INTEREST RATES AND INFLATION RATE INTERPLAY: IMPACT ON POLICY DECISION IN NIGERIA SINCE YEAR 2000

Musa Samuel Olayinka

Department of Economics, University of Lagos, Lagos Nigeria. (Email: olayinksam@yahoo.com)

ABSTRACT

This study examined the interrelationship between interest rate and inflation rate in Nigeria. Interest rate is one of the key policy instruments that can be employed by the central bank to attain inflation targeting. The rate can be adjusted to curb high inflation or to prevent economic depression. The study seeks to find the significance of interest rates in determining inflation rate and also responses of inflation rate to shocks. For over a decade, Nigeria has been challenged to keep the inflation rate low and maintaining single digit rate, but, this has proved unsuccessful. Empirical analysis started with various diagnostic tests such as unit root and Johansen co-integration tests. Coefficient estimates were based on vector error correction and vector auto-regression models. To achieve robustness in the study, interest rate was decomposed into three components: monetary policy rate, maximum lending rate and deposit rate. Responses of inflation rate to each interest rate were obtained. The years under review, 2000-2019, were disaggregated into 2000-2007 and 2009-2019. Findings established that interest rates were weak instruments to curb inflation in the short run but inclined to be significant and relevant instruments in the long run. Moreover, inflation rate responses to interest rates were weak in the short run but proved strong in the long run. The conclusion was not exactly similar to previous authors' because interest rates gradually proved applicable to inflation targeting in the long run. As the Central Bank of Nigeria (CBN) relies on interest rate to curb inflation rate, it is suggested the apex bank should ensure a smooth transmission channel between inflation rate and interest rates. Like in the United States (US) and other advanced countries, the bank should strive to keep inflation and interest rates lower than the current rates and simultaneously improve on macroeconomic policy management.

1. INTRODUCTION

The relationship between interest rate and inflation rate in developed countries has been studied extensively. In developing countries there has also been a handful of research on similar relationship particularly in the past two decades. Examining the two variables' interrelationship for the Nigerian economy merits attention because of the challenges often encountered by the monetary policy authority in combating year-on-year high inflation rate. Besides, Nigeria is the largest economy in sub-Saharan Africa, but has always been threatened by hyper-inflation for over a decade. In monetary policy management alone, the country is losing her prestige as a reliable anchor. This happens in spite of the Central Bank of Nigeria (CBN) monetary policy stance to keep policy instruments stable and predictable, and particularly, to keep inflation rate low at single digit through transparent policy which include announcement of periodic short term interest rate adjustment. Nevertheless, the general public perception is that the CBN is yet to do enough in stable price maintenance and complementing economic growth. In some cases, it appears the apex bank policy stance is overwhelmed by government fiscal policy. The CBN direct financing of public projects, instead of issuing debt instruments, seems increasing. As a result, a regular quarterly stagflation, meaning retarded production and price level rise further worsens the living standard and reduces public welfare.

  Fundamentally, monetary policy is performed by the apex bank to control or adjust interest rate and other policy instruments. In advanced countries, success stories have followed the neoclassical model advocating deregulation of policy instruments and allowing the market to determine rates. This should hold while the apex bank sets targets. For instance, these targets may include inflation rate and output growth rate. While the targets are being set, the apex bank can closely monitor the impacts of the policy instruments adopted to achieve the targets. Just as in the advanced countries, developing countries have recorded considerable degree of economic liberalization since the mid-1980s occurring simultaneously with high interest rate and inflation rate. In sub-Saharan Africa, for over two decades, both inflation rate and interest rate are high at double digits or more (IMF, 2019). In fact, there seems hardly any time in the last 40 years when the inflation rate or interest rate is as low as they are in developed countries. A single digit rate hardly persists for a long time. Main reasons given include monetary expansion, exchange rate

depreciation, economic deregulation and liberalization as well as rise in government expenditure largely financed by foreign debt.

When one considers monetary policy underpinning for over a decade in Nigeria, short term interest rate has always been set monthly or quarterly by the CBN monetary policy committee to check inflation rate. Nevertheless, since the 2008 global economic meltdown, inflation has remained at double digits despite periodic adjustment by the CBN. The rate has hovered between 11.0% and 13.0% year-on-year. It was higher in the period before the global economic meltdown. Many authors who examined the inflation rate and interest rate relationship in Nigeria found no significant relationship between the two variables (Fakiyesi, 1996; Moser, 1995 and Asogu, 1991). Rather, inflation is said to be generally caused by inflation expectations as well as shocks from inflation. Besides, some authors found that inflation is caused mainly by fiscal expenditure (Okoye et al., 2019; Adebiyi, 2009). Adebiyi (2007) established that broad money supply, increase in bank credits and exchange rate are responsible for high inflation in Nigeria. Mordi, Adebiyi, and Babatunde (2019) stated that interest rate is slow to curb the short term inflation spiral in Nigeria.

If the monetary policy stance in Nigeria is to closely adjust interest rate in response to inflation rate even though empirical research shows no significant relationship between the two variables, it then appears research might lack optimal modeling of the two variables in a manner to suggest how high inflation might be restrained. This also suggests that the apex bank hitherto has not adequately explored interest rates intricacies on price changes while the perennial problem of high inflation rate continues. The critical question is whether interest rate, when decomposed and modeled to capture annual changes in the general price level, would provide answer to the high inflation rate in Nigeria? Therefore, the study objective is to examine the interrelationship between interest rate and inflation rate in Nigeria. It is a common practice that the apex bank adjusts interest rate, the CBN is no exemption. Since the period after the Structural Adjustment Programme (SAP), the apex bank has been in the doldrums of ensuring single digit inflation rate for the Nigerian economy. A research on inflation and interest rates, specifically on their short and long run relationship, might offer a probable solution which the CBN might credit.

1.1 STATISTICAL FACTS ABOUT INTEREST RATE AND INFLATION RATE, IN NIGERIA AND SELECTED COUNTRIES

This section gives a concise description of interest rate and inflation rate in Nigeria and selected countries. Facts on key macroeconomic variables in Nigeria and selected countries are presented. Nigeria is compared with Kenya, China, Japan and the United States (US). The description provides insight into interest rate and inflation rate trends in these countries.

TABLE 1
Selected Countries Real Interest Rate (RI), Consumer Price Index (CPI) and Inflation Rate (INF) (2010 = 100)

Year	Nigeria			Kenya			China			Japan			United States		
	RI	CPI	INF	RI	CPI	INF	RI	CPI	INF	RI	CPI	INF	RI	CPI	INF
μ 2001-05	4.18	47.16	13.56	11.52	46.46	7.21	2.27	72.44	1.32	3.12	100.9	-0.45	2.90	84.85	2.48
σ 2001-05	6.66	10.44	1.90	5.79	6.45	3.50	2.30	2.16	1.65	0.31	0.58	0.38	1.13	3.33	0.64
μ 2006-10	5.90	80.90	9.10	2.14	83.51	10.90	0.82	82.55	2.81	2.81	100.80	-0.09	3.52	96.93	2.17
σ 2006-10	8.92	13.37	2.74	6.66	16.13	6.34	3.09	4.20	2.49	0.47	0.77	1.04	1.41	3.09	1.60
μ 2011-15	9.61	134.98	8.84	7.63	132.30	7.78	2.96	96.23	2.73	1.11	101.2	0.70	1.48	106.51	1.65
σ 2011-15	3.48	18.62	1.45	3.07	14.02	2.79	2.47	3.32	1.43	1.80	1.88	1.18	0.40	2.34	1.06
μ 2016-19	5.76	223.2	12.18	8.64	168.70	4.76	1.64	103.90	1.27	1.05	103.40	0.11	2.63	112.60	1.17
σ 2016-19	0.91	35.90	1.02	4.15	10.86	2.77	1.39	1.38	1.26	0.20	0.40	0.46	0.58	1.73	0.90

Source: IMF & WDI, 2019

Table 1 shows the mean (μ) and standard deviation (σ) of variables for selected countries. The table contains price level (CPI), inflation rate (INF) and real interest rate (RI) in developed countries, emerging economy and developing countries. Developed countries include Japan and United States. The emerging economy is the People's Republic of China. Developing countries include Nigeria and Kenya. The random selection of the countries are based on the level of economic development as contained in reliable statistics from the World Bank and International Monetary Fund (IMF). From the table, the standard deviation clearly shows the degree of variability in prices between developing and developed countries. Although price appears to be relatively higher in China, but comparatively, it is lower than in Nigeria and Kenya. The highest deviation in price recorded in China between 2006 and 2010 is 4.20 while the lowest 1.38 is between 2016 and 2019.

The table also shows that as a result of low and stable price in the emerging economy and developed countries, inflation rate generally remains single and very low. For instance, in Japan, inflation rate is zero or sometimes negative. In the US, the rate is single digit

and scarcely rises beyond 2.48% average within 2000 and 2019. However, from the table, inflation rate is too high in developing countries, but it tends to be higher in Nigeria than Kenya. Though the highest rate of 10.91% recorded in Kenya appears to be the result of the global economic boom and doom of 2006-2010.

One inference to be drawn from the table rests on Nigeria and Kenya with worst inflationary trend among the selected countries. Real interest rate which appears higher in Nigeria appears to be a reflection of high inflation rate. This reminds economic agents of the money illusion (popularized by Thaler, 1997; Dimand, 1993; Keynes, 1936; Pigou, 1936; Fisher, 1928).

This is so and might be the effect of poor response of inflation to policy adjustment in Nigeria. In Japan and US, low inflation rate is followed directly by low real interest rate as theorized by the "Taylor rule" and observed by Wu and Xia (2016) and Bernanke (2020). With this unfavorable description about Nigeria, an empirical research may be required to address the interest rate and inflation rate interplay for optimal monetary policymaking.

