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Exchange Rate and Inflation Rate Nexus: The Nigerian Experience

Dr. Boniface Linus Akpan[1] Dr. Aniefiok Benedict Udo[2*]
1. Department of Economics, Faculty of Social Sciences, Akwa Ibom State University, Obio Akpa-Nigeria
2. Department of Economics, Faculty of Management & Social sciences Topfaith University, Mkpatak-Nigeria
*corresponding author's email: ab.udo@topfaith.edu.ng

Abstract
This study examined the Exchange rate and inflation in Nigeria using annual time series data covering the period 1981-2021. To achieve this objective, the study adopted an ex-post facto research design, used secondary data obtained from the CBN Statistical Bulletin, and specifically employs the Autoregressive Distributive Lag (ARDL) technique to analyze the time series data from the period January 1981 to December 2021 to investigate the relationship between Real Gross Domestic Product, inflation expectation, Money Supply, Fiscal Deficit, Inflation Rate, and Exchange Rate. The study used the Augmented Dickey-Fuller test to determine the presence of a unit root, the Breusch-Godfrey Serial Correlation LM test to know the presence of serial correlation, and ARDL bound test for the co-integration test to establish the relationship among the variables in the study. The results of the stationarity test indicated that the variables have mixed order of integration while the result for co-integration shows that there is a long-run relationship between the variables. Findings showed that Real Gross Domestic Product (RGDP) and exchange rate (EXR) had a positive and significant impact on inflation, meaning that inflation in Nigeria is caused by exchange rate fluctuations as well as an increase in RGDP. From the Granger Causality test, it was found that Fiscal Deficit, Money Supply, and Real GDP granger cause inflation in Nigeria. Meanwhile, in terms of the ability of inflation to predict the explanatory variables, it was revealed that the exchange rate does not Granger cause the inflation rate. The test of the hypothesis shows that the Exchange rate has a significant impact on inflation in the short run. Based on the findings, the study recommended that the growth of the money supply should be controlled by the central bank to reduce inflation to the barest minimum.
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1.0 INTRODUCTION

The exchange rate is the rate at which one currency can be exchanged for another. It is the price of one's country expressed in another country's currency of foreign currency (Adeniji, 2013). Given that the exchange rate is defined as the number of domestic currencies to buy one unit of foreign currency; the appreciation of the domestic currency or depreciation of the exchange rate has serious implications on the economy. When the exchange rate of a country is appreciated, it is bound to lower the domestic price of traded goods while depreciation raises the domestic price of traded goods (Beggs, 2003). Put according to Magda and Ida (2003), depreciation of the exchange rate is expansionary through the initial increase in the price of foreign goods relative to home goods. By increasing the international competitiveness of domestic industries, the exchange rate diverts spending from foreign goods to domestic goods but introduces imported inflation into the domestic economy.

The Nigerian exchange rates have been highly volatile and have fluctuated widely over the years virtually in all segments of the foreign exchange markets (official, bureau de change, and parallel markets). In the official market, the exchange rate depreciated from ₦11.08 per US dollar in 1987 to ₦22.00 in 1994 and was later fixed at ₦21.87 per US dollar by the Federal Government between 1994 and 1998. It depreciated to ₦97.95 per US dollar in 1999, ₦125.00 between 2000 and 2006, and appreciated slightly to ₦117.97 per US dollar as a result of the global financial crisis coupled with the decline in the international oil price. In 2012, it depreciated further to ₦157.50, ₦158.55 in 2014, and then ₦196.49 in 2015, ₦253.19 in 2016, ₦305.30 in 2017, and ₦350 and ₦360 in 2018 and 2019 respectively. In 2020, the exchange rate was ₦358.8 per US dollar. The exchange rate of the Naira increased from ₦0.7 in 1971 to N358.8 per US dollar in 2020, growing at an average rate of 19.03%. In October 2021, the exchange rate was ₦413.7 per US dollar.

It is therefore obvious that an appreciation of the domestic currency leads to domestic inflation as caused by an increase in domestic prices of goods and services while a depreciation of the domestic currency imports inflation into the domestic economy. Both impacts are felt in our country Nigeria, but the impact of the latter is felt more as compared to the former since our country is a mono-product economy and depends greatly on the importation of goods and services.

The exchange rate and inflation in Nigeria are moving along with each other. In the official market, the exchange rate depreciated from ₦11.08 per US dollar in 1987 to ₦22.00 in 1994 and was later fixed at ₦21.87 per US dollar by the Federal Government between 1994 and 1998. It depreciated to ₦97.95 per US dollar in 1999,

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Inflation, before 1980, Nigeria experiences a single-digit low rate of inflation. The situation changed dramatically especially in 1986 when the inflation rate rose to double digits. Available statistics from the Central Bank of Nigeria (2019) have shown that inflation which stood at 13.7% in 1986 moved up to 48.8%in 1992 and rose further to 76.8% in 1994. In 2001, it fell to 16.5% and increased to 23.8% in 2003 with a further decline to an average of 11% -13% through 2004-2015 but moved up to 18.55% in 2016 and declined to 12.09% in 2018 and dropped further to 11.4% in 2019. However, in the wake of the COVID-19 pandemic, the inflation rate in Nigeria rose to 13.39% in 2020.

From the above trends of exchange rate and inflation in Nigeria, it can be seen that, either the exchange rate causes inflation in the economy or inflation leads to fluctuation in the exchange rate of the country. These two scenarios become a problem for the economy which is worth investigating and providing solutions to it. The objective of this study is to examine the impact of the exchange rate on inflation in Nigeria for the period, (1981 – 2021).

