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Impact of Exchange Rate Volatility on Inflation in Nigeria

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Abstract: *This study 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 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 stationarity test indicated that the variables have mixed order of integration and bounds test for co-integration confirmed the existence of a long-run relationship among the variables. Findings showed that money supply (MS) and nominal exchange rate(NER) had positive and significant effect on consumer price index, meaning that inflation in Nigeria is caused by exchange rate fluctuations as well as increase in money supply. Based on the findings, the study recommended that growth of money supply should be controlled by the central bank in order to reduce inflation to the barest minimum.*

Keywords: *Exchange rate, Volatility, Money supply, Inflation, VECM, Consumer price index.*

1. Introduction

One of the most serious challenges facing Nigeria and most developing economies is inflationary pressure coupled with exchange rate volatility. The adverse consequences inflationary pressure arising from exchange rate volatility have been a serious concern for economists and policy makers. In Nigeria, the Central Bank is saddled with the responsibility of maintaining stable exchange rate and price stability in the economy and, this is done by ensuring that the rate of inflation is kept within a certain bound. Monetary policy is one of the instruments of economic stabilization. The main objectives of monetary policy in Nigeria are to preserve the value of the Naira and to maintain enough foreign exchange reserves (Oleka & Okolie, 2016). In Nigeria, the central bank maintains the stability of the Naira exchange rate in order to achieve its objective of maintaining price stability because domestic prices (inflation) are very responsive to exchange rate fluctuations.

According to Ubi, Effiom, and Eyo (2012) in countries where exchange rate volatility tend to have adverse effects on inflationary pressure, more stable exchange rate through central bank intervention in the foreign exchange market is required in order to stabilize the economy. The Central bank uses its monetary policy such as monetary policy rate, interest rate, open market operation, and other weapons to stabilize the economy with a view to achieving some specified macroeconomic policy objectives and to counter undesirable trends in the economy such as unemployment, inflationary pressures, sluggish economic growth and external sector instability. Monetary policy therefore, is a package of actions carefully designed to manage the growth, value and cost of money with the broad objective of regulating economic conditions and activities during a given

period (Okwori & Abu, 2017). Monetary policy refers to the actions undertaken by a central bank to influence the availability and cost of money and credit as a means of helping to promote national economic goals of generating employment, increasing output, keeping inflation low and ensuring exchange rate stability (Chukwuemeka, 2018). The major policy instruments used to achieve price stability in Nigeria include: Open Market Operations (OMO), liquidity ratio, Reserve Requirement, Discount Window Operations, Monetary Policy Rate (MPR), selective credit control and moral suasion (Central Bank of Nigeria, 2019).

Babatunde and Kehinde (2016) opined that, during periods of volatility in the exchange rate, inflation rate, would be high. This means that exchange rate volatility engender inflation in an economy. He argued that price instability can lead to an increase in market risks and uncertainties. A policy of price stability is to keep the value of money stable and eliminate cyclical fluctuations. Fluctuations in domestic prices erodes the value of money as a store of value, and increases business uncertainty and risks. Okwori and Abu (2017) posited that in order to combat inflation and maintain price stability, Nigeria has adopted direct monetary policy instruments such as selective credit control, administered interest and exchange rates, credit ceilings, cash reserve requirements and special deposit . Yakub, Sani, Obiezue, and Aliyu (2019) posited that the Nigerian exchange rate is highly volatile and have fluctuated widely over the years, virtually in all the segments of the foreign exchange markets; official, bureau de change and parallel markets. In the official market, the exchange rate depreciated from N11.08 per US dollar in 1987 to N22.00 in 1994 and was later fixed at N21.89 per US$ dollar by the federal government between 1994 to 1998. It depreciated to N97.95 per US dollar in 1999, N125.00 between 2000 and 2006 and appreciated slightly to N117.97 per US dollar in 2007. Meanwhile, in 2009 the naira depreciated to N149.58 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 N157.50, N158.55 in 2014 and then N196.49 in 2015 , N253.19 in 2016, N305.30 in 2017 and N350 in 2018 and N360 in 2019 respectively.