2. LITERATURE REVIEW

2.1 THEORETICAL REVIEW

Interest rate is one of the important policy instruments that can be used as a transmission channel to achieve inflation targeting. Other key instruments include exchange rate, money supply and credits. Interest rates may include monetary policy rate (MPR), lending rate and deposit rate. On the other hand, inflation rate is the general rise in price level not counterbalanced by rise in production of goods and services. Inflation rate is an indicator of economic performances while interest rate is a transmission channel to achieve an objective or a target. The effort to curb inflation is an everyday activity for any apex bank. This is so because incessant rise in inflation rate may culminate in hyper-inflation and eventually becomes a national tragedy. Serious inflationary effects may include depletion of the value of money and income. However, interest rate adjustment and some other policy instruments can be employed to control the menace depending on monetary policy stance and the government it represents.

In the literature, common contextual theoretical arguments include distinguishing between twin issues such as nominal and real interest rate as well as core and headline inflation. Each of these is associated with deeper meaning. Real interest rate is nominal interest rate adjusted for inflation. It may also mean real rate of return on

investment. There are also disturbance terms such as trade cycle and expectations. All these key issues affect monetary policy stance in the process of getting it right. They also have impact on aggregate expenditure and consumer investment decision underpinning divergent theoretical views of both classical and Keynesian schools. While in the traditional theory, interest rate is seen as a price of capital and inflation is seen as a government driven phenomenon, in the Keynesian ideology, interest rate is a price of asset and inflation, aggregate expenditure phenomenon which occurs when demand rises at economic full level of employment.

Keynes (1936) argued that inflation occurs when economic production and aggregate demand exceeds society's endowed resources capacity. Friedman (1970) established that inflation is purely fiscal policy driven, but not monetary policy, adding that once money growth is not beyond output growth, there cannot be inflation. He emphasized that inflation is driven primarily by fiscal expenditure financed by printing of currency. He said "inflation is always and everywhere a monetary phenomenon." Totonchi (2011) reported that while inflation might be a monetary phenomenon in developed countries, in developing countries it is not necessarily a pure monetary phenomenon but a combination of macroeconomic factors such as political, structural and institutional factors. However, the role of interest rate is not discussed in his study.

Underlining interest rate importance, Alvarez, Lucas, and Weber (2001), using a model of segmented market, showed that "a policy of increasing short term interest rates to reduce inflation can be rationalized with essentially quantity theoretic models of monetary equilibrium". In their series of models developed to address interest rate rules relating to inflation targeting, they emphasized the necessary use of objective function that allots weight to some other objectives apart from accomplishing an inflation target. Khumalo and Mutambara, and Assensoh-Kodua (2017) highlighted that the whole macroeconomic environment all over the world is a function of inflation and interest rate. For instance, they highlighted how the Swaziland economy has experienced unprecedented high inflation and interest rate for a long time past. The authors were in agreement with Khan and Sattar (2014) and, Ogege and Shiro (2012) that money supply and the people's purchasing power matter in the nexus between interest rate and inflation rate because money affects both the demand and supply side of the economy. To mitigate the adverse effect of inflation through interest rate and money supply, they suggest a composed form of financial regulation and control of monetary supply

in the economy in order to achieve the desired state of macro and micro economic objectives.

Okoye et al. (2019) and Ireland (2014) argued that aggregate price level is affected by both classical and Keynesian postulations, which means changes in both money supply and aggregate demand. Hence, movements in monetary conditions and excess demand over output when the country is already at full level of employment lead to changes in general price level. The excess money, according to Friedman, is driven by the central bank's "printing press". Another set of studies recognize the fact that interest rates are key to achieving macroeconomic stability and to keep inflation within a manageable threshold. Kiley (2020), Oke and Shobande (2019), Kiley and Roberts (2017) and Black (1995), noted that interest rates specification could help regulate inflationary temperature when the monetary authority is at a cross road. Black unambiguously highlighted it might be futile modelling interest rate without considering nominal and real interest rates effects on demand and supply of capital. He argued that while investors usually focus on real interest rate, monetary authority focuses on nominal rate by assuming a simple random process and without worrying about the forces influencing the interest rates. He commented that appropriate interest rates should be drawn from effectiveness of nominal and real rate of interest.

Other theories associated with interest rates are the Keynesian fluidity theory, and liquidity and risk premium theory. In both cases, attempt is made to distinguish between short term and long term interest rates and the risk involved considering inflation. The Modigliani and Sutch (1966) preferred habitat theory combines the features of both expectations and segmented market theories; according to them, investors have preferences for securities of a given term and want to choose them according to their expected yield. However, they will be willing to purchase securities of some other term by substituting them for securities of preferred term provided they are compensated by the term premium. The term premium is an additional yield to motivate an investor to purchase more securities that give a later time yield. Furthermore, there is the Taylor rule, where Taylor (1993) postulated that the central bank should raise rates when inflation is above target or when GDP growth is too high and above potential. It also suggests that the central bank should lower rates when inflation is below the target level or when GDP growth is too slow and below potential. Keynes suggested that interest rate should be lowered to induce investment while McKinnon (1973) and Shaw (1973) suggested a high rate to induce investible fund. Which of these

premises would limit or aggravate inflation/depression and what about the role of expectations? At what interest rate is an investment worth taken considering inflationary factor? These are endless anxieties that distinguish a risk taker from a risk averse investor. Yet, in all of these, investors and monetary policy makers would like to find what rate of interest would be optimal to attain inflation target and promote public investment.

The theoretical argument concerning Nigeria and many developing countries' position to justify the use of interest rate to check high inflation rate appears not yet producing any positive outcome in policy making. Inflation rate continues to portend hyper-inflation. Nevertheless, in the advanced countries, for instance, the United States of America (US), using interest rate to suppress inflation rate appears to be a success story. Bernanke (2020) reiterates the use of fed rate (or MPR) as a key instrument in monetary policy stance and to check inflation, though in the case of US, it is done to prevent zero inflation rate or to check depression. He is of the opinion that quantitative easing (QE) might be the solution if interest rate, which though it has proven relevant in the late 20th century, continues to cause low inflation rate to the extent that it might pull down the economy into depression. According to him, "when the short-term policy interest rate reaches the effective lower bound, monetary policymakers can no longer provide stimulus through traditional means". The fact is that many developing countries have adopted the principle of QE in financing significant size of public expenditure.

In Nigeria, for over a decade monetary policy stance tends to be analogous to the US pattern relying explicitly on monetary policy rate adjustment and also exchange rate management to attain inflation targeting. However, unlike the US where the objective is to step-up inflation, the objective in Nigeria is to prevent hyper-inflation. Price volatility is a common phenomenon in developing countries and projects a serious threat to the effectiveness of monetary policy. Worsening the pressure is expectations. In the past two decades in Nigeria, expectations appear to underscore inflationary pressure and a psychological factor modelled into thinking faculty. As evidenced by yearly significant increase in price, the persistent rise in the general level of price and the use of interest rate adjustment to check it produces weak results. Therefore, for the Nigerian economy, it is considered necessary to address interest rate complexity in the effort to lessen hyper-inflation threat. MPR which serves as nominal anchor co-relating with other interest rates and vis-à-vis their relationship with inflation rate might produce a new outcome in the research and

might be useful as a policy framework. This study observes that in the previous literature, the aspect of simultaneously relating interest rate variants with inflation rate is either often omitted or not scrupulously done for the Nigerian economy.

2.2 EMPIRICAL REVIEW

A number of empirical literature on monetary policy have discussed monetary policy instruments as transmission channels to attain stable price and economic growth. Some of these instruments which include interest rates and broad money supply can be managed to stabilize prices and control inflation. In developing countries, these instruments are managed to avoid inflation spiral. In developed countries in the 1970s, literature was based on combating high inflation rate while in the past three decades, there has been a paradigm shift toward paying more attention to low inflation rate. However, in developing countries, the monetary policy stance has always been to combat high inflation. Yet, in spite of much effort, it appears that sub-Saharan Africa is yet to record significant achievement in the fight against high inflation.

Bernanke, Kiley, and Roberts (2017), Wu and Xia (2016) and Black (1995) are some of the popular empirical studies on inflation targeting versus interest rate. Black developed a Monte Carlo simulation to show how interest rates can behave over time relative to inflation rate. He discovered slight variation in behavioral pattern of nominal and real interest rates. He concluded that in the long run, "nominal interest rates are always positive since the future short rate may be positive even when the current short rate is zero". However, his work unveiled a caveat to continuous deflation scenario in the US; it probably can lead to scenario of the great depression.

Still on the US, the work of Wu and Xia (2016) examined the implication of maintaining near zero lower bound interest rates. They employed the shadow rate term structure model (SRTSM) which is an improvement over the Gaussian Affine term structure model (GATSM) which is rather difficult in modeling nominal interest rates in the zero lower bound (ZLB). In addition, they also used factor-augmented vector auto-regression (FAVAR) which gave improved results over the traditional vector auto-regression (VAR) in measuring the effects of monetary policy at the ZLB. According to the authors, previous authors such as Bernanke, Boivin, and Eliasz (2005), Stock and Watson (2001), used other VAR models (without the SRTSM), but the performance is limited by structural break in macroeconomic time series data relating to ZLB. The crux of their findings revealed

that MPR impacts the real economy since the global economic melt-down in 2009 in a similar fashion as the effective federal funds rate did before the great recession. They also found that an expansionary monetary policy shock boosts the real economy. They concluded that the Federal Reserve efforts to stimulate the economy via interest rate adjustment yielded positive result in lowering the unemployment rate.