The inflation rate in Nigeria seems to be moving along with the exchange rate. Before 1980, Nigeria experiences a single-digit low rate of inflation. The situation changed dramatically especially in 1986 when the inflation rate rose to double digits. Available statistics from the Central Bank of Nigeria (2019) have shown that inflation which stood at 13.7% in 1986 moved up to 48.8%in 1992 and rose further to 76.8% in 1994. In 2001, it fell to 16.5% and increased to 23.8% in 2003 with a further decline to an average of 11% -13% through 2004-2015 but moved up to 18.55% in 2016 and declined to 12.09% in 2018 and dropped further to 11.4% in 2019. However, in the wake of the COVID-19 pandemic, the inflation rate in Nigeria rose to 13.39% in 2020. The persistent increase in inflation over the years not only leads to a fall in purchasing power of average Nigerians but also serve as a threat to economic stability. Despite the different monetary policy measures to control and stabilize prices, inflation persists in Nigeria.

Inflationary pressure combined with exchange rate fluctuations is one of the most critical difficulties confronting Nigeria and most developing countries. The effect of exchange rate fluctuation on inflationary pressure has been a major source of concern for economists and policymakers as well as a subject of interest for researchers. The objective of this study is to examine the impact of the exchange rate on inflation in Nigeria for the period, 1981 -2021.

2.2 Theoretical Review

The exchange rate theories adopted in this study are; the monetary, the balance of payments, and purchasing power parity theories. In addition, the classical, Keynesian, and structural theories of inflation are also employed.

2.2.1 Theories of Exchange Rate

Purchasing Power Parity (PPP): This theory originated with Cassel (1918) and continues to be a very influential way of thinking about the exchange rate. It posits that exchange rates between two countries will be equal to the national price level of these countries. This theory also known as the law of one price, states in its absolute form that the exchange rate between the currencies of any pair of countries should equal the ratio of the general price levels in the two countries. This implies that exchange rates adjust to compensate for pricing differentials amongst countries. This implies that if cakes are sold for one dollar in the US and the same cake is sold for ₦100.00 in Nigeria then the exchange rate should be ₦100.00 to one dollar. Despite the criticisms that abound regarding the assumptions of this theory, it remains a valid explanatory exchange rate determination approach. Some of these criticisms are defects in calculating price level, comparison of general price level a problem, difficulty to find base year, not applicable to capital account, one-sided, static, and a long run theory.

Balance of Payments Approach (BPA): This approach of exchange rate determination is that there exists internal and external equilibrium. The internal equilibrium assumes that there is full employment i.e in it there is a natural rate of unemployment. In other words, unemployment is such that there are no pressures to change real wages. External equilibrium refers to equilibrium in the balance of payments. This approach explains permanent deviations of PPP. The main problem with this approach is that in general, it is extremely difficult to determine what is the exact natural rate of unemployment, or the exchange rate that is consistent with the equilibrium of the external accounts. However, the model will determine where the exchange rate has to converge; however, it provides very little guidance to short-term fluctuations (Hoontrakul 1999).

The Monetary Approach: Variations of the monetary model abound in literature but they all share the premise that exchange rate movements between two currencies can be attributed to changes in the demand and supply of money in the two countries. The shortfalls of the portfolio balance theory led to the development of the monetary

approach. Frankel (1979) posits that this model of exchange rate determination attains equilibrium when existing stocks of money in the two countries are willingly held. Obioma (2000) holds the view that the asset market or monetary approach attributes variation in exchange rate essentially to income and expected rates of return as well as to other factors that influence the supplies of and demands for the various national monies. Thus, based on the fact that supply and demand for monies are determined by the level of income, the monetary model postulates three basic determinants of the exchange rate as follows: relative money supplies, relative income, and interest rate differentials

2.2.2 Theories of Inflation

The classical theory of inflation, the Keynesian theory, and the structural theory of inflation are considered.

The Classical Theory of Inflation

One way of defeating inflation, according to early classical economists, is to reduce the money supply. The prescription arises from their belief that the economy always operates in equilibrium. The result of this belief is that when the money supply increases, this will simply result in more money chasing the same amount of goods. The excess demand will then increase the price level back to equilibrium (fast or immediately) and nothing in the "real" sector of the economy has changed. The only difference is an increase in the price level. There are some problems with this model. The main problem is that it ignores the possible rigidities in the economy. For example, the adjustment processes might work at different speeds. Another problem is that it does not account for the real effects of changes in the monetary sector on the goods sector.

Theory of Keynesian Inflation:

According to Keynesian, inflation can be caused by an increase in demand and or an increase in cost. In response to the deficiencies of the Classical theory, Keynes developed a new theory of inflation. This theory stressed rigidities in the economy, most importantly in the labour market. This source of rigidities was that workers were reluctant to reduce their nominal wages. Rigidity was that firms did not always change their prices as a response to changes in demand, often increasing output instead. Putting these rigidities (and others) together one gets what is called a fixed-price model. In this model, there are several ways of defeating inflation. The basic cause of inflation is excess aggregate demand and hence the most obvious cure is to reduce aggregate demand. The policy instruments available to do this could be tax increases or cuts in public spending. Another possibility in this model is to reduce the rigidities. Demand-pull inflation is a situation where aggregate demand persistently exceeds aggregate supply when the economy is near or at full employment. Aggregate demand could rise because of several reasons. A cut in personal income tax would increase disposable income and contribute to a rise in consumer expenditure. A reduction in the interest rate might encourage an increase in investment as well as lead to greater consumer spending on consumer durables. A rise in foreigner's income may lead to an increase in exports of a country. An expansion of government spending financed by borrowing from the banking system under conditions of full employment is another cause of inflation.

An increase in demand can be met initially by utilizing unemployed resources if these are available. Supply rises and the increase in demand will have little or no effect on the general price level at this point. If the total demand for goods and services continues to escalate, a full employment situation will eventually be reached and no further increases in output are possible. This leads to inflationary pressures in the economy.

Demand-pull inflation is caused by excess demand, which can originate from high exports, strong investment, a rise in money supply, or the government financing its spending by borrowing. If firms are doing well, they will increase their demand for factors of production. If the factor market is already facing full employment, input prices will rise. Firms may have to bid up wages to tempt workers away from their existing jobs.

