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HOW EFFECTIVE ARE MONETARY POLICY TOOLS IN CONTROLLING INFLATION IN NIGERIA? AN EMPIRICAL INVESTIGATION

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In applying the monetary policy in controlling inflation, the monetary authorities employ a mix of tools, which when varied, transfer their effects to the target outcome of inflation control. Despite monetary authorities having employed series of strategies including recently, inflation targeting, the Nigerian inflation rates have remained uncontrollable, thereby, suggesting that the question could, however, be of the effectiveness of tools being employed. This study thus, examines the effectiveness of monetary policy rates, treasury bills rates and liquidity ratio in controlling inflation in Nigeria using annual data covering the period between 1981 and 2019. Unlike most existing studies that employed a combination of policy tools and intermediate outcomes, this study employed only monetary policy tools in its analysis. Results obtained from the estimated ARDL (2, 2, 1, 2) model suggest that both in the long-run and short-run, monetary policy rates have insignificant impact on inflation rates, thus, implying that they have been ineffective in inflation control. More so, treasury bills rates were found to be effective only in the short-run as lagged treasury bills rates showed a significant negative impact on inflation in the short-run while liquidity ratio proved effective only in the long-run with an unfavourable effect on inflation control in the short-run. It is recommended, therefore, that the monetary authorities reduce the size of the informal financial system by strengthening the official financial system in a bid to make the monetary tools of choice more effective for inflation control.

Keywords: **Inflation, Monetary Policy, ARDL, Monetary Policy Rates, Liquidity Ratio, Treasury Bills**

JEL Classification: **E3, E4, E5**

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1. Introduction

One of the key functions of the apex bank (Central Bank in the case of Nigeria) in any country is the maintenance of a stable general price level in the economy. A persistent and uncontrolled increase in general prices in an economy is regarded as inflation, its antithesis is deflation, which is a persistent and uncontrolled decrease in general price level. A major cause of increasing general price level is the unproductive deployment of resources because economic agents (firms and individuals) erroneously regard variations in nominal variables as variations in real variables and so, act accordingly (Gbadebo & Mohammed, 2015). This is particularly evident in Nigeria due to the announcement effect associated with nominal increase in wages in some sectors of the economy, where businesses act on the news of the increase, thereby raising their prices.

Inflation is a grave economic difficulty; it makes it difficult to make a comparison based on facts, of economic conditions at different points in time. High and unpredictable rates of inflation are seen as detrimental to an economy as a whole as it breeds market inefficiency which makes budgetary planning challenging. This is because, owing to the unpredictability of general prices, individual, firms and governments witness insufficiency in their budgets due to the fallen purchasing power of the amount that had hitherto been budgeted. Thus, making actual demand for goods and services fall short of the expected demand. Furthermore, inflation discourages savings and investment due to the doubt on purchasing power of the currency (Anidiobu, Okolie & Oleka, 2018). Inflation may occur due to continuous intensification of the supply of money in the economy, which is not met with a proportionate increase in general output; a non-stop decrease in the aggregate demand for money, or a combination of both (Babalola, Danladi, Akomolafe & Ajiboye, 2015).

Monetary economists led by Friedman (1957) believe that inflation is always and everywhere, a monetary phenomenon which is brought about as a result of excess money supply in the economy, and as such, should be treated as one. Attaining a single-digit inflation rate at a low level, which will not surpass the threshold of the economy, has been one of the major objectives of monetary policy. Anyanwu (1993) advances that monetary policy is an indispensable economic tool of balance that enmeshes various actions used to regulate the availability, quantity, course and cost of money with the objective of attaining some set macroeconomic goals. Certainly, the accomplishment of this target is entwined with the existing transmission mechanism of monetary policy and the mode of operation capable of effectively achieving the particular goal set.

Following the postulate of the monetarists, the Central Bank of Nigeria (CBN) uses the monetary policy as a policy action to regulate price stability and curb inflationary pressures in the economy. Monetary policy is regarded as the usage of interest rates or money supply in the achievement of macroeconomic objectives and goals in an economy (Okotori, 2019).

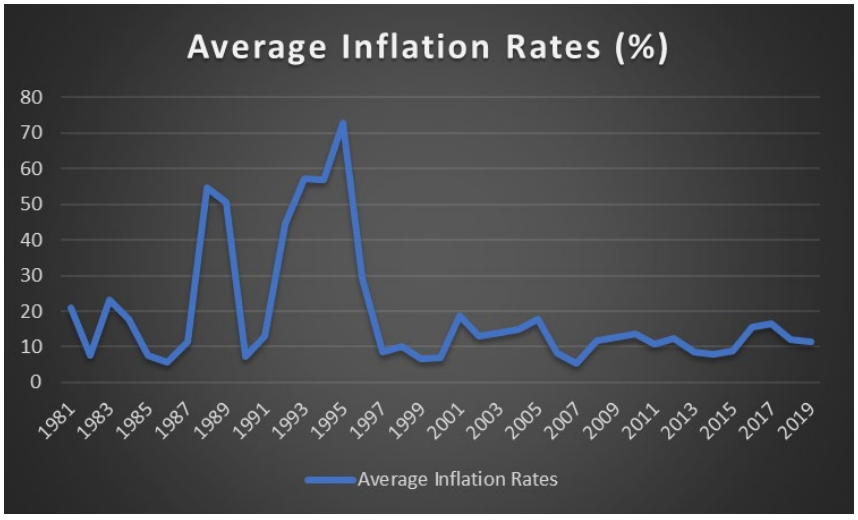
The workings of the monetary policy are such that, monetary policy instruments such as monetary policy rates, open market operations, and reserve requirements among others, are used to influence intermediate monetary targets such as money supply and interest rates in achieving the set macroeconomic objective of price stability (Maji, Waziri, Sulaiman, Tijani & Bala, 2015). In times when there is excess money in circulation and hence inflation, the CBN embarks on contractionary monetary policy, which shrinks the money in circulation by discouraging borrowing through interest rates increase meanwhile, on the other hand, to inject more money in the hands of individuals, the CBN uses the expansionary monetary policy which reduces interest rates in a bid to encourage borrowing.