In furthering the debate on inflation targeting and interest rate, particularly on ZLB, Bernanke (2020) and Bernanke and Mishkin (1997) gave descriptive analysis of the subject in their lecture note explanations. Bernanke and Mishkin (1997) recalled that inflation targeting started in the early 1990s among developed countries. The central bankers adopted the policy just like in the 1970s adoption of money growth and in the 1980s, intensification of efforts to reduce inflation. At this instance in 1997, it was a new change in the strategy of monetary policymaking. They highlighted how inflation targeting worked and how monetary policy committee meetings adjust policy instruments to attain the target. They mentioned advantages expected to be derived and suggested there should be "more transparent and coherent policymaking, increased accountability, and greater attention to long-run considerations in day-to-day policy debates and decisions".

Bernanke (2020) assessed the performance of inflation targeting and interest rate nexus. He commended that indeed interest rate adjustment has promoted inflation targeting in the US and many developed countries. He suggested that since inflation and interest rate tend to move in positive direction, therefore, in order to avoid recession monetary policy making should ensure the lower bound interest rate which tends to be zero or negative, does not pull inflation rate to zero. The abovementioned studies, based on the US economy, signified interest rate influence on inflation rate. What was left undone was to further decompose interest rate and find the effect of each type on inflation rate. Decomposition allows the finding of effects of optimal partition of a system in terms of its subsystems.

In Nigeria, just as in other developing countries, targeting inflation has also been a common practice, but the recorded outcome has been high inflation tending toward hyper-inflation. Like in the case of the US, most literature that examine interest rate effect appear to have left out decomposition of the variable. These past studies established the fact that interest rate is rather inertia in inflation rate determination. According to them, government expenditure, money supply, quantitative easing and poor exchange rate management are the principal factors responsible for high inflation rate in Nigeria.

Some of these authors include Afolabi and Atolagbe (2019), Odusanya and Atanda (2010) and Moser (1995). To arrive at the findings, estimation techniques used include modification of the ordinary least squares (OLS) to auto-regressive distributed lag (ARDL) model, vector error correction (VECM), co-integration, and error correction. While some findings reveal that inflation is mainly caused by fiscal policy, others established currency depreciation and ineffectiveness of both fiscal and monetary policy.

Adebiyi (2009) casts light on inflation and policy instruments to achieve its stability. He examined the existence of conditions for inflation target in Nigeria and Ghana. In a VAR model, he discovered that monetary policy instruments, such as interest rates and exchange rate, have little or no effect on prices and therefore are not significant instruments to be adopted for inflation targeting. He pointed out that Nigeria and Ghana are not good economies for targeting inflation but they should focus on inflation expectation by being transparent in monetary policy decision. Since his work, and till now, the CBN, just like the Federal Reserve in the US, has continued to target inflation rate using mainly interest rates. The CBN monetary policy committee sits monthly to adjust the interest rate (MPR) based on recent changes in price in the advanced countries, developing and emerging economics and Nigeria. The outcome of each meeting would suggest a policy rate for the month or quarter. Adebiyi's work focused on interest rate without decomposition and it was modelled with exchange rate order than interest rate variants. Again, the work focused on Nigeria and Ghana. Perhaps, if the basic structural composition of interest rate is examined painstakingly for Nigeria alone, it might give improved suggestion on how monetary policy could be amended to arrest high inflation.

In other multifarious studies, Mordi et al. (2013) examined inflation dynamics in Nigeria. In an ARIMA and error correction models they proved that interest rate, exchange rate and money supply are key variables that determine inflation in Nigeria and recommended appropriate management of these variables. His finding is similar to the Sola and Peter (2013) examination of money supply and inflation and their implications on development. They substantiated that interest rate, among other macroeconomic variables, is a significant variable to address inflation and to maintain stability. Also in their VAR estimation, they recognized inflation targeting as an operational guide in measuring the effectiveness of monetary policy in Nigeria. Adaramola and Dada (2020) confirmed these findings but employed the ARDL model. Unlike Adebiyi's study, these authors established

the fact that interest rate is a key factor in cushioning harmful effects of high inflation in Nigeria. Their work appears to be a cursory examination of inflation-interest rates relationship as all other aspects of interest rates are excluded in the model. Changes in monetary policy stance have taken place in the last half a decade in Nigeria which require a new study. The recent study of Adaramola and Dada (2020) focused on long run estimation following Pesaran and Pesaran (1997) ARDL method which is not necessarily focused on interrelationship of variables. A study that will fill the gap by employing the VAR model to correct the estimation gap is needed.

Spiro (1987) appears to have different opinion about inflation and interest rates. In his work concerning findings on inflation rate and real interest rate, he argued that keeping inflation low will result in high real interest rate. The trend might be detrimental to investment because the cost of borrowing would remain high. He suggested that future inflation is almost indeterminable and therefore, looking for alternative policy mix to address inflation might serve a better purpose. The argument of Kiley and Roberts (2017) centers on whether low interest rate and consequent low inflation rate target are the best policy options for the monetary authority. Their DSGE model for the US economy shows that "monetary policy strategies based on traditional or simple policy rules lead to poor economic performance when the equilibrium interest rate is low, with economic activity and inflation more volatile and systematically falling short of desirable levels". Although, they acknowledge inflation targets of between 2% to 3%, the monetary authority should choose a rate higher than the traditional rate. Equivalent low rate was suggested for Nigeria by Fabayo and Ajilore (2006). In a 2-stage Least Square (2SLS) study, they established a single digit of 6% inflation targeting might suffice for Nigeria. However, Spiro (1987) maintained that targeting a low inflation rate might jeopardize the real rate of return. Statistical facts available show serious challenges faced by the CBN in the effort to attain single digit inflation and interest rates. In the last two decades, the monetary policy authority in Nigeria has only achieved a single digit inflation rate for a few months before the global economic meltdown in 2008.

The literature review so far has identified salient points about inflation and interest rate. That interest rate is a key policy instrument when considering inflation targeting, although other instruments such as money supply, exchange rate and public expenditure might be significant. Inflation targeting in Nigeria appears to be comparable to the US monetary policy stance. In the two cases, the Federal Open

Market Committee (FOMC) (in the case of US) or Monetary Policy Committee (MPC) (in the case of Nigeria) sits at regular intervals to review national economic and financial conditions and determines appropriate stance of policy in the short to medium term. In Nigeria, the MPC reviews regularly outcome of the CBN monetary policy framework and adopts changes when necessary. The meeting is so important because inflation poses a serious challenge to economic policy and development of the Nigerian economy. Since interest rate appears one of the major policy instruments accessible by the apex bank, research on the variable in another perspective is imperative. Moreover, as a vital transmission line to inflation targeting, a more innovative study on interest rates dynamics might unfold new ideas for monetary policymaking as well as improved policy that meets the desirable objective of price and economic stability. More than any other time, Nigeria needs a stable and reliable macroeconomic framework.

3. METHODOLOGY

3.1 RESEARCH DESIGN

The research design starts with descriptive analysis of the variable used in the model and it is followed by the empirical analysis. The descriptive analysis will include finding the mean, standard deviation and other relevant statistics of the variables. The empirical analysis is based on the OLS variants (VAR and VECM) used by previous authors: Afolabi and Atolagbe (2019); Odusanya and Atanda (2010); Adebiyi (2009). The analysis is given simple approach using VAR and VECM and it is considered good for the Nigerian macro economy unlike the factor-augmented vector auto-regression (FAVAR) of Wu and Xia (2016). The FAVAR approach (and other estimation techniques) was employed to analyze the ZLB issue for the US economy it was further explained in Bernanke (2020). Historically, VAR originates from Sims (1986, 1980). Sims (1986) postulates that VAR allows impulse responses and variance decomposition. It makes possible the measurement of shocks or innovations to one variable on another variable. In VAR, everything determines everything. It allows measurement of interrelationship among variables and simultaneous estimation of variables (Sims, 1986) with regression applications such as mat-lab and e-views. Adrangi and Allender (1998) state that VAR models are the best method for investigating shocks transmission among variables because they provide information on impulse responses. Some authors show that any linear structural model can be

expressed as a VAR model. A VAR model serves as a flexible approximation to the reduced form of any wide variety of simultaneous structural models (Adebiyi, 2007).

The estimation technique is expected to give the responses of inflation rate to shocks from interest rates variants such as monetary policy rate, lending rate and deposit rate. Estimation will be done in two episodes: from the new millennium to 2000-2007, that is, the period before the global economic meltdown and the period after the meltdown (2009 to 2019). Time series data recorded in monthly series will be obtained from the CBN Statistical Bulletin (2019). They are monthly data from January, 2000 to December, 2019. Analyzing with monthly data is expected to yield improved results over previous studies.

3.2 MODEL SPECIFICATION

A linear equation is required for parameter estimate of variables modelled in the study. Therefore, to achieve the objective of the study, equation "(1)" below is expressed in an auto regressive linear equation in one lag period:

(1) $x_t = A_0 + A[L]x_{t-1} + \mu_t$

Where x_t is an exogenous variable, A $[L]$ is a matrix polynomial in the lag operator of variables, x_{t-1} is the lag value of exogenous variable, μ is the vector of estimated shocks for each of the monetary policy variables and it is assumed serially uncorrelated. "(1)" can be expressed in VAR (matrix notation) of a bivariate auto-regressive model, AR (1). Let us assume two variables *y* and *z* where *y* is inflation rate and *z* is interest rate, then,

(2) $\begin{pmatrix} y_t \\ z_t \end{pmatrix} = A_0 + A[L] \begin{pmatrix} y_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} \mu_{yt} \\ \mu_{zt} \end{pmatrix}$

With the knowledge of matrix specification in "(2)", we can derive the model for this study.

Following Odusanya and Atanda (2010), Adebiyi (2009), Christiano and Eichenbaum (1992), Sims (1980, 1986), the model for this study is specified in "(3)" to "(6)": the model is set to examine shock effects between inflation rate and interest rates. Inflation rate represents price movement and a target indicator to monitor economic performance. Interest rates are transmission channels through which the monetary authority can adjust to check inflation. In the two

episodes specified, attempt is made to examine the impact of shocks on inflation/interest rates in the short and long run.

