiple exchange rates regime (2015-2020), and the Nigerian autonomous foreign exchange rate (2020-2023). The exchange rate is a key determinant of a nation's economic competitiveness and influences its trade balance, investment flows, and overall macroeconomic stability (Barbosa, Jayme & Missio, 2018). This implies that the exchange rate plays a crucial role in shaping a nation's economic competitiveness, trade dynamics, investment flows, and overall macroeconomic stability. The exchange rate thus is a fundamental economic variable that can significantly influence a country's economic outcomes and its position in the global marketplace (Habib, Mileva & Stracca, 2017).

The foreign exchange market is integral to nations' economic advancement and stability globally. It functions as a vital platform for the exchange of currencies among countries, facilitating international trade and enabling cross-border financial transactions (Chaboud, Rime & Sushko, 2023). Nigeria, as one of Africa's largest economies, heavily relies on its foreign exchange market to support its economic activities. The country possesses vast reserves of natural resources and has emerged as a major player in the global oil industry (Duruji & Dibia, 2017). Consequently,

Nigeria's foreign exchange market exhibits significant volatility due to fluctuations in global oil prices, international trade dynamics, and domestic economic factors (Manasseh, Ogbuabor, Abada, Okoro, Egele & Onwumere, 2019). Nigeria's oil-dependent economy exposes its foreign exchange markets to various external and domestic disruptions that contribute to high exchange rate volatility and instability. Oil contributes to nearly 75% of Nigeria's export revenue and 95% of its foreign exchange profits, demonstrating the country's reliance on crude oil (World Bank, 2022; Organisation of Petroleum Exporting Countries [OPEC], 2023). This reliance makes Nigeria vulnerable to global oil price volatility and thus lower accretions to foreign reserves (Central Bank of Nigeria, 2021; Adeniran & Adeyemi. 2021).

Maintaining optimal foreign exchange reserve levels has become a necessary condition for Nigeria to achieve sustainable macroeconomic goals (Williams, 2018). The primary objective of foreign reserve management is safety, liquidity, and profitability in that order. As a result, Nigeria has implemented as part of its foreign reserve management a currency diversification policy by reducing dollar-denominated assets dominance (from 85% to less than 70% in the foreign reserves) by holding more euros, yuan, and SDRs. Furthermore, it boasted its gold reserves by increasing gold holdings (3% of reserves in 2023) as a hedge (Central of Nigeria, 2023; International Monetary Fund [IMF], 2023, World Bank, 2023). This suggests that Nigeria's foreign exchange reserves management approach is intrinsically tied to its strategies for stabilising exchange rates. Despite these forward-looking and laudable foreign reserve management initiatives, the Central Bank of Nigeria's frequent exchange rate policy in consistency over the years has exacerbated the exchange rate situation and led to a cascading effect at the official and interbank foreign exchange markets within the country with such interventions creating distortions in the markets, thereby undermining the intended objectives of maintaining exchange rate stability.

In Nigeria, the exchange rate has continued to suffer headwinds against other major currencies. The naira exchanged for ₦169.68, ₦306.95, ₦450.70, and ₦1570

against the US dollar recorded in January 2015, 2020, December 2022, and 2024 respectively portraying the volatility of the Nigerian currency (Central Bank of Nigeria, 2022). Despite the significance of the foreign exchange reserves on the exchange rate, there is a dearth of empirical studies in literature on the nexus between foreign reserve levels and the exchange rate at the official and interbank exchange markets in the Nigerian context. The extant studies often focus on broader aspects of exchange rate determination or examine the impact of specific variables such as oil prices or capital flows on the exchange rate, neglecting the specific effects of foreign exchange reserves levels on these two key foreign exchange markets. This study fills the gap identified by establishing empirical evidence of the effect of foreign exchange reserve levels on the exchange rate determination at the official interbank exchange markets in Nigeria. The other section of the paper comprised of literature review, methodology, results, and discussion as well as the conclusion.