Prior to 1980, Nigeria experienced a single digit low inflation rate but the situation changed dramatically especially as from 1986 when inflation rate in the country rose to double digits. Statistics from Central Bank of Nigeria (2019) have shown that inflation rate 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, due to COVID -19 pandemic, inflation rate in Nigeria rose to 13.39% in 2020. Thus, the persistent increase in inflation over the years does not only lead to a fall in purchasing power of most average Nigerians but also a threat to economic stability. Despite the monetary policy measures adopted to control and stabilize prices, inflation problem still persist in Nigeria. In view of this background, this study was undertaken to investigate the effect of exchange rate volatility on inflation in Nigeria for the period 1986-2019.

This study is structured into five sections. Following the introduction is section two, which deals with literature review. Section three deals with methodology employed for the study while section four deals with results and discussion. Finally, section five deals with conclusion and recommendations based on the findings.

2. Literature Review

2.1. Conceptual Issues

Exchange rate volatility refers to the erratic fluctuations in exchange rates. According to Yakub et al. (2019) exchange rate volatility refers to appreciation or depreciation of domestic currency over a period of time. Exchange rate is the rate at which a country's currency is exchanged with another country's currency.

Inflation on the other hand, refers a persistent rise in the general price level of goods and services over a period of time. Inflation has serious implication for the function of money as a medium of

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exchange and store of value. Chukwuemeka (2018) viewed inflation as a sustained rise in the general level of prices. Inflation refers to a condition of general and persistent rise in the general price level in an economy. Inflation may be defined as a persistent or intermittent rise in the general price level in an economy. A price increase by itself is not necessarily inflationary. The price increase must be general and wide-spread throughout the economy and the process must be continuous, for it to be called inflation.

Inflation can be grouped into two types: creeping and hyper- inflation. Creeping inflation refers to a slow but persistent upward movement in the general price level over long periods of time. In other words, the condition of a general rise in price persists for a long time but at a moderate and fairly steady pace. It will rise slowly but persistently and continuously getting worse.

Hyper-inflation otherwise called "runaway or galloping inflation" refers to inflation which is characterized by sudden and high increase in prices (with prices rising up to 50% or more every month). Hyperinflation can lead to rapid deterioration in the value of a nation's currency and erode the confidence reposed in it by the general public. Hyperinflation occurs when prices rise very fast at double or triple digit rates. Under this situation inflation rate becomes absolutely uncontrollable. Prices tend to rise very fast and doubles many times every day. Such a situation brings a total collapse of the monetary system because of the continuous fall in the purchasing power of money. However, unlike creeping inflation, hyper-inflation usually last for short periods of time. Consumer price index is used in measuring the rate of inflation. Consumer price index (CPI) measures the average change over time in the prices of goods and services over a period of time.

2.2. Theoretical Framework

The classical or Quantity theory of money(QTM), Monetarists, Keynesian, Mundell-Fleming theory of exchange rate determination and the purchasing power parity are relevant to this study. The classical theory propounded by Irving Fisher in 1956 postulates a direct and proportional relationship between money supply and the price level. That is, change in the supply of money causes a proportional change in the price level. Algebraically, it is expressed as follows:

$$MV = PT \qquad 1$$

where: M is the total money supply, V is the velocity of money in circulation and T is the volume of transactions. From the equation, the total money supply (MV) equals total value of output (PT) in the economy. Assuming V (the velocity of money) and T (the total output) to be constant, a change in the supply of money (M) causes a proportional change in the price level. The variable M is the policy variable, which is exogenously determined by the monetary authorities.

The monetarists led by Milton Friedman posit that money exerts significant influence on aggregate demand, price level and output (Ufoeze, Odimgbe, Ezeabalisi, & Alajekwu, 2018). The monetarists are of the view that changes in money supply determine the nominal price level and output.

The Keynesian economic theory posit that expansionary monetary policy increases the supply of loanable funds available through banking system, causing interest rates to fall. With the lower interest rates, aggregate investment increases, causing real gross domestic product to rise (Chukwuemeka, 2018; Nwoko, Ihemeje, & Anumadu, 2016). Keynes contends that monetary policy affects real output indirectly . He did not support the idea that the relationship between money and price is direct and proportional. He contends that a change in the supply of money has an indirect and non-proportional relationship with economic variables such as interest rate, investment, aggregate demand, level of employment, output and income.

The purchasing power parity (PPP) theory was developed by Swedish economist Gustav Cassel. This theory posits that the exchange rate between countries is determined by their relative price level. It explains how the exchange rate volatility affects inflation rates (Jhingan, 2011). The formula is expressed as shown in Equation 2.

$$P_t = E_t P_t^* \qquad [2]$$

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where; P_t is the domestic price index, E_t denotes the exchange rate between two countries and P_t* represents foreign prices.