(3) $\quad INF_t = \alpha_0 + \alpha_1 \sum INF_{t-1} + \alpha_2 \sum MPR_{t-1} + \alpha_3 \sum MLR_{t-1} + \alpha_4 \sum DPR_{t-1} + \mu_{t1}$

(4) $\quad MPR_t = \beta_0 + \beta_1 \sum MPR_{t-1} + \beta_2 \sum INF_{t-1} + \beta_3 \sum MLR_{t-1} + \beta_4 \sum DPR_{t-1} + \mu_{t2}$

(5) $\quad MLR_t = \gamma_0 + \gamma_1 \sum MLR_{t-1} + \gamma_2 \sum INF_{t-1} + \gamma_3 \sum MPR_{t-1} + \gamma_4 \sum DPR_{t-1} + \mu_{t3}$

(6) $\quad DPR_t = \delta_0 + \delta_1 \sum DPR_{t-1} + \delta_2 \sum INF_{t-1} + \delta_3 \sum MPR_{t-1} + \delta_4 \sum MLR_{t-1} + \mu_{t4}$

In the equations (3) to (6), inflation rate (INF), monetary policy rate (MPR), maximum lending rate (MLR) and 12 months (DPR) are clearly modelled in VAR. It is expected that one standard deviation shock to interest rates will trigger a reaction in inflation rate. This would trigger alert for necessary policy adjustment. MPR is the baseline of all other rates in Nigeria. MPR is used as the nominal anchor which influences the level and direction of other interest rates in the money market (Fajingbesi and Osanyintuyi, 2012). Its movement is expected to send a signal to market operators and the reaction that follows is expected to alert the monetary policy authority (Nnanna, 2001).

The only rate falling below MPR is the deposit rate (DPR). The deposit rate is the rate of return on savings. It is expected that the rate is inversely related with inflation rate. An increase in deposit rate induces savings and consequent fall in aggregate demand. However, the paradox of thrift explains too many people saving simultaneously might reduce aggregate consumption. Theoretically, the maximum lending rate (MLR) has the tendency to lessen money supply, the higher the lending rate, the lower the demand for money for investment and the result is a decreasing inflation rate. As already discussed in theory, inflation rate is an indicator of monetary policy performance. Monetary authority sets the target for inflation and adjustment of policy instruments, such as interest rates, to achieve the target.

The coefficients are $\alpha_1 \ldots \alpha_4, \beta_1 \ldots \beta_4, \gamma_1 \ldots \gamma_4$ and $\delta_1 \ldots \delta_4$, while the intercepts are $\alpha_0, \beta_0, \gamma_0, \gamma_0$ and δ_0. $\mu_{t1} \ldots \mu_{t4}$ are the stochastic error terms or shocks and they are assumed to be serially uncorrelated. The study will examine the responses of interest rates/inflation rate to one standard deviation shock. It is assumed

interrelationship exists among the variables which could be examined in the VAR model. The short run VECM is stated in "(7)" below.

(7) $dINF_t = \alpha_0 + \alpha_1\, d\sum INF_{t-i} + \alpha_2\, d\sum MPR_{t-i} +$
$\alpha_3\, d\sum MLR_{t-i} + \alpha_4\, d\sum DPR_{t-i} + \varepsilon_{ti}$

Where d represents difference value and ε_{t-i} is the error term of variables in the model.

4. PRESENTATION OF DESCRIPTIVE AND EMPIRICAL RESULTS

The discussion includes both descriptive and empirical results. The descriptive analysis shows the trend in both interest rates and inflation rate in Nigeria from year 2000 to 2019. On the other hand, the empirical analysis is based on the regression results.

4.1 DESCRIPTIVE ANALYSIS

Figure 1 and Figure 2 display monthly interest rates and inflation rate from year 2000 to 2007 and 2008 to 2019 respectively. In figure 1, maximum lending rate (MLR) has the highest trend value of about 32.5%. At the beginning of the period in year 2000, the variable shows gradual upward movement but starts decreasing in 2002 and stabilizes from 2005 to 2007. The reverse is the case in figure 2. MLR rises gradually from 20.1% in the first quarter of 2008 to 32.0% in the last quarter of 2019. The policy implication is that lending rate of double digit is detrimental to the macroeconomic framework of a developing country such as Nigeria particularly for business and investment. This is because, unlike the advanced countries where the rate is less than 4%, a high lending rate would affect cost of inputs and force high production cost. Consequently, it would lead to higher price per unit of output relative to foreign ones. It will also trigger inflation and worsening financial system performance.

FIGURE 1

Average Interest Rates and Inflation Rate Trend in Nigeria:
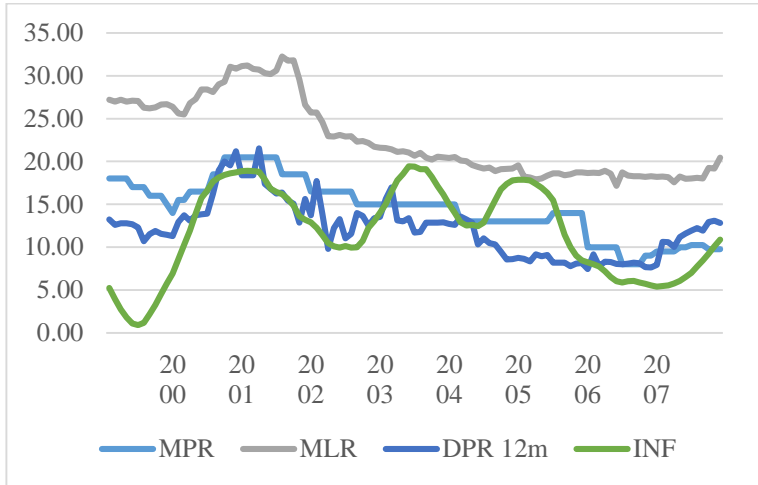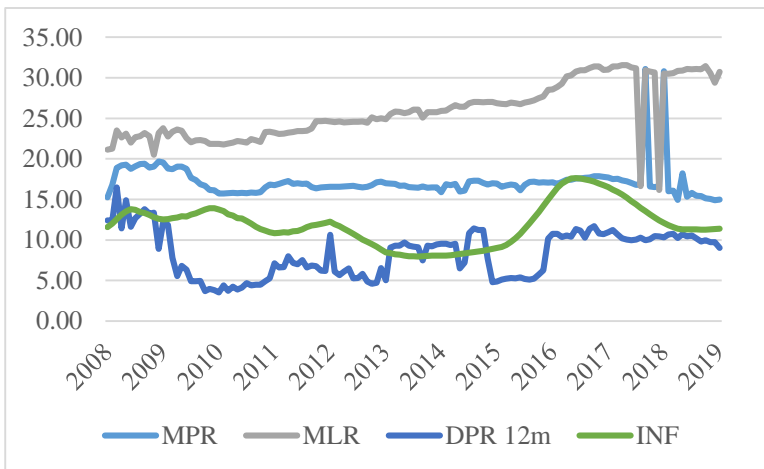2000-2007

FIGURE 2

Average Interest Rates and Inflation Rate Trend in Nigeria:
2008-2019

Source: CBN Statistical Bulletin, 2019

The regular upward and downward movement of INF reflects the high volatility of the variable in Nigeria. The volatility is significant before and after the global economic meltdown, although, there is evidence of sharp decline between 2017 and 2018. It implies that inflation rate targeting must be prudently managed. MPR and DPR remain almost the same before the meltdown; they range between 13% and 21%. However, after the global economic meltdown, the two rates fall apart. MPR remains steady between 15% and 20%. On the other hand, deposit rate gradually falls below 15% and it is between 3.6% and 4.0% in 2010, 2013 and 2015 to 2016. Overall, between 2000 and 2019, while the mean deposit rate remains 10.1%, mean inflation rate is 11.9%. This implies that inflation rate is higher than the deposit rate and thereby reducing the value of depositor's fund. This might be one of the reasons for low saving and the general shortage of real funds in the Nigerian financial system. The key interest rates as well as inflation rate are too high in Nigeria and as a result, it might be too hard to achieve a desirable result in the policy designed to target inflation. An empirical analysis is required for clearer inferences.

TABLE 2
Statistical Facts about Variables Used for Regression Analysis:
2000 to 2019

Panel a: Analysis of Descriptive Statistics, Year 2000-2019

Statistics	INF	MPR	MLR	DPR
Mean	11.88875	12.79688	24.49308	10.07588
Median	11.95	13	24.555	10.22
Maximum	19.4	20.5	32.27	21.54
Minimum	0.9	6	16.17	3.53
Std. Dev.	4.003231	3.429755	4.287476	3.629627
Skewness	-0.24181	-0.05477	0.08907	0.424742
Kurtosis	2.776908	3.01414	1.921803	3.180641
Jarque-Bera	2.836477	0.122006	11.94242	7.542537
Probability	0.24214	0.940821	0.002551	0.023023
Sum	2853.3	3071.25	5878.34	2418.21
Sum Sq. Dev.	3830.18	2811.41	4393.406	3148.632
Observations	240	240	240	240

Source: Author's computation with E-views 10.0., CBN Statistical Bulletin, 2019.

