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Effects of Exchange Rate Depreciation on the General Price Level in Nigeria

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Abstract

This study examined how exchange rate depreciation affects the overall price level in Nigeria. It utilized advanced econometric methods, including the Variance Inflation Factor, stationarity testing through the Augmented Dickey-Fuller technique, Johansen Cointegration, and the Error Correction Mechanism to analyze adjustment speeds. Additionally, tests for normality and model stability were carried out. The results indicate that a depreciating exchange rate significantly contributes to rising price levels. Similar effects were observed with imports and inflation, aligning with the study's initial expectations. Consequently, the research suggests adopting a fixed exchange rate system to curb excessive volatility and recommends import substitution policies to tackle import-driven inflation, thereby helping to control the persistent rise in general prices.

Introduction

The depreciation of the Naira, along with the persistent rise in inflation, remains a significant challenge for Nigeria's economy. Inflation is widely regarded as a harmful economic condition that no responsible government would ignore; rather, any serious administration would actively design and implement policies to reduce it to an acceptable level. As individuals experience income growth, they may lack awareness of how such increases can negatively influence overall price levels. For the average person, complex economic terms like exchange rate depreciation or nominal income growth may hold little meaning—their primary concern is the wellbeing of their household. Frequently, exchange rate depreciation leads to rising prices, a situation that has long troubled both past and present Nigerian governments, as well as concerned citizens, due to its role in fuelling inflation and worsening the cost of living.

The high general price level resulting from exchange rate depreciation has led the Nigerian government to adopt exchange rate pegging as a strategic policy aimed at accelerating economic growth and development, with the goal of bringing inflation down to a minimal level. In an open economy like Nigeria's, inflation creates both internal and external pressures. External pressures arise from rising global commodity prices, which are influenced by fluctuations in the real exchange rate. The extent to which exchange rate movements affect inflation depends largely on the exchange rate system in place. Under Nigeria's current flexible exchange rate regime, changes in the real exchange rate significantly influence output and price levels through both demand and supply channels. When the domestic currency depreciates or is devalued, it directly impacts price levels and output by increasing the cost of imported goods, as Nigeria is a price taker in the international market. Additionally, there is an indirect effect on inflation, as the cost of capital goods used by manufacturers in production rises. Since the 1970s, policymakers have been tasked with the ongoing challenge of curbing and stabilizing inflation (Akpokodje, 2009).

Nigeria's exchange rate policies have experienced major transformations over the past forty years, drawing considerable scholarly interest. As noted by Inyiama and Ekwe (2014), exchange rate policy became a contentious issue in developing nations during the 1980s, with strong resistance to currency devaluation due to concerns over its inflationary effects and other negative outcomes. Over time, Nigeria's monetary authorities have implemented various exchange rate frameworks. The country transitioned from a fixed exchange rate in the 1960s to a pegged system during the 1970s up until the mid-1980s. Since the

introduction of the Structural Adjustment Programme (SAP) in 1986, Nigeria has operated under different forms of a floating exchange rate regime (Dada and Oyeranti, 2012; Victor and Eze, 2013). The fixed regime led to an overvalued naira, reinforced by exchange controls that caused severe economic distortions. This overvaluation encouraged heavy imports of finished products, which negatively affected local industries, worsened the balance of payments, and depleted the country's foreign reserves (Obadan, 2006).

Despite the implementation of different exchange rate regimes, inflation has remained a persistent issue in Nigeria (Central Bank of Nigeria, 2013). Since the post-SAP era, the exchange rate has become increasingly volatile, largely due to heightened vulnerability to external shocks. During the recent global economic downturn, Nigeria's exchange rate experienced significant instability, with the naira depreciating sharply against the US dollar—from approximately ₦156/$1 in 2013 to over ₦305/$1 by 2016, representing an increase of about 96% (CBN, 2017). This depreciation was accompanied by a substantial decline in foreign revenue, largely attributed to the continuous drop in global crude oil prices, which fell from a peak of $147 per barrel in 2008 to just $40 per barrel by December 2016. Given these developments, it becomes imperative to assess the impact of both exchange rate movements and inflation on Nigeria's economic growth.

Before Nigeria gained independence, the country experienced relatively stable prices due to the absence of significant inflation, allowing citizens to afford basic needs at low costs. However, following the end of the civil war in the 1970s, inflation began to rise sharply, causing a noticeable shift in the general price level. This period also marked the beginning of a decline in the value of the naira relative to major foreign currencies. For instance, in 1970, one naira was equivalent to $1.40 and £0.584. By 1971, the rates shifted to $1.44 and £0.582 per naira, and by 1973, it increased to $1.519 and £0.614. The trend continued with $1.589 and £0.675 in 1974, reaching $1.623 and £0.734 in 1975. A significant factor behind this inflationary trend was the Udoji Salary Award of 1974, which led to a substantial wage increase. This rise in income boosted consumers' purchasing power, leading to higher demand and, consequently, increased prices across the economy.

The introduction of the Structural Adjustment Programme (SAP) and the Second-Tier Foreign Exchange Market (SFEM) in 1986 marked a major policy initiative by the Nigerian government, aimed at correcting the naira's overvaluation and making it more responsive to market forces and both domestic and international economic shocks. However, as noted by Anyanwu (1989), the SAP and SFEM turned out to be detrimental, rapidly undermining the foundations of Nigeria's economy. The naira experienced severe and continuous depreciation—from ₦1.56 to $1 in September 1986 to ₦7.90 by February 1990. By August 1998, the exchange rate reached ₦21.99 to the dollar in the official market, while the parallel market sold it for ₦45. This downward trend continued, with the naira falling to ₦115.7 to $1 by April 12, 2001, and further weakening to ₦130 by 2003. By 2015, the naira's exchange rate had plummeted to ₦141.97 to the dollar, contributing significantly to the rising cost of living and a surge in the general price level (CBN, 2015).