Monetary policy has over time, experienced noteworthy variations globally. From exchange rate bands or pegs, to monetary aggregate targets and subsequently, inflation targeting have at various times, being used as the typical intermediate target which directs policymakers in the quest for the decisive objectives (Arestis & Sawyer, 2006). Several nations have presently subscribed to inflation targeting as their key policy thrust over a decade ago with the aim of putting a reliable framework in place, which avoids the problems of preceding policy regimes. In Australia, Canada as well as New Zealand for instance, inflation targets substituted impromptu systems that were considered as logically insufficient and had been linked with phases of poor inflation performance. In Sweden and the United Kingdom, unsuccessful exchange rate pegs were traded off for inflation targeting (Putunoi, 2015). While in Nigeria, the CBN adopted inflation targeting in 2007 after it was given more autonomy of instruments in 1998 (CBN, 2007).

In Nigeria, the CBN switched to indirect or market based monetary policy measures after the liberalisation of the banking system during the structural adjustment programme era in 1986. The direct control era relied on instruments such as the credit ceilings, reserve requirement, moral suasion, cash and liquidity ratios and minimum rediscount rate among other things, to influence intermediate targets of money supply and interest rate while in the later era, Monetary Policy Rates (MPR) replaced Minimum Rediscount Rates (MRR) while open market operations (OMO), with which the CBN mops up excess liquidity or injects money into the economy through the trade of Treasury Bills (T-bills) or Repurchasing agreement (Repos), was the key instrument (CBN, 2007).

When the CBN desires to reduce excess liquidity in the economy, they reduce money supply by increasing commercial banks' reserve requirement, reduce loan to deposit ratio or increase liquidity ratio among other things, thereby reducing the banks' lending abilities; or alternatively, they increase the cost of borrowing (interest rates) by increasing the monetary policy rate, which is the rate at which banks borrow from the CBN to discourage borrowing, thus making it costly to borrow. Despite all attempts by the CBN to get a grip on inflation in Nigeria using monetary policy instruments in the past, inflation has continued at high undesired level, averaging 24.70 per cent between 1981 and 1993, 21.39 per cent between 1994 and 2006 as well as 11.35 per cent from 2007 to 2019, with a record high of 72.84

per cent in 1995 and a record low of 5.39 per cent in 2007 (World Bank, 2021). Ogbonna and Uma (2014) ascribed the failure of monetary policy in Nigeria to the nonchalant approach of Nigerians to the formal banking system, monoculture economy, unwarranted government meddling, and the failure of financial institutions to sufficiently play their parts, as some of the reasons why the several instruments of monetary policy have been unsuccessful in Nigeria in the past. This begs the question as to the efficacy of the various monetary policy instruments employed for combating inflation in the country, this thereby necessitates a study to critically assess the usefulness of various monetary policy tools employed by the CBN in controlling inflation in Nigeria.



Source: Author's Design

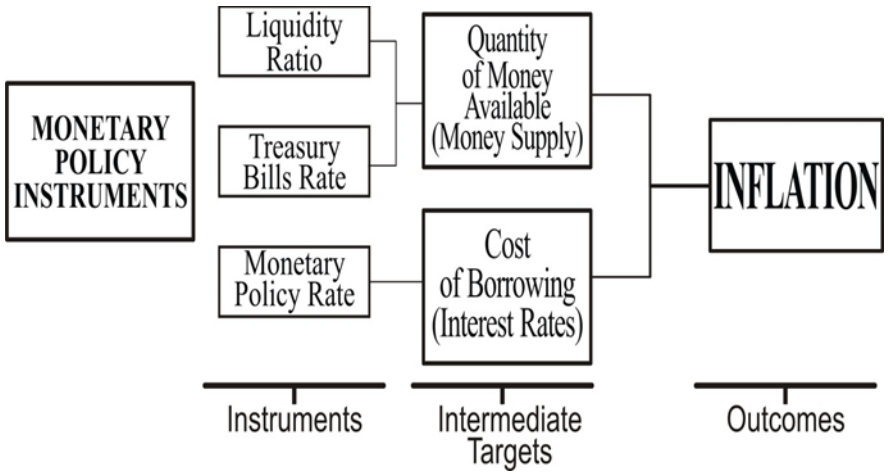
Figure 1: The Trend of Inflation

Several studies such as Itodo, Akadiri and Ekundayo (2017); Nwachukwu, Dibie and Nwoko (2014); Emerenini and Eke (2014); and Chinaemerem and Akujuobi (2012) among others have carried out studies on monetary policy and inflation in Nigeria and reached mixed conclusions where some argue that monetary policy instruments are only useful in the short run while others argue otherwise. The reason for discrepancy in findings may not be unconnected to the fact that most previous studies used intermediate monetary targets (money supply and interest rate) in place of actual monetary policy instruments, thereby creating an important gap which needs to be filled. This study therefore, is different from the previous studies in that it critically assesses the impact of actual monetary policy instruments including monetary policy rates, liquidity ratio and treasury bills rates on inflation in Nigeria. The remainder of this study is structured as follows; section two contains the literature review which discusses previous studies and theoretical background; section three contains the methodology, where the steps for which the data are analysed are detailed; section four carries the results and discussion of findings; while section five contains the conclusions drawn from findings.

