Nigerian Monetary Policy (1991-2021): Money Supply Rate and Inflation Rate

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Monetary policy can be so dicey or delicate that it requires great tact from the monetary authority. Contractionary monetary policy, when pushed too far, drags the economy to recession while` extreme expansionary monetary policy sinks the economy to liquidity trap. Central banks are in charge and are expected to favorably run the monetary policy by adjusting interest rates, influencing local lending rates, buying foreign currency, printing money, and use of other tools to modulate currency exchange rates, manage inflation, etcetera, with a sole target of creating a healthy economy. This study looks into the effect of money supply rate, exchange rate and interest rate on inflation rate in Nigerian economy between 1991 and 2021. With secondary data, the variables are found to be of mixed order of integration and, therefore, the ARDL model is our parameter estimator. Our model is found to be stable and our empirical investigation reveals that both money supply rate and interest rate in Nigeria have no significant effect on Nigeria's inflation rate while exchange `rate has a significant inverse effect on Nigeria's inflation rate – the less favorable the exchange rate, the more biting the inflation. The study is wrapped up `with a recommendation that Nigerian government/authorities should rise up to occasion of fixing the insecurity challenges of the nation so as to create safe environment that can attract local investments as well as foreign direct investments which, among other benefits, will be favorable to Nigeria in exchange rate.

Keywords: Monetary policy; inflation rate; money supply rate; exchange rate and interest rate.

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1. INTRODUCTION

One of the positive effects of the first and second world wars was the introduction of apex bank in all the countries of the world as it was unanimously dialogued, agreed and implemented by the united nation after the second war in 1945 where the apex or central banks were granted the veto power to manage, ruin, control and administer the financial affairs of their respective country's economy, hence the establishment of CBN in 1958 Act of Parliament with monetary policy as one of the possible strategies to achieve the desired stability in economic growth and development.

Monetary policy has been attempted to be defined by various authors depending on their respective professions cum background. However, monetary policy can be summarized as the imperative measures adhered to ensure the stability of any economy by controlling the demand and supply of money at all levels. Monetary policy can obviously be effective mostly when an economy is associated with well-developed money and financial markets hence that is how deliberate change in monetary variable influences the movement of many other variables such as interest rate, discount rate, liquidity ratio among others in the monetary sector.

Just as other central or apex banks in various economies in the world, Central Bank of Nigeria (CBN) as the custodian of economic growth and development in Nigeria always aim at maintaining favorable general price stability in the economy using the dynamics of the monetary policy instruments which include money supply, exchange rate and interest rate. Where a rise in money supply does not increase the interest rate and income hence it does not stimulate economic growth then an unhealthy economy called liquidity trap [1,2].

Monetary policy can however be described as measures that are adopted by the CBN through the monetary authorities of` a nation to keep in check either the interest rate payable for` very short-term borrowing (borrowing by banks from each other` to meet their short-term financial obligations) or money supply which usually attempts to scale down inflation and/or interest rate to ensure price, currency, value and general stability of the nation's economy [3-5]. However, monetary authorities can influence the quantity of money supply in the economy, either by expansionary or contractionary monetary policy. When the money supply is increased, it is an expansionary policy and when money supply is decreased, it is usually termed as a contractionary monetary policy.

An expansionary policy maintains short-term interest rates at a rate lower than usual or increases the total money supply in the economy more rapidly than usual. It is usually meant to scale down unemployment in any economy during recession by scaling down interest rates in the expectation that less expensive credit which will lure businesses into borrowing more money and thereby expanding their businesses/ventures. Thus this in other wards pushes aggregate demand upwards and resultant short-term growth as measured by an increase in GDP while expansionary measure scales down the exchange rate by pushing upwards the amount of currency in circulation [6-8].

However, whether the CBN applies contractionary or expansionary policy measure, it is pertinent that some paramount strategic instruments will be adopted in order to achieve the stipulated goals and objectives of economic stabilization in any economy in the world which ranges from interest rate, inflation rate, exchange rate and any other factor as it may be considered by the government of the nation through their apex bank [9,10].

Nevertheless, it is crystal clear that there is an inter connectivity between the monetary policy instruments such as interest rate, exchange rate, discount rate liquidity ratio among others and economic growth cum stability of an economy. To this end this research is to examine the effect of monetary policy on inflation rate in Nigeria with other specific objectives which are:

(i) to ascertain the extent to which money supply rate causes inflation in Nigeria.
(ii) to assess the extent to which the interest rate causes the inflation rate in Nigeria.
(iii) to determine the extent to which exchange rate causes inflation rate in Nigeria.

The following research questions have been designed as follows:

i. To what extent does money supply rate influenced inflation rate in Nigeria?
ii. How has interest rate effect inflation rate in Nigeria?

iii. To what extent does exchange rate effect inflation rate in Nigeria?

The following hypotheses, therefore, are to be tested in this study:

i. H_O^1:   money supply rate in Nigeria has no significant effect on inflation rate in Nigeria.
ii. H_O^2: interest rate in Nigeria has no significant effect on inflation rate in Nigeria.
iii. H_O^3: exchange rate has no significant effect on inflation rate in Nigeria

This study is very useful to banking and non banking financial institutions that would see the findings of this study useful in proactive planning strategies for operations just as it is expected that policy makers would also take it as guide in adopting suitable monetary policy measures to regulate economic growth in Nigeria and beyond. It however adds to the existing literatures in monetary policy and inflation control in Nigeria; a good reference material for researchers.

The scope of the study of empirical investigation involves variables in Nigeria's inflation rate, money supply rate, exchange rate and interest rate ranging from 1991 to 2021.