It is most likely that during full employment conditions, the rise in wages will exceed any increase in productivity leading to higher costs. Firms will pass the higher costs to consumers in the form of higher prices. Workers will demand higher wages and this will add fuel to aggregate demand, which increases once again. The process continues as prices in the product market and factor market are being pulled upwards. Keynesian theory of cost-push inflation attributes the basic cause of inflation to supply-side factors. This means that according to Keynesian, rising production costs will lead to inflation. Cost-push inflation is usually regarded as being primarily a wage inflation process because wages usually constitute the greater part of total costs. Powerful and militant trade unions that negotiate wage increases above productivity are more likely to succeed in their wage claims the closer the economy is to full employment and the greater the problem of skill shortages.

2.3 Empirical Review

Zidek and Suterova (2017) examined the effect of exchange rate volatility on inflation in Switzerland. The study used quarterly data covering the period 2000:Q1-2016:Q4, sourced from the European Central Bank. The study employed the Structural Vector Autoregressive (SVAR) technique for the analysis. Findings from the study revealed that exchange rate volatility caused inflationary pressure in the study area.

Adeniji (2013) examined the impact of exchange rate volatility on inflation in Nigeria using annual time series data for the period 1986 – 2012. The study employed the Augmented Dickey–Fuller Test (ADF), Philip

Perron (PP) and Kwiatkowski- Philips-Schmidt-Shin (KPSS) test of unit root, Johansen Julius Co-integration test, Vector Error Correction Model (VECM), granger causality test, impulse response function, and variance decomposition. The unit root test result shows that all variables are stationary at the first difference, while the Maxi-eigen value shows a long-run relationship between the variables. VECM results established a positive and significant relationship between inflation, exchange rate volatility, money supply, and fiscal deficit, while gross domestic product shows a negative relationship. Granger causality outcome shows a bi-directional relationship between all the variables. Subsequently, exchange rate volatility is deduced to influence inflation in Nigeria.

Nkoro and Uko (2016) investigated the effect of exchange rate volatility on inflation in Nigeria, using quarterly time series data from 1986QI-2012Q4 sourced from the CBN Statistical Bulletin and the National Bureau of Statistics. The volatilities of the exchange rate and inflation in this study were calculated using standard GARCH (1,1) models. The relationship between exchange rate, inflation volatility, and stock price volatility was examined using GARCH (1,1)-S models of an extended GARCH –X model. Findings from the study show that there is a negative relationship between stock market price volatility and exchange rate and inflation volatility in Nigeria.

Obiekwe and Osabunhien (2016) examined the effect of exchange rate volatility on inflation in Nigeria using annual time series data from 2006 to 2015. The study employed the GARCH technique to test for volatility in the exchange rate in Nigeria. The study applied the ARCH model in its analysis. The result revealed that volatility in the exchange rate significantly influenced the inflation rate in Nigeria.

Alavinasab (2014) examined the factors affecting the rate of inflation in Iran, using annual time series data between the periods of 1965-2012. Augmented Dickey-Fuller (ADF) and Johansen co-integration tests were used. The result shows that there exists a long-run co-integration relationship between money supply, gross domestic product, oil export revenue, and inflation. Money supply and oil export revenue have a positive relationship with inflation and GDP has a negative relationship with inflation. The error correction estimate obtained (-0.593003) was negative and statistically significant, indicating that these variables also have significant effects on the inflation rate in the short run.

Nuhu (2020) examined the effect of exchange rate volatility on inflation in Nigeria using annual time series data covering the period 1986-2019. To achieve this objective, the study employed the generalized autoregressive conditional heteroskedasticity (GARCH) and vector error correction model (VECM) to ascertain the long-run impact of exchange rate volatility on inflation. The study used the consumer price index as a proxy for inflation being the dependent variable while nominal exchange rate (NER), money supply (MS) import (IMP), and export (EPT) were used as the independent variables. The results of the stationarity test indicated that the variables have mixed order of integration and the bounds test for co-integration confirmed the existence of a long-run relationship among the variables. The findings of the study show that money supply (MS) and nominal exchange rate(NER) had a positive and significant effect on the consumer price index, meaning that inflation in Nigeria is caused by exchange rate fluctuations as well as an increase in the money supply. Based on the findings, the study recommended that the growth of the money supply should be controlled by the Central Bank of Nigeria to reduce inflation to the barest minimum.

Kirimi (2014) also investigated the main determinants of inflation in Kenya from 1970-2013 and estimated the time series data using ordinary least squares. More specifically, the study demonstrates that the central bank rates and GDP growth rate are significant determinants of the inflation rate during the period. According to the result, food price, GDP growth rate, and corruption perception had a negative relationship with inflation, while money supply (M2) and the exchange rate had a positive relationship with the inflation rate. Central bank rates were also found to be statistically significant at a 5% significance level in causing the variation in the inflation rate. However, the wage rate was found insignificant in causing the changes in inflation with political instability not affecting inflation.

Egwaikhide, Chete, and Falokun (1994) examined the impact of the exchange rate on inflation and budget deficit in Nigeria using annual data from 1973–1989. They employed co-integration and EECM models. The results from the inflation equation show that the official exchange rate is the main determinant of inflation. Egwaikhide et al. concluded that the official exchange rate in Nigeria is the main determinant of inflation and budget deficit.

Imimole and Enoma (2011) examined the impact of exchange rate depreciation on inflation in Nigeria for the period, 1986 – 2008, using Auto Regressive Distributed Lag (ARDL) co-integration method. They found that exchange rate depreciation, money supply, and real gross domestic product are the main determinants of inflation in Nigeria and that Naira depreciation is positive, and has a significant long-run effect on inflation in Nigeria. This implies that exchange rate depreciation can bring about an increase in the inflation rate in Nigeria and that the inflationary rate in Nigeria has a lagged cumulative effect. They recommend that the Naira depreciation policy should be combined with other macroeconomic policies to stabilize the volatile inflationary rate in Nigeria.

Lastly, Charles and Chilaka (2019) examined the impact of the exchange rate on inflation in Nigeria for the period (1981- 2015) using the vector Error Correction Mechanism (VECM) and the results of the analysis show that the fluctuating exchange rate significantly impacted in the persistence inflation in the Country.