The Mundell-Fleming theory of exchange rate determination on the other hand, is an extension of the IS-LM framework which deals with equilibrium in the product market and money market. In the Mundell-Fleming theory, the balance of payments is considered another equilibrium condition in addition to the product market and money market equilibrium. The Mundell-Fleming theory posits that expansionary monetary policy increases the supply of loanable funds available through banking system, causing interest rates to fall. The fall in interest rates leads to fall in capital inflows which results to capital account deficit leading to further pressure on domestic currency thereby causing depreciation of the exchange rate. The depreciation in currency stimulates domestic production causing IS curve and balance of payments (BP) curve to shift to the right (Chukwuemeka, 2018; Nwoko et al., 2016).

The IS represents the investment and savings equilibrium in the product market while the LM represents the liquidity preference and money supply equilibrium in the money market.

Odumusor (2019) gave a brief explanation of this model. The equilibrium equation in the product market can be written as in Equation 3

$$Y = c(y\text{-}t(y) + i + g \quad [3]$$

$$i=i(r) \quad [4]$$

Substituting Equation 3 into (2) and solving this relationship yields a downward sloping IS curve.

where Y is aggregate national income, C represents aggregate consumption expenditure which is a function of disposable income and disposable income is equal to income minus tax and I is real investment which is a function of interest rate r, and income (y), that is: I = I (r) (Iy>0) Ir< 0 . This means that investment is decreasing in interest rate but increasing in income and g stands for government purchases of goods and services.

The LM curve, on the other hand, represents the money market equilibrium condition. Equating money demand function to the exogenously fixed supply gives us the equilibrium condition in the money market. That is Ms =Md. where: Ms = Money supply Md = Demand for real money balances. Symbolically,

$$L^d = f(i, y) \quad [5]$$

where: L is the demand for money, i stands for the interest rate and y is the income.

Money supply is determined by monetary authority, while the demand for. money is determined by income and interest rate. An increase in money supply holding prices constant, would shift the LM curve outward to the right. As a result, interest rate will fall, leading to increase in investment and higher output level. The Mundell-Fleming model explains how expansionary monetary policy increases the money supply leading to outward shift in LM-curve and consequently fall in interest rate and depreciation in domestic currency. The depreciation in currency further stimulate domestic production causing IS curve and BP curve to shift to the right, resulting in higher output.

2.3. Empirical Literature

Achouak, Ousama, and Mourad (2018) examined the impact of exchange rate volatility on economic growth in a sample of 45 developing and emerging countries over the period 1985~2015. The study employed generalized autoregressive conditional heteroskedasticity (GARCH) model for the analysis. Findings revealed that nominal and real exchange rate volatilities had negative and significant impact on economic growth.

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 Structural Vector Auto regressive (SVAR) technique for the analysis. Findings from the study revealed that exchange rate volatility caused inflationary pressure in the study area.

Viola, Klotzle, Pinto, and Gaglianone (2017) explored the effect of exchange rate volatility on inflation in Brazil using annual time series data from 1980-2015 sourced from Central Bank of Brazil. In estimating volatility, the study used two models; the Generalized Autoregressive Conditional Heteroskedasticity (GARCH (1,1)) and the Exponential Generalized Autoregressive Conditional Heteroskedasticity (EGARCH (1,1)). Findings from the study revealed that GARCH (1,1) and the EGARCH (1,1) showed high persistence of volatility in the exchange rate.

Serenis and Tsounis (2014) investigated the effect of exchange rate volatility on two small countries, Croatia and Cyprus on aggregate exports using annual time series data for the period 1990 to 2012. Autoregressive distributed lag (ARDL) model was employed for the analysis and results revealed a positive and significant effect of exchange rate volatility on exports of Croatia and Cyprus.

Vieira, Holland, Gomes, and Bottecchia (2013) analysed the impact of exchange rate volatility on economic growth on a sample of 82 developed and emerging countries over the period of 1970~2009. The study employed generalized autoregressive conditional heteroskedasticity (GARCH) model for the analysis. Findings revealed that nominal and real exchange rate volatilities had negative and significant impact on economic growth in the sampled countries.