Empirical Literature Review

Despite various strategies implemented in Nigeria to control the general price level, inflationary pressures have continued to intensify. The persistent decline in the value of the naira has further undermined efforts to stabilize prices. As noted by Anyanwu (1989), mechanisms such as the SFEM, FEM, and IFEM have had a damaging impact, rapidly eroding the foundations of Nigeria's economy. The Structural Adjustment Programme (SAP) was originally introduced with key objectives, including the depreciation of the real exchange rate to enhance the balance of payments, as well as the implementation of tight fiscal and credit policies aimed at reducing overall spending and alleviating inflationary pressures (Okonkwo, 1996).

Carrera and Vuletin (2003) conducted an empirical study to examine the impact of exchange rate policies on inflation and economic growth. They analyzed the relationship between exchange rate accommodation and the persistence of inflation across ten European countries from the first quarter of 1974 to the second quarter of 1998, using a non-linear autoregressive inflation model. Their methodology accounted for possible unknown shifts in the average inflation rate. The findings revealed a significant positive relationship between exchange rate accommodation and inflation persistence, particularly in smaller economies and those more reliant on the Exchange Rate Mechanism (ERM). In contrast, little to no evidence of this

relationship was observed in larger nations or those that largely stayed outside the ERM during the study period. Overall, their results offered moderate support for the theoretical expectation of a positive link between exchange rate accommodation and sustained inflation.

Anyanwu (1987) noted that the on-going depreciation of the naira under the SFEM, FEM, and IFEM systems has exacerbated inflation and worsened the overall price level in Nigeria. This is primarily because domestic industries rely heavily on imported inputs, the cost of which has increased due to the naira's depreciation, leading to higher production costs and, consequently, higher prices (Ojo, 1989). Additionally, the study observed that the continuous decline in the naira has fostered smuggling, creating local shortages and driving up prices. The depreciation of the naira has also contributed to a brain drain, as individuals seek to benefit from the favourable exchange rates, with remittances largely used for consumption, further inflating local prices.

Obi and Gobna (2010) studied the factors influencing exchange rates in Nigeria using a cointegration approach. Their findings revealed that increases in productivity, the investment-GDP ratio, and inflation lead to an appreciation of the exchange rate. Conversely, factors such as a high degree of openness, growth in foreign reserves, and interest rate differentials contribute to exchange rate depreciation.

Zhanga (2011) examined the extent of exchange rate pass-through (ERPT) to import prices and estimated its impact on the Consumer Price Index (CPI). Using a structural VAR model, their results showed that exchange rates had a limited effect on the increase in domestic prices in China and India.

Adelowokan (2012) examined the channels of exchange rate pass-through (ERPT) to interest rates and inflation in Nigeria, using ordinary least squares estimation and annual data from 1970 to 2010. The study found no evidence of ERPT to inflation during the period, as neither the exchange rate of the naira against the US dollar nor its lagged values had an impact on consumer prices. However, the research did find evidence of exchange rate pass-through to interest rates.

Jiang and Kim (2013) used the structural VAR method to assess the effect of exchange rate fluctuations on producer and retail prices in China. Their findings indicated that the exchange rate pass-through (ERPT) to both producer and retail prices was partial, with the pass-through to producer prices being more pronounced than that to retail prices.

Adeyemi and Samuel (2013) explored the exchange rate pass-through (ERPT) to consumer prices in Nigeria using the VECM approach and data from 1970 to 2008. Their analysis through impulse response functions (IRF) revealed a significant degree of ERPT to consumer prices, reaching approximately 83% in the long run. The study also found that the exchange rate played a more crucial role in driving inflation in Nigeria than the money supply.

Ajao and Igbekoyi (2013) analyzed the factors influencing exchange rate volatility in Nigeria from 1981 to 2008. Their study found that key determinants of exchange rate volatility included the openness of the economy, government spending, interest rate fluctuations, and the lagged exchange rate.

Alim and Lahiani (2014) examined whether a reliable monetary policy focused on controlling inflation could reduce exchange rate pass-through in three East Asian and two Latin American countries. Their findings showed that a credible monetary policy aimed at controlling inflation was linked to lower exchange.

Mame (2017) explored the factors influencing consumer price inflation in Mali from 1979 to 2006. Using co-integration techniques within a general-to-specific model framework, the study identified average national rainfall and, to a lesser extent, deviations from monetary and external sector equilibrium as the key long-term drivers of inflation. Similarly, Philip (2010) applied the Johansen co-integration method to analyze the relationship between inflation and economic growth in Nigeria, using annual data from 1970 to 2005. The findings indicated a negative long-term relationship between inflation and growth during the study period. The Engle and Granger Causality test further revealed a unidirectional causality running from inflation to growth.

Bakare (2011) investigated the factors influencing money supply growth and its impact on inflation in Nigeria. The study utilized a quasi-experimental research design for data analysis, which integrated

theoretical considerations with empirical observations to extract the maximum insights from the available data. The regression results indicated a positive correlation between the growth of the money supply and inflation in Nigeria.

Agalega and Antwi (2013) analyzed the influence of macroeconomic variables on Ghana's GDP over the period from 1980 to 2010. The study utilized annual time series data sourced from the Bank of Ghana, Ghana Statistical Service, and the Institute of Statistical, Social and Economic Research (ISSER). Using multiple linear regression analysis, the study found a moderately significant positive relationship between GDP, interest rates, and inflation. However, inflation and interest rates were shown to explain only about 44% of the variation in GDP.

Arise et al. (2017) employed Johansen's co-integration technique along with the Error Correction Model to analyze the impact of real exchange rate fluctuations on exports across thirteen Less Developed Countries. Using quarterly data from 1973 to 1996, the study found that increases in the real exchange rate had a significantly negative effect on export demand, both in the short and long run, across all the countries examined.