2.3.1 Evaluation of Empirical Literature

From the reviewed literature it can be seen that most of the work conducted on this topic is mostly those of other countries. Though Nkoro and Uko (2016); Obiekwe and Osabunhien (2016); Imimole and Enoma (2011), and Charles and Chilaka (2019) have investigated, the "Impact of Exchange Rate on Inflation in Nigeria", their scope of analysis does not capture current trends in the Nigerian Economy. Therefore, in this study, we have the scope of analysis to span from 1981 - 2021 as well as adopting different econometric techniques to also investigate the above topic and draw conclusions and recommendations from the findings.

3.1 Research Design

This study adopted an ex-post facto research design because the design considers events that have already taken place due to the availability of data. Thus, it is possible to establish empirical evidence to show how effective exchange rate policy measures impact inflation in Nigeria. Ex-post facto study or after-the-fact research is a category of research design in which the investigation starts after the fact has occurred without interference from the researcher. It is a research design that examines past occurrences to understand a current state and involves both a dependent variable and an independent variable.

3.2 Data and Data Sources

Secondary data were used for this study. The data on the variables were collected from the Central Bank of Nigeria Statistical Bulletin, World Bank indicators, and those of the National Bureau of Statistics. Its period of coverage spanned from 1981 - 2021. All the variables were measured in monetary terms using Nigeria's currency (Naira). The study captured the systematic annual time series of the considered variables in the model specification.

3.2.1. Estimation Technique

This study examined the exchange rate and inflation in Nigeria. To achieve this, annual time series data on the money supply, fiscal deficit, national output (proxy by Real Gross Domestic Product), inflation rate expectation, and exchange rate as the independent variables, and the inflation rate is used as the dependent variable. To analyze this data, given the nature of the data which is annual time series data, Autoregressive-Distributive lag (ARDL) with E-view econometric software was used to perform investigate the impact of exchange rate fluctuation on inflation.

3.3 Model Specification

This study is anchored on the balance of payment theory of the exchange rate. It identifies- the exchange rate as a function of the relative shift in the money stock. Based on this theory exchange rate has been emphasized as the cause of inflation.

The functional form of the model is specified as:

$$INF = f(EXR, MS, FID, RGDP, INF_{t-1}) \quad - \quad - \quad - \quad (1)$$

The econometric form of the model is specified in Equation 2

$$INF = \beta_o + \beta_1 EXR + \beta_2 INF_{t-1} + \beta_3 MS + \beta_4 FID + \beta_5 RGDP + U_t \quad - \quad - \quad - \quad (2)$$

where; INF represents the Inflation rate (proxy by a consumer price index), which is used as the dependent variable while the independent variables are exchange rate (EXR), inflation rate expectation (INF_{t-1}), money supply (MS), fiscal deficit (FID), and national output proxy by real gross domestic product (RGDP). β_o is the intercept while $\beta_1 - \beta_5$ is the coefficients of the independent variables

A Priori Expectation

$\beta_1 - \beta_4 > 0$ and $\beta_5 < 0$

On a priori ground, the value of $\beta_1 - \beta_4$ is expected to be positive while β_5 is expected to be negative.

3.4 Criteria for Decision Making

In this study, the following tests shall be conducted:

3.4.1. Unit Root Test: It is used to test for the stationarity of the time series data to avoid spurious regression results. Stationary time series is one whose statistical properties such as mean, variance, autocorrelation, etc. are all constant over time. Thus, for data to be valid, it must be stationary. The research made use of the order of integration to test for stationarity. If a series is integrated of order (0), for example, I (0), then it is stationary but if otherwise, it is non-stationary. The test for stationarity was done through the use of the Augmented Dickey-Fuller Unit Root Test (Gujarati, 1995).

3.4.2. Augmented Dickey-Fuller Test

However, since the Dickey-fuller test may suffer autocorrelation in the residual process if OLS is applied in this paper, it made use of the augmented Dickey-Fuller test. This is because the errors may not be normally and identically distributed and the residual variance may be biased. This test is derived from the Dickey-Fuller test and it is an appropriate method of checking whether a variable is integrated with orders. This was proposed by Dickey and Fuller (1979). The null hypothesis may be taken to mean that prices follow a random walk and future prices

cannot be predicted, while the alternative may mean economic agents may predict future prices and it does not follow a random walk (Gujarati, 1995).

3.4.3. Cointegration Test: The cointegration test is used to test for the long-run relationship between the variables. To determine the existence or otherwise of a long-run relationship among the variables, this study will use the Engel-Granger co-integration test.

3.4.4 Granger Causality Test: this is a statistical hypothesis test for determining whether one-time series is useful in forecasting another. In other words, the Granger causality Test is used to verify the usefulness of one variable to forecast the other.

3.4.5. Heteroscedasticity

Heteroscedasticity occurs when population variances are not constant or unequal. This can be tested through the use of the Breusch-Pagan test. If the chi-square value obtained exceeds the critical chi-square value, the null hypothesis of no heteroscedasticity is rejected (Kirimi, 2014).

3.4.6. Autocorrelation

Autocorrelation occurs when the current error term is correlated with the previous error term. However, for the ordinary least squares to be consistent there must be no autocorrelation. When there is no autocorrelation in a multiple regression model, it simply means; E (Ui, Uj) =0 where I ≠ j. That means the expected value of the two error terms Ui and Uj are zero. Test for autocorrelation was performed using the Breusch-Godfrey Serial Correlation LM test

3.4.7. Normality Tests

Normality tests are used to determine whether a model is normally distributed and to compute how likely it is for a random variable underlying the data set to be normally distributed. This test is based on the assumption that the error term U_i is normally distributed. The study made use of the Shapiro-Wilk test to test for normality (Gujarati, 1995). The Jarque-Bera normality test was carried out to ascertain the normality of residuals in the model using the histogram-normality test.

3.4.8. Testing for Structural Stability of Regression Models

This test is used when dealing with time series data and there may be a structural change between the dependent variable Y and the explanatory variable Xs. This will be achieved by dividing the data into two sets. This research, it was investigated whether shocks in the economy had an impact on the inflation rate. To determine the stability of the model, CUSUM and CUSUM of squares will be employed.

