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RESEARCH

The nexus between monetary policy and sustainable development goals number ten in Nigeria

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This study examined the nexus between monetary policy and sustainable development goals number ten in Nigeria from (1987 to 2022). The data for this study were collected from secondary sources, which include World Bank and World Development Indicator online data base, previous studies, as well as journals articles. The estimation techniques used for this study were econometrics tools to run the regression, unit root test, ARDL, Bound Test, and granger causality tests. The results from the study showed that there is combination of I (1) and I (0) among the variables based on the stationarity test conducted. The ARDL test result shows that there is existing of long relationship through the bound test, of F-statistics 5.63 at 10 and 5 per cent respectively. The granger causality test indicated bidirectional causality and no causality relationship among the variables. The results of the short run and long run indicated that the monetary policy has both positive and negative impacts on SDG-10 in Nigeria. The study recommends that the government should consider the inflationary and exchange rates in Nigeria in order to tackle the level of inequality among the citizens. This can be effectively carried out through a stringent price control for goods and services as well as implementing a fixed exchange rate policy that would restrict the ever-declining value of naira relative to dollar exchange rate. If effectively articulated, it will ensure equitable distribution of income and wealth among the citizens in the country. The major scientific novelty introduced in this study is the measurement of inequality using Gini Coefficients based on SDG-10 perspective.

Keywords: monetary policy, reduced inequality, sustainable development goals, Nigeria

Introduction

There is a growing body of literature on the causes of income inequality both in developed and in developing countries. Several factors have been considered to be responsible for increasing disparity in the level of income. Such factors range from technological progress, demographics, globalization, structure of the labor market, and structure of the economy (1). Recently, monetary policy has also been identified as one of the causes of inequality. It has been argued that the distributional effect of monetary policy also affects income inequality; however, the net effect of this policy on income inequality is not clear (2).

In an attempt to examine the impact of monetary policy on sustainable development goals number ten (SDG-10), Jothr et al. (3) found that expansionary monetary policy shocks reduce inequality in the U.S. After this pioneering study, Khan and Khan (4) found a contradicting result in the case of Japan. The study reported a positive relationship between expansionary monetary policy shocks and inequality. These two contradicting results set the stage for further investigation of the subject matter. Further, the results of the research could be categorized into four different groups. The first set found out that contractionary monetary policy increases inequality (3, 5, 6). And the second set also discovered that contractionary monetary policy

decreases income inequality (7). The third set found out that expansionary monetary policy increases income inequality (8, 9) while the fourth set finds that expansionary monetary policy reduces income inequality (10).

Moreover, Toriola et al. (11) argues that many researchers commit the error of using measures or approach of income inequality that do not capture the distribution of income of the entire population. Such measures use household data that do not represent the income of the top few that control the economy, in peculiar with developing countries. In such a case, the results of the effect of monetary policy shocks on inequality from such data might be misleading. They suggested the use of an income inequality index that covers the whole income distribution of the entire population.

For this reason, this study adds to the body of literature in three different ways. It first validates the truthfulness or falsity of the policy ineffectiveness claim in Nigeria. The second part of the study looks at how Nigerian income inequality is affected by expected and unexpected conventional monetary policy shocks. From the monetary policy function, both expected and unexpected monetary policies are produced. In Nigeria, the short-term interest rate serves as the policy tool and monetary policy is implemented using the Taylor-type reaction function as described by Onwe et al. (12). Monetary policy expectations are represented by the predictive component of the policy function, while the unexpected is represented by the residual. Last but not least, the study employed the Gini coefficient recommended by Adeleke and Olomola (13) as a metric of income disparity. The income distribution across the three basic layers—upper, middle, and lower—of all Nigerian citizens was captured by this measure of income inequality.

It is also imperative to state that there are other measures of monetary policy like the income per capita, wages, salaries among others. This study relies mainly on the Gini coefficient in measuring inequality. This is because it provides a reliable explanation on the different measures of inequality especially in the Nigerian context.

Over the past decades, prominence in ensuring stability of the entire monetary policy has received attention due to several episodes of economic and financial crisis/instability and the severe consequences it has on monetary policy, inequality, economic growth and performance at large. To maintain stability in the monetary policy, financial authorities across the world in collaboration with IMF, ESCB, and WB introduced an initiative focused on a single methodology for the compilation of Financial Soundness Indicators (FSI) as a measure of the stability of an economy's monetary policy. The IMF's FSI aims to provide reliable and dependable financial indicators that are pre-emptive toward unanticipated monetary policy crisis and shocks emanating within or outside the economy (14).

The Nigerian economy having experienced several periods of financial instability, financial authorities have taken considerable steps and embarked on several reforms toward ensuring a much stable, robust, and viable monetary policy. Some of these were: in the 1990s, capital base requirement in the banking industry was increased, close supervision on non-performing loans among banks was intensified, and regulation on structure and ownership of commercial banks was strengthened. Furthermore, steps toward achieving total independence of the CBN from Federal Ministry of Finance (FMF) were advanced expediting legal proceedings in convicting illicit and fraudulent acts in financial institutions like the Decree No.18 of 1994 on failed banks and recovery of debts particularly on insider abuse in which key officials were alleged to have partaken in. In 2005, the CBN increased the minimum capital base to N25 billion, consolidating financial institutions through the creation of the Financial Intelligence Unit (FIU), and increased e-FASS completion, tightening cooperation with the EFCC, and mergers, and acquisitions. Furthermore, in August 2009, it formed the Monetary Policy Stability Committee (MPSC). Publishing a comprehensive Monetary Stability Report (MSR) every two years is the committee's assigned task (15).