Mukherjee and Pozo (2014) explored the impact of exchange rate volatility on the volume of bilateral trade across a sample of 200 countries, using the Gravity Model for their analysis. The findings showed that exchange rate instability negatively affected trade volumes. However, the strength of this negative effect diminished progressively as volatility reached very high levels.

Kogid et al. (2012) examined the impact of exchange rate on economic growth in Malaysia using time series data from 1971 to 2009. The study applied the ARDL Bounds testing approach to analyze the data and found a long-term co-integrating relationship between both nominal and real exchange rates and economic growth. As a result, the study concluded that exchange rate had a significant influence on Malaysia's economic growth.

Taiwo and Adesola (2013) examined how unstable exchange rates affect bank performance, using two indicators: the ratio of credit losses to total loans, and the capital reserve ratio. The study also considered government spending, interest rates, and real GDP as independent variables, alongside the exchange rate. The findings revealed that the impact of exchange rate fluctuations on bank performance depends on the performance indicator used. While the credit loss to total loan ratio suggests that volatile exchange rates can hinder banks' ability to manage loans leading to a higher incidence of bad debts—the capital reserve ratio showed no significant link to exchange rate movements.

Adeniran et al. (2014) examined the impact of exchange rate on Nigeria's economic growth between 1986 and 2013 using the Ordinary Least Squares (OLS) method. The study also found that interest rates and inflation had a negative influence on economic growth. Based on the findings, the researchers recommended that the government should promote export-driven strategies to maintain a trade surplus, improve infrastructure to attract foreign investment, and establish effective fiscal and monetary policies.

Gatawa and Mahmud (2017) analyzed the short- and long-term effects of exchange rate volatility on the volume of agricultural exports in Nigeria from 1981 to 2014. Using the GARCH and ARDL models to assess exchange rate fluctuations, their findings revealed that exchange rate movements had a significant impact on agricultural export volumes.

Methodology

Research Design

A research design outlines the overall strategy a researcher follows to address the research questions. It serves as a blueprint that directs the researcher in gathering evidence to either support or challenge a particular claim (Awotunde & Ugodulunwa, 2004). This study will adopt a causal research design, which, as noted by Kumar (2011), seeks to explain the relationship between variables specifically the dependent and independent variables in this context with the goal of identifying cause-and-effect links to inform sound policy decisions.

Type and Sources of Data

The data utilized in this research were primarily sourced from secondary materials, especially the annual and quarterly reports published by the Central Bank of Nigeria (CBN) and the National Bureau of Statistics (NBS), as well as relevant academic journals, textbooks, and financial newspapers. Key sources include the CBN's Statistical Bulletin, annual reports, and statements of account for the period studied.

Model Specification

In building the model for this study, the ordinary least square method of Regression analysis of the form Y=o+ iX1+X2+ 3X3 +4X4 …….+nXn is used where o -n are parameters to be estimated from the data and X1-Xnare the independent variable and Y is the dependent variable for the study, multiple regression analysis will be used. On this Basis, the model for the study can thus be specified as follow; the functional form of the model is given as;

INF = f (EXR, IMPT, GDP, M2)

The mathematical form of the model is

INF = a0 + a1EXR + a2IMPT + a3GDP+ a4 M2 1

While the econometric form of the model in log form is stated further as:

INF = a0 + a1EXR + a2 MPT + a3 GDP+ a4 M2+ECM(-1)+ u 2

Where

INF = Inflation

EXR = Exchange rate

IMPT= Import of goods and services

GDP =Gross domestic product

M2=Money supply

o: Intercept of the regression line or plane

1 – 3= Slopes of the regression line or plane

= Stochastic error term, representing other independent factors that may be affecting the dependent variable

ECM(-1) = Error correction mechanism.

Method of Data Analysis

This study employed a combination of descriptive statistics and econometric methods for data analysis. Descriptive tools were used to summarize the characteristics of the data through the use of graphs and trend analysis. The econometric techniques included the Augmented Dickey-Fuller (ADF) test for stationarity, co-integration tests, and the Granger causality test within a Vector Auto regression (VAR) framework to examine the relationships among the model variables. Additionally, the Vector Error Correction Model (VECM) was applied to evaluate the impact of exchange rate and inflation in Nigeria.

Results And Discussion

Results of Descriptive Statistics

The results of the descriptive statistics for the variables that are captured in the model are presented in Table 1.

Table 1: Descriptive Statistics of Variables

Tools	**INF (%)**	**EXR (%)**	**IMPT (₦Billion)**	**GDP (₦Billion)**	**M2 (₦Billion)**

Mean	19.34857	104.8234	4215.197	34033.93	7335.785
Median	12.20000	118.5700	1512.695	11332.25	1505.964
Maximum	72.80000	306.9200	20448.92	144210.5	34251.70
Minimum	5.400000	0.890000	5.983600	192.2733	22.29924
Std. Dev.	17.91318	92.11192	5145.298	42639.73	10204.76
Skewness	1.697288	0.698057	1.258428	1.143621	1.281086
Kurtosis	4.523177	2.759754	3.938858	3.050701	3.339092
Jarque-Bera	20.18802	2.926658	10.52336	7.632983	9.741241
Probability	0.000041	0.231464	0.022005	0.005187	0.007669
Sum	677.2000	3668.820	147531.9	1191188.	256752.5
Sum Sq. Dev.	10909.99	288476.6	9.00E+08	6.18E+10	3.54E+09
Observations	**35**	**35**	**35**	**35**	**35**

E-views 10.0 (2021)

The results in Table 1 show that from 1985 to 2019, the average values for inflation, exchange rate, imports, Gross Domestic Product (GDP), and money supply were 19.35%, 104.82%, NGN 4,215.197 billion, NGN 34,033.93 billion, and NGN 7,335.785 billion, respectively. The highest recorded values during this period were 72.80% for inflation, 306.92% for the exchange rate, NGN 20,448.92 billion for imports, and NGN 144,210.5 billion for money supply, all occurring in 2019. The lowest recorded values were 5.40% for inflation, 0.89% for the exchange rate, NGN 5.9836 billion for imports, NGN 192.2733 billion for GDP, and NGN 22.29924 billion for money supply, all recorded in 1985 and 1986.

