Analyzing Exchange Rates and Inflation in Nigeria with ARDL Models

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ABSTRACT

Changes in foreign exchange rates and rising costs for products and services are the main causes of fluctuations in economic development. Despite numerous attempts by the government to reduce inflation in Nigeria, prices of goods and services continue to rise. Thus, this study analyzed the exchange rate-inflation relationship in Nigeria using autoregressive distributive lag (ARDL) approach. The data for the study were collected from National Bureau of statistics (NBS) for the period1 1981 to 2023. The data collected were analyzed using Augmented Dickey Fuller test and autoregressive distributive lag (ARDL) model. The result of the data analysis revealed that there is no long relationship between inflation and exchange rate in Nigeria for the period under study. The results of the ARDL short run estimates revealed that there is a significant relationship between inflation rate and official exchange rate (($p<0.05$). However, there is no significant relationship between inflation rate and bureau de change in the short run ($p>0.05$). Based on these findings, it was recommended among others that there is need for adjusting exchange rate stabilization policy by the government that will help businesses and individuals to invest more, which in turn, decrease importation thereby reducing inflation in the country.

Keywords: *Autoregressive Distributive Lag, Black Market Exchange Rate, Inflation, Official Exchange.*

1.0 Introduction

The exchange rate and inflation are the two main factors used to evaluate a country's macroeconomic success. The primary drivers of variations in economic development are shifts in foreign currency rates and growing prices for goods and services (Abubakar et al, 2022). One of the essential instruments used by the Central Bank of Nigeria to attain monetary and economic stability and manage inflationary pressures is the exchange rate. One of the economic problems that many nations, including Nigeria, deal with is the parallel (black-market) exchange rate, which is subject to frequent changes due to the fragility of the Nigerian economy, which negatively affects the economy. This issue stems from a number of issues, including as economic instability, financial and administrative corruption, an excessive reliance on crude oil, and other elements that contributed to the local currency's loss in value. The official price listed in the nation's budget is

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still significantly lower than the US dollar exchange rates on the Nigerian black market. notwithstanding the Central Bank's attempts to resolve the issue (AL-Abdullah, et al., 2023).

As of May 30, 2024, the average parallel price of the US dollar in Nigeria is 1510 Naira per dollar. This represents a persistent difference of roughly 86.25 Naira between the official price and the parallel market, and despite the Central Bank's efforts to encourage the use of external transfers to cover imports and correct their trajectory, their rates have not decreased (Al-Raamadan & Hasan, 2022). Exchange rate mismatches will persist as long as currency smuggling persists and there are lax regulations to control the sale of dollars and penalize those implicated (Arora et al., 2022).

Nigeria's inflation rate surged from 21.91% in February 2023 to 31.70% in February 2024, representing a significant 9.79% increase in just one year (National Bureau of Statistics, 2024). This sharp rise exceeds previous records, with the exception of the percentage increase in 2022, which was the highest since October 2005. Historically, Nigeria's headline inflation rate has consistently remained in double digits, averaging 20.52% from 1974 to 2022 (Central Bank of Nigeria, 2021). This trend raises concerns about the investment climate in Nigeria. The relationship between inflation and exchange rates remains a topic of debate globally, affecting both developed and developing economies (Musa & Hussaini, 2021).

Efforts by the Nigerian government to curb inflation have yet to yield desired results, as prices of goods and services continue to rise. The ongoing inflationary trend may be further exacerbated by exchange rate fluctuations and other monetary policies that could impact the financial system. Furthermore, existing research on the topic presents conflicting evidence regarding the relationship between exchange rates and inflation in Nigeria. Many statistical and machine learning methods can be applied to analyze and gain a deeper understanding of the relationship between exchange rates and inflation rates. Prominent among the statistical methods include Correlation Analysis, Regression Analysis, Cointegration Analysis, Spectral Analysis, Time Series Decomposition, among others. This study aimed to analyzed the exchange rate-inflation relationship in Nigeria using autoregressive distributive lag model and Granger Causality. Other specific objectives include: To investigate the relationship between exchange rates and inflation rate in Nigeria; To investigate the validity of the ARDL model.

2.0 Literature Review

Barrie et al. (2023) investigated the dual exchange rate system in Sierra Leone, exploring the distinct effects of official and parallel exchange rates (Leone vs. USD) on inflation. Using

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Autoregressive Distributed Lag (ARDL) analysis and annual time series data from 1980 to 2020, the study found that Leone depreciation significantly drives inflation. Notably, the parallel exchange rate has a more pronounced impact, with a 1% depreciation leading to a 1.26% increase in inflation, gradually decreasing to 0.92% over two years. In contrast, official exchange rate depreciation results in a 0.43% increase in inflation, which rises to 0.52% in the second year.

Emikonel and Orhan (2023) investigated the long-term and short-term dynamics between exchange rates and inflation using monthly data from 1990 to 2020 for the "Fragile Five" countries (Brazil, Indonesia, India, South Africa, and Türkiye). Sourcing data from the International Monetary Fund's (IMF) online database, the study revealed a long-run relationship between exchange rates and inflation across these countries. However, the findings also showed that the exchange rate has no significant long-term impact on inflation in Brazil, Türkiye, and India, whereas it significantly affects inflation in Indonesia and South Africa.