In spite of the laudable reforms embarked upon to ensure financial stability, while available data suggest relative stability in the monetary policy, the economy still lacks the desired economic growth anticipated by economists and financial authorities (4, 16, 17). Although the Central Bank Nigeria has recorded considerable improvement and stability on inequality in Nigeria in its Monetary Stability Report for the past 5 years (15, 18). A plethora of researchers like Nosike and Ojobor (1), Onwe et al. (12), Khan and Khan (4), Adeleke and Olomola (13), George-Anokwuru (19), Jungo et al. (15), Oseni and Oyelade (5), Abdulrahman and Oniyide (2), Toriola et al. (11) argued that although there may be relative stability in the sector, the reforms policies are yet to achieve significant contribution to sustained economic growth and development.

Likewise, a study by George-Anokwuru (19) shows that the monetary policies to stimulate Economic growth and development depend on the health status, soundness, and stability of the inequality level in Nigeria. Hence, this study hopes to add to the lingering debate and take an informed position on the subject. To this end, this study attempted to analyze the nexus between monetary policy and SDG-10 in Nigeria and investigated why despite stability reforms, the Nigerian economy is not able to achieve stable and sustained income inequality in the country. Based on the earlier points highlighted, it is pertinent to ask what is the impact of monetary policy on sustainable development goals number ten in Nigeria?

The broad objective of this study was to ascertain the empirical relationship between monetary policy and inequality in Nigeria. The specific objectives were to:

(i) Find out the nature of causality between monetary policy and SDG-10 in Nigeria;

(ii) Examine whether there is a long-run significant relationship between monetary policy and SDG-10 in Nigeria;
(iii) Ascertain the impact of monetary policy on SDG-10 in Nigeria.

Consistent with the research objectives, the following null hypotheses were formulated:

H_{01}: There is no causality between monetary policy and SDG-10 in Nigeria;

H02: There is no significant long-run relationship between monetary policy and SDG-10 in Nigeria;

H03: Monetary policy has no significant impact on SDG-10 in Nigeria.

This study could serve as a morale booster to the government especially in tailoring its monetary policy agenda toward achieving a vibrant, strong, and stable financial system capable of contributing to economic growth, absorbing shocks, efficient allocation of scarce resources, even distribution of income, reducing income disparity (inequality), creating a financial mechanism and framework capable of warning and detecting a possible disruption in the function of the financial system from forces within or outside the economy.

This paper is arranged into five sections. The first section deals with the introduction and contains the background issues of the study and finally, significance of the study. Section two captures the conceptual framework of key ideas embedded in the study and reviews empirical literature as well as the theoretical framework underpinning the variables of the study. Section three presents the methodology of the study including the techniques used for data analysis. Section four deals with the presentation of data, analysis of empirical results, and discussion of findings. Section five is a highlight of the summary, conclusion, and recommendations of the study.

Review of empirical studies

Accordingly, extant studies have examined the effects of the types and nature of monetary policy shocks on income inequality. Types of monetary policy shock are expansionary and contractionary shocks. Likewise, monetary policy could either be anticipated or unanticipated. The pioneering study, George-Anokwuru (19), investigated the effects of the types of monetary policy shocks on consumption and income inequality in the United States. The findings showed that what increases income inequality is contractionary monetary policy. These findings were also backed by the findings of Jungo et al. (15) using a panel of 32 advanced and developing market countries between 1990 and 2013 and Zungu and Greyling (14) in Japan between 2002 and 2016. Similarly, Aye et al. (20) investigated the effectiveness of monetary and fiscal policy shocks on inequality in the face of uncertainty in the United States between 1980 and 2008. The findings also supported the fact that contractionary monetary policy shock increases income inequality in the USA.

Siami-Namini et al. (7), however, found out on the contrary that contractionary monetary policy shock decreases income inequality in the U.S. In a similar vein, another strand of the empirical literature (3, 6, 9, 21, 22) found out that expansionary monetary policy shock increases income inequality in Japan and 12 advanced economies respectively. Contrary to this finding, Hohberger et al. (10) found an inverse relationship between expansionary monetary policy shock and income inequality in European countries. Moreover, Onwe et al. (12) studied the effects of monetary policy shock on inequality using a panel of 32 emerging and advanced countries. The study put more emphasis only on the effect of unanticipated shock on inequality, neglecting the anticipated shock. The results showed that unanticipated shock increases inequality over the period under study. Aside from Onwe et al. (12), the empirical literature on the effects of the nature of monetary policy shocks on income inequality is sparse. This, therefore, calls for further research.

Another important issue raised in the literature is about the measurement of income inequality. Several studies (3, 15, 20, 23, 24) used Gini coefficient generated from micro-level data. Adeleke and Olomola (13) cast doubt on the estimates generated from such data because they might not represent the whole population, especially the top one percent that are controlling the economy. This study, therefore, contributes to the extant literature by investigating the impact of anticipated and unanticipated monetary policy in generating income inequality in Nigeria, using the Dynamic Stochastic General Equilibrium approach. This is because income inequality is prominent in developing countries and understanding the impact of these shocks can assist policy makers in curbing its spread. Besides, the study uses the Gini index, generated by World Development Indicator, to measure income inequality in the country. The index measures the extent to which distribution of income among individuals or households within an economy deviates from a perfectly equal distribution.

In particular, households with negative unhedged interest rate exposure typically benefit more from expansionary monetary policy which signify families with more maturing liabilities than maturing assets. There is also evidence of the opposite effect: expansionary monetary policies and low interest rates hurt savers and lenders while favoring borrowers who may come from low-income households (12). Therefore, the impact of monetary policy on inequality can be unclear. When the income sources of households are taken into account, the relationship becomes even more complicated. Homes for which a wage is the primary source

of income will be severely impacted if monitoring policy has an impact on labor income and wages. High-income households with financial wealth will be severely impacted if monetary policy significantly changes asset prices.