2. LITERATURE REVIEW

2.1 Conceptual Review

2.1.1 Monetary policy

The essence and importance of monetary policy in any economy like Nigeria cannot be over emphazised because monetary policy plays a vital role in the economy and it's impact as a tool for stabilization of the economy have changes on several economic growth indicators especially on commercial banks liquidity and profitability which increasingly concerns the economists and policy makers of our time as both financial and non financial sectors conditions have become volatile in recent years.

Monetary policy is one of the tools of controlling money supply in an economy of a nation by the monetary authorities in order to achieve a desirable economic growth. Governments try to control the money supply because most governments believe that its rate of growth has an effect on the rate of inflation. Hence, monetary policy comprises those government actions designed to influence the behaviour of the monetary sector.

Monetary policy is one of the instruments that government uses to regulate money in circulations in other wards Monetary policy refers to the credit control measures adopted by the central bank of a country which made Anyawu (2003), defined "monetary policy as the combination measures designed to regulate the value, supply and cost of money in an economy in consonance with the expected level of economic activity hence, it is designed to influence monetary variables or aggregates".

Samiksha S. (2001) classified "instruments of monetary policy as two types first, quantitative (known to be indirect or general) and second, qualitative (known to be direct or selective). Both types of the instruments affect the level of aggregate demand through the money supply, cost of money and availability of credit. Of the two types of instruments, the first category includes open market operations, bank rate variations and changing reserve requirements. They are meant to regulate the overall level of credit in the economy through commercial banks. The selective credit controls target at controlling specific types of credit. They include regulation of` consumer credit and changing margin requirements".

2.2 Theoretical Review

2.2.1 Reformulated quantity theory of money (1936)

Keynes (1936) rejected the Quantity theory of Money in the short run because their assumptions (Y was fixed at full employment and V was fixed) do not apply in an uncertain real world with high level of unemployment. Keynes argues that changes in money supply is not the only reason for changing the general price level, but there are other variables that affect the price level which is the employment of production factors. This brought about Keynes Reformulated Quantity theory of Money. Keynes used it to show the relationship between money, output and prices. Keynes points out that so long as there is unemployment, output will change in the same proportion as the quantity of money and when there is full employment, price's will change in the same proportion as the quantity of money. "Keynes developed his own quantity equation: n= p(k + rk') where n is the number of currency notes or other forms of cash in circulation with the public", p is the index number of the cost of living", and r is the proportion of the bank's potential liabilities, (k1) is held in the form

of cash. Keynes also assumes the public (k1) including the business world finds it convenient to keep the equivalent of k consumption in cash and of a further available k' at their banks against cheques. So long as k, k' and r do not change, changes in n causes proportional changes in p". (Friedman, 1968).

"Keynes thus accepts the Quantity theory as accurate over the long run but not over the short-term. Keynes remarks that contrary to contemporaries thinking, velocity and output will not be stable but highly variable and as such, the quantity of money was of little importance in driving prices" (Friedman, 1968).

Mises (1912), agreed that "there was a core of truth in the Quantity theory but criticized its focus on the supply of money without adequately explaining the demand for money. He said the theory fails to explain the mechanism of variations in the value of money". Keynes theory is based on the following assumptions:

1) All factors of production are in perfectly elastic supply so long as there is any unemployment.
2) All employed factors are homogenous, perfectly divisible and interchangeable.
3) There are constant returns to scale so that prices do not rise or fall as output increases.
4) Effective demand and quantity of money change in the same proportion so long as there are any unemployed resources.

Given this assumptions, the Keynesian chain of causation between changes in the quantity of money and in prices is an indirect one through the rate of interest. An increase in the money supply leads to a fall in the interest rate and an increase in investment expenditure. Keynes therefore implied that increase in investment will raise effective demand through the multiplier effect thereby increasing income, output and employment. His position is that there being constant return to scale, prices do not rise with the increase in output so long as there is any unemployment. Under the circumstances, output and employment will increase in the same proportion as effective demand and the effective demand will increase in the same proportion as the quantity of money. Therefore, the reformulated quantity of money stresses the point that with increase in the quantity of money, prices rise only when the level of full employment is reached and not before this. The reformulated quantity theory of money is illustrated in Fig. 1 (A) and (B) where OTC is the output curve relating to the quantity of money and PRC is the price curve relating to the quantity of money. Panel A of the figure shows that as the quantity of money increases from 0 to M, the level of outputs also rises along the OT portion of the OTC curve.

As the quantity of money reaches OM level, full employment output OQf is being produced. But after point T, the output curve becomes vertical because any further increase in the quantity of money cannot raise output beyond the full employment level OQf.
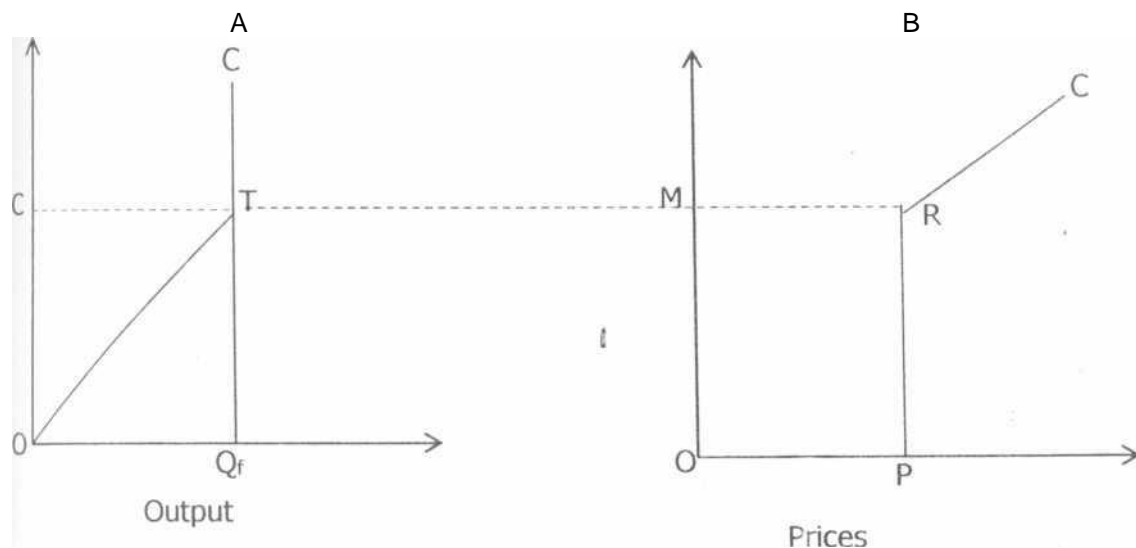