In addition, Mori, Rozilee, Jarati, Dullah, and Nanthakumar (2012) investigated the effects of the exchange rate volatility on economic growth in Malaysia during the period 1971- 2009. The variables employed include; GDP, real exchange rate and nominal exchange rate. The study employed Autoregressive Distributed Lag approach for the analysis. Results revealed that both nominal and real exchange rates had a positive and significant effect on economic growth in Malaysia.

In Nigeria, Yakub et al. (2019) investigated the impact of exchange rate volatility on trade flows in Nigeria using annual time series data for the period 1997-2016. A GARCH model was used to generate the nominal exchange rate volatility series. To detect the long-run relationship among variables, the ARDL bounds test approach was employed. Also, the Granger causality test was applied to ascertain the direction of causality among the variables. The study found that exchange rate volatility affected Nigeria's trade flows negatively in the short-run but does not in the long-run.

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 National Bureau of Statistics. The study employed GARCH model. Findings from the study revealed a persistent volatility in exchange rate and inflation rate in the 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 exchange rate in Nigeria. The study applied the ARCH model in its analysis. The result revealed that volatility in exchange rate significantly influenced inflation rate in Nigeria.

In addition, Ajao and Igbekoyi (2013) investigated the determinants of real exchange rate volatility in Nigeria using annual time series data from 1981 to 2008. Using Generalized Auto-regressive Conditional Heteroskedasticity (GARCH) techniques and the Error Correction Model (ECM), the result revealed that trade openness, government expenditures, interest rate and the lagged exchange rate had positive and significant effect on real exchange rate volatility during the period under investigation.

Dickson and Andrew (2013) analysed the impact exchange rate fluctuations on trade variations in Nigeria for the period 1970 - 2010. The study employed the error correction and GARCH model for the analysis and results of the study showed that exchange rate volatility was not significant in explaining variations in import, but was found to be positive and significant in accounting for variations in export.

Joseph (2011) investigated the impact of real exchange rate volatility on economic growth in Nigeria from 1970-2009. The study used the GARCH model for the analysis. Results indicated that a negative and insignificant transmission existed between exchange rate volatility and economic growth

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Aliyu (2010) analysed the impact of exchange rate volatility on Nigeria's non-oil exports using quarterly data from 1986 - 2006. Using vector error correction and the VAR model, results revealed a long-run stable and negative relationship between Naira exchange rate and non-oil exports in Nigeria.

From the literature reviewed, it is glaring that studies that examined the impact of exchange rate volatility on inflation in Nigeria are few. This study is one of very few studies that have examined the impact of exchange rate volatility on inflation in Nigeria. This study contributes to the existing literature in terms of methodology used and variables employed and scope of the study.. Unlike previous studies that measure volatility using the standard deviation to ascertain the extent to which exchange rate fluctuates in relation to its mean overtime (Achouak et al., 2018; Viola et al., 2017) this present study contributes the first logical analysis that measures volatility using the generalized autoregressive conditional heteroskedasticity (GARCH), a major lacuna that this study intends to bridge.

3. Methodology

The methodological framework for this study is based on the Generalised Autoregressive Conditional Heteroscedasticity (GARCH) model proposed by Bollerslev (1986) and Vector Error Correction Model (VECM) developed by Johansen and Juselius (1990) and Johansen. (1991) for the analysis. The study used annual time series data sourced from Central Bank of Nigeria (2019) and National Bureau of Statistics (2019).

3.1. Model Specification

This study employed the Generalised Autoregressive Conditional Heteroscedasticity (GARCH) model and Vector Error Correction Model (VECM) to examine the effect of exchange rate volatility on inflation in Nigeria. The justification for the choice of this model is based on the fact that it captures both the short-run and long-run dynamic impact of exchange rate volatility.

This study adopted and modified the empirical work of scholars like Obiekwe and Osabunhien (2016) and Achouak et al. (2018) who used GARCH and ARDL model in their analysis. The variables employed in this study include; consumer price index (CPI) nominal exchange rate (NER), money supply (MS) import (IMP) and export (EPT).

The specification of the conditional variance in a GARCH model is as shown in Equation 5

$$\lambda_t = \phi_0 + \sum \beta_i Y_{t-i} + \sum \alpha_j \varepsilon_{t-j} \quad [5]$$

where λ_t represents the exogenous variables, $\phi > 0$ to warrant that λ_t is a positive variance .