Additionally, Khan and Khan (4) look into the possibility that shifts in consumption and income inequality are a result of US monetary policy. George-Anokwuru (19) identified monetary policy shocks and used household level data from the Consumer Expenditures Survey (CEX) since 1980 at quarterly frequency to construct their various measures of inequality and examine how these measures react to these shocks. According to their findings, US household income, consumption, and wage inequality are all sharply increased by contractionary monetary policy shocks. However, in this study, we, investigated how monetary policy shocks impacted Nigerian earnings, income, and consumption inequality.

Similarly, Toriola et al. (11) examine the possibility that shifts in consumption and income inequality are a result of U.S monetary policy. Abdulrahman and Oniyide (2) investigated and identified monetary policy shocks and used household level data from the Consumer Expenditures Survey (CEX) since 1980 at quarterly frequency to construct their various metrics of inequality and examine how these measures react to these shocks. According to the results, contractionary monetary policy increases positively US household income, consumption, and wage inequality. This study investigated how monetary policy shocks impacted Nigerian earnings, income, and consumption inequality.

Many studies have been conducted in the past year using comparable techniques to look into this same problem for different groups of countries. Several studies have reported that monetary contraction increases inequality. These include Nosike and Ojobor (1) for the Africa and Asian countries, Khan and Khan (4) for developed and emerging countries, and Ovat et al. (6) for Nigeria, who report an unstable relationship between measures of inequality and changes in monetary policy. Squeezing monetary policy shocks caused an increase in income, consumption, and earnings inequality, according to research using a structural vector auto regression (SVAR). The monetary policy shock significantly influences the historical swings in the inequality measures, and these results hold true for different VAR specifications. To explore potential causes of the rising inequality, data from households at various distribution percentiles were used to estimate the SVAR.

Theoretical framework

The classical economists' view of monetary policy is based on the quantity theory of money. The quantity theory of money is usually discussed in term of Fisherian equation of exchange, which is given by the expression **MV = PY**. In the expression, M denotes the supply of money over which the Federal Government has some control; V denotes the velocity of circulation which is the average number of times a currency is spent on final goods and services over the course of a year; P denotes the price level. Hence PY represents current nominal GDP. The equation of exchange is an identity that states that the current market value of all final goods and services (nominal GDP) must equal the supply of money multiplied by the average number of times a currency is used in transaction in a given year.

According to the classical economist, real GDP is always at or close to its natural level. They therefore believe that the Y in the equation of exchange is fixed in the short term. They contend further that money tends to circulate at a constant speed in order for V to be considered Fixed as well. Since Y and V are both fixed, any monetary policy, whether expansionary or contractionary, by the Central Bank of Nigeria (CBN) would only have the effect of changing the money supply (M), which in turn would only affect the price level P in direct proportion to the change in M. Put differently, an expansionary monetary policy can only result in inflation, while a contractionary monetary policy can only cause a decrease in the level of prices.

Methodology and model specification

The model used in the study is the New Keynesian model with standard Calvo sticky price and no capital, as it was examined in the works of Nosike and Ojobor (1), Adeleke and Olomola (13), George-Anokwuru (19), Jothr et al. (3), and Toriola et al. (11), Apanisile and Osinubi (25), and Akinlo and Apanisile (26). The fundamental tenets of the model are sticky prices, which make it challenging for all firms to adjust their prices at once, and imperfect competition, which is predicated on the idea that firms produce heterogeneous goods. The government, business, and household are important entities in the model. Household: The model assumes a set of identical, infinitely-lived households that aim to maximize the following while making decisions about demand, money, bonds, and labor supply, as well as consumption and labor supply.

$$Maxc_tN_{t1}\frac{Mt\ Eo}{P_t}\ \sum_{t=0}^{\infty} B^tU(C_t,N_t\frac{M_t}{P_t} \qquad (1)$$

where E_0 denotes expectation operator condition on time 0 information, β is the discount factor, $M_t\ P_t$ is the real money holding; subject to the budget constraint:

$$P_tC_t + Q_tB_t + M_t \ \leq\ + M_{t-1}B_{t-1} + \ W_tN_t + J_t \qquad (2)$$

where C_t (i) represents the quantity of good i consumed by the household in period t, for I ∈ [0,1] for t = 0, 1, 2, …., Pt (i) is the price of good i, Nt denotes hours of work, W_t is the nominal wage, Bt represents purchases of

one-period bonds at a price Qt, B_{t-1} is the number of bonds purchased last year, M_t is money holding, and J_t is a lump-sum component of income. ∈ measures the inter temporal elasticity of substitution between the differentiated goods, which is equal to the price elasticity of demand. Using the Kuhn-Tucker approach to obtain FOC conditions of equations (1) and (2) and re-arrange, we have:

$$1 - B\,(1 + i_t)\,E_t \left(\frac{U_c\,(t-1)}{U_c\ (t)}\ \frac{P_t}{P_t}\right) \tag{3}$$

Equations (3), (4), and (5) determine the inter temporal consumption allocation (the Euler equation), the labor-leisure choice, and the money demand, respectively. The equations determine the rational forward-looking household's allocation decision.

$$\frac{U_N(t)}{U_c(t)} = \frac{W_t}{P_t} \tag{4}$$

$$\frac{U_M(t)}{U_C(t)} = \frac{i_t}{1 + i_t} \tag{5}$$

$$U\left(C_t, N_t M_t\right) = \frac{C_t^i - \sigma}{1 - \sigma} - \frac{N_t^i + \emptyset}{1 + \emptyset} + \left(\frac{\frac{M_t}{P_t}}{1 - V}\right) \tag{6}$$