4.2 Results and Discussion

4.2.1 Descriptive Statistics.

The table below shows the median, maximum, and maximum standard deviation, skewness, and kurtosis, as well as the Jaque-Bera test for the normality of the Model variables. The mean values simply tell us the average value of each of the variables. The descriptive statistics result above presents the mean of Inflation lag (INF$t-1$), Money Supply (MS), Inflation (INF), Fiscal Deficit (FID), Exchange Rate (EXR), and Real GDP(RGDP) as 18.99905, 5925800, 18.91687, -747.7836, 108.3203 and 38124.89 respectively. The media values tell the middle value of each of the variables. The Median variable taking from the highest to the lowest value is Exchange Rate (EXR) (111.9433) and Inflation Rate (INF) (12.87660) respectively.

The Money Supply (MS) takes the maximum value of 29137800, while the Fiscal Deficit (FID) has the minimum mean value of -6171.796 from the given observation. The standard deviation shows that the degree of variability of the exchange rate, inflation rate, money supply, and inflation lag, is lower than their various mean. This implies that the series is more spread out.

The skewness result below shows that INF$t-1$, Money Supply, Inflation rate, Exchange rate, and RGDP are positively skewed. This implies that the distribution has a long right tail and mean and median values are greater than the mode for each variable, while Fiscal Deficit is negatively skewed. The Kurtosis of INF$t-1$, MS, and INF are greater than 3 which implies that the distribution is assumed to be peaked (leptokurtic) relative to normal while FID, EXR, and RGDP are less than 3 (platykurtic), suggesting that their distributions were flat relative to a normal distribution. The Jarque−Bera statistics show that the series is normally distributed since the p-values of all the series are not statistically significant at the 5% level. Thus, informing the acceptance of the null hypothesis that says each variable is normally distributed.

Table 4.2.1: Summary Descriptive Statistics

	INFT_1	MS	INF	FID	EXR	RGDP
Mean	18.99905	5925800.	18.91687	-747.7836	108.3203	38124.89
Median	12.71580	699733.7	12.87660	-107.7350	111.9433	26935.32
Maximum	72.83550	29137800	72.83550	32.04940	403.5808	73382.77
Minimum	5.388000	16161.70	5.388000	-6171.796	0.610000	16211.49
Std. Dev.	16.86844	8810621.	16.66456	1420.962	110.0900	20553.99
Skewness	1.823485	1.350957	1.858146	-2.408610	0.983381	0.575236
Kurtosis	5.159023	4.453488	5.314459	2.154571	2.208178	1.703335
Jarque-Bera	29.93630	12.82273	32.74456	85.03265	6.682129	5.133416
Probability	0.000000	0.001643	0.000000	0.000000	0.001399	0.003788
Sum	759.9618	2.43E+08	775.5918	-30659.13	4441.132	1563121.
Sum Sq. Dev.	11097.23	3.11E+15	11108.30	80765338	484792.3	1.69E+10
Observations	41	41	41	41	41	41

Source: Author's computation (2022).

4.2.2. Test for Stationarity

The Augmented Dickey-Fuller (ADF) unit root test was performed to ascertain the order of integration. The results of the stationarity test are presented in Table 4.2.2.

Table: 4.2.2: Stationarity Test Results.

Variables	Order of Integration	Critical Values			ADF Statistics	Prob.
		1%	5%	10%		
Δ (EXR)	I(0)	-3.605593	-2.936942	-2.606857	2.785991	1.0000
Δ (FID)	I(0)	-3.639407	-2.951125	-2.614300	3.509604	1.0000
Δ (INF)	I(0)	-3.605593	-2.936942	-2.606857	-3.004296	0.0430
Δ (MS)	I(0)	-3.646342	-2.954021	-2.615817	-3.994183	0.0041
Δ (RGDP)	I(1)	-3.610453	-2.938987	-2.607932	0.614430	0.9884

Source: Author's computation (2022).

Note:

•Δ = Difference operator

• I(d) = Numbers of times of integration.

• Levels= 10%, 5%, 1% levels of significance

The table above reveals that all the series is stationary; hence has no unit root. Model estimation relating to time series data that are not stationary is sure to produce unreliable regression results. Exchange Rate, Inflation Rate, Money Supply, and Fiscal Deficit were stationary at level I(0) at a 5% significance level, while RGDP was stationary at the first difference at the 5% significance level. As can be seen, the calculated values are more negative than the critical values for each of the variables tested. The unit root test result shows that the order of integration of the variables comprises a mixture of 1(0) and 1(1), as such the most appropriate model to be adopted in analyzing data remains Auto - Regressive Distributed Lag (ARDL) Model and the appropriate co-integration method to be adopted is Engle-Granger co-integration method

4.2.3 ARDL (F-Bounds) Test for Cointegration

To investigate the presence of long-run relationships among the variables, the bound testing under Pesaran et al. (2001) procedure is used. The bound testing procedure is based on the F-test. The F-test is a test of the assumption of no co-integration among the variables against the premise of its existence, denoted as:

$H0$: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$, i.e., there is no co-integration among the variables. This hypothetical representation is based on the specified ARDL model in equations 9 and 10

$H1$: $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0$, i.e., there is co-integration among the variables.

Table 4.2.3 Result of the ARDL (Bounds) Test for Cointegration

ARDL Bound Test of Cointegration		
Variables	**F- Statistics**	**Decision**
F (INF, EXR, MS, FID,RGDP)	4.136971	Cointegration Exists
Critical Values Bounds (Significance)	Lower Bound I (0)	Upper Bound I (1)
10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.74	5.06

Source: Author's computation (2022).

The Bound test for cointegration determines the presence or absence of a long-run relationship (cointegration)

among the variable of the study. If the F-statistic of the bound test is higher than the lower and the upper bound critical value at a 5% significance level, the null hypothesis of no long-run relationship is rejected, whereas if the F-statistic of the bound test is lesser than the lower and the upper bound critical value at 5% significance level, the long-run relationship is accepted.