The general form of VECM model adopted for the study is specified as in Equation 6

$$\Delta \ln Y_t = \alpha_{0y} + \sum_i^n \alpha_{yi} \Delta \ln Y_{t-1} + \sum_i^n \alpha_{yi} \Delta \ln Y_{it-1} + \delta_1 \ln X_{it-1} + \delta_2 \ln X_{it-1} + \mu_t \quad [6]$$

where Δ is first difference operator, y_t is the dependent variable, which is a function of its lagged values as well as the lagged values of the independent variables, δ denotes the coefficients of the short run dynamics, μ_t is the error term.

The mathematical form of the model is specified as in Equation 7

$$CPI = f(IMP, EPT, MS, NER) \quad [7]$$

The econometric form of the model is specified as in Equation 8

$$CPI = \delta_0 + \delta_1 IMP + \delta_2 EPT + \delta_3 MS + \delta_4 NER + u \quad [8]$$

$$\ln CPI = \delta_0 + \delta_1 \ln IMP_{t-1} + \delta_2 \ln EPT_{t-1} + \delta_3 \ln MS_{t-1} + \delta_4 \ln NER_{t-1} + ECM_{t-1} + U_t \quad [9]$$

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where; CPI represents consumer price index which is used as the dependent variable while the independent variables are import (IMP), export (EPT), money supply (MS) and nominal exchange rate (NER). δ_0 is the intercept while $\delta_1 - \delta_4$ are the coefficients of the independent variables. All the variables for estimation in Equation 9 are expressed in their natural logarithmic function denoted by ln in the model. ECM_{t-1} represents one period lagged error correction term and U_t denotes error term.

3.2. A Priori Expectation

On a priori ground, we expect the value of $\delta_1 - \delta_4$ to be positive and greater than zero.

4. Results and Discussion

4.1. Test for Volatility

The test for volatility of real exchange rate was conducted by using the GARCH model. The results of volatility test are presented in Table 1.

Table-1.
Results of volatility test.

	Coefficient	Std. Error	z-Statistic	Prob.
C	1.05E+08	70338721	1.486582	0.1371
ARCH(1)	-1.043886	0.058413	-17.87068	0.0020
GARCH(1)	0.554921	0.094078	5.898532	0.0065

The result of volatility test presented in table 1 indicates that the coefficients of the GARCH(1) (0.554) is significant at 5% critical level. This implies that real exchange rate volatility measured using the GARCH model has positive and significant effect on inflationary pressure in Nigeria as shown by the z-statistic. This result is in line with studies conducted by Nkoro and Uko (2016) who discovered positive and significant effect of exchange rate volatility on inflation rate in Nigeria.

4.2. Test for Stationarity

The Augmented Dickey Fuller (ADF) unit root test was performed to ascertain the order of integration. The results of stationarity test are presented in Table 2.

Table-2.
Stationarity Test Results.

	At levels		At 1st difference			
Variables	ADF statistics	Critical value at 5%	ADF statistics	critical value at 5%	order of integration	Decision
LCPI	-2.789	-2.960	-4.336	-2.960	1(1)	Stationary
LIMP	-2.432	-2.957	-7.512	-2.960	1(1)	Stationary
LEPT	-2.467	-2.971	-3.286	-2.986	1(1)	Stationary
LMS	-0.651	-2.957	-5.282	-2.960	1(1)	Stationary
LNER	-2.607	-2.857	-4.380	-2.960	1(1)	Stationary

The results of stationarity test in table 2 indicates that, at 5% level of significance, all the series (*CPI*, IMP, EPT, MS, NER) are stationary at first difference 1(1). Since all the variables are stationary at the same level and are integrated of order one I (1), this lend support to the use of vector error correction model (VECM) . Thus, the presence of a unit root in the series suggests the need to carry out co-integration test .

4.3. Co-Integration Test

In order to determine the existence or otherwise of a long run relationship among the variables, this study used Johansen co-integration test and the results are presented in Table 3.

Table-3.
Co-integration test results.

No. of CE(s)	λ_{Trace}	5%	λ_{max}	5%
None *	68.25142	52.82613	48.40240	25.53436
At most 1	19.86882	27.79707	12.77607	21.13167
At most 2	7.092747	15.49471	7.525621	14.26460
At most 3	0.567126	3.841466	2.567126	3.841466

Note: Trace test indicates 1 cointegrating eqn(s) at the 0.05 level.
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level.
λ_{Trace} = Trace Statistic,; λ_{max} = Maximum eigenvalue.