LITERATURE REVIEW

Concept of Foreign Reserves

The concept of "reserves" can be traced back to the mercantilist school of economic thought, where economies were centred on the accumulation of gold reserves. This era was characterised by the use of precious instruments as the primary medium of exchange. The term "foreign reserves" has emerged to denote the presence of other countries' currencies within a nation's reserves, which serves to safeguard the stability of the balance of payments and domestic monetary policy. Nwosa (2017) opines that foreign reserves management is a monetary policy instrument, a liquidity buffer in the event of an international financial crisis, and a tool for mitigating vulnerability to external factors while bolstering stability and confidence in financial markets during periods of financial turmoil. Furthermore, the International Monetary Fund (IMF) (2012) identifies foreign reserves management as financing balance of payments imbalances and maintaining a competitive exchange rate that is conducive to achieving macroeconomic objectives. According to Akinwunmi and Adekoya (2016), the concept of foreign reserves involves maintaining an adequate volume of reserve assets to safeguard the value and exchange rate stability of the domestic currency. The Central Bank of Nigeria (CBN) (2007) characterises foreign

reserves as the official foreign assets that are under the control of monetary authorities and readily accessible. Expanding on this definition, Akims (2016) describes foreign reserves as international reserves or foreign exchange reserves that are held externally by a country's monetary authority, which are convertible and available to meet the nation's official needs. This study adopts the definition made by the International Monetary Fund (2012). The adoption of this definition lies in the importance of the foreign reserves' levels in the regulation of the economy, particularly in the area of international business dealings which Nigeria uses for international financial securities for borrowings, trade, and other monetary target objectives.

Concept of Exchange Rate

The exchange rate refers to the comparative value or price of one currency to another currency (Adebanjo, Oluwasegun, Adegbola, Asamu, Peter, Ben-Caleb & Eluyela, 2019). It represents the cost associated with exchanging one country's money for another country's money, which can be high, average, or below average (Kimberly, 2018). The exchange rate reflects the discrepancy in the comparative usage and demand for the currencies in question (Kimberly, 2018). Ibekwe (2021) further elaborates that the exchange rate measures the worth of a home currency in comparison to a foreign currency. This is a crucial factor in international economic transactions, as no nation can remain isolated due to the diversity of factor endowments. Morina, Hysa, Ergün, Panait, and Voica (2020) opine that the exchange rate is the ratio that quantifies one currency in terms of another emphasising the relative value of currencies in the context of international trade and finance. The foreign exchange market is the characteristic setting where these exchange rates are determined through the purchase and exchange of currencies from various nations. Egolum, Iliemena, and Goodluck (2020) provide a specific definition of the exchange rate used in the analysis, which encompasses both the nominal and actual values of the currency, with a focus on the measurement of the Nigerian naira against the US Dollar in the market, particularly trade on the official and inter-bank rates in Nigeria.

Theoretical Framework

This study is anchored on the Mundell-Fleming Model which was propounded by Mundell and Fleming (1963). The Mundell-Fleming Model posits that an increase in foreign exchange reserves influences the exchange rate through its effects on the money supply and capital flows. Therefore, when the Nigerian government or central bank boosts its foreign exchange reserves, it can impact the money supply via interventions in the foreign exchange market. Such an increase in reserves typically leads to an expansion of the money supply, which subsequently exerts downward pressure on the exchange rate. This relationship suggests that as foreign reserves rise, the currency may weaken relative to others, reflecting Nigeria's broader economic dynamic. Additionally, changes in foreign exchange reserves affect capital flows. Higher foreign exchange reserves levels may indicate increased confidence in the Nigerian economy, attracting foreign investors and capital inflows. Mundell-Fleming Model theory provides the rationale to justify increased accretions to the Nigerian foreign reserves, thus strengthening the local exchange rate. Conversely, a reduction in accretion to the foreign exchange reserves leads to a contraction of the money supply, potentially exerting upward pressure on the exchange rate. A decline in foreign reserves levels signals a lack of confidence, leading to capital outflows and a weaker exchange rate.

Empirical Review

Nwachukwu, Ali, Abdullahi, Shettima, Zirra, Falade and Alenyi (2016) explored the long-term nexus between the Bureau De Change (BDC) exchange rate and Nigerian Nigeria's foreign reserves utilising the Threshold Vector Error Correction Model (TVECM). Findings suggest that cointegration relating these two variables occurs when the divergence exceeds a specified threshold point estimate. The TVECM framework identified two distinct regimes: the "usual" regime, which encompasses 93.1% of the observations, and the "unusual" regime, which represents approximately 6.9% of the sample. Furthermore, it was disclosed that they were not significant at the 5% level for both the BDC exchange rate and foreign reserves

equations within the first regime. However, in the second regime, the error correction coefficient for foreign reserves was significant at the 10% level, indicating that adjustments between these variables primarily flow from foreign reserves to the BDC exchange rate.