The normality test for all variables (INF, EXR, IMPT, GDP, and M2) showed high Jarque-Bera statistics with corresponding low probability values. The results suggested that all variables exhibit a positively skewed distribution. This implies that the distributions are skewed to the right, indicating that the data tend to have larger values.

The kurtosis results, which describe the peak and flatness of a normal distribution, showed values below 3 (indicating less than excess kurtosis) for EXR, suggesting that the data for this variable have a platykurtic shape ($K < 3$). In contrast, INF and IMPT exhibited kurtosis values greater than 3, indicating a leptokurtic distribution. Meanwhile, GDP and M2 showed near mesokurtic distributions, with kurtosis values close to 3, meaning their distributions have a steeper peak compared to the others.

Trend Analysis

The trend analyses of the data for inflation and exchange rate in Nigeria are depicted in Figure 1.

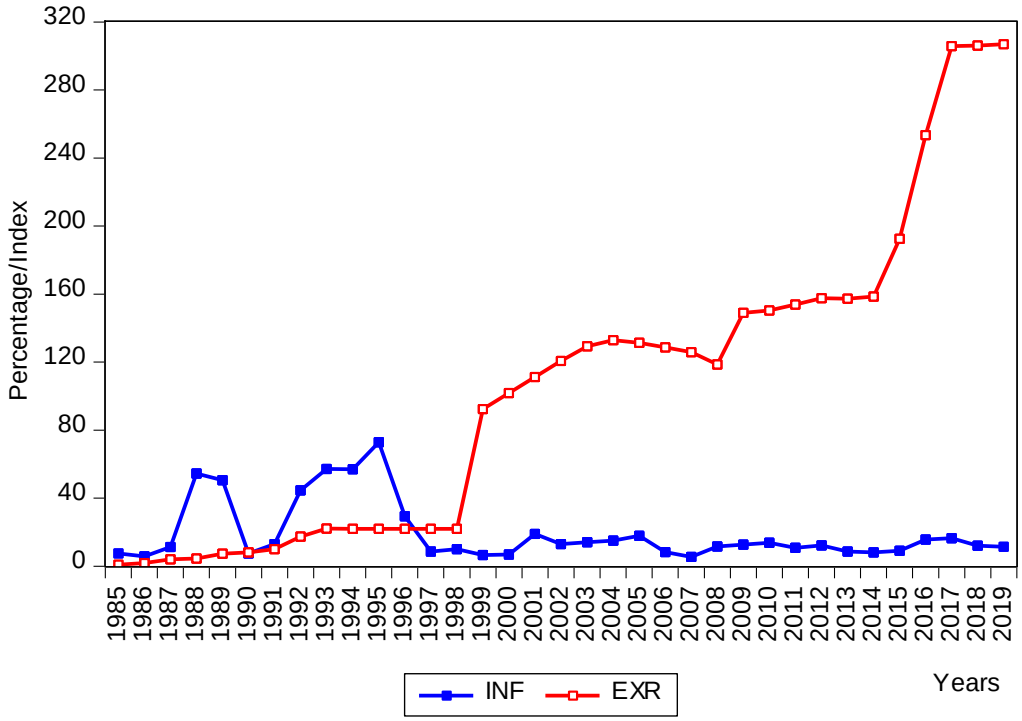

Figure 1: Trends of Inflation and Exchange rate in Nigeria

The trends in inflation and exchange rates in Nigeria from 1985 to 2019 show that both variables had similar starting values between 1985 and 1987. However, inflation surged to over 57% between 1988 and 1989, likely due to a severe drought in key agricultural regions, the delayed effects of a significant devaluation in 1986, and the expansionary fiscal and monetary policies that led to a sharp rise in food prices in 1988. From 1990 to 1991, the inflation rate fell to around 7%, which could be attributed to the contractionary fiscal and monetary policies introduced in late 1989 and improved harvests due to favourable rainfall.

Inflation reached a record high of 72.8% in 1995. According to Mordi et al. (2007), this was driven by excessive money supply, a shortage of foreign exchange, severe commodity shortages, and on-going labour and political unrest following the annulment of the June 1993 elections. The sharp drop in oil prices in 1998, coupled with a weakened balance of payments that caused a shift from a surplus to a deficit in the current account, likely contributed to the significant rise in exchange rates in 1999. Similarly, the increase in exchange rates from 2017 to 2019 may have been influenced by the collapse in global oil prices in 2016.

Unit Root Test Results

Before conducting any meaningful regression analysis with the time series data, it is essential to check the stationarity of the variables in this study and determine whether they exhibit a unit root problem. The data for the variables were tested using the Augmented Dickey-Fuller (ADF) unit root test. This step is crucial to identify the most suitable econometric method for analyzing the impact of exchange rate depreciation and inflation on the general price level in Nigeria from 1985 to 2019. The results are shown in Table 2

Table 2: Result of Unit Root Test (ADF)

Variables	At level	First Difference	1%Critical Level	5%Critical Level	10%Critical Level	Order of Integration
lnINF Prob	-2.718571 0.0813	-5.127276 0.0002***	-3.646342	-2.954021	-2.615817	I(1)
lnEXR Prob	1.071789 0.9964	-4.083561 0.0033***	-3.646342	-2.954021	-2.615817	I(1)
LnIMPT Prob	-2.199006 0.2103	-7.701371 0.0000***	-3.646342	-2.954021	-2.615817	I(1)
LnGDP Prob	-2.883497 0.0578	-3.363497 0.0198**	-3.646342	-2.954021	-2.615817	I(1)
LnM2 Prob	-1.733015 0.4062	-4.167066 0.0026***	-3.646342	-2.954021	-2.615817	I(1)