2. Literature Review

Conceptual Framework

The conceptual framework for this study is presented in Figure 2 below. It shows the relationship between the variables, in other words, how the monetary policy instruments relate to inflation rates.



Source: Author's Design

Figure 2. The Relationship between Monetary Policy Instruments and Inflation Rate

From Figure 2, it is seen that liquidity ratio, treasury bills rates and monetary policy rates have an indirect relationship with inflation rates. The effects are passed through the intermediate targets of money supply, the quantity of money available for borrowing; and interest rates, the cost of borrowing the available money, which lead to the outcome of inflation control.

Theoretical Background

The monetary economists led by Friedman (1973) regard monetary policy as the most effective way of controlling inflation and aggregate output in an economy. According to Humphrey (1986), inflation is purely a monetary phenomenon that can only be created by expanding the money supply at a rate faster than that at which aggregate output grows so that there is a rise in money supply which surpasses the absorptive capacity of the economy (Totonchi, 2011). Believing that money supply is the most dominant determinant of both level of output and prices in the short run and of the level of prices in the long run, the monetarists propose their opinion in a simple linear relationship known as the quantity theory of money which is given as follows:

$$MV = PT \tag{1}$$

Where; M is money supply, V is velocity of money in circulation, P is price level and T is transactions (volume of transactions). According to the monetarists, if the above equation must hold, the value of expenditure on goods and services must equal the value of output. Monetarists believe that in the short term, velocity is fixed, this is because of the rate at which money circulation is determined by institutional factors. Aminu and Anono (2012) described the monetarist theory as a process in which money is the main determinant of price level where a change in money in any amount will have an impact on the change in price level. Monetarist regards aggregate excess demand which result from excess supply of money as the only cause of inflation.

Mbutor (2014) argues that to contain inflation, money supply should be decreased which will increase interest rate, this process will eventually slow down inflationary rate and the level of aggregate demand. This study is hinged on this theory because it considers the two key variables (interest rates and money supply) which the monetary authorities target when applying any monetary policy instruments with the aim of controlling inflationary pressures. According to the quantity theory of money, money supply and interest rates are only means through which price stabilisation or economic growth are achieved.

Empirical Literature

Several attempts have been made at examining the efficacy of monetary policy in the control of inflation. For instance, Kinya (2019) in his study of the effectiveness of monetary policy instruments in inflation control in Kenya between 1997 and 2015 using factor augmented vector autoregression (FAVAR) technique, employed the use of a combination of monetary policy tool (repo rates) and intermediate outcomes such as exchange rates, broad money supply and bank lending rates. Findings from the study showed among other things that, only bank lending rates is statistically significant in controlling inflation in Kenya with a negative impact on inflation. Furthermore, exchange rates, broad money and repo rates showed no statistically significant impact on inflation rates in Kenya during the period of the study. Meanwhile, Bleaney, Morozumi and Mumuni (2019) estimated Ghanaian monetary policy reaction function for the period 2007 to 2017 using monthly time series data. Employing the least squares and other forms of analysis, they observed a negative significant relationship between monetary policy rate and inflation in Ghana, while lagged monetary policy rate and exchange rates were found to be insignificant.

Researching on the determinants on inflation rates in Indonesia between 2010 and 2017, Setiartiti and Hapsari (2019) employed the use of an error correction model. The results of their analysis reveal that money supply, exchange rate and bank lending rates are not significant predictors of inflation in the short run, whereas, in the long run, only money supply significantly determines inflation rate and it exhibits a positive relationship with inflation

rates. In another study, Iddrisu and Alagidede (2019) employed a Quantile regression approach in examining monetary policy and food inflation nexus using South African monthly data from January 2002 to November 2018. Including series such as monetary policy rates, transportation cost, exchange rates, national output and world food price index as explanatory variables, the study found the presence of structural breaks in the series and a positive significant impact of monetary policy rate, transportation cost, world food price index and exchange rates to the 75th quantile while output was found to be insignificant. The authors conclude that rising food prices in the country are destabilized when monetary policy response is restrictive.

Honore (2018) in his study, examined monetary policy and inflation in Cameroon using data from 1980 to 2016. Employing Johansen cointegration and error correction model, the study finds that money supply has a positive significant relationship with inflation while interest rate is not significant in both the short run and the long run. Meanwhile, Aghisna (2017) examined inflation dynamics in Indonesia by way of a multiple linear regression model. She concluded from the results that the interest rates, exchange rates and fuel subsidy have positive and significant impact on the growth of inflation in Indonesia. Moreover, Islam, Abdul Ghani, Mahyudin and Manickam (2017) investigated the determinants of factors that affect inflation in Malaysia between 1980 and 2014 using ordinary least squares. Their results reveal that there is a negative significant relationship between exchange rate and inflation rates in Malaysia while, the relationship between money supply and inflation rates is found to be statistically insignificant. Again, Mutwiri and Jagongo (2017) examined monetary policy tools and inflation in Kenya between 2008 and 2012 using ordinary least squares. The results reveal that treasury bills rates, exchange rates, repo rate and money supply have positive relationship with inflation while Central Bank rates has a negative relationship with inflation. The study however, has a very short scope and neglects the necessary pre- and post-estimation tests.

In examining the impact of monetary policy tools on inflation rates, the Nigerian context has also been considered by several authors including Okoye, Olokoyo, Ezeji, Okoh and Evbuomwan (2019) which investigated the determinants of inflation rate in Nigeria following an autoregressive distributed lag method with annual time series data from 1981 to 2016. Results from bounds test reveal that cointegration exists between inflation rates and the explanatory variables which includes money supply, exchange rate, interest rate, aggregate output, external debt and fiscal deficit. Furthermore, short run estimates show that lagged exchange rate as well as current period money supply have negative significant relationships with inflation rate while lagged money supply, current period and lagged interest rates have positive significant relationships with inflation rate. The authors conclude that the explanatory variables included have no significant impact on inflation rates in the long run.