Abdulhamid et al. (2022) examined the relationship between inflation and exchange rates in Nigeria using annual data from 1980 to 2021. Employing Granger causality and ARDL approaches, the study revealed a cointegration relationship between inflation, exchange rates, imports, and GDP. The error correction term was found to be negative and statistically significant, indicating a rapid adjustment from short-run to long-run equilibrium. In the short run, exchange rates have a positive and significant impact on inflation, while in the long run, the relationship becomes negative and significant. Additionally, Granger causality testing showed no causal links between inflation and exchange rates in either direction.

Musa (2021) investigated the impact of exchange rate volatility on inflation in Nigeria, using annual time series data from 1986 to 2019. The study employed Generalized Autoregressive Conditional Heteroskedasticity (GARCH) and Vector Error Correction Model (VECM) analyses. The results revealed that money supply and nominal exchange rate have a positive and significant impact on the consumer price index, indicating that inflation in Nigeria is driven by both exchange rate fluctuations and increases in money supply.

Abubakar et al. (2021) investigated the effect of exchange rate depreciation on inflation in Nigeria, covering the period 1981-2017. Utilizing the Auto Regressive Distributed Lag (ARDL) Bounds Test Cointegration Procedure, the study revealed that Nigeria's inflation rate is significantly influenced by lagged inflation rate, exchange rate, lagged exchange rate, lagged broad money, and lagged gross domestic product at a 5% significance level. Additionally, a long-run relationship was

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discovered between inflation rate, gross domestic product, and general government expenditure, indicating that the model has a self-correcting mechanism for restoring equilibrium when deviations occur.

Şen et al. (2020) investigated the long-term relationships between interest rates, inflation, and exchange rates in five fragile emerging market economies (Brazil, India, Indonesia, South Africa, and Turkey). Using Autoregressive Distributed Lag analysis, the study examined monthly time-series data from January 2013 to December 2018 to test for threshold cointegration. The findings revealed a long-run positive relationship between inflation rates and nominal interest rates, supporting the ex-post Fisher hypothesis in all sample countries. Additionally, the study found that exchange rates and inflation rates co-move in the long run, indicating that currency depreciation leads to inflation through higher import prices in all the examined countries.

Victor et al. (2020) utilized the autoregressive distributed lag (ARDL) method to examine the determinants of inflation in Nigeria, using quarterly data from January 1999 to December 2018. Their findings revealed that poor infrastructure development, exchange rate fluctuations, political instability, corruption, and double taxation are significant drivers of inflation, beyond just money supply. The study established a causal relationship between these factors and inflation, with the ARDL results indicating a substantial long-run and short-run relationship.

Alieu (2019) investigated the long-run relationship between exchange rates and inflation, as well as the impact of exchange rates on inflation, using Johansen co-integration tests and OLS regression. The findings revealed that there is no long-run relationship between the variables. However, the regression analysis showed a negative relationship between GDP and inflation (-10.27533), and a negative impact of interest rates on inflation, significant at the 5% level. Additionally, the exchange rate has a positive relationship with inflation, although not statistically significant, indicating that a unit increase in the exchange rate would lead to a 0.2750727 increase in inflation.

Ebaidalla (2019) investigated the factors influencing parallel exchange rate premiums in Sudan between 1979 and 2014, as well as their impact on economic performance, specifically focusing on economic growth, inflation, and exports. The empirical analysis revealed that parallel exchange rate premiums are significantly affected by policy variables such as real exchange rates, trade openness, and money supply. Additionally, the results identified GDP growth, expected rate of devaluation, budget deficit, and foreign aid as the most significant factors influencing parallel

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exchange rate premiums. Furthermore, the study found that parallel premiums have a detrimental impact on economic growth and export performance, while also showing a positive association with inflation rates.

Wasiu et al. (2019) investigated the determinants of exchange rates in Nigeria, comparing official and parallel market rates from 1986 to 2017 using quarterly time series data. The study analyzed various macroeconomic variables, including GDP, inflation, interest rates, imports, oil exports, non-oil exports, and reserves. After testing for stationarity using ADF and co-integration, the ARDL was applied. The results revealed that GDP, inflation, interest rates, non-oil exports, oil exports, and reserves are the primary determinants of official exchange rates in Nigeria. In contrast, inflation, non-oil exports, and GDP are the main drivers of parallel exchange rates.

Lowe (2019) investigated the relationship between the exchange rate regime and the sources of inflation in Gambia, using a time series dataset covering the period 1978-2016. The study employed the Augmented Dickey-Fuller (ADF) test to examine the stationarity of the data and the Johansen co-integration test to determine if a long-run relationship exists among the variables. The results revealed that there is no long-run relationship between the exchange rate and inflation, suggesting that other factors may be driving inflation in Gambia.

Bui (2018) examined the relationship between official and black-market exchange rates in Vietnam from January 2005 to April 2011 using a Vector-Error-Correction model and Granger tests. The study found a long-run relationship between the official and parallel market rates of the Vietnam Dong against the U.S. dollar. Additionally, the Granger causality test revealed a unidirectional causality, where the official exchange rate drives the black-market exchange rate, but not the other way around.