Odior and Nwaogwugwu (2017) employed Autoregressive Distributed Lag (ARDL) and assessed the long-and short-term connection concerning international reserves and Nigeria's nominal official exchange rate utilising information from 1980 to 2014. Empirically, a lagged value of the official exchange rate is negatively correlated with Nigeria's international reserves in the long run. The study identified oil exports as a primary contributor to the country's international reserves, while imports and external debts were noted to inversely affect these reserves in both the long and short run.

Williams (2018) investigated the determinants foreign exchange level in Nigeria. Using the Autoregressive Distributed Lag (ARDL) model, inflation rate, interest rate, and government expenditure significantly impacted Nigeria's foreign exchange reserves level in the long run negatively. Conversely, the real effective exchange rate and oil revenue were identified as having a positive influence on foreign exchange reserves significantly in the long run. Also, a bi-directional causality was unveiled concerning foreign exchange reserves and exchange rates, suggesting a dynamic interplay between these variables. The study also found that the adjustment to the long-run equilibrium level of foreign exchange reserves is relatively slow, indicating the need for more proactive policy measures to manage foreign exchange dynamics.

Kalu, Ogwu, Ndubuaku, and Ifeanyi (2019) used the AutoregressiveDistributed Lag (ARDL) technique and correlation analysis to evaluate the nexus concerning foreign exchange reserves and exchange rate variables in the Nigerian economy. Findings indicated a positive and statistically significant relationship concerning real exchange rate and foreign exchange reserves. The relationship between the nominal exchange rate and foreign exchange reserves was found to be positive but not statistically significant.

Marcel, Gloede, Menkhoff, Sarno, and Stöhr (2019) evaluated the foreign exchange intervention effect using innovative daily data from 33 countries covering the period from 1995 to 2011. Panel outcomes uncovered that interventions are particularly effective in smoothing exchange rate fluctuations and stabilising rates in countries operating within narrow-band regimes. In flexible exchange rate regimes, however, achieving desired adjustments necessitates meeting specific conditions, such as implementing substantial volumes of intervention and ensuring that these actions are publicly communicated and supported through effective messaging.

Gustavo, Lisack, and Mano (2019) explored the effects of foreign exchange interventions on exchange rate levels, employing an instrumental-variable panel approach to assess the macroeconomic significance of these effects. Evidence showed that such interventions meaningfully influence the exchange rate from a macroeconomic viewpoint. Specifically, a purchase of foreign currency equivalent to 1 percentage point of GDP results in a depreciation of both nominal and real exchange rates by approximately 1.7% to 2.0% and 1.4% to 1.7%. Furthermore, the study revealed that these effects are both persistent and symmetric for foreign exchange purchases and sales, indicating a consistent connection between intervention actions and currency valuation.

Oyeniran and Alamu (2020) adopted the Vector Error Correction Model (VECM) and Generalised Method of Moments (GMM) estimation techniques where the outcome noted the existence of a long-run connection concerning foreign reserves, exchange rate, and other Nigerian macroeconomic factors. Nigeria's optimal foreign reserves level was estimated to be within the range of 3 to 6 months of import cover, which is consistent with the internationally recommended benchmarks. The study found that the actual foreign reserves level in Nigeria has been below the estimated optimal level, indicating the need for the country to enhance its reserve accumulation efforts. The study also identified several factors that influence the optimal foreign reserves level, including exchange rate volatility, economic growth, and the country's external debt position.

Loretta (2021) analysed exchange rate fluctuations effect and foreign reserves effect on Nigeria's macroeconomic performance from 1980 to 2019. Utilising ARDL and Granger causality assessments, a unidirectional nexus concerning foreign reserves and the exchange rate was unraveled. It was also determined that the exchange rate Granger causes foreign reserves, while the reverse does not hold. This indicated that changes in the exchange rate, whether depreciation or appreciation, consistently affect Nigeria's foreign reserves.