Furthermore, Okotori (2019) examined the dynamics of monetary policy and inflation in Nigeria using monthly data from 2009 to 2017. He estimated two models with inflation as

the regressand in the two models, using money supply, exchange rate and monetary policy rate as regressors in one model and treasury bills rate, reserve requirement and liquidity ratio as regressors in the other. Employing Johansen cointegration and error correction model, he found for the first model that in the short run, inflation at one, three and four-period lags, as well as current period money supply, exchange rate and monetary policy rate positively influence current period inflation while for the second model, one-period lag inflation as well as liquidity ratio at current period both positively impact on inflation rate at the current period.

Meanwhile, Adodo, Akindutire and Ogunyemi (2018) employed Johansen cointegration and error correction model in examining monetary policy and inflation control in Nigeria from 1985 to 2016. Using money supply, interest rate and exchange rates as regressors, results indicate that only lagged inflation rates and interest rates are statistically significant in inflation control in the short run and both exert a positive impact on the current period inflation. The authors conclude that the monetary policy has only been partially effective in inflation control in the period of study.

In another study based on monthly time series data covering the period January, 2009, to December, 2016, Akarara and Azebi (2018) employed an error correction model in their research on the effectiveness of monetary policy in controlling inflation in Nigeria. Using regressors such as money supply, exchange rate, monetary policy rates and treasury bills rate, results show that the treasury bills rate alone negatively impacts inflation while the other regressors have significant positive impact on inflation. Udoh and Isaiah (2018) assessed inflation in Nigeria based on a predictive model using quarterly series from 1995 to 2016. Employing a dynamic model which considers the lag, differenced and lagged-differenced values of series, they predicted inflation based on regressors such as interest rates, money supply and exchange rates. The backward selection model found a positive significant impact of the third period lag of money supply, twelfth period lag of interest rates and the fourth period lag of exchange rates on inflation while the fourth period lag of interest rate has a significant negative relationship with inflation rates. The authors conclude that past values of interest rates, money supply and exchange rates are potent predictors of future inflation rates.

Assessing monetary policy and price stability in Nigeria, Itodo et al. (2017) analysed data covering the periods between January 1996 and October 2016 using the vector autoregression model. Results show that there is no cointegration between inflation and money supply in Nigeria. Furthermore, VAR estimates show that only money supply at two periods lag has a significant impact on inflation, and the impact is negative. More so, Bada, Olufemi, Tata, Peters, Bawa, Onwubiko and Onyowo (2016) investigated the exchange rate pass-through to inflation in Nigeria using quarterly data from 1995Q1 to 2015Q1. Employing a vector error correction model, they find a long run relationship between inflation proxied by consumer price index and exchange rate variables as well as other control variables. Estimates reveal that a negative significant relationship exists between nominal exchange

rates and inflation in Nigeria in both the long and the short run. Meanwhile, Ujuju and Etale (2016a) employed ordinary least squares on annual time series data from 1982 to 2011 in their macroeconomic analysis of the relationship between monetary policy instruments and inflation in Nigeria. Results revealed that all monetary policy instruments they included in their study, interest rate, minimum rediscount rate, liquidity ratio and cash reserve ratio, are not statistically significant in determining inflation rate in Nigeria. This finding however, can be flawed based on the premise that their study neglected the examination of the unit root properties of the series and necessary diagnostic checks. Similary, Ujuju and Etale (2016b) examined the role of interest rates and liquidity ratios in inflation control in Nigeria from 1980 to 2011 using the same technique. They find a non-significant impact of all regressors (interest rate, minimum requirement ratio, cash reserve ratio and liquidity ratio) on inflation. This unusual result may be as a result of their negligence of stationarity tests and the necessary diagnostic checks for the model.

Maji et al. (2015) in another study, empirically investigated the nexus between monetary policy rate, interbank rate, savings deposit and inflation rate in Nigeria using autoregressive distributed lag model on monthly data covering January, 2006 to November, 2014. Results from bounds test indicate a long run relationship between inflation, inter-bank rate, monetary policy rates and savings-deposit rate. Furthermore, estimates from the long run coefficients show that all three explanatory variables have negative significant relationship with inflation while in the short run, interbank rates and monetary policy rates maintain the negative significant relationship while savings deposit rate was found to be insignificant. The authors conclude that the included monetary policy tools have been effective in controlling inflation in Nigeria.

3. Methodology

Model

The model used in this study is an adaptation from Maji et al. (2015), using some of the monetary policy tools employed in the study while tailoring it to fit the objectives of the study. In its functional form, the model for this study is given as follows:

$$INF = f(MPR, TBR, LQR) \tag{2}$$

Where; *INF* is inflation rates, *MPR* is monetary policy rates, *TBR* is treasury bills rates and *LQR* is liquidity ratio. Equation (2) is further restated into an estimable form, which is the general stochastic linear form of the relationship given as:

$$IINF_t = \varphi_0 + \omega_1 MPR_t + \tau_2 TBR_t + \delta_3 LQR_t + \mu_t \quad (3)$$

With apriori expectation $\omega_1, \tau_2, \delta_3 < 0$

Where; φ_0 is the intercept of the equation and ω_1, τ_2 and δ_3 are unknown parameters while μ is the stochastic error term.