The Johansen cointegration test results in table 3 indicates the presence of a long-run relationship among the variables in the model. This is confirmed by both the *t*race test and max-eigen value, which shows 1 cointegrating eqn(s) at the 0.05 level. These results indicate that the variables exhibit long run relationship . Having established that there is a long-run relationship among the variables, the next step was to estimate the long-run results.

Table-4.
Long-run static regression results.
Dependent variable is LnCPI

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.078473	0.022997	46.89546	0.0000
LnIMP	-2.869965	0.856351	-3.351388	0.0032
LnEPT	0.086437	0.043051	2.007793	0.0556
LnMS	0.474455	0.202164	2.346885	0.0268
LnNER	1.646799	0.774260	2.126934	0.0461
R-squared	0.770711	F-statistic		13.44527
Adjusted R-squared	0.713389	Prob(F-statistic)		0.000000
Durbin-Watson stat	2.082624			

The results of the long run regression results in Table 4 indicate that the nominal exchange rate has positive and significant effect on inflation, meaning that exchange rate volatility influences inflation in Nigeria. This is in line with a priori expectation. This result is in line with studies conducted by Obiekwe and Osabunhien (2016) who discovered a positive and significant relationship between exchange rate volatility and inflation rate in Nigeria.

From the analysis, import has a negative and significant effect on inflation in Nigeria. This negative coefficient is an indication that Nigeria is an import dependent economy ,suggesting that excessive importation of goods is inimical to the growth prospect of the economy while at the same time fuelling inflation into the economy.

The result also indicates that export has positive and significant relationship with economic growth. The coefficient of EPT is 0.086437 with a probability value of 0.0556. This is in line with a priori expectations. The result further indicates that money supply has positive and significant relationship with inflation. The coefficient of MS is 0.474455 with a probability value of 0.0268. This regression coefficient is positive and significant as shown by the probability value. This result implies that a- unit increase in MS will increase inflation by about 0.47 unit. This is in agreement with a priori expectations.

The coefficient of determination (R-square) shows that about 0.77% of the total variation in the dependent variable is explained by changes in the explanatory variables. Thus, the regression is a good fit.

The F-statistic (13.4) indicates that all the variables are jointly statistically significant at 5 per cent level as shown by the low probability value of 0.0000. The Durbin-Watson statistic of 2.08 indicates absence of autocorrelation in the estimate.

Having analysed the long-run dynamics, the next step was to analyse the short-run dynamic impact of the independent variables on the dependent variable. The results of the short-run dynamics are presented in Table 5.

Table-5.
Dynamic short-run results.
Dependent variable is *LnCPI*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.078473	0.022997	46.89546	0.0000
D(CPI(-1))	3.671029	1.036226	3.542690	0.0015
D(IMP(-1))	-0.392764	0.163190	-2.406790	0.0227
D(EPT(-1))	0.555476	0.281356	1.974282	0.0591
D(MS(-1))	1.652275	0.631799	2.615190	0.0181
D(NER(-1))	2.230552	0.681695	3.272069	0.0045
ECM(-1)	-2.163624	0.444934	-4.862798	0.0001
R-squared	0.730452	F-statistic		53.78871
Adjusted R-squared	0.681444	Prob(F-statistic)		0.000000
Durbin-Watson stat	2.023522			

The short- run results in Table 5 indicate that the lagged value of EPT, MS and NER exert positive and significant effect on inflation during the period of investigation. The signs of the coefficients are as theoretically expected. The R-square from the estimates is about 73 percent, suggesting that the model has a good fit.

The coefficient of the error correction (ECM) is negative and significant, confirming the long run relationship among the variables. The coefficient of the error term is -2.163624 which indicates that about 21 % of the disequilibria of the previous year's shocks will be corrected in the current year.

4.4. Diagnostic Tests

4.4.1. Heteroskedasticity Test Results

Heteroskedasticity was tested using the Autoregressive Conditional Heteroskedasticity (ARCH) test. The results of White Heteroskedasticity test are presented in Table 6.

Table-6.
Results of white heteroskedasticity test.

F-statistic	0.040456	Probability	0.841995
Obs*R-squared	0.043186	Probability	0.835375

The results on Table 6 indicate that the F-statistic is 0.040 with a probability value of 0.841. The observed R-squared is 0.043 with a probability value of 0.835, which is greater than 0.05. This result indicates that there is no evidence of heteroskedasticity in the model.