Secondary data used in this study were sourced from the Central Bank of Nigeria (CBN) statistical bulletin (2022) and the World Bank Data Indicators (WDI) online data base. A number of data points were acquired, including the GDP, trade openness (TOP), domestic inflation rate (DINR), nominal interest rate (NINT), nominal exchange rate (NEXR), and Gini index (GID). The methodology used in this study to arrive at the parsimonious model of the study over a thirty-six-year period (1987–2022) is explained clearly. The model has the following specifications:

$$GDP = f(RINR,\ OEXR,\ DIFR,\ TOT,\ GDI) \tag{7}$$

$$\begin{aligned} GDP_t = {} & \beta_o + \beta_1 RINR_t + \beta_2 OEXR_t + \beta_3 DINF_t \\ & + \beta_4 TOT_t + \beta_5 GDI_t + \mu_t \end{aligned} \tag{8}$$

Where:

GDP = Gross Domestic Product; RINR = Real Interest Rate; OEXR = Official Exchange Rate; DINF = Domestic Inflation; TOT = Term of Trade; GDI = Gini Index; β_0, β_1, β_2, β_3, β_4, β_5 = Slopes of the regressions; μ_t = Error term

A prior Expectation

$$\beta_1 > 0,\ \beta_2 < 0,\ \beta_3 < 0, \beta_4 > 0, \beta_5 > 0,$$

Based on the aforementioned, the details of the variables measurement and their sources have been depicted under **Table 1**.

Unit root test

The Augmented Dickey-Fuller (ADF) test, created by Dickey Fuller (27, 28), is the unit root test procedure used in this investigation. In order to pass the ADF test, the alternative hypothesis that the series are stationary must be rejected in Favor of the null hypothesis that the unit root is non-stationary (29). For every series, there was no deterministic trend observed during the testing. Thus, the ADF test can be expressed generally as follows:

$$\triangle Y_t = \alpha_1 t + \alpha Y_{t-1} + \sum_{i=1}^{m} \alpha_i \triangle Y_{t-i} + \varepsilon_t \tag{9}$$

where: y is a time series, t is a linear time trend, Δ is the difference operator, β_o is a constant, n is the optimum number of lags in the dependent variable, and ε_t is the error time t.

Autoregressive Distributed Lag (ARDL)

ARDL is a mixed-order integration technique that can be used or applied to both non-stationary and stationary data using the ordinary least squares (OLS) techniques. In order to capture the data generation process in a macro to individual modeling framework, this approach employed a sufficient number of lags (30). An easy linear transformation from the ARDL model yields the dynamic error correction model (ECM). In the same vein, the error correctional model (ECM) takes all along the long-run equilibrium relationship along with the short-run dynamics relationship. The test is based on the Wald known as F-statistic in a Generalized Dickey-Fuller type regression, which is used to test the significance of lags levels of the variables being considered in a conditional unrestricted equilibrium correction model (UECM), accordingly by Akpan and Akpan (31).

Presented below is the general form of the Autoregressive Distributed Lag (ARDL) bounds testing model.

$$y_t = \alpha + \beta x_t + \delta z_t + e_t \tag{10}$$

The error correction version of the Autoregressive Distributed Lag (ARDL) bounds testing model is expressed as:

$$\begin{aligned} \triangle y_t = {} & \alpha_0 + \textstyle\sum_{i=1}^{p} \beta_1 \triangle y_{t-1} + \sum_{i=1}^{p} \delta_i \triangle x_{t-1} + \\ & \sum_{i=1}^{p} \varepsilon_i \triangle z_{t-1} + \lambda_1 y_{t-1} + \lambda_2 x_{t-1} + \lambda_3 z_{t-1} + \mu_t \end{aligned} \tag{11}$$

The first part of equation (v) with β, δ, and ∈ denotes short-run dynamics of the model while the second part with λs represents long-run relationship. The null hypothesis that guides the ARDL approach is $\lambda_1 + \lambda_2 + \lambda_3 = 0$, which implies non-existence of long-run relationship.

TABLE 1 | Variables measurements and sources.

Variables	Description	Sources	A priori Sign
Gross Domestic Product (GDP)	The GDP figures in this indicator are expressed in current international dollars and are converted using a purchasing power parity (PPP) conversion factor. GDP is the total of the gross value added by all of the nation's resident producers plus any product taxes and less any subsidies that are not factored into the product value. The PPP conversion factor is a currency converter and spatial price deflator that removes the impact of regional price disparities. In order to align the underlying GDP in local currency units with the time series of PPP conversion factors for GDP, which are extrapolated using linked GDP deflators, as of April 2020, the term "GDP: linked series (current LCU)" is used.	World Bank Development Indicator [WDI] (37) online data base, Liu and Zhang (38)	
Real Interest Rate (RINR)	When the GDP deflator is used to measure inflation, the lending interest rate becomes the real interest rate. But lending rates are not comparable across nations because of the terms and conditions attached to them.	World Bank Development Indicator [WDI] (37)	+
Official Exchange Rate (OEXR)	Official exchange rate refers to the exchange rate determined by national authorities or to the rate determined in the legally sanctioned exchange market. It is calculated as an annual average based on monthly averages (local currency units relative to the U.S. dollar).	World Bank Development Indicator [WDI] (37).	+
Domestic Inflation Rate (DIFR)	The consumer price index, which measures inflation, shows the annual percentage change in the average consumer's cost of purchasing a basket of goods and services. This cost can be fixed or vary at predetermined intervals, like annually. Typically, one applies the Laspeyres formula.	World Bank Development Indicator [WDI] (37).	+
Term of Trade (TOT)	The terms of trade effect equal capacity to import less exports of goods and services in constant prices. Data are in constant local currency.	World Bank Development Indicator [WDI] (37).	+
Gini Index (GDI)	Gini index measures the extent to which the distribution of income (or, in some cases, consumption expenditure) among individuals or households within an economy deviates from a perfectly equal distribution. A Lorenz curve plots the cumulative percentages of total income received against the cumulative number of recipients, starting with the poorest individual or household. The Gini index is a percentage of the maximum area under the line that represents the area, in this case, between the Lorenz curve and a hypothetical line of absolute equality. Perfect equality is thus represented by a Gini index of 0, whereas perfect inequality is implied by an index of 100.	World Bank Development Indicator [WDI] (37).	+

Source: Authors' Compilation.