We employ the ARDL bounds test technique proposed by Pesaran et al. (2001) to test for cointegration among the series considering that the conventional cointegration techniques, fundamentally the Engle and Granger (1987) residual based cointegration test and Johansen (1995) cointegration rank test, have been faulted on the premise that they are incapable of estimating equations which combine series of mixed integration levels (i.e., a combination of levels and first difference stationary series) without producing spurious results (Ibrahim, Matthias & Liman, 2020). Furthermore, the ARDL technique is preferred over other cointegration methods because of its ability to generate robust estimates in the face of small observation size. Also, the ARDL technique combines the levels and differenced forms of series in a single reduced form equation (Abu, 2017; David, 2018).

The ARDL technique begins with the examination of the time series properties of the variables through a unit root test. The ARDL bounds testing procedure requires that series are not integrated at levels higher than I(1). Therefore, it is necessary to ensure that none of the series are stationary at I(2). For this, we employ the Phillips and Perron (1988) unit root test process conducted using the following AR(1) process given below:

$$y_t = c + \delta t + \sigma y_{t-1} + e(t) \quad (4)$$

where; y is the variable, *c is the intercept, δ_t is the drift term and e(t)* is the innovation term. It tests the null hypothesis that the variable, y, contains a unit root. The decision rule is to reject the null hypothesis if the obtained test statistic (in absolute terms) is greater than the critical value at 5 per cent (in absolute terms) at whatever level of test (levels, after first or second differencing). After establishing that none of the series is stationary at second difference, the ARDL bounds test for cointegration is conducted to investigate the presence of a long-run integration among the series using the following equation as proposed by Pesaran et al. (2001).

$$\Delta INF_t = a_0 + \alpha_1 \sum_{i=0}^{n} \Delta INF_{t-i} + \alpha_2 \sum_{i=0}^{n} \Delta MPR_{t-i} + \alpha_3 \sum_{i=0}^{n} \Delta TBR_{t-i} + \alpha_4 \sum_{i=0}^{n} \Delta LQR_{t-i} + \delta_1 INF_{t-1} + \delta_2 MPR_{t-1} + \delta_3 TBR_{t-1} + \delta_4 LQR_{t-1} + \mu_t \quad (5)$$

Where; Δ denotes first difference, a_0 is the intercept of the equation, $\alpha_1 - \alpha_4$ are short-run parameters while $\delta_1 - \delta_4$ are the unknown parameters for the levels (long-run) forms of the

relationship. The f-statistic generated from estimating equation (5) is compared to the critical bounds value in Pesaran et al. (2001) for the cointegration test. If the f-statistic is greater than the upper bounds critical value at 5 per cent level of significance, it implies that the series are cointegrated while an f-statistic lower than the 5 per cent lower critical bounds value denotes the non-existence of cointegration among the series.

The conditional error correction model in equation (5) was used to determine the optimum lag length for the estimation using a general-to-specific elimination approach where the variables were specified with a sufficient number of lags, (5 in this case) and with each estimation, the most statistically insignificant coefficient is eliminated and the Akaike Information Criterion (AIC) is recorded while a re-estimation is done without the eliminated lagged variable. This iteration is repeated several times and the information criteria obtained are compared. The model with the least AIC is then chosen for the analysis.

The presence of cointegration among the variables necessitates the estimation of the levels and error correction forms of the model to capture the long-run and short-run estimates. The equations for the levels and error correction estimates are presented in equations (6) and (7) respectively.

$$INF_t = a_0 + \delta_1 INF_{t-1} + \delta_2 MPR_{t-1} + \delta_3 TBR_{t-1} + \delta_4 LQR_{t-1} + \mu_t \quad (6)$$

$$\Delta INF_t = a_0 + \alpha_1 \sum_{i=0}^{n} \Delta INF_{t-i} + \alpha_2 \sum_{i=0}^{n} \Delta MPR_{t-i} + \alpha_3 \sum_{i=0}^{n} \Delta TBR_{t-i} + \alpha_4 \sum_{i=0}^{n} \Delta LQR_{t-i} + \gamma \varepsilon_{t-1} + \mu_t \quad (7)$$

Where; γ is the coefficient of the error correction term (ε_{t-1}) which records the speed at which long-run convergence is achieved in the system.

Data

Data for all variables in this study (inflation rates, liquidity ratio, monetary policy rates and treasury bills rates) cover a period of 39 years covering the period between 1981 and 2019 and have been sourced from recognised published sources. Explicitly, data for the dependent variable (inflation rates) were collected from the World Bank World Development Indicators (WDI) (2021) while data for all explanatory variables (monetary policy rates, liquidity ratio and treasury bills rates) were collected from the 2020 Annual Statistical Bulletin published by CBN (2021).

4. Results

Discussion of Summary Statistics

In order to assess relationships between variables in a regression model, it is important to examine the individual characteristics of each variable entering the model using the summary/descriptive statistics. Presented in Table 1 is the summary statistics for the variables where the dependent variable, inflation rate, is observed to have an average value of 19.15 per cent with a standard deviation of 17.06, with a corresponding coefficient of variance of 89 per cent (calculated as the ration of standard deviation to the mean), which implies that observations are very much dispersed from the mean value, and thus, the sample has a high variance and the mean value does not properly represent the sample. By implication, this means that during the period 1981 to 2019, Nigeria had witnessed highly unstable rates of inflation. With the maximum and minimum values of 72.84 per cent and 5.39 per cent respectively, inflation rate shows a skewness of 1.78 which is greater than the normal skewness, 0, and hence, implies that the series is positively skewed while the kurtosis statistics of 4.998 shows that inflation rate in this sample is leptokurtic and has thin tails, therefore, several extreme values are observed for inflation within the sample period.