Olokoyo, Fapetu, Ucheaga, Adu and Oluwole (2021) applied the Vector Autoregressive (VAR) to investigate the effects of shocks to foreign reserves levels on various macroeconomic indicators in Nigeria. Output unveiled that a one standard deviation shock to foreign reserves inversely affected the exchange rate across all quarters studied. Additionally, during periods of significant positive shocks to external reserves, the currency tends to appreciate, further contributing to a decrease in the exchange rate. Furthermore, it was established that export levels responded positively to substantial increases in external reserves.

Soro and Aras (2021) investigated how exchange rate shocks affected Nigeria's foreign reserves using annual data spanning from 1980 to 2019 with the Autoregressive Distributed Lag (ARDL) model being applied revealing that exchange rate fluctuations have an asymmetric influence on foreign reserves. Also, the effects of exchange rate changes differed in magnitude and direction, indicating that positive and negative shocks impact reserves differently. Particularly, a positive shock in the exchange rate had a significant effect on foreign reserves, while a negative shock did not yield significant results in the long run. This pattern also held for short-term effects, although both positive and negative impacts were insignificant in that time frame.

Adama, Ohwofasa, and Onabote (2022) investigated how foreign reserves affected Nigeria's economic growth over the period from 1986 to 2020. Applying autoregressive distributed lag (ARDL) and unrestricted error correction model (ECM), in the long term, all explanatory factors including external reserves, inflation, exchange rate, and lagged GDP are significant determinants of Nigeria's

economic growth. Distinctively, economic growth exhibited positive responses to variations in foreign reserves, inflation, and lagged GDP, while it showed a negative response to fluctuations in the exchange rate in the short term.

Fapetu, Oluwole, Olokoyo, Olabisi and Owoeye (2023) analysed how exchange rate fluctuations affected Nigeria's foreign reserves levels. Their analysis, conducted using an error correction model, revealed that the exchange rate exerted an inversely significant effect on external reserves. Furthermore, there was a positive relationship between gross domestic product (GDP) and foreign reserves levels significantly, while inflation showed an inverse and insignificant association with foreign reserves.

Yemisi and Adeyinka (2023) applied the Autoregressive Distributed Lag (ARDL) co-integration testing method and investigated the interaction effect relating to the exchange rate and Nigeria's foreign reserves with the outcome indicating that the exchange rate positively affected foreign reserves significantly. Additionally, a one-way causality flowing from the exchange rate to foreign reserves was identified.

Adewale and Raji (2023) considered the connection between exchange rate fluctuations and foreign reserves levels in Nigeria. Adopting the ordinary least square method, results demonstrated an inverse linkage concerning foreign reserves levels and exchange rate fluctuations, underscoring the roles of the rate of inflation, interest, and public debt with the outcome confirming statistical significance, excluding public debt.

This paper differs from the reviewed literature by specifically examining the impact of foreign reserves levels on both the official exchange rate and the interbank foreign exchange market. The current research uniquely isolates how fluctuations in reserve levels influence two critical exchange rate mechanisms within Nigeria's monetary framework which other studies have isolated.

METHODOLOGY

This study employed econometric methods to analyse the impact of foreign reserves

levels on exchange rate volatility in Nigeria. The study employs monthly foreign reserve and foreign exchange rate data sourced from the Central Bank of Nigeria's statistical bulletin, covering the period from 2015 to 2024. Aligned with the study's objectives, the researchers developed a model drawn from a Mundell-Fleming theoretical framework. In this model, the official exchange rate and interbank foreign exchange market rate served as the dependent variables in Model 1 and Model 2, respectively, while foreign reserves levels were the explanatory variables. The short- and long-run behaviour of the variables was obtained through the Vector Autoregressive Model (VAR). To ensure the validity of the results, the researchers conducted unit root tests, co-integration, and lag length criteria tests as well as diagnostic tests such as autocorrelation, heteroscedasticity, and stability, to avoid the issue of spurious regression. The functional model drawn from the Fleming-Mundell theory is as follows:

$$OEXR = f(EXRES) \quad (1)$$

$$IFEM = f(EXRES) \quad (2)$$

Where:

OEXR is the official exchange rate for a dollar,

IFEM represents the Interbank Foreign Exchange Market rate and

EXRES represents the foreign reserve levels in Nigeria.