Granger causality test

A variable x is said to Granger cause another variable y if past values of x help predict the current level of y given all other appropriate information

The granger causality test in relation to this research work is given as follows:

$$GDP = \Sigma\beta_1 GDP_{t-1} \Sigma\beta_2 GDI_{t-1} \Sigma\beta_3 DINF_{t-1} OEXR_{t-1} RINT_{t-1} \Sigma\beta_4 TOT_{t-1} \quad (12)$$

$$GDI = \Sigma\beta_1 GDP_{t-1} \Sigma\beta_2 GDI_{t-1} \Sigma\beta_3 DINF_{t-1} OEXR_{t-1} RINT_{t-1} \Sigma\beta_4 TOT_{t-1} \quad (13)$$

$$DINF = \Sigma\beta_1 GDP_{t-1} \Sigma\beta_2 GDI_{t-1} \Sigma\beta_3 DINF_{t-1} OEXR_{t-1} RINT_{t-1} \Sigma\beta_4 TOT_{t-1} \quad (14)$$

$$EXR = \Sigma\beta_1 GDP_{t-1} \Sigma\beta_2 GDI_{t-1} \Sigma\beta_3 DINF_{t-1} OEXR_{t-1} RINT_{t-1} \Sigma\beta_4 TOT_{t-1} \quad (15)$$

$$INT = \Sigma\beta_1 GDP_{t-1} \Sigma\beta_2 GDI_{t-1} \Sigma\beta_3 DINF_{t-1} OEXR_{t-1} RINT_{t-1} \Sigma\beta_4 TOT_{t-1} \quad (16)$$

$$TOT = \Sigma\beta_1 GDP_{t-1} \Sigma\beta_2 GDI_{t-1} \Sigma\beta_3 DINF_{t-1} OEXR_{t-1} RINT_{t-1} \Sigma\beta_4 TOT_{t-1} \quad (17)$$

Decision rule

The decision rule for the causality model is the test of the null hypothesis that estimated coefficient is zero at the appropriate level of significance where at least four null hypotheses will either be rejected or accepted.

Data analysis and interpretation

This section deals with the data analysis and interpretation in respect of the variables used in the study. The variables comprises of the Gross Domestic Product (GDP), Real

TABLE 2 | Unit Root Test.

Variables	At level	Prob.	1st difference	Prob.	Order of integration
Augmented Dickey Fuller (ADF) Test					
GDP	−1.0846	0.7105	−3.0570	0.0396**	1(1)
GDI	−1.4373	0.5529	−5.0948	0.0002***	1(1)
DINF	4.6285	1.0000	−2.0742	0.2557	1(1)
OEXR	1.8132	0.9996	−3.9883	0.0041***	1(1)
RINT	−3.1695	0.0306**	−6.2757	0.0000***	1(0)
TOT	−0.8925	0.7788	−5.9344	0.0000***	1(1)

(*) indicates significant at the 10%, (**) significant at the 5% and (***) significant at the 1% Source: Computed by the author using EViews 10.

TABLE 3 | Lag selection criteria.

Lag	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	−1949.445	NA	3.63e+42	115.0262	115.2955	115.1180
1	−1724.059	357.9663*	5.47e+37*	103.8858*	105.7713*	104.5288*
2	−1695.210	35.63663	1.03e+38	104.3065	107.8081	105.5006

*Indicates lag order selected by the criterion. LR, sequential modified LR test statistic (each test at 5% level); FPE, Final prediction error; AIC, Akaike information criterion; SC, Schwarz information criterion; HQ, Hannan-Quinn information criterion. Source: E-Views Output Results, (2023).

Interest Rate (RINR), Official Exchange Rate (OEXR), Domestic Inflation (DINF), Term of Trade (TOT) and Gini Index (GDI).

Unit root test

In order to prevent the spurious regression results that are typical of time series data that are non-stationary, Gujarati (32) suggested carrying out a stationarity test on them. Both the Phillips-Peron (PP) and Augmented Dickey-Fuller (ADF) unit toot tests were used to test the variables at both the level and first difference. The results of the ADF test at levels indicated that some of the variables were stationary at that level, whereas the PP test generally indicated that the variable was non-stationary at that level. Since the PP test's results are valid even in cases of serial correlation and heterogeneity—a characteristic that the non-parametric ADF test lacks—it was chosen to supplement the latter. The results obtained are summarized in **Table 2**.

The unit root results presented in **Table 2** show that all the variables are stationary at after first difference except Real interest rate (RINT) that was stationary at level and at 1% level of significance. This implies that the variables are integrated of order I (0) and I (1) using the ADF. This is because the test statistics of all the variables at first difference are greater than their critical values at 5 per cent and 1 per cent levels of significance. Consequently, ARDL bounds test for Cointegration was deemed appropriate to check for the long-run relationship among the variables in the models used in this study.