Among the explanatory variables, treasury bills rates displays the highest coefficient of variation, 40 per cent with a corresponding mean value of 11.66, which is the lowest among the explanatory variables, and a standard deviation of 4.69. The coefficient of variation makes treasury bills rates the most varied among the explanatory variables, although all explanatory variables have coefficient of variations less than 70 per cent, which implies that they are not much dispersed from the mean.

Table 1: **Summary Statistics**

Variables	Mean	Standard Deviation	Coefficient of Variance	Maximum	Minimum	Skewness	Kurtosis
INF	19.1465	17.0628	89%	72.8355	5.38801	1.78359	4.99767
MPR	13.0769	4.04667	31%	26	6	0.66929	4.33233
LQR	48.4428	13.3388	28%	103.898	29.1	1.84691	8.78115
TBR	11.6602	4.68924	40%	26.9	3.6599	0.90442	4.47256

Source: Author's Computation

Furthermore, all explanatory variables show a kurtosis higher than 3, which suggests that the three monetary policy tools employed are leptokurtic and contain extreme values in the sample period, with liquidity ratio being the most leptokurtic. Meanwhile, for the skewness, all three monetary policy tools are positively skewed as they are greater than 0, however, monetary policy rate and treasury bills rates are closer to the normal skewness than liquidity ratio is.

Discussion of Stationarity Test

As it is important to ascertain the unit root properties of time series data entering a regression model, we conduct the Phillips-Perron test for stationarity. The result of the stationarity tests presented in Table 2 shows that of all the series, only liquidity ratio (LQR) becomes stationary only after first differencing as the others, inflation rate, treasury bills rate and monetary policy rate, are stationary at levels. This conclusion is arrived at through the comparison of the PP-statistics to the 5% critical value, both in absolute terms and the null hypothesis is rejected when the test statistic exceeds the critical value. Therefore, we conclude that the series are of mixed stationarity, that is, a mixture of I(0) and I(1) integration, which implies that the bounds test approach for cointegration is required.

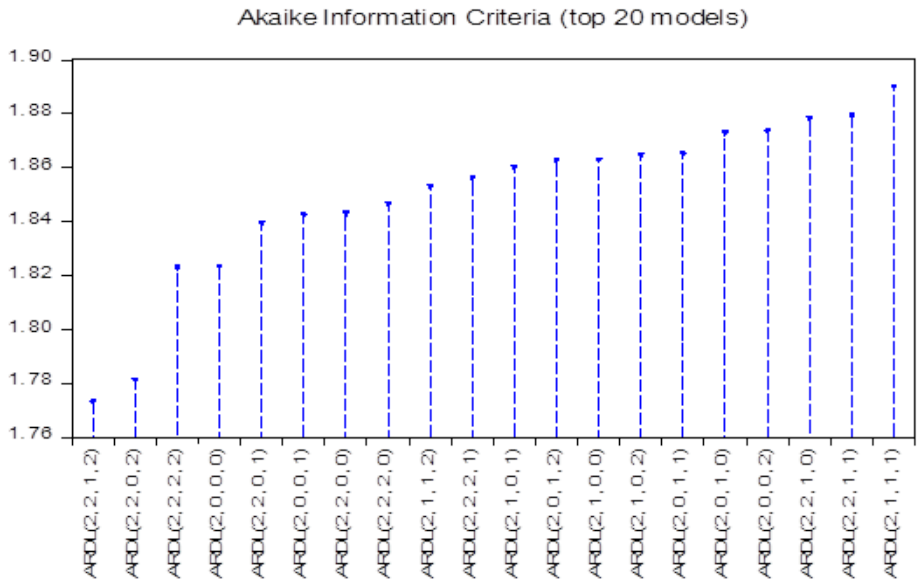
Table 2: **Results of Stationarity Tests**

VARIABLES	Levels		First Difference		Remark
	PP	5% Critical value	PP	5% Critical value	
INF	-3.271640	-2.941145	-9.623778	-2.943427	I(0)
MPR	-3.122200	-2.941145	-7.756985	-2.943427	I(0)
TBR	-2.972003	-2.941145	-7.569139	2.943427	I(0)
LQR	-2.698508	-2.941145	-6.188098	-2.943427	I(1)

Source: Author's Computation

Discussion of Lag Selection Results

In order to ensure that the optimum lags were employed for the variables in the analysis, we use the conditional ECM to determine the optimum lag length for each variable entering into the model. The optimum lags were decided using the AIC. Results of the lag selection process is presented in Figure 3 shows the lag selection map of the model and clearly indicates that the ARDL (2, 2, 1, 2) is the most suitable model to use in the estimation. This was decided based on its AIC value which is less than the value for all other combinations of the variables using different lags. It is important to note that the lag selection test is conducted before the bounds test for cointegration in order to ensure that the optimum lag for the model is actually employed in testing for cointegration, and by so doing, giving credibility to the results of the bounds test.



Source: Author's Computation

Figure 3. Result of Optimum Lag Selection Test

Discussion of Cointegration Test

Table 3 contains the results of the bounds testing approach to cointegration test among the series. Following the decision rule stated in the previous section, it is observed that the f-statistics generated from estimating the unrestricted ARDL model is 6.39, which is greater than the lower bound (2.20) and upper bound (4.96) critical values at 1%, 2.5%, 5% and 10% as prescribed by Pesaran et al. (2001). This simply implies that inflation rate, monetary policy rate, liquidity ratio and treasury bills rate have a long-run relationship. What this translates into is that inflation and the applied monetary policy tools are integrated in the long-run. This finding supports the assertion of the monetarists that monetary policy is useful in both the long-run and the short-run control of inflation. More so, similar empirical studies which obtained the same results include Maji et al. (2015) and Okoye et al. (2019) among others, while, the finding is in contrast to Itodo et al. (2017).