E-views 10 (2021)

Note: The probability values from the ADF test statistics are calculated using McKinnon (1996). The asterisk (*, **, ***) indicates the rejection of the unit root hypothesis at the 10%, 5%, and 1% critical levels. Based on the unit root test results, all the variables (INF, EXR, IMPT, GDP, and M2) are integrated at the first difference, meaning they are I(1). Therefore, all the variables are integrated at the first difference, as the probability values for inflation rate, exchange rate, import, Gross Domestic Product, and money supply are all less than the 0.05 critical value at the first difference. This suggests that the variables exhibit mean-reverting behaviour, necessitating a co-integration test. In this case, the Johansen co-integration test is appropriate, as all the variables are integrated at the same order, I(1).

VAR Lag Order Selection Criteria

The results of VAR lag selection criteria are presented in Table 4. 3.

Table 3: VAR Lag Order Selection Results

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-360.6622	NA	2898.798	22.16134	22.38809	22.23764
1	-182.1804	292.0610*	0.269949*	12.85942*	14.21988*	13.31717*
2	-158.6046	31.43439	0.329148	12.94574	15.43992	13.78495

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* indicates lag order selected by the criterion. LR: sequential modified LR test statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion and HQ: Hannan-Quinn information criterion. The results presented in Table 3 show that lag two (1) have the least LR, FPE, AIC, SC and HQ relative to the other lags. This implies that the best lag selection for optimal performance of the model is lag two (1).

Results of Pairwise Granger Causality

Since the Vector Error Correction (VEC) model estimates Granger causality at the first difference within the VAR framework (commonly referred to as VEC Granger Causality/Block Erogeneity Wald Tests), the study employed the VEC Granger causality test based on the stationarity properties of the data. The results of the VEC Granger causality test are shown in Table 4.

Table 4: Results of VEC Granger Causality Test

Variables (Dependent)	**Excluded**	**Probability At 5%**	**Chi-Square Value**	**Decision at 5% Level of Significance**
D(lnINF)	Variables			
	D(EXR)	0.9477	0.004303	Not Significant
	D(LNIMPT)	0.3384	0.916333	Not Significant
	D(LNGDP)	0.9617	0.002309	Not Significant
	D(LNM2)	0.0850	2.966856	Not Significant
	Joint (All)	0.4248	3.863323	Not Significant
D(lnEXR)	Variables			
	D(LNGDP)	0.0181**	5.587412	Significant
	Joint (All)	0.1047	7.664367	Not Significant
D(lnIMPT)	Variables			
	D(INF)	0.0880	2.910414	Not Significant
	D(LNGDP)	0.0013***	10.32051	Significant

	Joint (All)	0.0062***	14.36537	Significant
D(lnGDP)	Variables			
	D(LNM2)	0.0551	3.680424	Not Significant
	Joint (All)	0.1318	7.078576	Not Significant
D(lnM2)	Variables			
	(None)			
	Joint (All)	0.4707	3.547181	Not Significant

Using E-views 10 (2021)

The asterisk (*, **, ***) indicates the rejection of the null hypothesis of no causality at the 10%, 5%, and 1% significance levels. According to the results in Table 4, there is a unidirectional causal relationship from Gross Domestic Product to exchange rate in Nigeria at the 5% significance level. Inflation, imports, and money supply do not Granger cause the exchange rate in Nigeria. The study also shows that none of the variables jointly Granger cause the exchange rate in Nigeria. This suggests that changes in Nigeria's Gross Domestic Product have an impact on the exchange rate in the country.

Additionally, there is a unidirectional relationship from Gross Domestic Product to imports in Nigeria at the 1% significance level. This suggests that changes in Gross Domestic Product influence import levels in the country. The study further indicates that all the variables together Granger cause imports in Nigeria at the 1% significance level. This means that combined changes in inflation, exchange rate, Gross Domestic Product, and money supply have an impact on the level of imports in Nigeria.

Conintegration Analysis

As the unit root test revealed that the series are integrated at the first difference, the Johansen Cointegration test was performed to determine if there is a long-run relationship among the variables included in the study. The test includes two methods: the trace test and the eigenvalue test, which are used to identify the number of co-integrating relationships. The results are presented in Table 6.

Table 5: Result of Unrestricted Co-integration Rank Test (Trace)

Null hypothesis	Hypothesized No of CEs	Eigen value	Trace statistic	0.05 critical value	Prob **
r = 0	None *	0.618516	75.72314	69.81889	0.0156
r ≤ 1	At most 1	0.487141	43.92153	47.85613	0.1116
r ≤ 2	At most 2	0.323210	21.88562	29.79707	0.3049
r ≤ 3	At most 3	0.191312	9.002627	15.49471	0.3651
r ≤ 4	At most 4	0.058673	1.995330	3.841466	0.1578

Source: Author's computation, using E-views 10 (2021)

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 5 shows that there is one co-integration among the variables. This is evident as the Trace statistic of 75.72314 exceeds the critical value of 69.81889 at the 5% significance level. Therefore, we reject the null hypothesis that there are no co-integrating equations. For the other hypothesized numbers of co-integrating equations (at most 1, 2, 3, and 4), we fail to reject the null hypothesis, as their Trace statistic values are below the critical values at the 5% significance level.