The transformation of equations 1 and 2 into an econometric model is expressed as in equations 3 and 4 respectively:

$$OEXR = \beta_0 + \beta_1 EXRESV + \mu\varepsilon_t \quad (3)$$

$$IFEM = \beta_0 + \beta_1 EXRESV + \mu\varepsilon_t \quad (4)$$

The apriori expectation of the study for model one is that an increase in foreign reserves level is expected to cause a fall in the official exchange rate while in model two, the apriori expectation is that an increase in foreign reserves level would result in a decline in the interbank foreign exchange market rate in Nigeria. Symbolically, $\beta_1 < 0$

The study appliedthe Vector Autoregressive Model (VAR) to examine the impact of foreign reserves level on the exchange rate in Nigeria. The VAR models using the defined lags of the VAR lag length criteria are illustrated as:

$$OEXR_t = \alpha_0 + \alpha_1 OEXR_{t-1} + \alpha_2 OEXR_{t-2} + \alpha_3 OEXR_{t-3} + \beta_1 EXRESR_{t-1} + \beta_2 EXRES_{t-2} + \beta_3 EXRES_{t-3} + \varepsilon_t \quad (5)$$

$$IFEM_t = \alpha_0 + \alpha_1 IFEM_{t-1} + \alpha_2 IFEM_{t-2} + \alpha_3 IFEM_{t-3} + \beta_1 EXRES_{t-1} + \beta_2 EXRES_{t-2} + \beta_3 EXRES_{t-3} + \varepsilon_t \quad (6)$$

Where;

$OEXR_t$ = Official Exchange Rate at time t;

$EXRESR_t$ = Foreign reserves levels at time t;

α_0= constant term;

$\alpha_0, \alpha_0$and α_0 are coefficients of the lagged values of OEXR and IFEM;

$\beta_1, \beta_1, \beta_2 | \beta_1, \beta_2$ coefficients of the lagged values of EXRESV; while

$\varepsilon_t$is the error term.

This VAR equation captures the dynamic relationship between the official exchange rate (OEXR), the Interbank Foreign Exchange Market (IFEM) rate, and the foreign reserves levels (EXRES), with three lags included for each variable. The coefficients $\alpha_0, \alpha_0$and α_0 represent the effects of the past three periods' official exchange rates on the current exchange rate, and $\beta_1, \beta_1, \beta_2 | \beta_1, \beta_2$ present the effects of the past three periods of foreign reserves level on the current exchange rate and interbank foreign exchange market rate. The VAR model allows for the examination of the interdependence and feedback effects between the official exchange rate, interbank foreign exchange market rate, and external reserves, providing a more comprehensive analysis of their dynamic relationship.

RESULTS AND DISCUSSION

The results of the study are presented and discussed in this section of the paper. The outcome from the descriptive statistic is illustrated in Table 1.

Table 1: Descriptive Statistics Results

	EXRES	OEXR	IFEM
Mean	35691.72	318.8246	320.1944
Median	35972.15	306.8823	306.8823
Maximum	47438.22	450.7075	450.7075
Minimum	23689.87	169.6800	181.7835
Std. Dev.	6198.954	74.62063	75.21025
Skewness	-0.004361	-0.249880	-0.215667
Kurtosis	2.063341	2.288841	2.203001
Jarque-Bera	3.509627	3.022029	3.285028
Probability	0.172939	0.220686	0.193493
Observations	96	96	96

Std. Dev. = Standard Deviation
Source: EViews 10.0

Table 1 shows that the mean value of Nigeria's foreign reserves levels (EXRES) over the sample period is $35,691.72 million, with a median value of $35,972.15 million. The foreign reserves levels exhibit a relatively wide range, with a maximum value of $47,438.22 million and a minimum value of $23,689.87 million. The standard deviation of $6,198.954 million indicates a moderate level of volatility in the foreign reserve's levels over the sample period. The skewness and kurtosis values suggest that the foreign reserves levels data is approximately normally distributed. Furthermore, the mean official exchange rate (OEXR) is ₦318.8246 per U.S. dollar, with a median value of ₦306.8823 per U.S. dollar. The official exchange rate ranges from a minimum of ₦169.68 per U.S. dollar to a maximum of ₦450.7075 per U.S. dollar. The standard deviation of ₦74.62063 indicates a moderate level of volatility in the official exchange rate over the sample period. The skewness and kurtosis values suggest that the official exchange rate is also approximately normally distributed. In addition, the mean interbank foreign exchange market (IFEM) rate is ₦320.1944 per U.S. dollar, very close to the official exchange rate. The IFEM rate ranges from a minimum of ₦181.7835 per U.S. dollar to a maximum of ₦450.7075