4.4.2. Results of Serial Correlation Test

Test for autocorrelation was performed using Breusch-Godfrey Serial Correlation LM test. The results are presented in Table 7.

Table-7.
Results of serial correlation LM test:

F-statistic	9.002445	Probability	0.001010
Obs*R-squared	13.20215	Probability	0.001359

The Serial Correlation LM test results indicate that the value of F-statistic is 9.002 and observed R^2 is 13.202 with probability values of 0.0010 and 0.0013 respectively. Since this probability values are greater than 0.05, we conclude that there is absence of serial correlation in the estimates.

4.4.3. Results of Normality Test

The Jarque-Bera normality test was carried out to ascertain the normality of residuals in the model using histogram-normality test. The results of the normality test are presented in Figure 1.

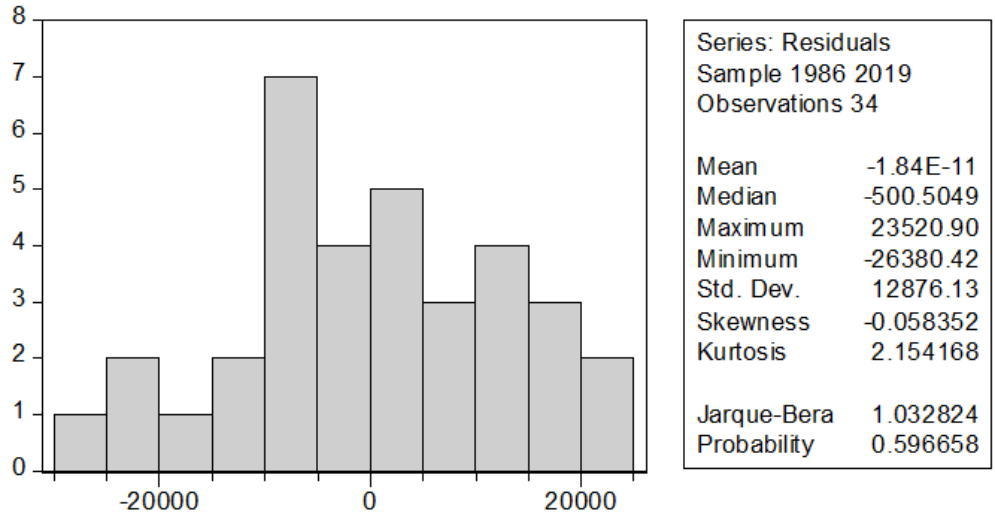

Figure-1.
Results of jacrque -bera normality test.

The result of the normality test shows a probability value of 0.5966 which is greater than 0.05. This result indicates that the residual is normally distributed.

4.4.4. Results of 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 stability test are presented in Figure 2a and 2b.