Umar and Umar (2022) investigated the asymmetric effects of exchange rate on food inflation in Nigeria, using the Non-Linear ARDL model and quarterly data from 2008Q1 to 2020Q4. The bounds testing approach revealed a long-run relationship between exchange rate, food inflation, and GDP. Furthermore, the results showed a significant and asymmetric positive relationship between exchange rate and food inflation in both the long-run and short-run. Conversely, GDP had a negative and significant impact on food inflation.

Mohammed and Bashir (2018) examined the exchange rate pass-through (ERPT) to import and consumer prices in Nigeria, using quarterly time series data from 2000 Q1 to 2021 Q4. They employed autoregressive distributed lag and nonlinear ARDL techniques to analyze the data. The

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study revealed an asymmetric and incomplete ERPT to Nigerian import and consumer prices, with a direct link between exchange rate appreciation and increases in consumer and import prices. Additionally, the analysis showed that previous quarter's import price significantly impacts inflation in Nigeria, and that GDP has an inverse relationship with inflation, with a greater impact on consumer prices than the exchange rate.

Ademola et al. (2023) investigated the impact of interest rates on Nigeria's inflation rate using time series data spanning 68 quarters from Q1 2006 to Q4 2022. The data was sourced from the Central Bank of Nigeria, National Bureau of Statistics, and World Development Indicator databases. The study employed the ARDL model to analyze the relationship between interest rates and inflation, while the Augmented Dickey-Fuller and Phillip-Perron tests were used to examine stationarity. The results revealed a long-run significant cointegrating relationship between interest rates and inflation rates in Nigeria.

3.0 Materials and Methods

3.1 Source of Data

The data used in this study were collected from National Bureau of Statistics. A time series data on the three variables (BDC, official exchange rates and inflation rate) were collected for the period spanning from 1981 – 2023.

3.2 Techniques for Data Analysis

The study used the autoregressive distributive lag (ARDL) model and pair wise Granger Causality as the technique for data analyses.

3.2.1 Unit Root Test

The study utilized the Augmented Dickey Fuller (ADF) test to examine the time series data for unit roots. Since time series data often exhibit non-stationarity, differencing the data can convert it into a stationary form. The ADF test provides a straightforward method for achieving this by employing the ADF t-statistic to determine the presence of unit roots and subsequently transforming the data into a stationary series.

The ADF test constructs a parametric correction for higher-order correlation by assuming that the y series follows an $AR(P)$ process and adding P lagged difference terms of the dependent variable y to the right-hand side of the test regression (Dickey & Fuller, 1979) as follow:

$$\Delta y_t = \alpha y_{t-1} + x_t'\delta + \beta_1 \Delta y_{t-1} + +\beta_2 \Delta y_{t-2} + \cdots + +\beta_p \Delta y_{t-p} + v_t \quad (3.1)$$

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where x_t are optional exogenous regressors which may consist of constant, or a constant and trend. The null hypothesis of the ADF t-test is:

$$H_0: \theta = 0 \quad (3.2)$$

which means that the data needs to be differenced to make it stationary. The alternative hypothesis of

$$H_1: \theta < 0 \quad (3.3)$$

which means that the data is trend stationary and needs to be analyzed by means of using a time trend in the regression model instead of differencing the data.

The test statistic is conventional t-ratio for α:

$$t_\alpha = \frac{\hat{\alpha}}{SE(\hat{\alpha})} \quad (3.4)$$

Where $\hat{\alpha}$ is the estimate of α and $SE(\hat{\alpha})$ is the coefficient of standard error.

3.2.2 Autoregressive Distributed Lag (ARDL) Model

Pesaran et al (2001) proposed an Autoregressive Distributed lag (ARDL) model/bounds testing approach to investigate the existence of co-integration in relationship among variables. The generalize ARDL (p, q) model is specified as:

$$Y_t = \gamma_{oi} + \sum_{i=1}^{p} \delta_i Y_{t-i} + \sum_{i=0}^{q} \beta_i' X_{t-i} + \varepsilon_{it} \quad (3.5)$$

Where Y_t' is a vector of the dependent variable and variables in $(X_t')'$ is the vector of regressors which are allowed to be purely I(0) or I(1) or co-integrated; β and δ are coefficients; γ is the constant; $i = 1, \dots, k; p, q$ are optimal lag orders; ε_{it} is vector of the error terms- unobservable zero mean white noise vector process (serially uncorrelated or independent). The $p - lags$ are used for the dependent variable and the $q - lags$ are used for the regressors variables.