per U.S. dollar, similar to the official exchange rate. The standard deviation of ₦75.21025 is also comparable to the official exchange rate, indicating a moderate level of volatility. The skewness and kurtosis values suggest that the IFEM rate data is approximately normally distributed, similar to the foreign reserves levels and official exchange rate. The stationarity of the series was examined and the result is presented in Table 2.

Table 2: Unit Root Result (Augmented Dickey-Fuller)

Variable	Level		1st Diff		Order	Remark
	Statistic	Critical Value	Statistic	Critical Value		
EXRES	-1.612216	-2.892536	-7.638824	-2.892536	*I*(1)	Stationary
OEXR	-0.733008	-2.893589	-4.947440	-2.893589	*I*(1)	Stationary
IFEM	-0.862635	-2.893589	-4.916017	-2.893589	*I*(1)	Stationary

Source: EViews 10.0

Table 2 shows the Unit Root Result (Augmented Dickey-Fuller). Establishing a 5% level of significance, all the variables, namely, foreign reserves levels (EXRES), official exchange rate (OEXR), and Interbank Foreign Exchange Market (IFEM) rate revealed critical values greater than the ADF statistic values indicating that the series are non-stationary in their level forms. However, the first-difference of the EXRE, OEXR, and IFEM series has ADF test statistic values less than the critical values, suggesting that the series are stationary in their first-difference forms. Therefore, since the factors are non-stationary in their levels but stationary in their first differences, the long-run equilibrium connection concerning the factors was examined via the Johansen Co-integration test.

Table 3: Co-integration Result

Hypothesized: No. of CE(s)	Trace		Max-Eigen	
Model 1	Statistic	Critical Value	Statistic	Critical Value
None	9.803561	15.49471	9.235805	14.26460
At most 1	0.567756	3.841466	0.567756	3.841466
Model 2: None	9.803561	15.49471	9.235805	14.26460
At most 1	0.567756	3.841466	0.567756	3.841466

Source: Eview 10.0

Table 3 which shows the outcome of the co-integration test uncovered that there is no long-run relationship between the foreign reserves levels (EXRE), official exchange rate (OEXR), and interbank foreign exchange market (IFEM) rate in Nigeria. The outcome showed that the values of the Trace and Max-Eigen statistic compared to the corresponding critical values are lower at 5% level of significance. Based on these results, the null hypothesis of "No co-integration" cannot be rejected, indicating that there is no long-run equilibrium linkage concerning external reserves, official exchange rate, and interbank foreign exchange market rate in Model 1 and Model 2, respectively. This means that shocks to one variable may not necessarily be transmitted to the others in the long run. Therefore, since the variables are not co-integrated, the auto-regression (VAR) model was employed for analysis. Before the estimation of the VAR mode, VAR Lag Order Selection Criteria were performed and the outcome is presented in Table 4.

Table 4: VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1383.474	NA	1.62e+11	31.48804	31.54434	31.51072
1	-1074.609	596.6703	1.59e+08	24.55930	24.72821	24.62735
2	-1058.614	30.17166	1.21e+08	24.28669	24.56821	24.40011
3	-1048.431	18.74667*	1.05e+08*	24.14616*	24.54028*	24.30494*
4	-1045.509	5.246329	1.08e+08	24.17066	24.67739	24.37481
5	-1041.657	6.741183	1.08e+08	24.17402	24.79336	24.42354
6	-1040.799	1.462574	1.17e+08	24.24543	24.97737	24.54031
7	-1038.236	4.252538	1.21e+08	24.27808	25.12263	24.61833
8	-1037.706	0.854595	1.31e+08	24.35696	25.31411	24.74257

Source: Eview 10.0

Table 4 shows the output provided of the results of a lag order selection procedure for a Vector auto-regression (VAR) model. This procedure is used to determine the appropriate number of lags to include in the VAR model, which is a crucial step in the analysis of time series data. Based on the information provided in the output, the optimal lag length is 3, as indicated by the * next to the corresponding values in the last three columns (AIC, SC, and HQ).The LR test statistic is significant at the 5% level for 3 lags, as illustrated by the * next to the LR value. The FPE is minimised at 3 lags, suggesting the appropriate lag length for the VAR model.