Fig. 1. Relationship between quantity of money and prices

Panel (B) of the figure above shows the relationship between quantity of money and prices. So long as there is unemployment, prices, remain constant whatever the increase in the quantity of money. Prices start rising only after the full employment level is reached.

In the figure above, the price level OP remains constant at the OM quantity of money responding to the full employment level of output OQf. But an increase in the quantity of money above OM raises prices in the same proportion as the quantity of money. This is shown by the RC portion of the price curve PRC. Keynes himself pointed out that the real world is so complicated that the simplified assumptions upon which the reformulated quantity of money is based, will not hold. According to Keynes (1936), the following possible complications would qualify the statement that so long as there is unemployment, output will change in the same proportion as the quantity of money and when there is full employment, prices will change in the same proportion as the quantity of money. The following are Keynes assumption after considering the real world complication;

1. Effective demand will not change in exact proportion to the quantity of money.
2. Since resources are homogenous, there will be diminishing and not constant returns as employment gradually increases.
3. Since resources are not interchangeable, some commodities will reach a condition of inelastic supply while there are still

unemployed resources available of the production of their commodities.

4. The wage-unit will tend to rise, before full employment has been reached. Taking into account these complications, it is clear that the reformulated quantity theory of money does not hold. An increase in effective demand will not change in exact proportion to the quantity of money, but it will partly spend itself increasing output and partly increasing the price level. So long as there are unemployed resources, the general price level will not rise much as output increases. But a sudden large increase in aggregate demand will encounter bottlenecks when resources are still unemployed. The complicated model of the Keynesian theory of money and prices is shown diagrammatically in Fig. 2 below in terms of aggregate supply (S) and aggregate demand (D) curves. The price level is measured on the vertical axis and output on the horizontal axis.

2.2.2 The quantity theory of money by Friedman (1956)

Kirti Shailesh (2021), Friedman in his essay, "The Quantity Theory of Money-A Restatement" published in 1956 beautifully restated "the old quantity theory of money. Friedman, in his restatement, says that "money does matter". For a better understanding and appreciation of` Friedman's modern quantity theory, it is necessary to state the major assumptions and beliefs of` Friedman".
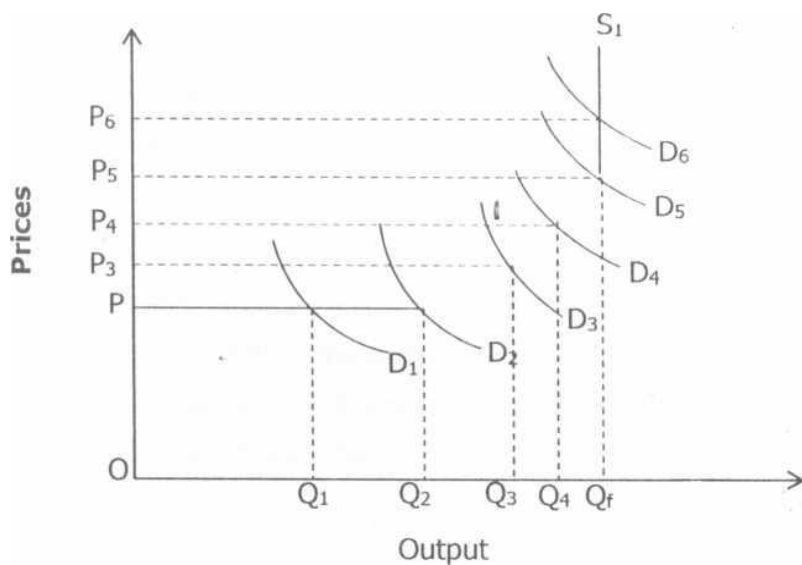
Fig. 2. Demand for money

Firstly, Friedman says that his quantity theory is a theory of demand for money and not a theory of output, income or prices.

Secondly, Friedman distinguishes between two types of demand for money. First, money is demanded for transaction purposes. It serves as a medium of` exchange. This view of` money is the same as the old quantity theory. In the second type however, money is demanded because it` is considered as an asset. Money is more basic than the medium of` exchange. It is a temporary abode of` purchasing power thus an asset or a part of wealth. Friedman sees the demand for money as an important part of the wealth theory.

Thirdly, Friedman treats the demand for money just like the demand for any durable consumer good. He says that the demand for money depends basically on three factors:

(a) The total wealth held in various forms
(b) The prices or returns from these various assets and
(c) Tastes and preferences of` the asset holders.

Friedman considers five different forms in which wealth can be held, namely: money (M), equities (E), bonds (B), physical non-human goods (G) and human capital (H). In a broader sense, total wealth consists of all types of "income". By "income" Friedman means "aggregate nominal permanent` income" which is the average expected yield from wealth during its life time.

The wealth holders distribute their total wealth among its various forms so as to maximize utility from them. They distribute the assets in a way that the rate at which they can substitute one form of wealth for another is equal to the rate at which they are willing to do.