To perform the bound test for co-integration in the current study with three variables (one dependent and two regressors, the conditional $ARDL(p, q_1, q_2)$. The functional ARDL model for the current study is given below:

$$\Delta lnINFR_t = \alpha_0 + \beta_1 lnINFR_{t-i} + \beta_2 lnBDC_{t-i} + \beta_3 lnOER_{t-i} + \sum_{i=1}^{p} \omega_{1M} \Delta lnINFR_{t-i} + \sum_{i=1}^{q} \omega_{2M} \Delta lnBDC_{t-i} + \sum_{i=1}^{q} \omega_{3M} \Delta lnOER_{t-i} + \varepsilon_{it} \quad (3.6)$$

Where:

$lnINFR$ is the natural log of Inflation Rate

$lnBDC$ is the natural log of Bureau De change Exchange rate

$lnOFR$ is the natural log of Official Exchange Rate

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ε_{it} is the error term

The equation 3.6 tests for the long run level relationship. The hypothesis to be tested are:

H₀: There is no long run relationship

H_1: There is long run relationship

If co-integration is identified by the rejection of the null hypothesis, the error correction model (ECM) representation according to (Pesaran et al., 2001; Wolde-Rufael, 2010) is specified as:

$$\Delta lnINFR_t = \alpha_0 + \sum_{i=1}^{p} \omega_{1M} \Delta lnINFR_{t-i} + \sum_{i=1}^{q} \omega_{2M} \Delta lnBDC_{t-i} + \sum_{i=1}^{q} \omega_{3M} \Delta lnOER_{t-i} + \lambda ECT_{t-1} + \varepsilon_{it} \quad (3.7)$$

At the other hand, if there is no co-integration, the $ARDL(p, q_1, q_2)$ model is specified as:

$$\Delta lnINFR_t = \alpha_0 + \sum_{i=1}^{p} \omega_{1M} \Delta lnINFR_{t-i} + \sum_{i=1}^{q} \omega_{2M} \Delta lnBDC_{t-i} + \sum_{i=1}^{q} \omega_{3M} \Delta lnOER_{t-i} + \varepsilon_{it} \quad (3.8)$$

Where:

$\lambda = (1 - \sum_{i=1}^{p} \delta_i)$, speed of adjustment parameter with negative sign

$ECT = (lnINFR_{t-i} - \theta X_t)$ is the error correction term

$\theta = \frac{\sum_{i=1}^{q} \beta_i}{\alpha}$ is the long run parameter

$\omega_{1M}, \omega_{2M}, \omega_{3M}$ are the short run dynamic coefficient of the model's adjustment long-run equilibrium.

3.2.3 Pair Wise Granger Causality

Granger causality is a technique for determining whether one time series is useful in forecasting another (Granger, 1981). The pair wise granger causality is a technique for determining the direction of relationship between pairs of variables. The pair wise Granger Causality specification model with respect to Black market, official exchange rates and inflation rate were established as presented below;

$$INFR_t = \varphi_0 + \varphi_1 INFR_{t-1} + \cdots + \varphi_i INFR_{t-i} + \alpha_1 BDC_1 + \cdots + \alpha_i BDC_i + \varepsilon_t \quad (3.9)$$

$$BDC_t = \varphi_0 + \varphi_1 BDC_{t-1} + \cdots + \varphi_i BDC_{t-i} + \alpha_1 INFR_1 + \cdots + \alpha_i INFR_i + \varepsilon_t \quad (3.10)$$

$$INFR_t = \varphi_0 + \varphi_1 INFR_{t-1} + \cdots + \varphi_i INFR_{t-i} + \alpha_1 OER_1 + \cdots + \alpha_i OER_i + \varepsilon_t \quad (3.11)$$

$$OER_t = \varphi_0 + \varphi_1 OER_{t-1} + \cdots + \varphi_i OER_{t-i} + \alpha_1 INFR_1 + \cdots + \alpha_i INFR_i + \varepsilon_t \quad (3.12)$$

$$BDC_t = \varphi_0 + \varphi_1 BDC_{t-1} + \cdots + \varphi_i BDC_{t-i} + \alpha_1 OER_1 + \cdots + \alpha_i OER_i + \varepsilon_t \quad (3.13)$$

$$OER_t = \varphi_0 + \varphi_1 OER_{t-1} + \cdots + \varphi_i OER_{t-i} + \alpha_1 BDC_1 + \cdots + \alpha_i BDC_i + \varepsilon_t \quad (3.14)$$

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From the above Granger causality equation model, six different hypothetical tests were formulated as presented in equation (3.9), (3.10), (3.11), (3.12), (3.13) and (3.14) above. The first hypothesis was based on the null hypothesis that INFR does not granger causes BDC, the second null hypothesis states that BDC does not granger cause INFR, the third hypothesis states that INFR does not Granger cause OER, the fourth hypothesis states that OER does not granger cause INFR, the fifth hypothesis states that BDC does not granger cause OER and the sixth hypothesis states that OER does not granger cause BDC.