Panel b: Analysis of Descriptive Statistics, Year 2000-2007

Statistics	INF	MPR	MLR	DPR
Mean	12.3114	15.05208	23.17448	12.31094
Median	12.95	15	21.59	12.635
Maximum	19.4	20.5	32.27	21.54
Minimum	0.9	8	17.17	7.45
Std. Dev.	5.30582	3.221212	4.54132	3.445209
Skewness	-0.47294	-0.27536	0.496249	0.572699
Kurtosis	2.077113	2.75904	1.830812	2.814907
Jarque-Bera	6.985598	1.445436	9.408219	5.384777
Probability	0.030416	0.485431	0.009058	0.067719
Sum	1181.9	1445	2224.75	1181.85
Sum Sq. Dev.	2674.42	985.74	1959.24	1127.6
Observations	96	96	96	96

Source: Author's computation with E-views 10.0, CBN Statistical Bulletin, 2019

Panel c: Analysis of Descriptive Statistics, Year 2009-2019

Statistics	INF	MPR	MLR	DPR
Mean	11.62727	11.08523	24.88258	8.443788
Median	11.85000	12.00000	24.61500	9.210000
Maximum	17.60000	14.00000	31.56000	16.47000
Minimum	5.500000	6.000000	16.17000	3.530000
Std. Dev.	2.932109	2.682789	3.679404	3.010004
Skewness	0.141354	-0.76632	0.026353	0.107783
Kurtosis	2.437864	2.329387	2.636095	1.941588
Jarque-Bera	2.177566	15.39303	0.743627	6.416878
Probability	0.336626	0.000454	0.689483	0.040420
Sum	1534.800	1463.250	3284.500	1114.580
Sum Sq. Dev.	1126.242	942.8537	1773.480	1186.876
Observations	132	132	132	132

Source: Author's computation with E-views 10.0, CBN Statistical Bulletin, 2019

Table 2 is divided into three panels: a, b and c. A general observation from the results is that the series relatively have large differences between the minimum and maximum values. This represents instability in the macroeconomic framework in Nigeria and resulted in enormous discomfort for the monetary authority since the early 1980s. In panel a and b, INF and MPR are negatively skewed while MLR and DPR are positively skewed. In panel c, only MPR is negatively skewed at -0.76632. The rest of the variables are positively skewed. However, the distribution in the three panels appears symmetrical since none of the values is greater than $(+1)$ or less than (-1).

A kurtosis value is either greater than or less than 3.0. In panel a, the values for INF (2.7769) and MLR (1.9218) are platykurtic, that is the data set has lighter tails than a normal distribution. MLR (3.0141) and DPR (3.1806) are leptokurtic in distribution, the data has kurtosis larger (or flatter) in the tails than that of a normal distribution. In panel b and c, all the variables are platykurtic because their kurtosis values, each are less than 3.0. The fact that they have thinner tails than a normal distribution means a fewer extreme positive and negative distribution. With the slight deviation from normal distribution, the series might be liable to a level of predictive accuracy. The Jarque-Bera tests whether sample data has skewness and kurtosis matching normal distribution. Apart from MPR in panel a, and MLR panel c, it appears the data is not normally distributed. However, a test of stationarity before model estimation would give a clearer result.

Other important descriptive statistics are the averages and the standard deviations. The average rate of (INF) in Nigeria from January, year 2000 and December, year 2019 is 11.9%. It was 12.3% and 11.6% in panel b and c respectively. It can be explained that inflation rate in Nigeria has been fairly high and mostly double digits from year 2000 to 2019, but relatively too high when compared to emerging and advanced economies. In spite of the 2008 global economic meltdown, the inflation rate has remained within the threshold of the pre-2008 rate. This signifies relative stability achieved through prudent economic management by the CBN. The monetary authority led by the CBN has put a series of restructuring in place which include merger and acquisition to consolidate the financial system. These created relative stability even though a lot still needs to be done to achieve single digit inflation and interest rates.

While the minimum value of INF before the 2008 meltdown was 0.9% the maximum was 19.4%, whereas, after the meltdown, it was 5.5% and 17.6% respectively. The maximum value of 17.6% after the global economic meltdown is an improvement over the period before meltdown. One may conclude that inflation rate management has been relatively efficient in Nigeria since the 2008 global economic meltdown. In panel c, the mean value of MPR is 11.1% after the global economic meltdown, while before the meltdown (panel b), it is approximately 15.1%. Overall, in panel a, MPR is 12.8%. A lower rate after the meltdown can be interpreted as an improvement in interest rates control cushioning the effect of inflation expectations and maintaining stable prices. The mean value of maximum lending rate, 24.9% is greater than the pre-meltdown of 23.2%. MLR ranges from 16.2% and 31.6% in the post-meltdown period. Relatively, there

appears to be no significant difference between lending rate in the two periods. The standard deviations from the table are relatively small, meaning that the series are distributed close to their mean or the expected values. Lastly, from 2009 to 2019 average deposit rate is 8.4%, this falls below the 2000 to 2007 period which is 12.3%. This might discourage depositors considering inflation rate in the period is higher at 11.6%. Looking at the whole period, 2000 to 2019, while DPR is 10.1%, INF is higher than DPR at 11.9%. This means that outcome of saving mobilization might have been abysmal in Nigeria since year 2000.

It can be deduced that while inflation rate appears to have been stable since year 2000, it has also been high to the extent that it has overwhelmed the real interest rate and might have prevented substantial savings mobilization or capital formation. The mean maximum lending rate is relatively too high and cannot be a catalyst to economic growth. On the other hand, the deposit rate is low and cannot offset inflationary effect. These appear to be a true picture of the Nigerian macro economy.

4.2 EMPIRICAL RESULTS

4.2.1 UNIT ROOT TEST

The unit root test will be carried out to check for stationarity of the variables used for the regression analysis. Unit root test is essential to avoid spurious regression results. This exercise is the first step to the regression analysis.

TABLE 3
Augmented Dickey Fuller (ADF) and Phillips-Perron (PP)

Variable	ADF Test at Level	ADF Test at 1st Difference	PP Test at Level	PP Test at 1st Difference	Order of Integration
INF	-6.1722	-3.6331	-3.0749	-4.66229	I(1)
MPR	-1.7389	-15.2100	-1.8233	-15.2674	I(1)
MLR	-1.0014	-9.5931	2.5517	-30.5404	I(1)
DPR	-2.4076	-19.9989	-2.7180	-20.3931	I(1)

Author's computation with E-views 10.0

The Augmented Dickey Fuller and Phillips-Perron (PP) tests are presented in Table 3. All the variables are integrated of order one.

That is all the variables have unit root but are stationary at first difference. Generally, it is not uncommon for time series data to have unit root. Running regression without examining the time series properties of the variables could generate spurious regression results (Engle and Granger, 1987).

4.2.2 LAG LENGTH CRITERIA

The next step is the selection of an optimal lag length. This is very essential before carrying out a Johansen co-integration test because it is lag sensitive. As seen in Table 4, five criteria are assessed and tested at the 5% level of significance. Although different lag length is revealed by each criterion, in this study, the Schwarz information criterion (SC) of optimal lag (2) is selected. This is assumed to be an improvement over the Akaike information criterion. According to the author, the SC criterion is effective and serves as asymptotic approximation and also can be used in both small and large samples.

TABLE 4
Criterial for Lag Selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2423.40	NA	14390.62	20.9250	20.985	20.94
1	-1276.40	2244.50	0.8389	11.1750	11.473	11.29
2	-1049.27	436.64	0.1359	9.3558	9.8905*	9.57
3	-1029.47	37.38	0.1316	9.3230	10.095	9.63

Source: Author's computation using E-views 10.0 (2020), *indicates lag order selected by the criterion

4.2.3 CO-INTEGRATION TEST

The next important stage in the regression analysis is the co-integration test. The result of the Johansen co-integration test with respect to the Trace and Eigenvalue statistic tests are presented in Table 5. The co-integration test is important because it allows testing for the long run co-movement of the variables.

From Table 5 the trace test indicates one co-integrating equation at the 5% level. The null hypothesis of no co-integration is rejected. Therefore, the alternative hypothesis is accepted. One may conclude that there is a long run relationship existing among the variables. Apart from VAR, we may run the vector error correction model (VECM) using lag (2) for the study to obtain short run and long run coefficients. So, the Johansen Co-integration short run and long run estimates are presented in Table 6 and Table 7 respectively.

TABLE 5
The Johansen Co-integration Integration Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.135333	59.25721	47.85613	0.0030
At most 1	0.063735	24.79484	29.79707	0.1689
At most 2	0.028065	9.186759	15.49471	0.3484
At most 3	0.010244	2.440311	3.841466	0.1183

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

4.2.4 RESULTS OF THE SHORT RUN VECM, 2000-2019

In this section, the results of the short run and long run VECM are presented. The estimation for 2000-2019 is presented for having the largest observation. It is necessary to highlight that the 2000-2007 and 2009-2019 results have been confirmed, each having similar results with the 2000-2019. The results are jointly discussed in Table 6 and Table 7.

TABLE 6
Short Run Vector Error Correct Model

Variables	Coefficient	Std. Error	t-Statistic	Prob.
VEC	-0.027342	0.004712	-5.802470	0.0000
INF(-1)	0.913632	0.064917	14.07382	0.0000
(INF(-2)	-0.020101	0.065113	-0.308703	0.7578
MPR(-1)	-0.026861	0.028836	-0.931496	0.3526
MPR(-2)	0.009205	0.028779	0.319854	0.7494
MLR(-1)	-0.006900	0.009442	-0.730797	0.4657
MLR(-2)	-0.005327	0.009453	-0.563529	0.5736
DPR(-1)	-0.006876	0.012257	-0.561035	0.5753
DPR(-2)	-0.017645	0.012223	-1.443548	0.1502
C	0.008166	0.016451	0.496397	0.6201

R-squared	0.833	Adjusted R-squared	0.825	
F-statistic	124.577	Prob (F-statistic)	0.000	

Source: Author's computation, E-Views 10

The result of the VECM is presented in Table 6. The VEC term (-0.0273) is negative and significant at 1%. The speed of adjustment toward equilibrium is 27.3% indicating a slow speed of adjustment towards long run equilibrium. In other words, there might

be lag between policymaking and target variables in Nigeria. Each variant of interest rate is inversely related to inflation rate except 2nd period lag of MPR. That is, for instance, in the short run, a fall in interest rate induces borrowing, increases money supply and heightens inflation. This result corroborates Keynesian economics theoretical fact that a fall in interest rate induces investment and boosts aggregate demand. The trend might heighten inflation especially if the country is already at optimal point of production possibility.