Table 3: Results of Bounds Test Approach to Cointegration

Test Statistics	Value	K=3
F- Statistics	6.386935	
Critical Value Bounds Significance	I(0)	I(1)
10%	2.37	3.2
5%	2.20	4.96
2.5%	3.15	4.08
1%	3.65	4.66

Source: Author's Computation

Discussion of Long-run Estimates

The results of the long-run estimates presented in Table 4 show that liquidity ratio and monetary policy rates have negatively signed coefficients, which implies that they maintain a negative or inverse relationship with inflation rates while treasury bills rates have a positively signed coefficient thereby implying a positive or direct relationship between treasury bills rates and inflation rates in Nigeria. Considering the probability values, it is observed that liquidity ratio alone is statistically significant at the 5 per cent level of significance while treasury bills rates and monetary policy rates are statistically insignificant as their probability values are greater than 0.05.

With a coefficient of -1.80, a percentage increase in liquidity ratio yields a 1.80 per cent decline in inflation rates in the long-run. This is not surprising as the liquidity ratio, from apriori, is expected to have a negative impact on inflation rates due to the reduction effects its increase has on banks' funds available for borrowing. An increase in the statutory liquidity ratio for lending institutions reduces the volume of loanable amounts available to banks, thereby, reducing the amount available for borrowing and, hence, the volume of money in circulation which consequently leads to a reduction in the prevailing rates of inflation. This finding is contradictory to Ujuju and Etale (2016a and b) who found the impact of liquidity ratio insignificant in inflation control.

Table 4: Results of Long-run Estimates

Dependent Variable: INF			
Variables	**Coefficient**	**T-statistics**	**P-value**
LQR(-1)	-1.804981	-3.045677	0.0053
MPR(-1)	-1.763443	-1.255651	0.2204
TBR(-1)	1.983316	1.858885	0.0744
Constant	9.350224	3.988808	0.0005

Source: Author's Computation

In the case of treasury bills rates, a coefficient of 1.98 suggests that a percentage increase in treasury bills rates increases inflation in the long-run by 1.98 per cent. This finding contrasts apriori expectations as it is expected than at higher treasury bills rates, banks shall purchase more bills and by so doing, reducing their lending capabilities. In this case, however, a negative relationship may mean that treasury bills rates do not get high enough so much as they become enticing for banks to purchase so much that their funds available for lending are affected, notwithstanding its risk-free nature. Similarly, monetary policy ratio displays a long-run coefficient of -1.76 which implies that a percentage increase in monetary policy rates brings inflation down by 1.76 per cent. This is expected as it is in line with the workings of the monetary policy rates, which determines the rate at which banks get money from the CBN and consequently, the rate at which they lend it out to borrowers. However, what is surprising about this finding is the insignificant impact of monetary policy rate on inflation judging from its probability value, 0.2204 which is greater than 0.05. This, is despite the fact that the monetary policy rate is the key policy tool employed by the CBN. This is likely due to the fact that there is a large amount of credit circulating outside the formal banking sector, which

exists in the informal sector such that changes to the statutory monetary policy rate may not have the desired impact on inflation rates in the long-run.

Discussion of Error Correction Estimates

The results of the short-run and error correction estimates are presented in Table 5 below. It is evident that among the variables, only lagged inflation, lagged liquidity ratio and lagged treasury bills rate are statistically significant judging by the probability values.

With a coefficient of 0.45, current period inflation rates in the short-run are positively affected by inflation from last year such that, a percentage increase in last year's inflation rates leads to an increase in this year's inflation rates by 0.45 per cent. This implies that in the short-run, inflation is fueled by previous incidences of inflation, albeit not to a large extent. This may be attributed to the fact that people tend to engage in panic buying or speculation, as increase in general prices is generally expected to be followed by further increase.

Table 5: Results of Short-run and Error Correction Estimates

Dependent Variable: DINF			
Variables	**Coefficient**	**T-statistics**	**P-value**
D(INF(-1))	0.454734	3.217965	0.0034
D(LQR)	-0.345710	-0.937533	0.3571
D(LQR(-1))	1.000157	2.376261	0.0251
D(MPR)	-0.603071	-1.081614	0.2894
D(TBR)	0.445134	1.133557	0.2673
D(TBR(-1))	-0.763435	-2.614001	0.0147
ε_{t-1}	-0.964080	-6.070231	0.0000
R2 =0.572939	Adj. R2 =0.487526		

Source: Author's Computation

On the other hand, lagged treasury bills rates has a coefficient of -0.76, thus, implying that the previous year's treasury bills rates negatively impact current period inflation. This follows with the expected relationship as it is expected that higher treasury bills rates will encourage purchase of treasury bills, which consequently reduces the amount available for banks to lend out. Meanwhile, lagged liquidity ratio has a coefficient of 1.00 which indicates that there is a positive impact of previous year's liquidity ratio on current period inflation rates. This implies that, increasing the liquidity ratio in the short-run does not help in curbing inflation rates, but rather, deepens the level of inflation in the economy. This could be because higher liquidity ratios reduce the amount available for banks to lend out and as such, producers are not able to adjust their output to the shortage of funds in the presence of growing demand, thus, making the available output scarce. In essence, in the short-run, an increase in the rates of treasury bills are much more effective in controlling inflation while increasing liquidity ratio worsens the prevailing inflationary pressure on the economy, with a one-year delay before the impacts are manifest. Following the coefficient sizes, it is evident that the impact of lagged treasury bills rates is less pronounced than that of lagged liquidity ratio. This may be because of the time it takes for policies to have impact on the economy at large, due to

the channels through which policies are transmitted. This finding partly corresponds with the monetarist doctrine that monetary policy is effective in short-run inflation control. These results are similar to the findings of Akarara and Azebi (2018) and Mutwiri and Jagongo (2017), while they contradict the findings of Ujuju and Etale (2016a and b).