Accordingly, the cost of` holding various assets except human capital can be measured by the rate of` interest on various assets and the expected change in their prices. Friedman thus says there are four factors which determine the demand for money. They are: real income, price level, rate of interest and rate of increase in the price level.

The demand for money is unitarily elastic. The relationship between the demand for money and real income (output of goods and services) is also direct. But it is not proportional as in the case of price. Thus, while changes in the price level cause direct and proportional changes in the demand for money, changes in real income create direct but more than proportional changes in the demand for` money.

The rate of` interest and the rate of rise in the price level constitute the cost of holding cash balances. If money is kept in the form of cash, it does not earn any income. But if the same money is lent out, it could earn some income in the form of interest to the owner.

The interest is the cost of holding cash. At higher interest rate the demand for money would be less. On the other hand, a lower rate of interest creates a rise in the demand for money. Thus, there is an inverse relationship between the rate of interest and the demand for money.

The rate of increase in the price level also influences the demand for money. There is an inverse relationship between the rate of increase in the price level and the demand for money. When the price level increases at a high rate, the cost of holding money will increase.

The people would like to hold smaller cash balances. The demand for money will reduce. On the flipside, when the price level goes up at a low rate, the cost of holding money will reduce and the demand for money rises.

Fourthly, Friedman is of the belief that each form of wealth has its own characteristics and a different yield or return. In a broader sense, money includes currency, demand deposits and time deposits which yield interest. Money also yields real return in the form of` convenience, security etc., to the holder which is measured in terms of` price (P). When the price level scales down, the rate of returns on money is positive because the value of money rises. When the price level goes up, the value of money declines and the rate of return is negative. Thus, P is a very important variable in the demand function of Friedman.

The rate of return on equities, bonds and physical assets consists of` currently paid interest rate and changes in their prices. When it comes to human wealth, it is very difficult to measure the conversion of` human into non-human wealth owing to institutional constraints. But there is some likelihood of` substituting human wealth for non-human wealth.

Freidman terms the ratio of` non-human wealth to human wealth or ratio of` wealth to income as

W. Income elasticity of demand for money, according to Friedman, is greater than unity. Moreover, there are certain variables like the tastes and preferences of the wealth holders which also affect the demand functions. These variables are represented by m.

Friedman has derived a demand function for an individual wealth holder on the basis of the above assumptions and formulations. It can be symbolically expressed as

$$M = f\left[p, r_b - \frac{1}{r_b} \cdot \frac{dr_b}{dt}; \ r_e + \frac{1}{p} \cdot \frac{dp}{dt} - \frac{1}{r_e} \cdot \frac{dr_e}{dt}; \frac{1}{p} \cdot \frac{dp}{dt}; \ w; y; m\right] \dots \dots \dots \dots \quad (1)$$

Where M equals the total demand for money, P equals the general price level,

r_b equals the market interest rate on bonds, r_e equals the market interest rate on equities,

$\frac{1}{p} \cdot \frac{dp}{dt}$ is the nominal return from physical goods, w is the ratio of non-human to human wealth,

Y is the money income available to the wealth holder, m is the variables affecting tastes and preferences on the wealth holders.

By assuming r_b and r_e to be stable, Friedman replaces the variables representing the return on bonds and equities

$$\left[r_b, \frac{1}{r_b} \cdot \frac{dr_b}{dt}\right] + \left[r_e + \frac{1}{p} \cdot \frac{dp}{dt} \frac{1}{r_b} \cdot \frac{dr_e}{dt}\right]$$

in equation 1 by simply r_b and r_e. With this replacement, the demand function can be written as

$$M = f\left(P, r_b; \ r_e; \ \frac{1}{p} \cdot \frac{dp}{dt} w; y; \mu\right) \dots \dots \dots \dots \quad (2)$$

Further Friedman states that when there are changes in money income and price, there will be a proportionate change in the demand for money. This implies that equation 2 must be taken as homogenous of the first degree in P and Y, and equation 2 becomes

$$IM = f\left(\lambda P, r_b; \ r_e; \ \frac{1}{p} \cdot \frac{dp}{dt} w; \lambda y; \mu\right) \dots \dots \dots \dots \quad (3)$$

Putting $\lambda = \frac{1}{p}$, equation 3 can be written as

$$\frac{M}{p} = f\left(r_b; \ r_e; \ \frac{1}{p} \cdot \frac{dp}{dt}; w\frac{\gamma}{p}; \mu\right) \dots \dots \dots \dots \quad (4)$$

In this form, the equation 4 shows the demand for real cash balances as a function of "real" variable.

Putting $\lambda = \frac{1}{\gamma}$, equation 3 can be given as

$$\frac{M}{\gamma} = f\left(r_b; \ r_e; \ \frac{1}{p} \cdot \frac{dp}{dt}; w; \frac{P}{p}; \mu\right) \dots \dots \dots \dots \quad (5)$$

Or $M = f\left(r_b; \ r_e; \ \frac{1}{p} \cdot \frac{dp}{dt}; w; \frac{P}{p}; \mu\right) \gamma \dots \dots \dots \dots$ (6)

Friedman's modern quantity theory of money shows that the supply of money is independent of demand for money owing to the actions of the monetary authorities, the supply of money changes, while the demand for money remains more or less stable. It implies that the amount of money which people wish to have as cash or bank deposits is more or less fixed to their permanent income.

If the central bank buys securities, people who sell securities to the central bank receive money and this leads to a rise in their cash holdings. The people will spend this excess money partly on consumer goods and partly by buying assets. This spending will scale down their cash balances and at the same time there is an increase in the national income.

On the other hand, when the central bank sells securities, the money holding of the people drop, in relation to their permanent income. Therefore, they will try to push up their cash partly by reducing their consumption and partly by selling their assets. This will scale down national income and in both cases, therefore, the demand for money remains stable.