4.0 Results

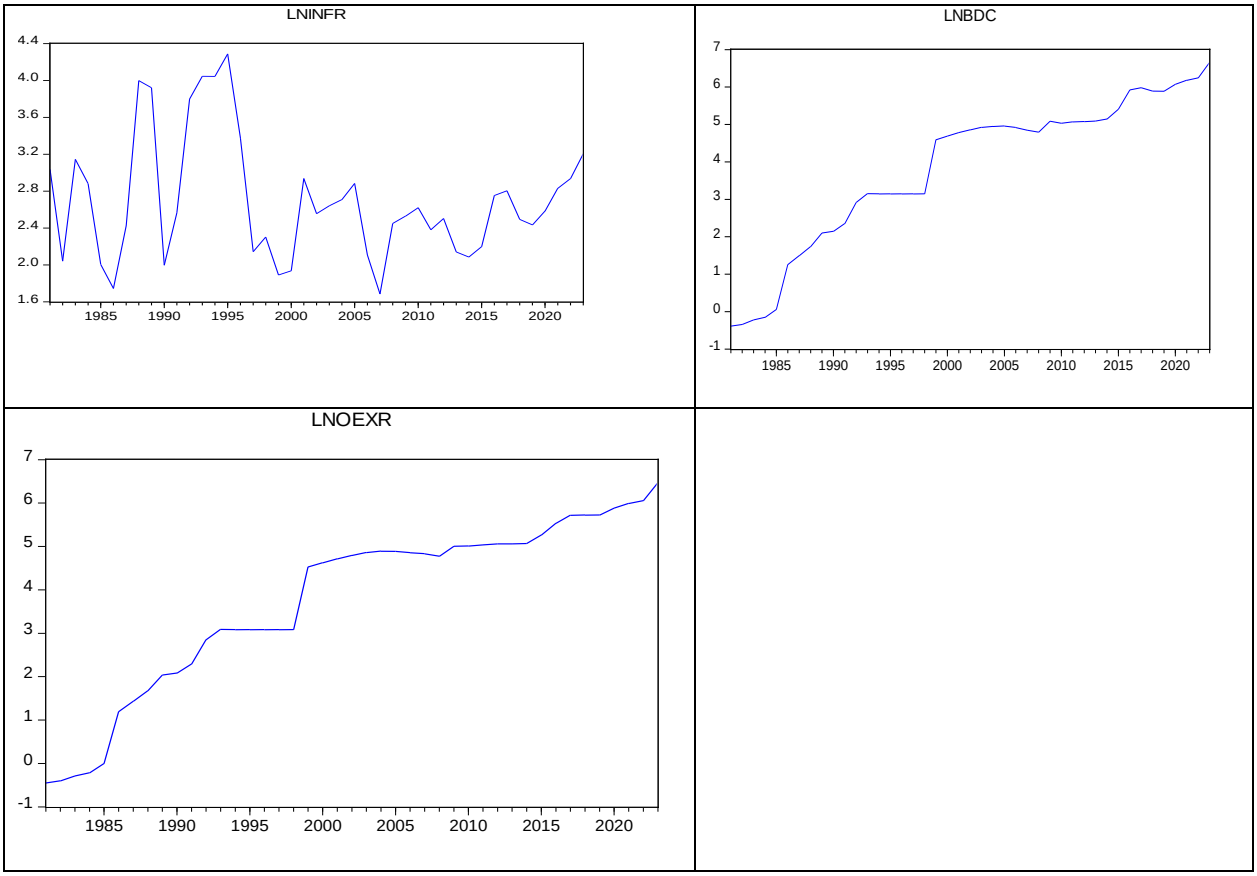

Figure 1: Time plot of log of Inflation Rate (LNINFR), black-market exchange rate (LNBDC) and Official Exchange Rate (LNOEXR)

The time plot of log of inflation rate presented in Figure 1 revealed that the log of inflation rate fluctuates over the period under study 1981 to 2023. It was also observed that log of BDC exchange rate exhibits an increasing pattern for the period under study. Furthermore, log of official exchange rate exhibits an increasing pattern for the whole periods under study.

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Table 1: Descriptive Statistics Results

	LNBDC	LNINFR	LNOEXR
Mean	3.835807	2.698675	3.747140
Median	4.793391	2.565486	4.775477
Maximum	6.660844	4.288204	6.471279
Minimum	-0.385662	1.684176	-0.451143
Std. Dev.	2.033364	0.665429	2.003274
Skewness	-0.758708	0.810991	-0.804704
Kurtosis	2.462217	2.949759	2.492353
Jarque-Bera	4.643574	4.718082	5.102493
Probability	0.098098	0.094511	0.077984
Sum	164.9397	116.0430	161.1270
Sum Sq. Dev.	173.6520	18.59742	168.5505
Observations	43	43	43

Source: computed using EVIEWs

Table 1 presents the descriptive statistics results of variables (log of BDC, log of official exchange rate and log of inflation rate). The results revealed average log of BDC and official exchange rate to be 3.835807 and 2.698675 with standard deviations of 2.033364 and 0.665429 respectively. Also, mean of log of inflation rate was 3.747140 with standard deviation of 2.003274. All the variables were normally distributed as the p-values of Jarque-Bera statistic were greater than 0.05

Table 2: Augmented Dickey Fuller Unit Root Result

Variables	Order	Test Critical Values			Test Statistic	P-value
		1%	5%	10%		
LNINFR	0	-3.6056	-2.9369	-2.6069	-2.6878	0.0850
	1	-3.6056	-2.9370	-2.6069	-7.2037	0.0000
LNOEXR	0	-3.5966	-2.9331	-2.6049	-1.9361	0.3132
	1	-3.6010	-2.9350	-2.6058	-5.8379	0.0000
LNBDC	0	-3.5966	-2.9332	-2.6049	-1.8238	0.3642
	1	-3.6010	-2.9350	-2.6058	-5.8547	0.0000

Source: Extracted from EVIEWs Output

Table 2 presents the unit root test result using Augmented Dickey Fuller test. The results revealed that all the variables were not stationary at level (p-value > 0.05). However, the variables become stationary after first difference (p-value < 0.05).