Table 5: Diagnostic test Results

	Test	Statistic	P-value
Model 1	Autocorrelation Test	1.681524	0.1566
	Heteroscedasticity Test	66.69438	0.0614
Model 2	Autocorrelation Test	1.696465	0.1532
	Heteroscedasticity Test	63.13489	0.0734

Source: EViews 10.0

Based on the results in Table 5, both Model 1 and Model 2 appeared to satisfy the key assumptions of no autocorrelation and homoscedasticity in the residuals. This suggests that the models are properly specified and do not violate these crucial assumptions. The failure to reject the null hypotheses in both tests indicates that the models have been adequately formulated and the parameter estimates are reliable and unbiased. The diagnostic test results provide evidence that the models are well-specified and the underlying assumptions are met, supporting the validity and robustness of the analyses conducted.

Table 6: VAR Results for Model 1

OEXR	Coefficient	Std. Error	t-Statistic	Prob.
OEXR(-1)	1.617351	0.098685	16.38910	0.0000
OEXR(-2)	-1.000156	0.166947	-5.990858	0.0000
OEXR(-3)	0.385577	0.098982	3.895415	0.0002
EXRES(-1)	-0.001203	0.000589	-2.043021	0.0441
EXRES(-2)	0.001476	0.000903	1.634160	0.1059
EXRES(-3)	-0.000505	0.000573	-0.881938	0.3803
C	9.578505	4.991887	1.918814	0.0583
R-squared	0.990119	F-statistic		1436.238
Adjusted R-squared	0.989429	Prob(F-statistic)		0.000000

Source: Eview 10.0

Table 6 shows the R-squared of 0.990119 indicating that the model explains 99.01% of the variation in the official exchange rate. The F-statistic of 1436.238 and its associated p-value of 0.000000 suggest the current official exchange rate is significantly influenced by foreign reserve level lags and endogenous lags of its own, indicating the presence of dynamic relationships between these variables. The coefficients on OEXR(-1), OEXR(-2), and OEXR(-3) are all statistically significant (p-values < 0.05). This suggests that past values of the official exchange rate have a significant impact on its current and future values. This is expected in time series

analysis, where past values often influence present and future outcomes. EXRES (-1) has a statistically significant negative coefficient. This implies that a decrease in foreign exchange reserves in the previous period is associated with a depreciation of the official exchange rate in the current period. EXRES (-2) has a positive coefficient, but it is not statistically significant. This suggests that the effect of foreign exchange reserves two periods ago on the current exchange rate is not statistically significant. EXRES(-3) has a negative coefficient, but it is also not statistically significant. The constant term is statistically significant, suggesting that there is a constant factor influencing the exchange rate even when all lagged values of the variables are zero. The outcome corroborates with those of Olokoyo et al. (2021) and Odior and Nwaogwugwu (2017). The implications for foreign reserves and exchange rate market: (i) Persistence in exchange rate movements: The significant coefficients on the lagged values of the exchange rate suggest that exchange rate movements in Nigeria exhibit persistence. Past exchange rate changes can have a lasting impact on future movements. (ii) Impact of foreign reserves: The negative coefficient on EXRES(-1) indicates that a decline in foreign exchange reserves in the previous period can lead to a depreciation of the official exchange rate. This highlights the importance of maintaining adequate foreign exchange reserves for exchange rate stability.

Table 7: VAR Results for Model 2

IFEM	Coefficient	Std. Error	t-Statistic	Prob.
IFEM(-1)	1.652618	0.098716	16.74111	0.0000
IFEM(-2)	-1.043492	0.168432	-6.195312	0.0000
IFEM(-3)	0.391015	0.099496	3.929952	0.0002
EXRES(-1)	-0.000974	0.000575	-1.695607	0.0936
EXRES(-2)	0.000993	0.000879	1.130653	0.2613
EXRES(-3)	-0.000222	0.000556	-0.400054	0.6901
C	9.328629	4.841599	1.926766	0.0573
R-squared	0.990866	F-statistic		1554.906
Adjusted R-squared	0.990229	Prob(F-statistic)		0.000000