When the demand for money is given, it is possible to predict the effects of changes in the supply of money on expenditure and income. If the economy is at less than full employment level, a rise in the money supply increases the expenditure, employment and output levels. This is, however, possible only in the short run.

2.3 Empirical Review

Babalola et al. [11], studied "the effect of inflation and interest rate on economic growth using

secondary data sourced from World Bank databank and Central Bank of Nigeria. The study adopted ordinary least square (OLS) method of analysis. The long run relationship between the variables was analyzed using the Johansen integration test. The Augmented Dickey Fuller test performed showed that only inflation is not stationary` at first difference. The direction of` causality and trend analysis was also performed on variables. It was found that Inflation and Interest rate has a negative effect on Economic growth but neither Inflation nor Interest rate granger causes economic growth. Babalola et al recommended that policy makers should focus on maintaining inflation at a low rate (single digit) and ensuring interest rate stability".

Mukhtar et al. [12], examined "the effect of money supply on Economic Growth in Nigeria using annual time series data for the period 1981 – 2015. Johansen co-integration approach was used to check the long run relationship among the variables while Vector Error Correction Model (VECM) was used to measure the short run dynamics and the pairwise Granger causality test was used to check the direction of the causality between the variables. The empirical result confirmed long run relationship among the variables where money supply and interest rate showed positive significant impact while real exchange rate had negative significant impact on the economy. However, in the short run lagged value of money supply had negative significant effect but lagged value of exchange rate showed negative significant effect while lagged value of GDP and lagged value of interest rate did not have any significant effect on the economy. The causality test revealed bidirectional causality between money supply and GDP, unidirectional causality running from exchange rate to money supply and interest rate to money supply while there is no causality between exchange rate and GDP, interest rate and GDP, and also interest rate and exchange rate. In the conclusion, the study recommended expansionary monetary policy for achieving economic growth in Nigeria in addition to greater emphasis on the improvement of monetary policies and institutions for ensuring effective and efficient monetary system in Nigeria". `

Dinh Doan Van [13], in his study of` "supply and inflation impact on economic growth applied the economic theories of Fisher, Friedman to analyze econometrically, the relationship between money supply and inflation. Vietnam's and China's research data were collected in the period of 2012-2016. His study found out that the continuous increase in the money supply caused inflation in the long-term, but the continuous increase in the money supply growth did not cause inflation in a short time; this was analyzed based on the theory of monetary quantity. The study showed that inflation and money supply were closely related, and that money supply directly affected economic growth. He therefore proposed that government should have the relevant monetary policy to grow the economy and proposals to make monetary policy, control inflation levels and stimulate economic growth".

Amassoma, et al. (2011), examined "the effect of monetary policy on macroeconomic variables in Nigeria for the period 1986 to 2009 by adopting a simplified Ordinary Least Squared technique found that monetary policy had a significant effect on exchange rate and money supply while monetary policy was observed to have an insignificant influence on price instability, therefore recommended that government should consider necessary factors in setting exchange standards in Nigeria".

Ajisafe and Folorunso (2002) examined "the relative effectiveness of monetary and fiscal policy on economic activity in Nigeria using co-integration and error correction modeling techniques and annual series for the period 1970 to 1998. The study revealed that monetary rather than fiscal policy exerts a greater impact on economic activity in Nigeria and concluded that past emphasis on fiscal measures by the government has led to greater distortion in the Nigerian economy".

Hameed et al. (2012), in "presenting a review on how the decisions of monetary authorities influence macro variables like GDP, money supply, interest rates, exchange rates and inflation using the method of ordinary least square OLS found that tight monetary policy (in term of increase interest rate) had significantly negative impact on output, therefore asserting that increase in money supply has strong positive impact on inflation but affects output negatively. In addition to this exchange rate was found to be negatively related to output and in recommendation the study advised that there should be caution on planning and implementing increase and decrease in money supply".

Chukuigwe and Abili (2008) analyzed "the impact of monetary and fiscal policies on non-oil exports in Nigeria from 1974 to 2003. Using Ordinary

Least Squares estimation, the study revealed that both interest rate and exchange rate, both proxies for monetary policy negatively affect non-oil exports. Similarly, budget deficits—proxy for fiscal policy also had a negative effect on non-oil exports. He therefore recommended the introduction of new strategies for monetary policy implementations to address this problem".

3. RESEARCH METHODOLOGY

3.1 Research Design

The study is basically an empirical Investigation of the effect of money supply rate, exchange rate and interest rate on inflation rate in Nigerian economy between 1991 and 2021 using secondary data

3.2 Model Specification

The lag structure is chosen by default. The ARDL model is our parameter estimator and we go with the structural form $ARDL\ (p, q_1, q_2, q_3)$ where p, q_1, q_2, q_3 are the optimal lag structures of inflation rate (Inf), Exchange rate (Exch), Interest rate (Int) and money supply rate (MSR) respectively.

The model is specified as follows:

$\Delta Inf_t =$
$\beta_0 + \sum_{i=1}^{p} \beta_{1i}\Delta(Inf)_{t-i} + \sum_{j=0}^{q_1} \alpha_j\Delta(Exch)_{t-j} +$
$k=0q2\delta k\Delta(Int)t{-}k+$
$l=0q3\omega l\Delta(MSR)t{-}L+\varphi 1(Inf)t{-}1+$
$\varphi 2(Exch)t{-}1+\varphi 3(Int)t{-}1+\varphi 4(MSR)t{-}1+\mu t.$

Where:

$\sum_{i=1}^{p} \beta_1\Delta(Inf)_{t-i} + \sum_{j=0}^{q_1} \alpha_j\Delta(Exch)_{t-j} +$
$k=0q2\delta k\Delta(Int)t{-}k+\ l=0q3\omega l\Delta(MSR)t{-}L$ is the short-run specification

and $\quad \varphi_1(Inf)_{t-1} + \varphi_2(Exch)_{t-1} + \varphi_3(Int)_{t-1} +$ $\varphi_4(MSR)_{t-1}$ is the short-run specification.