TABLE 4 | ARDL Bounds Test.

Test statistic	Value	*K*
F-statistic	5.633258	5
	Critical value bounds	
Significance level	**I(0) Bound**	**I(1) Bound**
10%	2.08	3.2
5%	2.39	3.38

Computed by the author using EViews 10.

TABLE 5 | Results of estimated short- run coefficients using ARDL approach ARDL, (1, 0, 0, 1, 0, 0) selected based on Akaike information criterion.

Variable	Coefficient	Std. error	t-Statistic	Prob.*
GDP(-1)	1.07403	0.050113	21.89872	0.0000
GDI	92.9744	474.2252	0.194628	0.8471
DINF	−21.9398	140.1407	−1.797764	0.0834
OEXR	−13.7993	85.95369	−1.323960	0.1966
OEXR(-1)	25.9735	121.5436	2.270571	0.0314
RINT	−23.8713	899.5924	−0.237742	0.8139
TOT	1.92E−10	5.08E−10	0.377819	0.7085
C	−21411.10	21896.24	−0.977844	0.3368

Computed by the author using EViews 10. Autoregressive Distributed Lag - Short-Run.

VAR lag order selection criteria

Before testing for the long-run relationship among the variables, the study tested for the optimum lags to be used in the ARDL bounds test and its short- and long-run estimates using the VAR lag order selection criteria. The results obtained are presented in **Table 3**.

From **Table 3**, the different criteria suggested different optimum lags that can be used for the specified output. Sequential Modified LR test statistic (LR) chooses 2 lags, Final Prediction Error (FPE) and Akaike Information Criterion (AIC) picked 1 lag out of a maximum of 3 lags while Schwarz Information Criterion (SC) chooses lag 1 and Hanna-Quinn

TABLE 6 | Results of estimated long- run coefficients using ARDL approach ARDL, (1, 0, 0, 1, 0, 0) selected based on Akaike information criterion.

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	−21411.10	21896.24	−0.977844	0.3368
GDP(−1)	0.097403	0.050113	1.943687	0.0624
GDI	92.29744	474.2252	0.194628	0.8471
DINF	−21.9398	140.1407	−1.797764	0.0834
OEXR(−1)	12.1743	88.27781	1.837090	0.0772
RINT	−23.8713	899.5924	−0.237742	0.8139
TOT	1.92E−10	5.08E−10	0.377819	0.7085
D(OEXR)	−13.7993	85.95369	−1.323960	0.1966

Information Criterion, out a maximum of 2 lags. If there are limited observations in the ARDL model, it is often advised to use the Akaike Selection Criterion (AIC) in selecting the optimum lag length. Thus, this study used 1 lag to determine the long-run relationship among the variables in the output equation.

ARDL bounds test for cointegration

Having established the order of integration and the maximum lags to be used in the equations adopted for this study, it went further to ascertain if there is a long-run relationship among the variables using autoregressive distributed lag (ARDL) bounds testing approach. The results obtained are presented in **Table 4**.

Table 4 shows the results of the ARDL bounds test for cointegration for human capital development, poverty, and inequality in Nigeria. The first step in this procedure is to compare the value of the calculated f-statistic and critical value bounds. From **Table 4**, the estimated f-statistic of 4.456343 calculated at k = 3 (number of explanatory variables) and the estimated exceeds the upper critical bounds at 10 and 5 per cent levels of significance, respectively. Hence, the null hypotheses that no long-run relationship among the variables are also rejected. This implies that there is a long-run association between the variables. The next step is to investigate the short and long-run association of monetary policy on inequality in Nigeria.

ARDL short-run

The short-run estimate coefficient in **Table 5** reveals that negative sign of Domestic inflation (DINF) 1 per cent increase will decrease the Gross Domestic Product (GDP) at 10 per cent level of significance, the positive sign of official exchange rate (OEXR) (−1) 1 per cent increase will increase the Gross Domestic Product (GDP),

TABLE 7 | Granger Causality Test.

Null hypothesis:	Obs	F-statistic	Prob.
DINF does not Granger Cause GDP	34	0.83717	0.4431
GDP does not Granger Cause DINF		6.84761	0.0037
TOT does not Granger Cause GDP	34	3.97225	0.0299
GDP does not Granger Cause TOT		3.92989	0.0309
OEXR does not Granger Cause GDI	34	2.96663	0.0673
GDI does not Granger Cause OEXR		0.43677	0.6503
RINT does not Granger Cause GDI	34	0.10882	0.8973
GDI does not Granger Cause RINT		2.81636	0.0762
OEXR does not Granger Cause DINF	34	2.45631	0.1034
DINF does not Granger Cause OEXR		4.60946	0.0183
TOT does not Granger Cause DINF	34	0.71700	0.4967
DINF does not Granger Cause TOT		3.62161	0.0394
TOT does not Granger Cause OEXR	34	3.47201	0.0445
OEXR does not Granger Cause TOT		1.41946	0.2582
TOT does not Granger Cause RINT	34	0.92372	0.4084
RINT does not Granger Cause TOT		0.13463	0.8746

Source: Authors' computation using E-views 10.

TABLE 8 | Result of Heteroskedasticity and Serial Correlation Test.

Heteroskedasticity Test: Breusch-Pegan-Godfrey

Null Hypothesis: No Heteroskedasticity			
F-Statistic	1.806615	*P*-value	0.1340
Breusch-Pegan-Godfrey Serial Correlation LM Test			
Null Hypothesis: No Serial Correlation			
F-Statistic	0.271019	*P*-value	0.7647

Source: Computed by the author using EViews 10.

and is statistically significant at 5 per cent level of significance in the short-run. This indicates that the two variables play a vital role in the impact of monetary policy on inequality in Nigeria. This study is in line with the study of Khan and Khan (4), Apanisile (33), Gidigbi (17), but contrary to the study of Kuhelika and Venoo (34).