The adjusted *R*-squared (83%) shows that the explanatory variables can strongly determine the dependent variable, that is, interest rates can jointly explain the variation in inflation rate in the short run, there by debunking the Adebiyi (2009) and Adaramola and Dada (2020) findings for the Nigerian economy. *F*-statistic is significant at 1% and this, as well as the *R*-squared, shows a goodness of fit. The Wald statistical test also shows that all the dependent variables can jointly determine inflation rate in the short run.

4.2.5 RESULTS OF THE LONG RUN ESTIMATION: 2000-2019

In the long run, as displayed in Table 7, the *R*-squared (15.4%) reveals a weak co-efficient of determination although the F-statistics is significant at 1%.

TABLE 7

Variables	Coefficient	Std. Error	*t*-Statistic	Prob.
INF(-1)	-3.377665	0.897405	-3.763812	0.0002
INF(-2)	4.818361	0.889725	5.415562	0.0000
MPR(-1)	0.484815	0.417262	1.161897	0.2465
MPR(-2)	0.391774	0.417368	0.938679	0.3489
MLR(-1)	-0.002383	0.137279	-0.017356	0.9862
MLR(-2)	-0.021336	0.137452	-0.155229	0.8768
DPR(-1)	0.011456	0.177984	0.064366	0.9487
DPR(-2	-0.072752	0.177357	-0.410202	0.6820
C	11.98694	0.239188	50.11521	0.0000
R-squared		0.154	Adjusted R-squared	0.125
F-statistic		5.202	Prob (F-statistic)	0.000

Source: Author's computation, E-Views 10.0

In Table 7, none of the explanatory variables is significant at 5% although MPR and one period lag of DPR are positively related to INF. This means that MPR, which is the benchmark for interest rates in Nigeria, would likely drive inflation rate upward or downward. It

can serve as a reliable long run policy instrument to address inflation spiraling. When it rises, inflation rate rises; when it falls, inflation rate also falls. In other words, MPR remains a nominal anchor in monetary policy making in Nigeria. It is a very crucial transmission channel to manage inflation targeting in the economy.

4.2.6 IMPULSE RESPONSE FUNCTION

We need to find the short run relationship between inflation rate and interest rate in terms of responses to shocks. Impulse responses identify responsiveness of the endogenous variable in a VAR model when a shock is exerted on the error terms in the regression equation. It is assumed a unit shock is applied to each variable to see the effect in the VAR system; hence one standard deviation positive shock is applied to the VAR residual to see how it affects the whole VAR model. The study conducts proper ordering of the variable through the Cholesky adjustment method.

TABLE 8
Responses of Inflation Rate to Interest Rates: 2000 to 2019

Responses of INF:				
Period	INF	MPR	MLR	DPR
1	0.252522	0.000000	0.000000	0.000000
2	0.475080	-0.011392	-0.011992	-0.002301
3	0.659451	-0.013504	-0.026183	-0.021858
4	0.804724	-0.012364	-0.033461	-0.027133
5	0.911071	-0.008494	-0.040096	-0.024055
6	0.980436	0.001269	-0.044292	-0.016408
7	1.015224	0.015043	-0.045880	-0.003271
8	1.019102	0.031902	-0.045749	0.014513
9	0.995927	0.051161	-0.043812	0.035525
10	0.949823	0.071993	-0.040393	0.058840

Table 8 shows that, in Nigeria, responses of INF to one standard deviation is positive in the whole period. It means inflation can significantly and gradually cause inflation year-on-year except if checked. Responses to MPR at the beginning of period 1 to period 5 is weak all through. It is stable and negative in the first to 5th periods but thereafter, it is gradually becoming positive and rising. In other words, INF may be insensitive to MPR in the short run but in the long run it becomes sensitive. This suggests the reason for continuous use of MPR as a nominal anchor for all interest rates in Nigeria and to

check inflation rate. The contemporaneous responses of INF to MLR and DPR are negative and are also insignificant. However, in the 8th to 10th period, responses are positive. The MPR as an announcer to other interest rates, is a key factor in the Nigerian economy. The CBN must ensure effective management of the variable for favourable monetary policy outcome.

TABLE 9

Responses of Inflation Rate to Interest Rates: 2000 to 2007

Responses of INF:

Period	INF	MPR	MLR	DPR
1	0.367781	0.000000	0.000000	0.000000
2	0.690500	-0.011093	-0.067578	0.031654
3	0.954751	-0.001226	-0.158157	0.040607
4	1.170834	0.041706	-0.274634	0.122115
5	1.324366	0.096466	-0.401375	0.248452
6	1.422949	0.172024	-0.547257	0.391848
7	1.466810	0.255645	-0.699160	0.544065
8	1.465985	0.335813	-0.845653	0.693940
9	1.431459	0.409283	-0.980293	0.831575
10	1.371679	0.472604	-1.097294	0.949928

In Table 9, between year 2000-2007, INF has positive responses to own shocks, MPR and DPR. However, the response to MLR is negative. All the shocks are rather stable and neutral. This reveals the ineptitude of interest rate to address inflation in the long run.

TABLE 10

Responses of Inflation Rate to Interest Rates: 2009 to 2019

Responses of INF:

Period	INF	MPR	MLR	DPR
1	0.123878	0.000000	0.000000	0.000000
2	0.218057	0.003004	0.000834	0.011334
3	0.316961	0.031445	-0.000955	0.030091
4	0.417605	0.048442	0.025261	0.051184
5	0.508941	0.063708	0.045925	0.072757
6	0.594338	0.074547	0.074090	0.094726
7	0.673742	0.080999	0.109788	0.116461
8	0.746459	0.083677	0.145952	0.137403
9	0.812939	0.082920	0.185758	0.157874
10	0.873632	0.079437	0.227462	0.177456

From 2009 to 2019, though almost all responses of INF to monetary policy instruments are positive, they are not significant; they are weak and neutral. Nevertheless, the responses tend to increase in the long run as the values tend to increase gradually over the time horizon. Therefore, for the period between 2009 and 2019, the importance of interest rate in inflation rate check is emphasized. The apex bank can then underscore measures to smoothen the transmission channels by removing the financial sector distortions and rigidities prevalent in Nigeria.

4.2.7 VARIANCE DECOMPOSITION

In this section, the study measures the degree of variation caused by a particular variable to another. The forecast error variance decomposition measures the degree of variation of the fluctuation of the variables. The decomposition reveals the proportional contribution of policy shocks to variations in a given macro-economic variable. The greater the proportion of variation attributable to a given policy variable, the more important is the variable in the policymaking and also as a policy instrument. While variance decomposition may reveal the importance of a policy variable to movement in a macro variable, the direction or extent of these movements can only be detected in the impulse responses (Fakiyesi and Adebiyi, 2012; Adebiyi and Lawanson, 2006).

TABLE 11
Variance Decomposition of Inflation Rate: 2009 to 2019

Variance Decomposition of INF:					
Period	S.E.	INF	MPR	MLR	DPR
1	0.252522	100.0000	0.000000	0.000000	0.000000
2	0.538282	99.90374	0.044793	0.049635	0.001827
3	0.852038	99.77622	0.042996	0.114243	0.066542
4	1.172842	99.73587	0.033805	0.141688	0.088638
5	1.485889	99.73315	0.024330	0.161093	0.081431
6	1.780830	99.74382	0.016989	0.174011	0.065181
7	2.050458	99.75106	0.018197	0.181323	0.049420
8	2.290473	99.73719	0.033983	0.185207	0.043621
9	2.498787	99.68631	0.070473	0.186356	0.056863
10	2.675140	99.58270	0.133913	0.185395	0.097991

From Table 11, for the period under review, own shocks constitute significant source of variation to INF forecast errors decomposition ranging from 99.58% to 100%. Every other variable accounts for insignificant variation of external shocks to INF. In other words, for the Nigerian economy, curbing future inflation rate will require limiting the current rate of inflation which may demand efficient transmission channel between interest rate and inflation rate in the current and last periods.

TABLE 12
Variance Decomposition of Inflation Rate: 2000 to 2007

Variance Decomposition of INF:					
Period	S.E.	INF	MPR	MLR	DPR
1	0.367781	100.0000	0.000000	0.000000	0.000000
2	0.785967	99.07862	0.019919	0.739262	0.162200
3	1.247380	97.92051	0.008005	1.901108	0.170374
4	1.737494	95.87824	0.061744	3.478246	0.581771
5	2.237178	92.87574	0.223171	5.316838	1.584256
6	2.740872	88.82918	0.542597	7.528854	3.099372
7	3.242545	83.93223	1.009276	10.02864	5.029847
8	3.738002	78.53785	1.566536	12.66437	7.231237
9	4.223948	72.99121	2.165707	15.30414	9.538945
10	4.696064	67.58443	2.764949	17.84145	11.80917

From Table 12, own shocks constitute significant source of variation in INF forecast errors decomposition ranging from 100% to 67.58% over the periods under review. In 2000-2007, MLR and deposit rate contribute some noticeable variation of 17.84% and 11.81% respectively. MPR makes the lowest contribution. This shows that interest rates are not necessarily significant in determining shocks to INF before the global economic meltdown.

In Table 13, from 2009 to 2019, own shocks constitute significant source of variation in INF forecast errors decomposition ranging from 100% to 92.50%. MLR and DPR contributions were not significant because their maximum values were 2.71% and 2.92% respectively. MPR contributed to the variation gradually though it was not significant. The percentage contribution of MLR and DPR tends to rise gradually in the long run. That is in the long run and particularly after the global economic meltdown, interest rate begins to have significant impact in inflation rate control or targeting.