μ_t is the disturbance term or the white noise term. Δ = the difference operator, β_0, β_1, α_j, δ_k, ω_l and $\varphi_i (i = 1, 2, 3, 4)$ are the parameters.

3.3 Source of Data

Annual time series data from 1991 to 2021 are used in this study and the following websites are the sources of the data:
https://www.worlddata.info,
www.globalhungerindex.org,
https://www.theglobaleconomy.com/download-data.php and
https://www.ceicdata.com/en/indicator/nigeria/money-supply-m2

3.4 Model Estimation/ Method of Data Analysis

The empirical investigation will take the following steps:

- Examination of the stationarity of the variables using the Unit Root Test
- ARDL Cointegration Tests: The Bounds Test, Long-run relationship and Short-run relationship tests.
- Examination of the causal relationships among the variables using the Granger Causality Test and
- Diagnostic Tests.

4. RESULTS AND DISCUSSION

4.1 Multicollinearity Test

Since the Centered VIF coefficients are less than 10 for all the explanatory variables, we conclude that no severe multicollinearity exists in the model.

Table 1. Multicollinearity test

Variance Inflation Factors
Date: 03/05/22 Time: 18:50
Sample: 1989 2019
Included observations: 31

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	418.8070	62.88214	NA
EXCH	0.002241	4.690781	1.266752
INT	0.793140	48.29820	1.293001
MSR	1.58E-08	1.088624	1.053075

Table 2. Unit root test from eviews 9

Series	5%Crit. value @ Level	ADF t-Stat. @ Level	5%Crit. value @ 1st Difference	ADF t-Stat. @1st Difference	Order of Integration
Inf	−2.963972	−2.920806	−2.967767	−6.169967	$I(1)$
MSR	−2.963972	−5.477982	-	-	$I(0)$
Int	−2.963972	−2.836599	−2.967767	−7.230789	$I(1)$
Exch	−2.963972	−1.022490	−2.967767	−5.292419	$I(1)$

4.2 Summary of the Unit Root Test Results

The unit root test result above shows that Money Supply Rate (MSR) is stationary at level while Inflation rate (Inf), Interest rate (Int), and Exchange rate (Exch) are all stationary at 1st difference. We have a mixed order of integration. ARDL Bounds test is therefore needed to investigate the cointegration or long-run relationship of the variables.

4.3 ARDL Cointegration Tests

4.3.1 Bounds test

From the table, F-statistic value (9.937558) is greater than the upper bound 5% critical value. We therefore reject the null hypothesis which states that "No long-run relationships exist".

Thus, we uphold that long-run relationships exist amongst the variables.

4.3.2 ARDL short-run cointegration and long run coefficients test

Table 3 shows that in the short-run, inflation rate lag 1 is statistically significant and in direct relationship with the current inflation rate. 1% increase in inflation rate lag 1 brings about 0.497749% increase in the current inflation rate. The current exchange rate is statistically significant and in inverse relationship with the current inflation rate. 1% increase in exchange rate will bring about 0.369458% decrease in the inflation rate. Interest rate lag 1 is significant and in inverse relationship with the current inflation rate. 1% increase in interest rate lag 1 brings about 2.567128% decrease in the current inflation rate.

Table 3. Bounds test from eviews 9

ARDL Bounds Test		
Date: 02/26/22 Time: 11:10		
Sample: 1991 2019		
Included observations: 29		
Null Hypothesis: No long-run relationships exist		
Test Statistic	Value	k
F-statistic	9.937558	4
Critical Value Bounds		
Significance	**I0 Bound**	**I1 Bound**
10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.74	5.06

Table 4. ARDL cointegration tests

ARDL Cointegrating And Long Run Form
Dependent Variable: INF
Selected Model: ARDL(3, 4, 4, 0)
Date: 02/26/22 Time: 11:48
Sample: 1989 2019
Included observations: 27
Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INF(-1))	0.497749	0.170098	2.926244	0.0127
D(INF(-2))	0.565810	0.177226	3.192584	0.0077
D(EXCH)	-0.369458	0.104346	-3.540707	0.0041
D(EXCH(-1))	-0.044525	0.108538	-0.410229	0.6889
D(EXCH(-2))	0.116954	0.109849	1.064679	0.3080
D(EXCH(-3))	-0.213350	0.079904	-2.670086	0.0204
D(INT)	0.533586	0.625232	0.853420	0.4101
D(INT(-1))	-2.567128	0.621811	-4.128473	0.0014
D(INT(-2))	0.272430	0.847667	0.321388	0.7534
D(INT(-3))	1.986098	0.766139	2.592347	0.0236
D(MSR)	-0.000049	0.000053	-0.921616	0.3749
CointEq(-1)	-1.101567	0.223812	-4.921830	0.0004
Cointeq = INF - (-0.2129*EXCH -0.3465*INT -0.0000*MSR + 53.2063)				
Long Run Coefficients				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
EXCH	-0.212926	0.034040	-6.255178	0.0000
INT	-0.346507	0.872330	-0.397221	0.6982
MSR	-0.000044	0.000050	-0.880767	0.3957
C	53.206266	20.241851	2.628528	0.0220

Source: eviews9 output

Money Supply Rate is not statistically significant. It means that Money Supply Rate has no significant impact on inflation rate in Nigeria.

The long-run cointegrating equation is

$$Inf = 53.2063 - 0.2129(Exch) - 0.3465(Int) - 0.0000(MSR)$$

In the long-run, both the exchange rate and the interest rate are in inverse relationship with the inflation rate. However, while this inverse effect of the exchange rate on the inflation rate is statistically significant, that of interest rate is not.