Table 6: Result of Unrestricted Co-integration Rank Test (Maximum Eigen value)

Null Hypothesis	*Hypothesized No of CEs*	*Eigen value*	*Trace statistic*	*0.05 critical value*	*Prob* **
r = 0	***None***	***0.618516***	***31.80161***	***33.87687***	***0.0867***
r ≤ 1	***At most 1***	***0.487141***	***22.03591***	***27.58434***	***0.2185***
r ≤ 2	***At most 2***	***0.323210***	***12.88300***	***21.13162***	***0.4630***
r ≤ 3	***At most 3***	***0.191312***	***7.007297***	***14.26460***	***0.4883***
r ≤ 4	***At most 4***	***0.058673***	***1.995330***	***3.841466***	***0.1578***

Using E-views 10 (2021)

Max-eigenvalue test indicates no cointegration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

The Maximum Eigen statistic shown in Table 4.6 indicates that there is no cointegrating equation among the variables at the 5% significance level. This means we accept the null hypotheses of no cointegrating equations, and at most 1, 2, 3, and 4 cointegrating equations. Therefore, the Johansen cointegration test suggests the presence of a long-run relationship between exchange rate and inflation.
In Nigeria since there is one cointegrating relationship in the Trace statistics in Table 6.

In order to determine the nature of the long run relationship by using the normalized Johansen co-integrating equation this is based on the lowest log likelihood. It is stated as:

$$\ln INF = 0.045 \ln EXR - 44.075 \ln IMPT - 27.465 \ln GDP + 62.639 \ln M2$$

(0.136) (16.787) (42.072) (27.014)

[0.328] [-2.626] [-0.653] [2.319]

Using E-views 10 (2021)

Note: Standard errors are presented in parentheses, and t-statistics are in brackets.

The estimated coefficient for Exchange Rate (EXR) is positive, which aligns with theoretical expectations in the long run. However, the results show that exchange rate is not statistically significant at the 5% significance level concerning inflation. The positive effect of exchange rate could be attributed to the Nigerian naira's lack of competitiveness in the global market, as Nigeria heavily relies on imports. This dependence causes the demand for dollars to exceed its supply, leading to an increase in exchange rates. The continued reliance on imported goods drives the exchange rate up, which, in turn, has a positive impact on inflation.
The results also show a positive coefficient for money supply (M2), which is both theoretically sound and statistically significant at the 5% significance level. This suggests that a 1% increase in money supply leads to a 62.639% rise in inflation in the long run. Therefore, there is a positive and significant relationship between money supply and inflation in Nigeria over the long term.
The results also show that the coefficient for Gross Domestic Product (GDP) is negative, and it is not statistically significant at the 5% critical level. This suggests that a 1% increase in GDP leads to a 27.465% reduction in inflation in the long run. The estimate for imports also shows a negative effect on inflation in the long run and is statistically significant at the 5% critical level. The negative impact of imports on inflation could be attributed to the increasing level of imports coupled with a rising trade deficit, leading to a negative effect on inflation over time.

Table 7: Short Run Effect of Exchange Rate and Inflation

Variable	Coefficient	Std. Error	t-statistics	Prob.**
D(lnINF(-1))	-0.060086	0.19076	-0.31498	0.7533
D(lnEXR(-1))	0.009677	0.14752	0.06560	0.9478
D(lnIMPT(-1))	7.973541	8.32961	0.95725	0.3402
D(lnGDP(-1))	-1.826631	38.0122	-0.04805	0.9617
D(lnM2(-1))	40.85829	23.7209	1.72246	0.0874
CointEq1(-1)	-0.309851	0.11410	-2.71550	0.0075

Using E-views 10 (2021)

The short-run estimates presented in Table 7 indicate that the coefficients for exchange rate (EXR), imports (IMPT), and money supply (M2) are positive and theoretically reasonable. However, these coefficients are statistically insignificant at the 5% significance level, suggesting that a percentage increase in exchange rate, imports, or money supply will lead to an increase in inflation in the short run. On the other hand, the coefficient for gross domestic product (GDP) is negative and theoretically consistent in the short run, but it is also statistically insignificant at the 5% level. The lack of significance for all the variables in affecting inflation in the short run may be due to their immediate effects on inflation.

The estimated coefficient of the error correction term is negative and statistically significant at the 5% level. This suggests that any deviation from the long-run equilibrium will be corrected at an annual rate of 30.9%. In other words, the adjustment toward the long-run equilibrium for inflation in Nigeria, even when there is an initial disequilibrium, occurs gradually at a rate of 30.9%.

VEC Post-Estimation Diagnostics

The robustness of the (VEC) estimates was assessed by testing for serial correlation, normality, and residual stability. This was done using the VEC residual serial correlation LM test, VEC residual heteroskedasticity test, VEC residual normality tests (including Skewness, Kurtosis, and Jarque-Bera), and the inverse roots of the AR characteristic polynomial. The results of the serial correlation and normality diagnostics are shown in Table 5, while the stability results are presented in Table 8.

Table 8: Post-Estimation Diagnostics

Test	F-statistic/chi-square	Probability
(VEC) Residual Serial Correlation LM test	34.51438	0.1045
(VEC) residual Heteroskedasticity Test	195.9198	0.1975
Skewness	-0.725854	0.0887*
Kurtosis	4.881055	0.0874*
Jarque-Bera	7.763009	0.0906*

* Probability values at lag 1.