Table 6 shows that the long-run coefficient of the negative Domestic Inflation (DINF) with (−21.9398) 1 per cent decrease will decrease the Domestic Inflation with −21 per cent and is statistically significant at 10 per cent, the positive sign of official exchange rate (OEXR) 1 per cent increase will increase the domestic product (GDP) at 10 per cent and is statistically significance at 10 per cent in the long-run. This indicates that the inflation and exchange rate play a vital role in influencing the impact of monetary policy on inequality in Nigeria. The study is in line with the work of Nosike and Ojobor (1), Abdulrahman and Oniyide (2), Khan and Khan (4), and Voinea and Mihaescu (35) although the finding is contrary to the work of Olamide et al. (36), who documented that

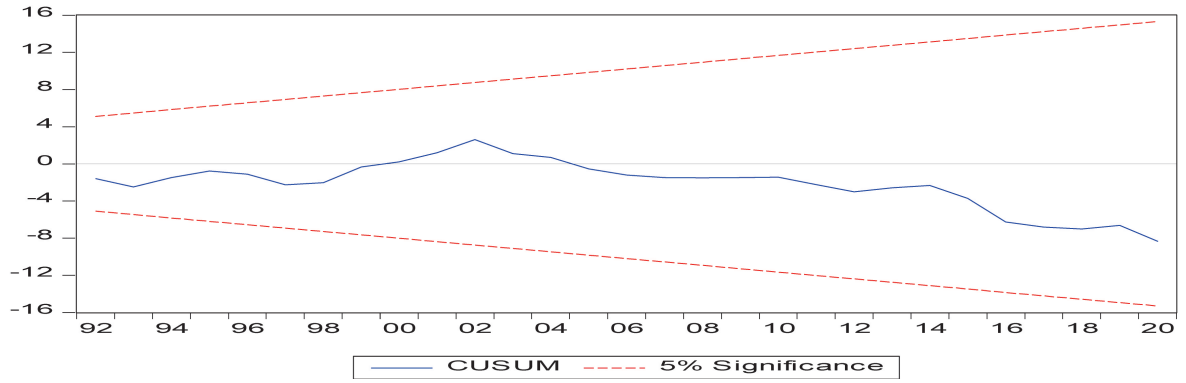

FIGURE 1 | Cumulative sum of recursive residuals (CUSUM).

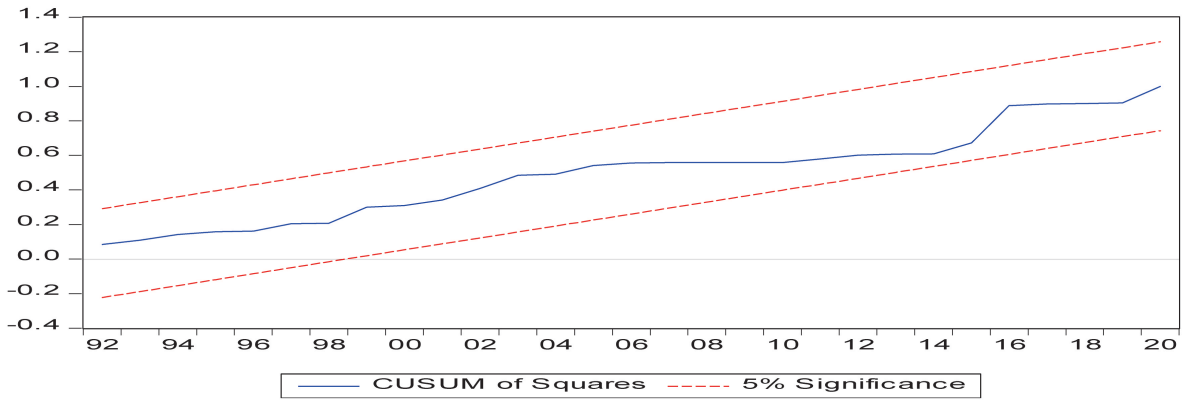

FIGURE 2 | Cumulative sum of square (CUSUMSQ).

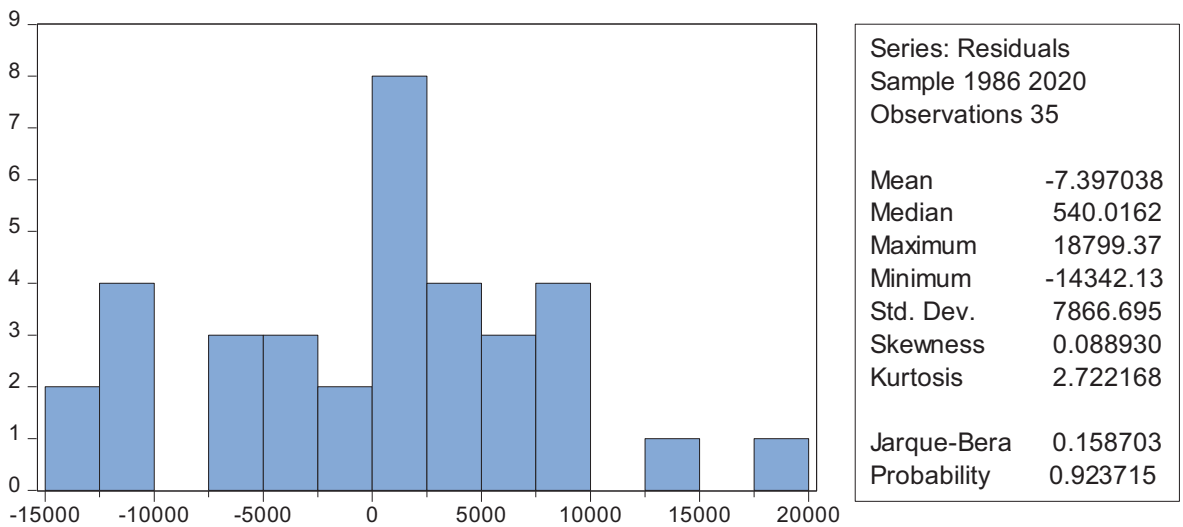

FIGURE 3 | Histogram Test of Normality.

inflation rate and exchange rate have no significant influence on inequality in Nigeria.