From the table below, the results of the ARDL bound test of co-integration of the model indicate that the F-statistics has a higher value of 4.136971 than the upper bound (4.01) and lower bound (2.86) of the criteria values at 0.05 level of significance., provided by Pasaran et.al (2001) at all levels of significance, hence, there is sufficient reason to reject the null hypothesis.

That is, there is a long-run relationship between the exchange rate and inflation in Nigeria. We can conclude that there is co-integration.

Having found that a long-run relationship exists among the series in the model, the short-run and long-run ARDL model was estimated.

4.2.4 Short-run ARDL Estimates

Table: 4.2.4: Short-run ARDL Test Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
INF(-1)	0.748125	0.155146	4.822087	0.0000
INF(-2)	-0.434107	0.161899	-2.681344	0.0118
EXR	-0.171425	0.141820	-1.208753	0.2362
EXR(-1)	0.150332	0.147844	1.016826	0.3174
FID	0.001765	0.002825	0.624522	0.5370
MS	-2.22E-07	4.77E-07	-0.465550	0.6449
RGDP	-0.004069	0.001878	-2.166603	0.0383
RGDP(-1)	0.004308	0.001978	2.178429	0.0374
C	16.73410	8.594258	1.947125	0.0609

R-squared	0.562343	Mean dependent var	19.15593
Adjusted R-squared	0.445635	S.D. dependent var	16.99583
S.E. of regression	12.65436	Akaike info criterion	8.113055
Sum squared resid	4803.986	Schwarz criterion	8.496954
Log-likelihood	-149.2046	Hannan-Quinn criteria.	8.250795
F-statistic	4.818359	Durbin-Watson stat	1.891074
Prob(F-statistic)	0.000697		

Source: Author's computation (2022).

The ARDL result as shown in the table above suggests that the lagged value Exchange rate has a positive impact on inflation. A percentage increase in the Exchange rate would bring about a 0.1503 percent increase in inflation. Also, a percentage increase in RGDP (-1) would bring about a 0.0043 percent increase in inflation, and vice versa. Also from the table, the lagged value of the inflation rate at (-1) and (1) had a negative and positive significant impact on the exchange rate. A keen examination of the result shows that RGDP (-1) had a positive significant impact on inflation at a 5% level of significance as supported by the corresponding probability value of 0.0374 which is < 5% significance level. Exchange rate (-1) can be said to have exerted a positive, yet insignificant impact on inflation as shown by its corresponding probability value of 0.3174 which is > 5% significance level. The R-squared as well as the Adjusted R-squared of 0.56 and 0.45 showed that the explanatory variables accounted for more than 56% and 45% variations in the explained variable. The p-value of the F-Statistics is less than 5% (I.e., 0.0000697 < 0.05). This implies that the F statistics is significant, therefore the null hypothesis is rejected and it is concluded that the explanatory variables are jointly significant in influencing the dependent variable INF. Thus, the study posits that the Exchange rate has a significant impact on inflation in Nigeria. The Durbin-Watson statistic of 1.89 indicates the existence of no autocorrelation as the ARDL model revealed 1.89 which fell within the acceptance range in applied research of no autocorrelation.

4.2.4A ARDL Cointegrating And Long Run Form

$INF = \beta_o + \beta_1 EXR + \beta_2 MS + \beta_3 FID + \beta_4 RGDP + U_t$

INF=16.73409 -0.030748EXR - 3.24E-07MS +0.002572FID +0.000349RGDP

The long-run results show that the Exchange rate is negatively insignificant to the Inflation rate in the long run and implies that a 1% increase in EXR will lead to a 3.0748% decrease in INF.

Table 4.2.4A Result of the Long-run ARDL

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	16.73409	8.594257	1.947125	0.0609
INF(-1)*	-0.685982	0.153478	-4.469565	0.0001
MS**	-2.22E-07	4.77E-07	-0.465550	0.6449
RGDP(-1)	0.000239	0.000398	0.601782	0.5518
FID**	0.001765	0.002825	0.624523	0.5370
EXR(-1)	-0.021093	0.062669	-0.336572	0.7388
D(INF(-1))	0.434107	0.161899	2.681344	0.0118
D(RGDP)	-0.004069	0.001878	-2.166604	0.0383
D(EXR)	-0.171425	0.141819	-1.208754	0.2362

* p-value incompatible with t-Bounds distribution.
** Variable interpreted as Z = Z(-1) + D(Z).

Levels Equation
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MS	-3.24E-07	6.90E-07	-0.469423	0.6422
RGDP	0.000349	0.000578	0.603093	0.5510
FID	0.002572	0.004177	0.615748	0.5427
EXR	-0.030748	0.090742	-0.338850	0.7371

EC = INF - (-0.0000*MS + 0.0003*RGDP + 0.0026*FID -0.0307*EXR)

Source: Author's computation (2022).

Also, FID has an insignificant negative relationship with the Inflation rate as a 1% increase in FID in long run will lead to a 0.2572% increase in INF. RGDP was found to be insignificantly positive to the Inflation rate indicating that a 1% increase in RGDP will lead to a 0.0349% increase in the Inflation rate (INF). Money supply (MS) shows an insignificant negative relationship with the Inflation rate as a 1% increase in MS will lead to a 324 % decrease in INF.

4.2.5. Diagnostic Tests

4.2.5.1. Heteroskedasticity Test Results

The presence of heteroskedasticity in linear regression analysis implies that the model coefficients estimated using ordinary least squares (OLS) are biased. This occurs when the variance of errors or the model is not the same for all observations. The null hypothesis is that the residuals are homoscedastic and the alternate hypothesis is that the residuals are heteroscedastic. The decision rule is to reject the null hypothesis if the p-value is less than 0.05 level of significance. From the result in Table 4.2.3, the p-values of the F-stat. (0.0212) and Obs*R-squared (0.0288) is less than a 5% significance level, this indicates that we rejected the null hypothesis. This result indicates that there is evidence of heteroskedasticity in the model.