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Table 3: Bound test

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	2.519147	10%	2.63	3.35
K	2	5%	3.1	3.87
		2.5%	3.55	4.38
		1%	4.13	5

Source: Author's compilation

Table 3 presents the ARDL bound test result which was used to test for the existence of long run relationship among the variables under study. In the ARDL bound test, the null hypothesis of no long relationship is rejected when the F-statistics value is greater than the upper bound I(1) and accept the null hypothesis when the F-statistics value is lower than lower bound, I(0) and the results is inconclusive when the F-statistics value lies within the range of I(0) and I(1) (Pesaran et al., 2001). The result of the bound test presented in Table 4.3 revealed that is no long relationship between the variables since the F-statistic = 2.519147 which is lower than the I(0) bound. This implies that the variable does not co-move in the long run.

Table 4: ADRL Short Run Estimate Equation

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNINFR(-1)	0.859345	0.142777	6.018786	0.0000
LNINFR(-2)	-0.548363	0.164977	-3.323884	0.0023
LNINFR(-3)	0.381600	0.146878	2.598082	0.0142
LNBDC	1.032479	1.130347	0.913418	0.3681
LNOEXR	-1.247822	1.240059	-1.006260	0.3221
LNOEXR(-1)	0.455134	0.379629	1.198891	0.2397
LNOEXR(-2)	0.713340	0.362716	1.966665	0.0582
LNOEXR(-3)	-0.929609	0.259231	-3.586024	0.0011
C	0.490807	0.649038	0.756207	0.4552
R-squared	0.637381	Mean dependent var		2.695547
Adjusted R-squared	0.543801	S.D. dependent var		0.676567
S.E. of regression	0.456970	Akaike info criterion		1.466710
Sum squared resid	6.473472	Schwarz criterion		1.846708
Log likelihood	-20.33420	Hannan-Quinn criter.		1.604105
F-statistic	6.811134	Durbin-Watson stat		1.880056
Prob(F-statistic)	0.000038			

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Source: Author's Compilation using EVIEWs

Table 4 presents the ARDL short run estimate results. The F-statistic = 6.811134, p-value < 0.05 indicates that the overall model is significant. The R-square value of 0.637381 indicates that 63.7% of the variation in log of inflation rate is explained by log of black-market exchange rate, log of official exchange rate and the past values of log of inflation rate. The first and third period lag of log of inflation rate were positively signed with p-value < 0.05. This suggest that the first and third periods lags of log of inflation rate have positive and significant impact on the current log of inflation rate. However, the second period lag of inflation was negatively signed with p-value < 0.05 suggesting that the second period lag of log of inflation rate have negative impact on the current log of inflation rate.

In addition, the coefficient of log of BDC was positively signed with p-value > 0.05. This suggest that log of BDC have positive and insignificant impact on log of inflation rate in the short run. However, the coefficient of log of official exchange rate was negatively signed with p-value > 0.05 suggesting that log of official exchange rate have negative and significant impact on log of inflation rate in the short run.

The first period lag of log of official exchange rate has positive but insignificant impact of log of inflation rate (B = 0.455134, p-value > 0.05) while the second period lag of log of official rate have positive and significant impact on log of current inflation rate (B = 0.713340, p-value < 0.05) in the short run. However, the third period lag of log of official exchange rate have negative and significant impact of the log of inflation rate (B = -0.929609, p-value < 0.05) in the short run.

Table 5: ARDL Error Correction Regression model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNINFR(-1))	0.166763	0.114633	1.454754	0.1558
D(LNINFR(-2))	-0.381600	0.123143	-3.098840	0.0041
D(LNOEXR)	-1.247822	0.336406	-3.709275	0.0008
D(LNOEXR(-1))	0.216268	0.222227	0.973189	0.3380
D(LNOEXR(-2))	0.929609	0.222957	4.169456	0.0002
CointEq(-1)*	-0.307418	0.092473	-3.324416	0.0023

R-squared	0.580633	Mean dependent var	0.001512
Adjusted R-squared	0.518961	S.D. dependent var	0.629128
S.E. of regression	0.436344	Akaike info criterion	1.316710
Sum squared resid	6.473472	Schwarz criterion	1.570042
Log likelihood	-20.33420	Hannan-Quinn criter.	1.408307

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Durbin-Watson stat	1.880056

Source: Author's Compilation using EVIEWs

Table 5 presents the results of ARDL error correction regression model. The error correction *ECT* = -0.307418 was less than 1, negative and statistically significant at 5% level. The error correction term (ECT) portrays the speed of adjustment required to restore equilibrium in the dynamic model from an innovation. Its value of -0.307418 implies that an impulse to inflation rate in the current period will be restored at a speed of adjustment of about 30.7% in the next period. This implies that 30.7% of the short-run disequilibrium is corrected annually.

The result revealed that the coefficient of the first period lag of log of inflation rate and the first period lag of log of inflation rate were positively signed with p-value > 0.05 implying positive and insignificant impact on the current log of inflation rate. However, the coefficient of the second period lag of log of inflation rate and current official exchange rate were negatively signed with p-value < 0.05 implying negative and significant impact on the current inflation rate in Nigeria while the coefficient of second period lag of log of official exchange rate was positively signed with p-value < 0.05 implying negative and significant impact on current value of inflation rate.