1% increase in exchange rate will bring about 0.2129% decrease in the inflation rate. Our result shows that no significant relationship exists between the money supply rate and the inflation rate.

The error correction term ECT (-1) is significant, properly signed and the speed of adjustment towards long-run equilibrium is -1.101567. This means that approximately 110% of the error is corrected in each period. This high speed of adjustment implies that all deviations/errors will be corrected within one year to bring the system to long-run equilibrium.

Table 5. Granger causality test

Pairwise Granger Causality Tests			
Date: 02/26/22 Time: 19:19			
Sample: 1989 2019			
Lags: 4			
Null Hypothesis:	**Obs**	**F-Statistic**	**Prob.**
EXCH does not Granger Cause INF	27	3.09660	0.0419
INF does not Granger Cause EXCH		4.52560	0.0105
INT does not Granger Cause INF	27	5.20032	0.0058
INF does not Granger Cause INT		3.42468	0.0300
MSR does not Granger Cause INF	27	0.08066	0.9873
INF does not Granger Cause MSR		0.06103	0.9925
INT does not Granger Cause EXCH	27	1.37421	0.2822
EXCH does not Granger Cause INT		1.18794	0.3497
MSR does not Granger Cause EXCH	27	0.00856	0.9998
EXCH does not Granger Cause MSR		0.90106	0.4839
MSR does not Granger Cause INT	27	0.24235	0.9105
INT does not Granger Cause MSR		0.49352	0.7406

Source: eviews9 output

4.4 Granger Causality Test

The Granger Causality test results above examines causal relationship amongst the variables. As usual, only two variables are considered at a time and the two variables are both dependent and in turn independent. The test gives us the direction of causality among these variables, and three types of causal relationship exist. Viz: Bidirectional causality, Unidirectional causality and No causal relationship.

In our test results above, we observed that at 5% level of significance, there is bidirectional relationship between exchange rate and inflation. Bidirectional relationship also exists between interest rate and inflation. No other causal relationship exists between any other pair of variables.

4.5 Diagnostic Tests

4.5.1 Breusch-godfrey serial correlation LM test

Here, we test for autocorrelation. This is to find out if our model is free from serial correlation.

H_O: There is no autocorrelation.

The result in the table shows that Prob. Chi-Square of 0.1864, which is not significant at 5% level of significance. We cannot therefore reject the null hypothesis. Thus, our model has no significant trace of autocorrelation.

4.5.2 Breusch-pagan-godfrey heteroskedasticity test:

H_O: There is no Heteroskedasticity

The result shows that Prob. Chi-Square corresponding to Obs*R-squared is 0.5308, which is not significant at 5% level of significance. Thus, we cannot reject the null hypothesis. We therefore conclude that our model has no significant trace of heteroskedasticity.

4.5.3 ARCH heteroskedasticity test

To examine if our model is free from ARCH effect

H_O: There is no ARCH effect

The result in the table shows that Prob. Chi-Square corresponding to Obs*R-squared is 0.8114, which is not significant at 5% level of significance. Therefore, we cannot reject the null hypothesis. Thus, we conclude that our model is free from ARCH effect.

4.5.4 Jarque – bera test

To find out if the residuals of our model are normally distributed.

With the prob value greater than 5%, our conclusion is that the residuals of our model are normally distributed.

Table 6. Breusch-godfrey serial correlation lm test

F-statistic	0.760324	Prob. F(1,11)	0.4019
Obs*R-squared	1.745593	Prob. Chi-Square(1)	0.1864

Source: eviews9 output

Table 7. Breusch-pagan-godfrey heteroskedasticity test

F-statistic	0.789476	Prob. F(14,12)	0.6671
Obs*R-squared	12.94522	Prob. Chi-Square(14)	0.5308
Scaled explained SS	2.379361	Prob. Chi-Square(14)	0.9998

Source: eviews9 output

Table 8. Heteroskedasticity test: ARCH

F-statistic	0.333175	Prob. F(4,18)	0.8520
Obs*R-squared	1.585507	Prob. Chi-Square(4)	0.8114

Series: Residuals	
Sample 1993 2019	
Observations 27	
Mean	5.89e-15
Median	-0.131749
Maximum	7.994620
Minimum	-6.157324
Std. Dev.	3.600764
Skewness	0.367033
Kurtosis	2.860998
Jarque-Bera	0.627946
Probability	0.730539
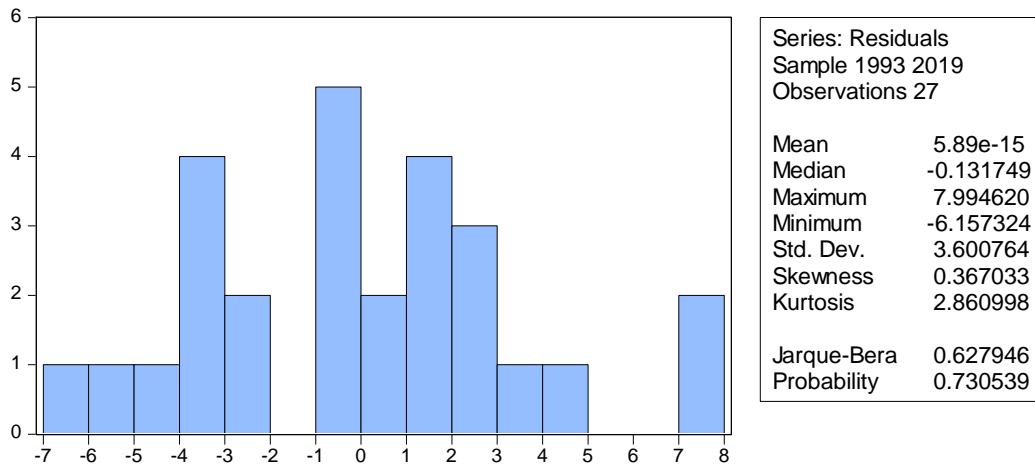
Fig. 3. Jarque – bera test
Source: eviews9 output

4.5.5 CUSUM stability test

Our model is further subjected to CUSUM and CUSUM of squares stability tests and the figures below are the results. CUSUM means cumulative sum. It is used to investigate whether or not the coefficients (parameters) of our model are changing systematically (stable).