TABLE 13
Variance Decomposition of Inflation Rate: 2009 to 2019

Variance Decomposition of INF:

Period	S.E.	INF	MPR	MLR	DPR
1	0.123878	100.0000	0.000000	0.000000	0.000000
2	0.251063	99.78077	0.014316	0.001102	0.203812
3	0.406685	98.77059	0.603285	0.000971	0.625150
4	0.587700	97.78863	0.968287	0.185219	1.057859
5	0.784776	96.89884	1.202050	0.446325	1.452782
6	0.994550	96.04515	1.310276	0.832863	1.811715
7	1.214593	95.16713	1.323257	1.375479	2.134132
8	1.442089	94.30282	1.275373	2.000058	2.421745
9	1.675350	93.41649	1.189922	2.711263	2.682324
10	1.913000	92.50388	1.085073	3.493273	2.917776

4.3 SENSITIVITY ANALYSIS COEFFICIENT AND RESIDUAL DIAGNOSTIC TESTS

The null hypothesis is rejected based on the Chi-square statistics which is significant at the 1% level. It is concluded that the various forms of interest rates used in the determination of inflation can jointly determine the variable in the short run.

TABLE 14
Wald Statistical Test for Short Run Co-Integration Estimation: 2000-2019

Wald Test:

Test Statistic	Value	Df	Probability
F-statistic	135.0700	(8, 227)	0.0000
Chi-square	1080.560	8	0.0000
Null Hypothesis: C(2) = C(3) = C(4) = C(5) = C(6) =C(7) = C(8) = C(9) = 0			

The null hypothesis is rejected based on the Chi-square statistics which is significant at the 1% level. It is concluded that the various form of interest rates used to address inflation rate can jointly determine the variable in the long run.

TABLE 15
Wald Statistical Test for Long Run Co-Integration Estimation:
2000-2019

Wald Test:
Equation: Untitled

Test Statistic	Value	Df	Probability
F-statistic	118.9039	(8, 228)	0.0000
Chi-square	951.2314	8	0.0000

Null Hypothesis: $C(2) = C(3) = C(4) = C(5) = C(6) = C(7) = C(8) = C(9) = 0$

From Table 8, we accept the alternative hypothesis that the residuals of the model are normally distributed as displayed by the chi-square statistics.

TABLE 16
VECM Residual Normality Tests

Component	Skewness	Chi-sq	Df	Prob.*
1	-0.075596	0.225734	1	0.6347
2	-1.203597	57.22150	1	0.0000
3	-4.931762	960.7299	1	0.0000
4	-0.07584	0.227190	1	0.6336
Joint		1018.404	4	0.0000

The null hypothesis is rejected because the probability value is less than 5%. The alternative hypothesis is accepted and conclude that the model is homoscedastic.

TABLE 17
VECM Residual Heteroscedasticity Tests (Levels and Squares)

Joint test:		
Chi-sq	Df	Prob.
238.6165	180	0.0023

The null hypothesis of serial correlation is accepted, that is, the residuals are serially correlated. This may be as a result of the fact that each interest rate and inflation rate tend to have similar monthly percentage change.

TABLE 18
Serial Correlation Test

Lag	LRE* stat	df	Prob.	Rao F-stat	Df	Prob.
1	71.28905	16	0.0000	4.649217	(16, 672.7)	0.0000
2	43.39824	16	0.0002	2.772005	(16, 672.7)	0.0002

5. DISCUSSION OF FINDINGS

The findings of this study reveals a weak relationship between interest rates and inflation rate in the short run, but the influence of interest rate rises in the long run. Jointly, interest rates can determine variability in inflation rate but smoothness of the transmission channels is essential to successful outcomes. In other words, for the Nigerian economy, interest rate adjustment might not be an important instrument to address inflation in the short run, but in the long run the rate would be significant with appropriate transmission channel in place. The MPR as announcer to other interest rates, is a key factor in the Nigerian monetary policy stance; however, it requires proper transmission from policy maker to other interest rates and the entire economy. By decomposing the interest rate, this study is able to discover the lending rate has greater influence on inflation than monetary policy and deposit rate, though, each of the interest rate variants are not significant in the short run.

The insignificant responses of inflation rate to interest rates confirm Adebiyi (2009), Odusanya and Atanda (2010), Afolabi and Atolagbe (2019). However, the exogenous variables in these previous studies included multifarious instruments other than interest rates alone; as a result, the robust intricacies of interest rate effect on inflation rate were not captured. It is noted that in the short run, nearly each interest rate is inversely related to inflation rate. This appears not analogous to Keynesian economics theory that postulates low interest rate induces investment demand, increases money supply, aggregate demand and economic growth. But in the Nigerian case, results in this study indicate it may heighten inflation. In a typical macroeconomic framework, if funds obtained in the financial system are invested in the real economic sector as hypothesized by conventional economists, then there would be economic growth without inflationary effect. However, in a typical developing country such as Nigeria, a fall in interest rate has always been leading to a rise in inflation. This may be as a result of surge in money supply induced by the rush to the financial sector to obtain credits which would unlikely be invested in

the real sector. This might also be one of the reasons why monetary authority attempts at raising short term interest rates to avoid too much money in circulation fail to yield desired result. The long run result establishes that monetary policy rate is positive to inflation rate and tends to be significant. Since MPR is the benchmark for interest rates, it would most likely affect inflation rate. When it rises, inflation rate rises; when it falls, inflation rate also falls. In other words, MPR remains a nominal anchor in monetary policy making in Nigeria. It is a very crucial instrument to manage inflation targeting.

Generally, the impulse response function established weak responses of inflation rate to interest rate in the short run. The responses are either positive or negative. The study findings established responses to maximum lending rate for 2000-2019 is negative but also weak. This suggests that an attempt by the monetary authority to adjust maximum lending rate via monetary policy rate changes might have no effect on inflation rate. The result of the variance decomposition reveals that inflation own shocks constitute significant source of variation in inflation forecast errors decomposition in Nigeria. On the other hand, interest rates show short run weak forecast but tends towards a long run significance. That is, interest rate adjustment might produce answer to high inflation rate in Nigeria in the long run. As established by Adebiyi (2009), Nigeria (and Ghana) may not be sound enough for inflation targeting, this might be true in the short run, but in the long run interest rates are something to rely upon to check inflation rate. Moreover, findings in this study preclude Wu and Xia (2016) and Bernanke (2020) studies for the US economy which appear to follow Taylor Rule. That is interest rate and inflation rate tend to move in the same direction. On the other hand in Nigeria the two variables might have inverse relationship owing to poor macroeconomic framework. This is why policy makers have to be more prudent in policy formulation. Although, the Nigerian situation seems analogous to the US because of the two countries' similar setting of inflation targeting and then adjusting interest rate, especially monetary policy rate, to attain the target. However, it might be sub-optimal to attempt to check inflation by simply adjusting the rate of interest only. Interest rates might not be adequate enough. Therefore, if interest rates are not enough to address or target inflation rate in Nigeria, there must be other key policy variables to examine. This may be a foundation for future research.

6. CONCLUSION AND SUGGESTIONS

This study examined interest rate and inflation rate interplay for the Nigerian economy. The objective is to find the significance of interest rates relative to inflation targeting. The study is able to establish that interest rate relationship with inflation rate is significant in the long run and that interest rates, as decomposed, can jointly determine inflation rate in the long run. However, in the short run, it is not established adequately that interest rate can provide answer to the volatile inflation rate in Nigeria. This may be as a result of the fact that the transmission from MPR to other interest rates and the entire Nigerian economy is not smooth and the macroeconomic outlook is rather bleak. The relationship between inflation and interest rates is established by co-integration and Wald statistical tests. Responses of inflation rate to interest rates are also discovered to possess short run weaknesses but improved in the long run. Nigeria would eventually record success in inflation targeting if the bases (the transmission channels) are right. The Nigerian situation should be unnecessarily different from the United States where research has shown that interest rate adjustment has positive significant impact on inflation targeting. Nigeria faces serious macroeconomic framework challenges which hinders her monetary policy framework.

Nevertheless, the objective of Nigeria and US is dissimilar because the monetary policy stance in the US is based on low interest rate to prevent too low inflation rate. This is the stance with the US to curb recession. Conversely, in Nigeria, monetary policy stance attempts to avoid high inflation rate to prevent inflation spiral. To achieve these diverse objectives both countries solely rely on interest rates adjustment. While it seems in the US, inflation targeting, via low interest rate, has produced significant results, it has not been so in Nigeria. As the monetary authority struggles to attain single digit inflation rate via periodical monetary policy rate settings, hyper inflation remains a threat. Still, handful of success might have been recorded judging from the fact that the inflation rate has remained between 11.0% and 13.0% for over two decades. It was as high as 40% to 72% in the 1990s. Therefore, the CBN continues with the use of interest rate alteration with a view to attaining manageable inflation rate. Moreover, in Nigeria, since the interest rate is a significant instrument employed by the CBN in inflation targeting, the following suggestions might be useful with respect to optimal use of the variable. First, effort at lowering interest rate to follow the Taylor Rule, as in the US Federal Reserve, must be pursued by the CBN for the Nigerian

economy. The CBN monetary policy committee should look at strategies in line with smoothening transmission channels between monetary policy rate, other interest rates and through to inflation rate and the rest of the economy. Concurrently, a close monitoring of the financial system and strict compliance with CBN directives by the commercial banks must be established.

Second, although interest rate and inflation rate should be brought to single digit, this is a long run objective to attain. But in the short run, there is a lot the monetary authority can do to lower the maximum lending rate which is detrimental to businesses and discourages investors. This may include gradual reduction of monetary policy rate from average 13.0% to as low as 7.0% within the next three quarters. This might be achieved through incentives and disincentive methods. Incentive method may include rebate on commercial banks transactions with the CBN to encourage compliance with the apex bank's directives and an even transmission channel. Disincentive method may include suspension from or limiting foreign exchange market dealings of the faulty banks. Third, the entire macroeconomic environment must be stable and reliable. This may require cooperation of the government, private sector and the general populace to create a plausible transmission channel to enhance effectiveness of interest rates on economic variables.