Table: 4.2.5.1: Test of Heteroskedasticity
Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	3.081665	Prob. F(5,34)	0.0212
Obs*R-squared	12.47428	Prob. Chi-Square(5)	0.0288
Scaled explained SS	16.00898	Prob. Chi-Square(5)	0.0068

Source: Author's computation (2022).

4.2.5.2 Serial Correlation Test

The presence of serial correlation is tested using the Breusch-Godfrey Serial Correlation LM Test. The null hypothesis is no presence of serial correlation. The decision rule is to reject the null hypothesis if the p-value is less than 0.05 level of significance. From the result in Table 4.2.5, the Serial Correlation LM test results indicate that the value of F-statistic is 2.741334 and observed R2 is 5.850883 with probability values of 0.0796 and 0.0536 respectively. Since these probability values are greater than 0.05, we conclude that there is an absence of serial correlation in the estimates.

Table: 4.2.5.2: Result of Serial Correlation
Breusch-Godfrey Serial Correlation LM Test:

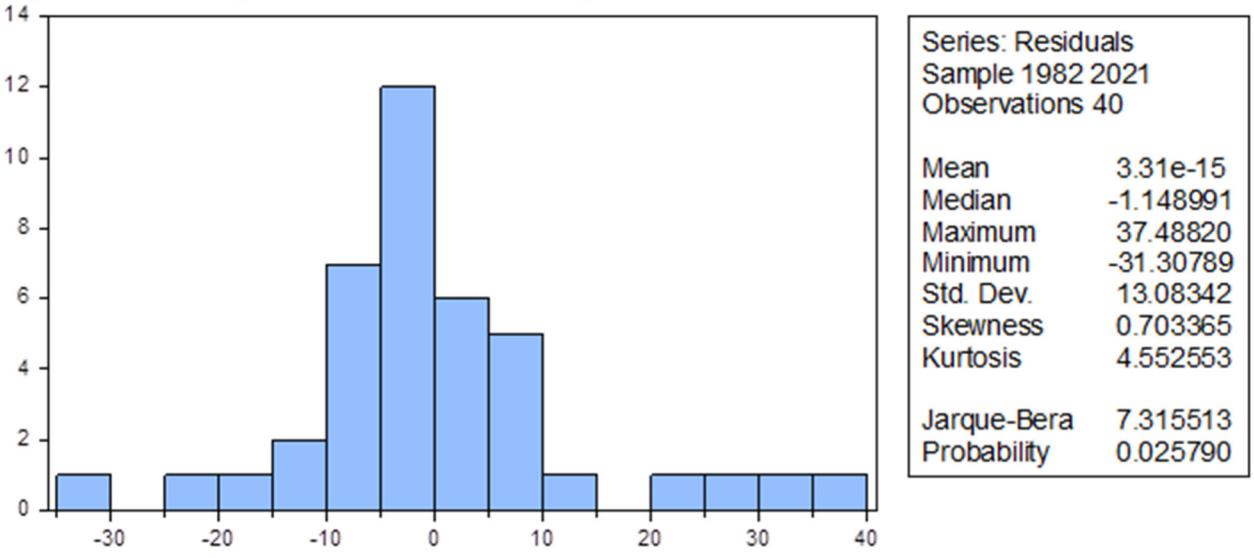
F-statistic	2.741334	Prob. F(2,32)	0.0796
Obs*R-squared	5.850883	Prob. Chi-Square(2)	0.0536

Source: Author's computation (2022).

4.2.5.3. Normality Test

The models are examined for normal distribution. The Jarque-Bera (JB) statistics is used to test for the normality of the models. The null hypothesis is that the models are normally distributed. The decision rule is to reject the null hypothesis if the p-value is less than 0.05 level of significance.

Figure 4.1: Normality test of the models of the study



In Figure 1 above, the Jaque-Bera statistics are used to test for the normality of the model. The Jaque-Bera p-value of 0.025790 is less than 0.05, thus, there is no normal distribution. That is, the study, therefore, rejects the null hypothesis that the model is not normally distributed. The standard deviation shows the distribution has a higher spread. It is positively skewed and kurtosis is 4.55 above 3.

4.2.5.4. Stability Test

To determine the stability of the model, CUSUM and CUSUM of squares were used. The estimated model is stable if its recursive residuals lie within the two critical bounds. On the other hand, if residuals fall outside the two critical lines the model is said to be unstable. The results of the stability test are presented in Figures 2a and 2b. The analysis in Figure 2a and 2b indicates that both the graph of CUSUM was stable because the recursive residuals fall within the critical line, meaning that they are all within the 5 % critical bounds. This result implies that the estimated parameters for the study are stable for the period under investigation. while the CUSUMSQ test showed relative instability in some periods.

Figure 4.2: Plot of Cumulative Sum of Recursive Residuals
The straight
CUSUM RESULT