Table 6: Long-run estimate

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNBDC	3.358549	4.069290	0.825340	0.4155
LNOEXR	-3.282033	4.088424	-0.802762	0.4282
C	1.596547	1.300454	1.227684	0.2288

Source: Author's Compilation using EVIEWs

The long run estimates were presented in Table 6. The results revealed that LNBDC have positive and insignificant impact of log of inflation rate while LNOEXR have negative and insignificant impact on log of inflation rate in the long run.

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Diagnostics Test

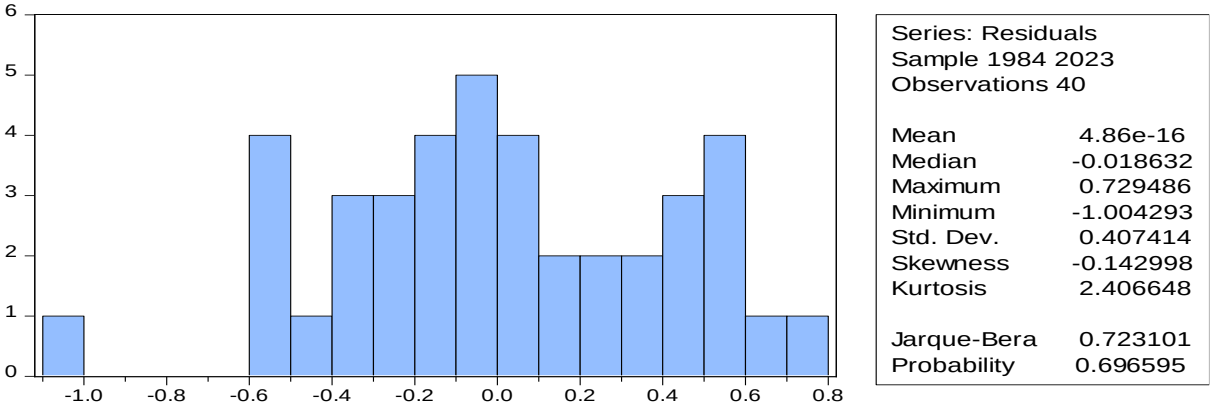

Figure 2: Histogram of Residuals

Figure 2 presents the histogram of residuals of the fitted ARDL model. The Jarque-Bera statistic = 0.723101, p-value > 0.05 indicates that the residuals of the fitted model are normally distributed.

Table 5: Breusch-Godfrey Serial Correlation LM Test

F-statistic	0.145975	Prob. F(3,28)	0.9314
Obs*R-squared	0.615975	Prob. Chi-Square(3)	0.8928

Source: Author's compilation

Table 5 presents the results of Breusch-Godfrey Serial Correlation Lagrange Multiplier (LM) test. The result revealed F-statistics = 0.145975, p-value > 0.05 suggesting that there is no serial correlation in the residuals of the fitted model.

Table 6: Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.956916	Prob. F(8,31)	0.0864
Obs*R-squared	13.42211	Prob. Chi-Square(8)	0.0981
Scaled explained SS	5.669955	Prob. Chi-Square(8)	0.6841

Source: Author's compilation

Table 6 presents the results of Breusch-Pagan-Godfrey for heteroskedasticity test. The results revealed F-statistic = 1.956916, p-value > 0.05 suggesting absent of heteroskedasticity test in the residuals of the fitted ARDL model.

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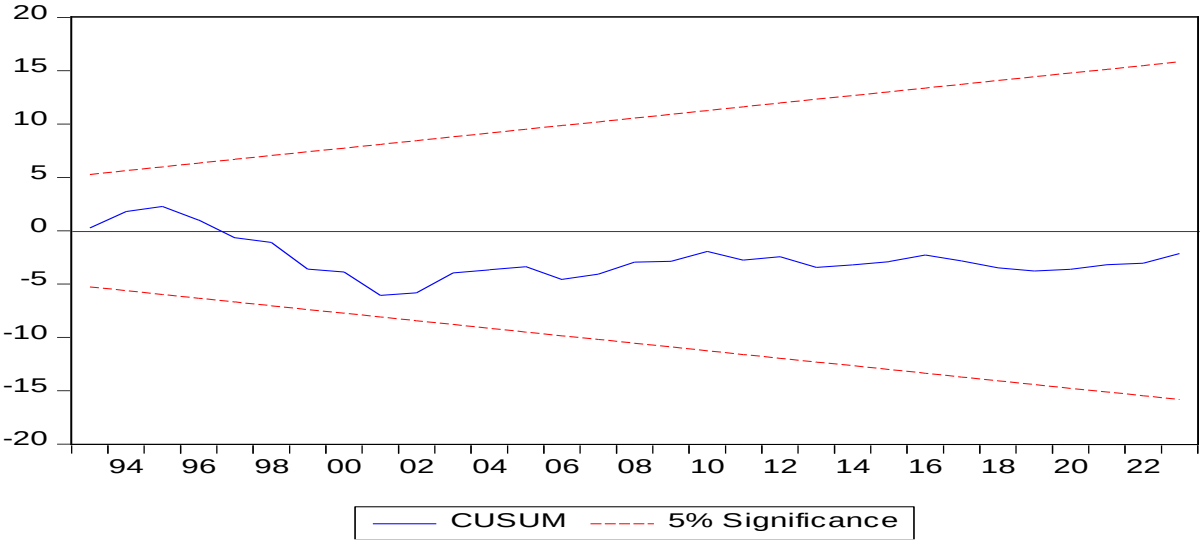

Figure 5: CUSUM Chart

The graphs of the CUSUM in figure 5 indicated that the model is stable as the parameters of the estimated model are within the critical bounds at 5% critical level, implying that the estimated model is dynamically stable suggesting that the ARDL model performed.