Going further, monetary policy rates, which is the key monetary policy tool employed by the Nigerian monetary authority, is again found insignificant, thereby buttressing the results obtained for the long-run estimates. Meanwhile, the error correction term (ε_{t-1}) shows a negatively signed coefficient and a probability value less than 0.05 which means that the error correction coefficient satisfies all requirements for error correction. With a coefficient of -0.96, random shocks to the system are corrected towards long-run convergence at a speed of 96 per cent, which is high, but not excessive as the regressors included consists of the key monetary policy tools in Nigeria.

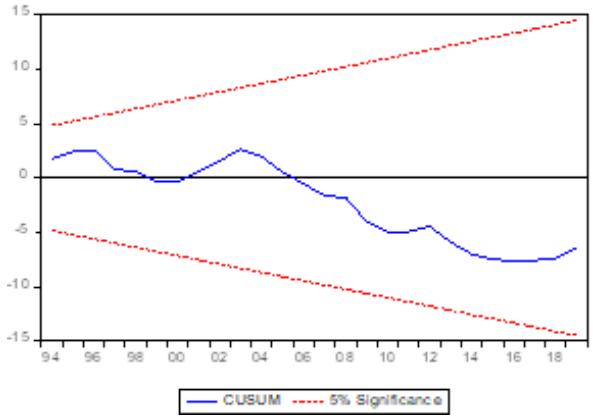
Discussion of Model Diagnostics

In order to ascertain the reliability of results and stability of estimates, diagnostic tests including model residual diagnostics and model stability checks are employed with the results displayed in Table 6 and Figures 3a and b. In table 6, it is observed that the probability values of all tests shown are greater than 0.05, hence, the null hypotheses cannot be rejected. This implies that the estimates are free from problems associated with time series analysis including serial correlation, heteroskedasticity, non-normality and functional misspecification. To further buttress this, the results of model stability using the Cumulative Sum (CUSUM) of Residuals and Cumulative Sum of Squares (CUSUM of Squares) are presented in figures 4a and 4b. Both plots show that the model is stable in the long-run because in both cases, the trend line does not exceed the upper and lower limits.

Table 6: Results of Residual Diagnostic Tests

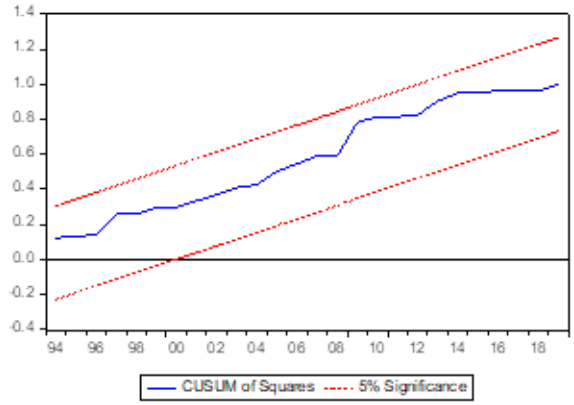
Test Statistics	P-value
Serial Correlation: F-statistic(2, 24)	0.7493
Heteroskedasticity: F-statistic(10, 26)	0.8822
Normality: Jarque-Bera	0.960114
Specification Error: F-statistic(2, 24)	0.1133

Source: Author's Computation



Source: Author's Computation

Figure 4a: CUSUM Plot



Source: Author's Computation

Figure 4b: CUSUM of Squares Plot

5. Conclusion

This study examined the effectiveness of monetary policy tools in controlling inflation in Nigeria under the framework of the quantity theory of money (Fisher's theory of exchange). Using annual time series data which covers the period from 1981 to 2019, we employed an ARDL (2, 2, 1, 2) model chosen by the Akaike information criterion through the estimation of a conditional error correction model. Major findings from the study suggest that monetary policy rates have been ineffective in the control of inflation in both the long-run and short-

run, while conversely, treasury bills rates have been the most effective monetary policy tool for inflation control in the short-run during the period. Meanwhile, liquidity ratio was found to be effective in controlling inflation only in the long-run, as its usage in the short-run causes a short-term disequilibrium in the economy, which further deepens the level of inflation. The combination of the three monetary policy tools, however, results in a high speed of error correction (96%).

From the findings, we therefore conclude that although the monetary policy rate is the leading policy tool in Nigeria, it has not been effective in inflation control, probably due to the large size of the informal financial system in Nigeria, where informal lenders loan money out to borrowers at varying high rates which are not affected by the official rates stipulated by the monetary authorities for the official financial system. This, therefore, leads to a kind of leakage in the transmission of monetary policy rates to the economy as some borrowings and their associated rates are not affected by the policies. Moreover, liquidity ratio has proven to be the most effective monetary policy tool for long-run inflation control while in the short-run, its workings further deepens the level of inflation. Meanwhile, treasury bills rates have only proven to be effective in inflation control in the short-run period with its effect less pronounced than the undesirable effect of liquidity ratio on the level of inflation.

It is, therefore, recommended that the monetary authority takes necessary steps towards the stabilisation of the rates in the formal financial system so as to discourage or at least, reduce the size of the informal system to enable the actualisation of monetary policy targets. Furthermore, liquidity ratio should be given more attention in long-term inflation control while for short-run inflation targets, treasury bills rates should be the key focus in monetary policy design and implementation.

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