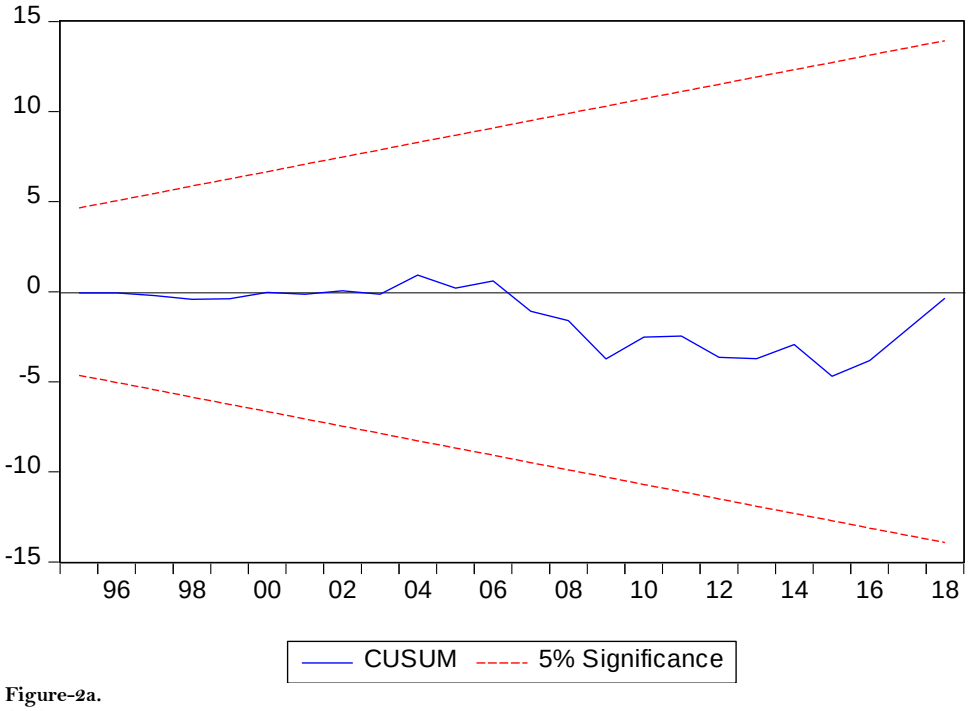

Figure-2a.
CUSUM Test.

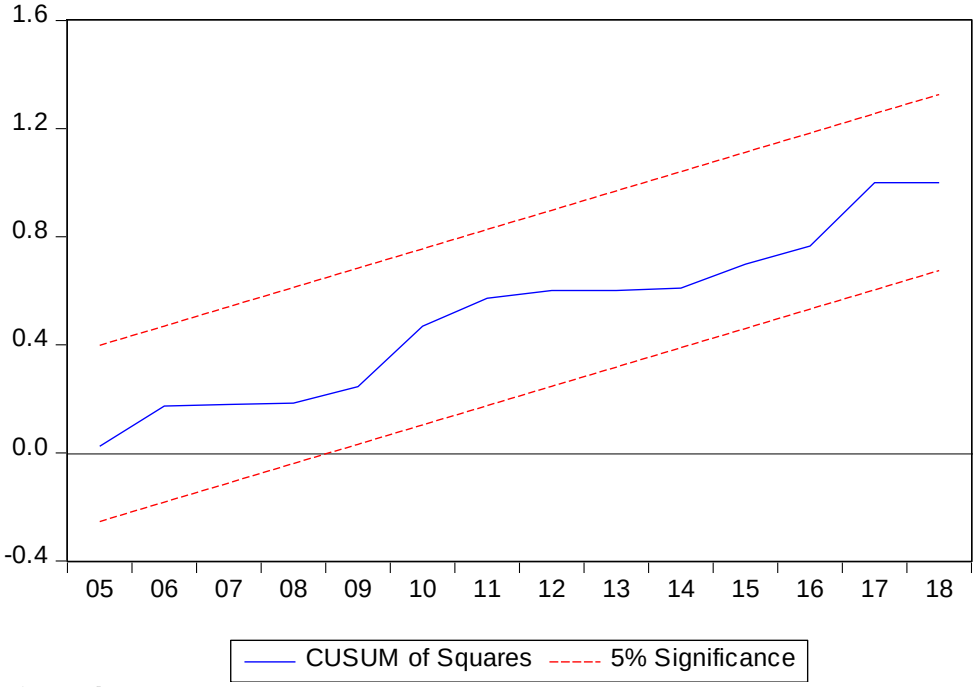

Figure-2b.
CUSUM of squares test.

The analysis in Figure 2a and 2b indicate that both the graph of CUSUM and CUSUM of squares are stable because the recursive residuals fall within the critical lines, meaning that they

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are all within the 5 % critical bounds. This result implies that the estimated parameters for the study are stable for the period under investigation.

5. Conclusion and Recommendations

This paper examined the effect of exchange rate volatility on inflation in Nigeria for the period 1986-2019. The results from VECM indicated that money supply (MS) and nominal exchange rate (NER) exerted positive and significant effect on inflation rate in Nigeria during the period under investigation. The policy implication of this result is that an increase in money supply is capable of fuelling inflationary pressure in Nigeria. Based on the findings, the following recommendations were made:

1. The Central Bank should regulate the amount of money supply in the economy. This is because an increase in money supply generally leads to inflation and to control inflation the volume of money supply should be properly monitored by the CBN .
2. 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 stable exchange rate by allowing it to be determined competitively.
3. There is need to reduce excessive importation of some goods. Inflation may be imported from countries experiencing general rise in prices. A rise in the cost of imported goods can have a spillover effect on the domestic economy. These higher prices, in turn, affect other local prices and further worsen the inflationary situation in the domestic economy.

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