Finally, if the previous authors' findings are anything to go by, there might be other relevant policy instruments that might be important in checking the high inflation rate in Nigeria. This may be a crucial research topic in the future.

REFERENCES

Adaramola, A.O., and O. Dada. "Impact of Inflation on Economic Growth: Evidence from Nigeria." *Investment Management & Financial Innovations* 17, no. 2 (2020): 1-13.

Adebiyi, M.A. "Does Money Tell Us Anything About Inflation in Nigeria?" *The Singapore Economic Review* 52, no. 1 (2007): 117-34.

_____. "Inflation Targeting: Can we Establish a Stable and Predictable Relationship between Inflation and Monetary Policy Instruments in Nigeria and Ghana?" *Applied Econometrics and Macro-econometric Modelling in Nigeria* (2009): 211-39.

_____. and O.I. Lawanson. "Financial Sector Reforms, Monetary Policy Transmission Mechanism and Commercial Bank

Credit." In *The NEEDS, Philosophy, Opportunities and Challenges*, edited by Akano O. and Familoni K.A. (2006): 220-35.

Adrangi, B., and M. Allender. "Budget Deficits and Stock Prices: International Evidence." *Journal of Economics and Finance* 22, no. 2-3 (1998): 57-66.

Afolabi, J.O., and O. Atolagbe. "Empirical Analysis of Fiscal Dominance and the Conduct of Monetary Policy in Nigeria." (2019). https://mpra.ub.uni-muenchen.de/88786/

Alvarez, F., R.E. Lucas, and W.E. Weber. "Interest rates and inflation." *American Economic Review* 91, no. 2 (2001): 219-25.

Asogu, J.O. "An Econometric Analysis of the Nature and Causes of Inflation in Nigeria." *Economic and Financial Review* 29, no. 2 (1991): 239-54.

Bernanke, B.S. "The New Tools of Monetary Policy." *American Economic Review* 110, no. 4 (2020): 943-83.

_____, M.T. Kiley, and J.M. Roberts. "Monetary Policy Strategies for a Low-Rate Environment." In *AEA Papers and Proceedings,* 109 (2019): 421-26.

_____, and F.S. Mishkin. "Inflation Targeting: A New Framework for Monetary Policy?" *Journal of Economic Perspectives* 11, no. 2 (1997): 97-116.

_____, J. Boivin, and P. Eliasz. "Measuring the Effects of Monetary Policy: A Factor-Augmented Vector Autoregressive (FAVAR) Approach." *The Quarterly Journal of Economics* 120, no. 1 (2005): 387-422.

Black, F. "Interest Rates as Options." *The Journal of Finance* 50, no. 5 (1995): 1371-76.

Central Bank of Nigeria, Annual Statistical Bulletin, 2019, CBN 2019, Financial Statistics; Domestic Production, Consumption and Prices; External Sector Statistics.
    https://www.cbn.gov.ng/documents/statbulletin.asp

https://www.cbn.gov.ng/documents/statbulletin.asp

Christiano, L.J. and M. Eichenbaum. "Liquidity Effects and the Monetary Transmission Mechanism." *American Economic Review,* 82 (1992): 346-53.

Dimand, Robert W. "The dance of the dollar: Irving Fisher's monetary theory of economic fluctuations." History of Economics Review 20, no. 1 (1993): 161-172.

Fabayo, J.A. and O.T. Ajilore. "Inflation: How Much is too Much for Economic Growth in Nigeria." *Indian Economic Review, New Series* 41, no. 2 (2006): 129-47.

Fajingbesi, A.A. and T. Osanyintuyi. "Monetary Policy and Long Term Interest Rates in Nigeria: A Vector Auto Regressive Analysis". *In Monetary Policy and Economic Development in Nigeria. A Festschrift in Honour of Professor Siyanbola Tomori*. (2012): 225-40.

Fakiyesi, O.M. "Further Empirical Analysis of Inflation in Nigeria." *CBN Economic and Financial Review* 34, no. 1 (1996): 489-99.

Fakiyesi, T. and M.A. Adebiyi. "Channels of Monetary Policy Transmission Mechanism in Nigeria and their Impact on Output and Price." *In Monetary Policy and Economic Development in Nigeria: A Festschrift in Honour of Professor Siyanbola Tomori* (2012): 397-418.

Fisher, Irving. The money illusion. Simon and Schuster, 2014.

Fisher, Irving, and Herbert Bruce Brougham. Prohibition still at its worst. Alcohol information committee, 1928.

Friedman, M. "A Theoretical Framework for Monetary Analysis." *Journal of Political Economy* 78, no. 2 (1970): 193-238.

International Monetary Fund (IMF) Press release (2019).

Ireland, Peter N. "The macroeconomic effects of interest on reserves." *Macroeconomic Dynamics* 18, no. 6 (2014): 1271-312.

Keynes, John Maynard. *The General Theory of Employment, Interest and Money*. London, United Kingdom: Macmillan, 1936.

Khan, W.A., and A. Sattar. "Impact of Interest Rate Changes on the Profitability of Four Major Commercial Banks in Pakistan." *International Journal of Accounting and Financial Reporting* 4, no. 1 (2014): 142-54.

Khumalo, L.C., E. Mutambara, and A. Assensoh-Kodua. "Relationship between Inflation and Interest Rates in Swaziland Revisited." *Banks & Bank Systems* 12, no. 4 (2017): 218-26.

Kiley, M.T. "The Global Equilibrium Real Interest Rate: Concepts, Estimates, and Challenges." *Annual Review of Financial Economics* 12 (2020): 305-326.

_____, and J.M. Roberts. "Monetary Policy in a Low Interest Rate World." *Brookings Papers on Economic Activity*, no. 1 (2017): 317-96.

McKinnon, Ronald I. Money and Capital in Economic Development. Brookings Institution Press, 2010.

Modigliani, F., and R. Sutch. "Innovations in Interest Rate Policy." *The American Economic Review* 56, no. 1/2 (1966): 178-97.

Mordi, C., A. Essien, O.A. Adenuga, P.N. Omanukwe, M. Ononugbo, A.A. Oguntade, M.O. Abeng, and O.M. Ajao. "The Dynamics of Inflation in Nigeria." Research and Statistics Department Central Bank of Nigeria, 2013.

_____, C, Michael A. Adebiyi, and Babatunde S. Omotosho. "Modelling interest rates pass-through in Nigeria: An error correction approach with asymmetric adjustments and structural breaks." Contemporary Issues in the Nigerian Economy: A Book of Readings (2019).

Moser, Gary G. "The main determinants of inflation in Nigeria." Staff Papers 42, no. 2 (1995): 270-289.

Nnanna, O.J. "Monetary Policy Framework in Africa: The Nigerian Experience." Paper Presented at *The 2001 South African Reserve Bank Conference,* South Africa, 2001.

Odusanya, I.A. and A.A. Atanda. "Analysis of Inflation and its Determinants in Nigeria." *Pakistan Journal of Social Sciences* 7, no. 2. (2010): 97-100.

Ogege, S, and A.A. Shiro. "The Dynamics of Monetary and Fiscal Policy as a Tool for Economic Growth: Evidence from Nigeria." *Journal of Management and Sustainability* 2, no. 2 (2012): 247-58.

Oke, D.M. and O.A. Shobande. "Monetary Policy Vis-a-Vis Inflation Control, Unemployment and Income Per Capita in West Africa." *A Festschrift in Honour of Professor Oluwatayo Fakiyesi* (2019): 375-89.

Okoye, L.U., F.O. Olokoyo, F.N. Ezeji, J.I. Okoh, and G.O. Evbuomwan. "Determinants of Behavior of Inflation Rate in Nigeria." *Investment Management and Financial Innovations* 16, no. 21 (2019): 25-36.

Pesaran, M.H., and B. Pesaran. *Working with Microfit 4.0: Interactive Econometric Analysis.* Oxford, United Kingdom: Oxford University Press, 1997.

Pigou, Arthur C. "Mr. JM Keynes' General theory of employment, interest and money." Economica 3, no. 10 (1936): 115-132.

Shaw, Edward S. *Financial Deepening in Economic Development*. Oxford, United Kingdom: Oxford University Press, 1973.

Sims, C.A. "Macroeconomics and reality." *Econometrica: Journal of the Econometric Society* (1980): 1-48.

_____. "Are Forecasting Models Usable for Policy Analysis?" *Quarterly Review* Winter (1986): 2-16.

Sola, O., and A. Peter. "Money Supply and Inflation in Nigeria: Implications for National Development." *Journal of Scientific Research* 4, no. 3 (2013): 161-70.

Spiro, P.S. "New Findings on the Effects of Inflation on Interest Rates." *Business Economics* (1987): 38-42.

Stock, J.H., and M.W. Watson. "Vector Auto-regressions." *Journal of Economic Perspectives* 15, no. 4 (2001): 101-15.

Taylor, John B. "Discretion Versus Policy Rules in Practice." In *Carnegie-Rochester Conference Series on Public Policy*, 39 (1993): 195-214.

Thaler, Richard H. "Irving Fisher: modern behavioral economist." The American economic review 87, no. 2 (1997): 439-441.

Totonchi, J. "Macroeconomic Theories of Inflation." In *International Conference on Economics and Finance Research* (2011): 459-62.

Wu, J.C., and F.D. Xia. "Measuring the Macroeconomic Impact of Monetary Policy at the Zero Lower Bound." *Journal of Money, Credit and Banking* 48, no. 2-3 (2016): 253-91.