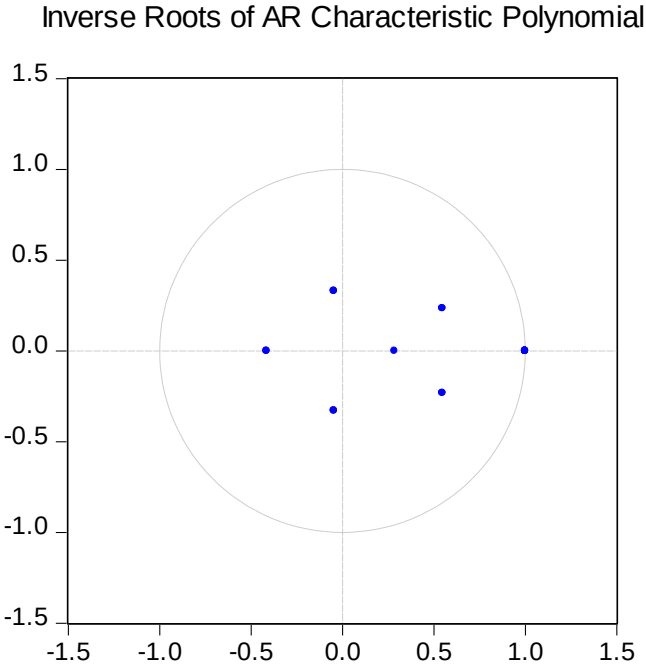

Figure 4. 2: VAR stability test

The residual diagnostic tests indicate that the residuals are not serially correlated at lag 1 and follow a normal distribution. This is confirmed by the fact that the null hypotheses of no serial correlation, no heteroskedasticity, and normality of residuals cannot be rejected at the 5% significance level, as the chi-square test probabilities for each of these at lag 1 exceed the 0.05 threshold.

The inverse roots of the AR characteristic polynomial indicate that the residuals are statistically stable. This is evident as all the points in Figure 4.2 lie within the critical circular or unit circle. This suggests that the short-run estimates presented in this analysis are both statistically and economically reliable, allowing for valid inferences to be made from the study.

Impulse Response and Accumulated Forecast Error Variance

The study analyses the impulse response of inflation to shocks in the exchange rate and other variables in Nigeria, as well as the cumulative forecast error variance of inflation resulting from shocks in the exchange rate and other variables in Nigeria.

Impulse Response of Inflation to Shocks or Innovation

The result of the impulse response of inflation to shocks or innovation is presented in Figure 3.

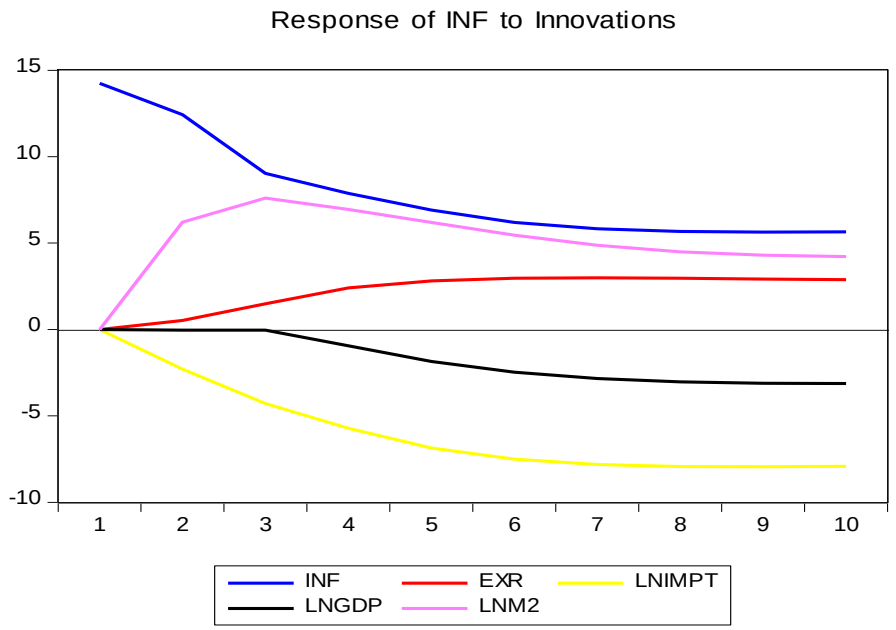

Figure 3: Results of Inflation to shocks or innovation

The ten-year forecast results suggest that inflation will respond positively and permanently to its own shocks, both in the short-run and long-run. However, the responses will display a fluctuating trend, particularly during the initial forecast period. Additionally, the results indicate that inflation's response to shocks in exchange rate and money supply is both positive and permanent throughout the forecast period. This means that a one standard deviation shock or innovation in exchange rate and money supply would lead to a positive and lasting effect on inflation in Nigeria.

The study found that inflation would react negatively and permanently to shocks in gross domestic product and imports, both in the short-run and long-run. This means that a one standard deviation shock or innovation in these variables would lead to a lasting negative effect on inflation in Nigeria.

Impulse Response of Exchange rate to Shocks or Innovation

The result of the impulse response of Exchange rate to shocks or innovation is presented in Figure 4.4.