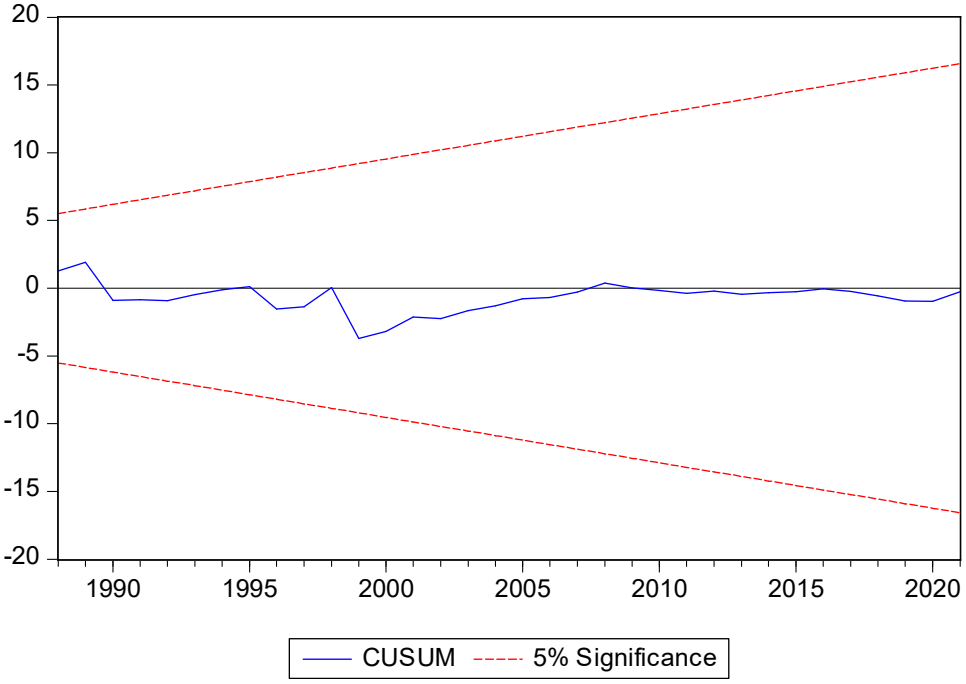


Figure-4.2a. CUSUM of squares test

CUSUM OF SQUARES

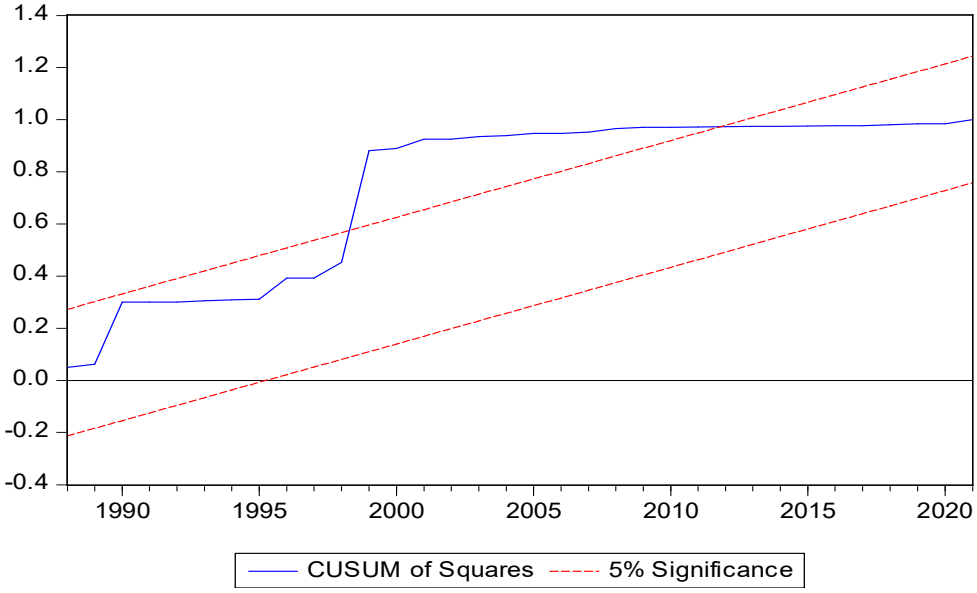


Figure-4.2b. CUSUM of squares test

4.2.5.5. Granger Causality

Cointegration between two variables does not specify the direction of a causal relation, if any, between the variables. Economic theory guarantees that there is always Granger Causality in at least one direction Order, D. and L. Fisher, (1993). Before the Granger causality test, we assume that the variables are stationary and the residuals are uncorrelated. To the hypothesis of the Granger causality test, the probability values of the F-statistics are appointed. We accept the null hypothesis if the P-value is greater than 5% otherwise reject Ho. Hence, this aspect of the work seeks to verify the direction of Granger Causality between INF, MS, EXR RGDP, and FID. Estimation results for Granger causality between the very variables are presented below:

From the table above, it was found that Fiscal Deficit, Money Supply, and Real GDP granger cause inflation in Nigeria. Meanwhile, in terms of the ability of inflation to predict the explanatory variables, it was revealed that the exchange rate does not Granger cause the inflation rate.

5.1 Summary of Major Findings

The Study examined the impact of the Exchange rate on inflation in Nigeria. The explanatory variables are Money Supply (MS), Exchange Rate (EXCHRT), Fiscal Deficit (FID), Inflation rate expectation ((INFt-1),), and Real Gross Domestic Product (RGDP) in Nigeria between the periods of 1981 through 2021 while the dependent variable is the Inflation Rate (INF). The study adopted an ex-post facto research design and used secondary data obtained from the CBN Statistical Bulletin. The study covered a period of 40 years (1981 to 2021). The data were subjected to the Augmented Dicker Fuller stationarity test to determine the best suitable econometric tool for analyses. The Autoregressive Distributive Lag (ARDL) was used for the model estimation.

5.2. Conclusion

This paper examined the Impact of the exchange rate on inflation in Nigeria for the period 1981-2021. The results from ARDL indicated that the Exchange rate (EXR) and RGDP (NER) exerted a positive and significant impact on the inflation rate in Nigeria during the period under investigation. The policy implication of this result is that an increase in the exchange rate is capable of fueling inflationary pressure in Nigeria. From the Granger Causality test, it was found that Fiscal Deficit, Money Supply, and Real GDP granger cause inflation in Nigeria. Meanwhile, in terms of the ability of inflation to predict the explanatory variables, it was revealed that the exchange rate does not Granger cause the inflation rate. The test of the hypothesis shows that the Exchange rate has a significant impact on inflation in the short run.

5.3 Recommendations

Based on the findings, the following recommendations were made:

1. The Central Bank should choose a fixed system exchange rate in the economy. One important reason to choose a system of fixed exchange rates is to try to dampen inflationary tendencies. One effective way to reduce or eliminate this inflationary tendency is to fix one's currency. A fixed exchange rate acts as a constraint that prevents the domestic money supply from rising too rapidly. The Central Bank should intensify efforts to ensure that the exchange rate is kept stable. A stable exchange rate makes the domestic prices of goods to be stable. Therefore, the CBN should maintain a stable exchange rate by allowing it to be determined competitively.
2. There should be a Control of the money supply – Monetarists argue there is a close link between the money supply and inflation, therefore controlling the money supply can control inflation.

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