Null Hypothesis: parameters are stable.

Acceptance of the null hypothesis is desirable.

The CUSUM test result above shows that our model is fairly stable given that the CUSUM line is within the 5% significance boundary.

4.6 Discussions on Our Research Hypotheses

Having carried out the necessary tests, it is now time to give responses to our research hypotheses based on our findings.
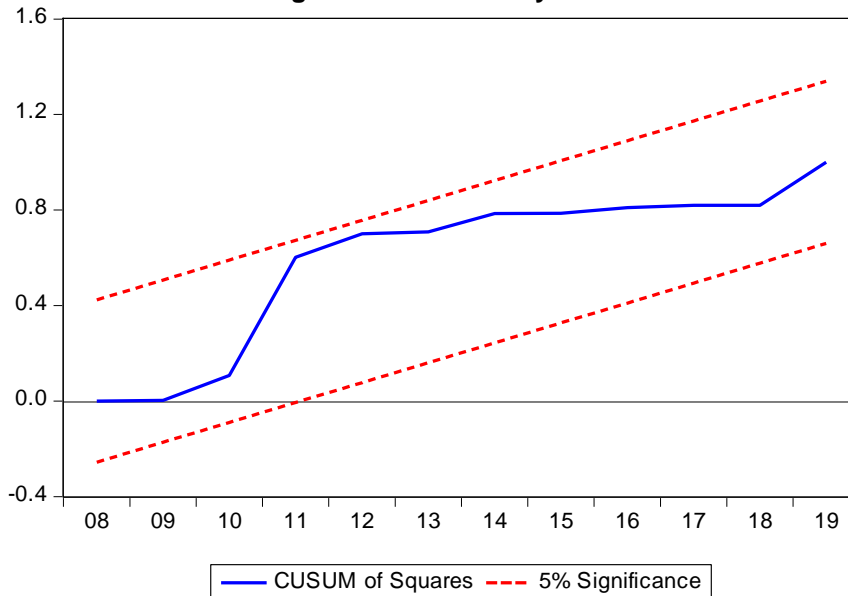
4.6.1 H_0^1

Money supply rate in Nigeria has no significant effect on Nigeria's inflation rate.

Our findings in Table 4 show that money supply rate in Nigeria has no significant effect on Nigeria's inflation rate.

Decision: We accept H_0^1.
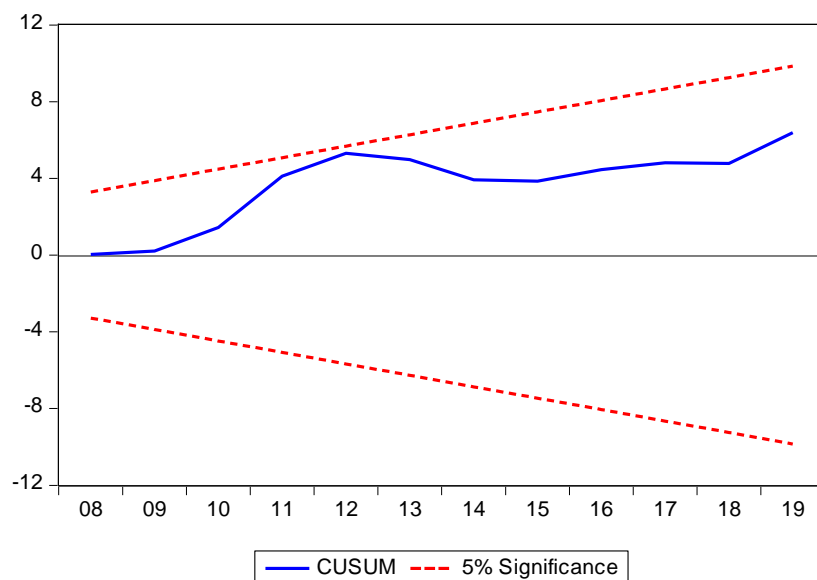
Fig. 4. Cusum stability test

Fig. 5. Cusum squares stability test
Source: Eviews 9 output

4.6.2 H_0^2

Exchange rate in Nigeria has no significant effect on Nigeria's inflation rate.

Our findings in Table 4 show that exchange rate in Nigeria has a significant effect on Nigeria's inflation rate.

Decision: We reject H_0^2.

4.6.3 H_0^3

Interest rate in Nigeria has no significant effect on Nigeria's inflation rate.

Our findings in Table 4 show that Interest rate in Nigeria has no significant effect on Nigeria's inflation rate.

Decision: We accept H_0^3.

5. SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of Findings and Conclusion

Our model in this study was found to be stable and the empirical findings show that money supply rate and interest rate in Nigeria are not necessarily the factors responsible for Nigeria's high inflation rate within the period of time (1991

– 2021). Exchange rate, however, has a significant effect on Nigeria's inflation rate within the period.

In conclusion, therefore, we state that the less favorable the exchange rate is to Nigeria, the more biting the inflation.

5.2 Recommendations

Nigerian authorities should take giant strides to fix the insecurity problems of the country in order to create safe environment that can attract both local investments and foreign direct investments which will, among other benefits, favour Nigeria in exchange rate.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/92228