Based on the result in **Table 7** in respect of of the pairwise granger causality, it shows that domestic inflation is a cause of gross domestic product. However, as shown by the probability values 0.0037 and 0.4431, gross domestic product does not granger cause domestic inflation at the five percent significance level. The relationship between the gross domestic product and domestic inflation is therefore unidirectional. GDP also granger causes term of trade. As shown by the probability values 0.0299 and 0.0309, term of trade does not, however, granger cause domestic product at the five percent significance level. As a result, the term of trade and gross domestic

product have a bidirectional causal relationship. The official exchange rate has no bearing on the Gini index. The probability values 0.0673 and 0.6505 also show that the official exchange rate does not granger cause the Gini Index at the 10 percent significance level. The official exchange rate and the Gini index are therefore bidirectionally causal.

Real interest rate does not granger cause Gini Index. Similarly, Gini index does not granger cause real interest rate at 5% level of significance as indicated by the probability values 0.0762 and 0.8973. Thus, there is unidirectional causality between real interest rate and Gini Index.

Official exchange rate granger causes domestic inflation. However, official exchange rate does not granger cause domestic inflation at 5% level of significance as indicated by the probability values 0.0183 and 0.1034. Thus, there is a unidirectional causality from official exchange rate to domestic inflation.

Official exchange rate granger causes Domestic Inflation. However, official exchange rate does not granger cause domestic inflation at 5% level of significance as indicated by the probability values 0.0183 and 0.1034. Thus, there is a unidirectional causality from official exchange rate to domestic inflation.

Term of trade granger causes Domestic Inflation. However, term of trade rate does not granger cause domestic inflation at 5% level of significance as indicated by the probability values 0.4967 and 0.0394. Thus, there is a unidirectional causality from domestic inflation to term of trade.

Term of trade granger causes official exchange rate. However, term of trade rate does not granger cause official exchange rate at 5% level of significance as indicated by the probability values 0.0445 and 0.2582. Thus, there is a unidirectional causality from term of trade to official exchange rate.

Term of trade granger causes real interest rate. However, term of trade rate does not granger cause interest rate at 5% level of significance as indicated by the probability values 0.4084 and 0.8746. Thus, there is a no causality from term of term of trade and real interest rate. Reference to the results of the robustness checks in **Table 8** depicted earlier, and Heteroskedasticity with the context of the Breusch-Godfrey Serial Correlation LM test and Breusch-Pegan-Godfrey Heteroskedasticity test, respectively. Both tests were conducted under the null hypotheses of "no autocorrelation" and "no Heteroskedasticity" respectively. The result indicated that the estimated model was free from the econometric problems, as the F-statistics in both tests were statistically insignificant (both P-value were greater than 0.05), leading to a rejection of the null hypotheses in the test as presented in **Table 8**.

Cumulative sum of recursive residuals of CUSUM and CUSUM square

Model stability is necessary for prediction and economic inference. This is regarded as a sufficient condition; hence, the study employed stability test for estimated parameters by using the cumulative sum of recursive residual (CUSUM) and cumulative sum of square (CUSUMS Q) tests. The graphical presentation of these tests are presented in **Figures 1** and **2** respectively.

Histogram test of normality

Reference to the graphical information in **Figure 3**, it shows the histogram test of normality in respect of the data used in the study. The histogram test of stability seem to be normally distributed which was validated by the Jargue-Bera test which shows a value of about 0.158703, and the probability of obtaining such a statistic under the normality assumption is about 64 per cent. Therefore, the hypothesis was not rejected in this study since the error terms are normally distributed as shown in **Figure 3**.

Conclusion and recommendations

The study concludes that in both the short-run and long-run, the domestic inflation decreases the domestic product at 10 per cent level and official exchange rate has positive increase on the gross domestic product in the short-run and in the long-run the domestic inflation also has negative sign in domestic product, the exchange rate increases the domestic product at 10% respectively both in the short-run and long-run coefficient. It is also concluded that monetary policy is significantly related to sustainable development goals number ten in Nigeria.

In line with the findings of this study, the study proffers the following recommendations :

(i) The Federal Government of Nigeria (FGN) through the Central Bank of Nigeria (CBN) should consider the inflationary trend and fluctuating exchange rate in Nigeria to stabilize inequality. This can be effectively achieved through implementing a monetary policy that focuses on the expectations of the citizens and thus helps drastically reduce the increasing level of inflation and exchange rate fluctuations to the barest minimum if not completely eradicated;

(ii) The government should focus on monetary policy instruments which if effectively articulated will reduce the high disparity (inequality) in Nigeria. Hence, it will ensure the attainment of sustainable development goals number ten (SDG-10) by the year 2030 in Nigeria;

(iii) The FGN in collaboration with the Federal Ministry of Humanitarian Affairs should endeavor to implement fiscal stability measures aimed at reducing the wide level of disparity between the rich and the poor in Nigeria. This can be achieved through addressing and improving the basic needs of the citizens such as equal distribution of income and other scarce resources.

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