Source: Eviews 10.0

Model two in Table 7 shows the R-squared of 0.990866 which indicates that the model explains 99.09% of the variation in IFEM. The F-statistic of 1554.906 and its associated p-value of 0.000000 suggest that the model as a whole is statistically

significant. The coefficients on IFEM(-1), IFEM(-2), and IFEM(-3) are all statistically significant (p-values < 0.05). This indicates that past values of the IFEM rate have a strong influence on its current and future values. This suggests a high degree of persistence or inertia in the IFEM rate. EXRES(-1) has a negative and statistically significant coefficient. This suggests that a decrease in foreign exchange reserves in the previous period is associated with an appreciation of the IFEM rate. This relationship may seem counterintuitive, but it could reflect market expectations or adjustments in response to declining reserves. EXRES(-2) and EXRES(-3) have coefficients that are not statistically significant, indicating that the impact of foreign exchange reserves on the IFEM rate diminishes over longer lags. The constant term is statistically significant, suggesting that there is a constant factor influencing the IFEM rate even when all lagged values of the variables are zero. The finding is in line with the theoretical postulation of Mundell-Fleming, however, the impact is said to be insignificant on the interbank foreign exchange market rate in Nigeria. This is due to the insignificant influence of the Central Bank's control over the interbank rate in Nigeria which allows the banks to determine the rate at which they trade with other banks in Nigeria. Implications for foreign reserves and the interbank foreign exchange market: (i) Persistence in exchange rate movements: The significant coefficients on the lagged values of the IFEM rate confirm the persistence observed in the previous model. This suggests that exchange rate movements in the interbank market are influenced by past trends. (ii) Impact of foreign reserves: While the impact of foreign reserves on the IFEM rate is not as strong as in the previous model, the significant negative coefficient on EXRES(-1) suggests that declining reserves can exert pressure on the exchange rate, potentially leading to appreciation. This could be due to market expectations of potential policy adjustments by the Central Bank of Nigeria (CBN) to address declining reserves.

CONCLUSION AND RECOMMENDATIONS

The study demonstrates that Nigeria's foreign exchange reserves levels play an important yet time-lag and asymmetric role in exchange rate determination. The study highlights the findings from model one (1) regarding the persistence of the

official exchange rate movements and the strong impact of foreign exchange reserves on the official exchange rate. The study also highlights the strong persistence in interbank foreign exchange market rate movements and the weak impact of foreign exchange reserves levels on the interbank foreign exchange market rate in model two (2). The study underscores the limitations of relying solely on foreign reserve management for exchange rate stability and highlights the need for complementary structural reforms to mitigate systemic vulnerabilities. The study suggests that maintaining and managing an adequate level of external reserves is crucial for influencing and stabilising the official exchange rate in Nigeria. The study also suggests that the country's Central Bank, through its management of foreign reserves, can have a substantial impact on the value of the national currency relative to other currencies. However, the study reveals that the interbank foreign market rate is insignificantly affected by foreign reserves levels in Nigeria. The study suggests that the level of foreign reserves held by the country may not have a substantial impact on the supply and demand dynamics of foreign currencies in the interbank market, and therefore, may not significantly affect the exchange rate. The Nigerian Central Bank's ability to influence the official exchange rate through interventions in the foreign exchange market is unlimited, as depletions in foreign reserves levels significantly impact the official exchange rate. Therefore, without accretions to the foreign reserves, the exchange rate in the foreign exchange markets will continue to be volatile.

Based on the findings and conclusion of the study, the paper makes the following recommendations anchored on international best practices for improved foreign reserve management in Nigeria:

i. The Nigerian apex bank should adopt proactive and forward-looking reserve management strategies like fully implementing the Guidotti-Greenspan rule as a benchmark for foreign exchange adequacy at the Central Bank of Nigeria to mitigate against the risk of external shocks, especially since Nigeria has not diversified from an oil and import-dependent economy.

ii. The government should ensure robust stress testing of foreign reserve levels on a quarterly basis to assess resilience against shocks like commodity

price collapses and geopolitical crises.

iii. The unified exchange rate regime introduced in 2023 should be strengthened with a more robust monitoring mechanism and fully implemented to reduce information asymmetry and arbitrage across the various foreign exchange windows.

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