Granger Causality Test Result

Table 7: Pairwise Granger Causality Tests

Null Hypothesis:	Obs	F-Statistic	Prob.
LNBDC does not Granger Cause LNINFR	40	4.40416	0.0103
LNINFR does not Granger Cause LNBDC		2.26884	0.0988
LNOEXR does not Granger Cause LNINFR	40	4.89607	0.0063
LNINFR does not Granger Cause LNOEXR		2.11259	0.1175
LNOEXR does not Granger Cause LNBDC	40	0.23996	0.8678
LNBDC does not Granger Cause LNOEXR		0.39774	0.7555

Source: Author's compilation

The results of pairwise Granger Causality test were presented in Table 7. The results revealed a unidirectional relationship between BDC and inflation rate and, official exchange rate and inflation rate. This implies that BDC and official exchange rate granger cause inflation rate while inflation rate granger cause BDC and official exchange rate. The result revealed further that there was no causal relationship between BDC and official exchange rate.

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6.0 Discussion of Results

The graphs of the variables under study revealed that inflation rate exhibits some fluctuations with small trend patterns while official exchange rate and the Bureau De change exhibits an increasing trend. The trend pattern in data indicates the non-stationary nature in the data set. The data were further evaluated for unit root and the results revealed that al the variables were stationary after first difference. The result of Jarque-Bera test for normality of data set indicates that all the data were normally distributed.

Furthermore, the bound test result revealed an F-statistic value lower than the I(0)) bound indicating that there is no long run relationship between the variables. This finding was not agreement with findings of Emikonel and Orhan (2023), Abdulhamid et al (2022), Alieu (2019) and Şen *et al* (2020).

The ARDL estimated revealed that the first and third periods lag of inflation, have positive and significant impact on the current value of inflation rate while the second period lag have negative and significant impact on the current values of inflation rate. These findings were in agreement with findings from previous study by Abubakar *et al* (2021). Also, the result revealed that the current values of BDC and the first and second periods lag of official exchange rate have positive and insignificant impact on inflation rate. However, the current official exchange rate has negative and insignificant impact on inflation rate while the third period lags of official exchange rate have negative and significant impact on inflation rate in the short run. The finding of the current study was not in agreement with findings from previous study by Musa (2021) and Barrie et al (2023) whose study revealed significant impact of exchange rates on inflation rate. The long run estimates revealed that BDC have positive and insignificant impact on inflation rate while official exchange rate have negative and insignificant impact on inflation rate. The error correction term of -0.307418 implies that an impulse to inflation rate in the current period will be restored at a speed of adjustment of about 30.7% in the next period. This implies that 30.7% of the short-run disequilibrium is corrected annually. Of course, this could be attributed to various economic policies, shifts and other concomitant factors like the population growth.

The diagnostic test result revealed that the residuals of the estimated model was normally distributed. Also, there was absent of serial correlation and heteroskedasticity in the residuals of the estimated model. The CUSUM test parameters of the estimated model are within the critical

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bounds at 5% critical level, implying that the estimated model is dynamically stable suggestion that the ARDL model performed.

The results of pairwise Granger Causality test revealed a unidirectional relationship between BDC and inflation rate and, official exchange rate and inflation rate. This implies that BDC and official exchange rate granger cause inflation rate while inflation rate granger cause BDC and official exchange rate. This finding was similar to findings from previous study by Wasiu *et al* (2019). However, there was no causal relationship between BDC and official exchange rate for the period under study. This finding contradicts findings from previous study by Ebaidalla (2019) whose study revealed that official exchange rate influence bureau de change exchange rate. This finding was also not in agreement with Bui (2018).

6.0 Conclusion and Recommendations

The study examined the relationship between exchange rates and inflation rate in Nigeria using autoregressive distributive lag approach. The bureau the de change and official exchange rate were used as the measures of exchange rate. Based on the findings of the study, it was concluded that there is no long relationship between inflation and exchange rate in Nigeria for the period under study. The study concludes further that there is a significant relationship between inflation rate and official exchange rate. However, there is no significant relationship between inflation rate and bureau de change in the short run. Based on the findings of the study, the following recommendations were made:

i. exchange rate stabilization policy should be adjusted by the government that will help businesses and individuals to invest more, which in turn, decrease importation thereby reducing inflation in the country.
ii. The CBN and or government should re-introduce tight monetary policies by implementation of price stability programmes to help sustain low inflation rate in Nigeria.
iii. Third, government through the CBN should create policy to ensure easy and direct access to forex by individual and businesses.
iv. Lastly, local Firms should continue to produce goods or services which help to reduce the rate of importation, despite unstable exchange rate in Nigeria.

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