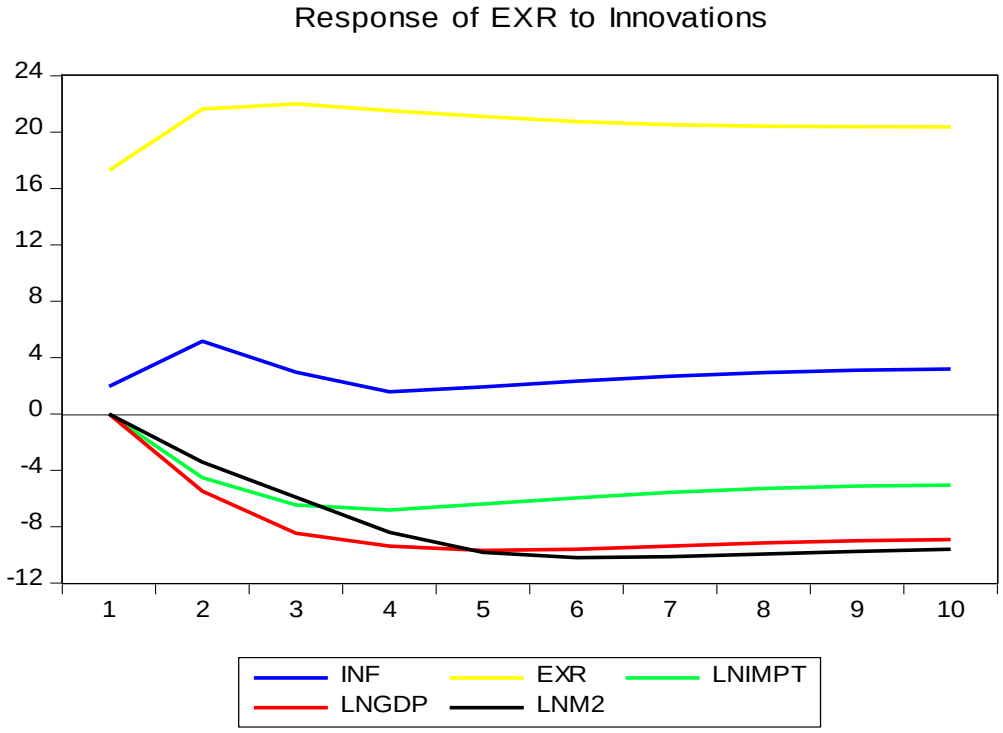

Figure 4: Results of Exchange rate to shocks or innovation

The exchange rate would react positively and permanently to its own shocks in both the short-run and long-run. The results also show that the exchange rate's response to inflation shocks is positive and permanent throughout the forecast period. However, the responses would display a fluctuating trend, particularly during the initial forecast period. This suggests that a one standard deviation shock or innovation in either inflation or exchange rate (own shocks) would lead to a lasting positive effect on the exchange rate.

The study also revealed that the exchange rate would experience a negative and lasting response to shocks in importation, gross domestic product, and money supply, both in the short-run and long-run. This means that a one standard deviation shock or change in importation, GDP, or money supply would result in a negative and permanent effect on the exchange rate in Nigeria.

The Accumulated Forecast Error Variance of Inflation to Shocks

Table 9: Variance Decomposition of Inflation to Shocks.

Period	**INF**	**EXR**	**LNIMPT**	**LNGDP**	**LNM2**
Initial (first year)	100.000	0.0000	0.0000	0.0000	0.0000
Short-term (Fifth year)	64.16259	1.890766	12.06271	0.505809	21.37813
Long-term (Tenth year)	46.98294	3.905333	26.83030	3.092543	19.18888
Decision	**Decrease**	**Increase**	**Increase**	**Increase**	**Decrease**

Using E-views 10 (2021)

The accumulated forecast error variance of inflation due to its own shocks would account for 100% in the initial period, 64.16% in the short term, and 46.98% in the long term. This suggests that the impact of inflation caused by its own shocks would decrease over time. Similarly, the accumulated forecast error variance of inflation due to shocks in money supply would explain about 21.38% in the short term and 19.19% in the long term, indicating that the effect of shocks in money supply on inflation would diminish over the years.

A unit shock in exchange rate, importation, and gross domestic product would contribute 1.89%, 12.06%, and 0.51% to the accumulated forecast error variance of inflation in the short term, and 3.91%, 26.83%, and 3.09% in the long term, respectively. This indicates that the impact of innovations in exchange rate, importation, and gross domestic product on inflation would grow over time.

The Accumulated Forecast Error Variance of Exchange rate to Shocks

Table 10: Variance Decomposition of Exchange rate to Shocks.

Period	**INF**	**EXR**	**LNIMPT**	**LNGDP**	**LNM2**
Initial (first year)	1.266148	98.73385	0.0000	0.0000	0.0000
Short-term (Fifth year)	1.590756	75.71256	5.248613	9.942424	7.505650
Long-term (Tenth year)	1.425186	70.31514	4.888911	11.68857	11.68219
Decision	**Decrease**	**Decrease**	**Decrease**	**Increase**	**Increase**

Using E-views 10.0 (2021)

The accumulated forecast error variance of exchange rate in response to shocks in inflation would account for 1.27% at the initial period, 1.59% in the short term, and 1.43% in the long term. This suggests that the influence of inflation shocks on exchange rate would diminish over time. The accumulated forecast error variance of exchange rate in response to its own shocks would account for 98.73% initially, 75.71% in the short term, and 70.32% in the long term, indicating a gradual decrease in exchange rate changes due to its own shocks over time. Similarly, the accumulated forecast error variance of exchange rate due to shocks in importation would account for 5.25% in the short term and 4.89% in the long term.

According to the results in Table 10, the accumulated forecast error variance of exchange rate in response to shocks in gross domestic product and money supply would account for 9.94% and 7.51% in the short term, and 11.69% and 11.68% in the long term, respectively. This implies that the impact of innovations in gross domestic product and money supply on exchange rate would increase over time.

Findings

Stationarity and Co-integration: all variables (inflation, exchange rate, importation, GDP and Money Supply) were found to be non-stationarity at level but became stationary at first difference, leading to the use of the johansen co-integration test. The result confirmed a long-run relationship among the variables.

Causality Tests: The VEC Granger causality test revealed no significant causal relationship from exchange rate to inflation. However, there was a unidirectional causality from GDP to exchange rate and from GDP to importation.

Impulse Response Analysis:

Inflation responds positively and permanently to shocks in exchange rate and money supply.

Inflation responds negatively and permanently to shocks in GDP and importation.

Exchange rate responds positively and permanently to its own shocks and inflation shocks.

Exchange rate responds negatively and permanently to shocks in importation, GDP and money supply.

Variance Decomposition:

Over time, the contribution of exchange rate shocks to inflation increases, indicating that depreciation influence rising prices.

Similarly, the influence of GDP and money supply on exchange rate also increases over the long run.

Conclusion

The study concludes that exchange rate has a positive impact on inflation both in the short run and long run in Nigeria. However, no direct causal relationship was established between exchange rate and inflation. The analysis confirms that fluctuations in exchange rate, especially depreciation, contribution to long-term inflation dynamics in the Nigerian economy.

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