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INFLATION AND MONETARY POLICY EFFECTIVENESS IN THE PRESENCE OF EXTERNAL SHOCKS: EVIDENCE FROM THE NIGERIAN ECONOMY

Abstract

The inability of monetary policy to maintain price stability under the flexible exchange rate system, with the high volatility of the Naira/Dollar exchange rate in Nigeria, motivates this study. This study, therefore, investigates monetary policy effectiveness on price stability when an external shock threatens the system. With the standard deviation of the Naira/Dollar exchange rate as a proxy for external shock, results from the nonlinear autoregressive distributed lag (NARDL) using quarterly data from 1980Q1 to 2024Q1 reveal that monetary policy effectiveness is weakened by external shock. Specifically, monetary expansion is less inflationary in the short run than in the long run, whereas its contraction dampens productivity with no significant impact on inflation in a closed economy with no shocks. However, in the presence of external shocks, monetary contraction and expansion produced an overly ambiguous and inconsistent impact on inflation in both periods. This implies that besides the structural imperfections from external shocks, it weakens the policy response of monetary policy on price stability. With inflation persistence at 77.7%, while the adjustment speed to steady state equilibrium stood at 7.7% per quarter, it implies that the system will be divergently unstable in the long run. The study concludes that monetary policy effectiveness is weakened by external shocks; therefore, fiscal-monetary policies on price stability, a managed-float exchange rate system, and inflation targeting were recommended.

Keywords

monetary policy, inflation, shocks, exchange rate, asymmetry, interest rate, money supply, NARDL

JEL Classification

E52, E31, F31, E43, C22

INTRODUCTION

Over the years, policymakers have contended with the dual policy dichotomy of price stability and unemployment, each of which presents unique obstacles to the effectiveness of monetary policy. The Phillips relation proposes a trade-off between these two and hence, a stable relationship between them, particularly during the short run. However, it became apparent that this trade-off was not permanent and that it could shift depending on expectations, supply shocks, and other economic factors (Crust et al., 2023). This shift strengthens the need to examine the asymmetric effects of monetary policy on inflation, especially under conditions of supply shock from abroad. This is necessary as monetary policy effectiveness is not uniform and, as such, can exhibit asymmetry based on the prevailing economic conditions (Shah & Kundu, 2023).

Apart from the irreconcilable differences in monetary policy objectives, the uncertainties surrounding inflation, especially among import-dependent economies like Nigeria, make monetary policy insufficient in maintaining price stability. Notable among these uncertainties is the

highly volatile Naira exchange rate. This introduces shocks in the system and can weaken policy effectiveness on price stability. Uncertainties from exchange rate can reduce the potency of monetary policy on price stability, especially for import-dependent economies (Leitemo & Söderström, 2005). Kumo (2015) added that such external shocks are beyond the control of monetary policy and can introduce asymmetric challenges. These asymmetric challenges are often structurally driven rather than policy driven; little wonder that monetary policy instruments have not been so effective in price stability in Nigeria. Besides, the polarized legal system, high levels of insecurity, political instability, and lack of government effectiveness were among the peculiar factors that weaken policy effectiveness in Nigeria. Consequently, the fear of capital loss and, in most cases, the inability to access funds for investment, weakens not only the real sector performance but also raises commodity prices, thereby making high inflationary pressures inevitable.

This explains why most central banks resort to other unconventional approaches, such as quantitative easing, bank credibility, accountability and transparency, financial development, and, in recent times in Nigeria, inflation targeting to stabilize prices. However, the fact that all these efforts have not sufficiently reduced inflation in Nigeria suggests that certain external factors could be responsible for their ineffectiveness on price stability. This could worsen during periods of supply shocks from abroad, especially when it coincides with economic weaknesses such as disruptions in production, rising commodity prices, budget deficit, etc. This can make monetary policy management for price stability more difficult as it becomes unlikely to control inflation without simultaneously risking growth. This hypothesis, among others, is tested in this study.

Finally, the challenges surrounding the restricted space for policy adjustments under conditions of inflation dynamics with high inflation expectations further strengthen the need to investigate the nonlinear relationship between monetary policy and inflation.

1. LITERATURE REVIEW

Studies that examined the nexus between monetary policy and inflation abound in the literature, though with limited focus on its effectiveness under supply shocks. Besides, there is also a dearth of literature on its policy dilemma with output growth. With specific reference to the Nigerian economy, Ezeanyeji et al. (2021), Olayiwola (2019), Kelikume (2017), and Gbadebo and Mohammed (2015), among others, examined monetary effectiveness on inflation. Although some of these studies placed emphasis on shocks from exchange rate, treasury bill, monetary policy shocks, and oil price, however, they could not control the policy dilemma of price stability and output growth dichotomy. Apart from their inability to control for this policy conflict, most of these studies (Oladejo et al., 2025; Ezeanyeji et al., 2021; Kelikume, 2017; Gbadebo & Mohammed, 2015) employed models/techniques that examined a linear relationship among these variables. Consequently, the adaptive expectation effect of inflation and/or inflation persistence will be highly underestimated under such

limited linear assumptions, which can ultimately lead to ambiguous policy implications.

In addition, studies that employed different estimation techniques, such as the error correction mechanism (Ezeanyeji et al., 2021) and the linear autoregressive distributed lag (ARDL) (Gbadebo & Mohammed, 2015), also reached similar conclusions that there is no causality running between monetary policy and inflation, particularly in the long run. Whereas this consistent conclusion seems to defy claims that monetary policy has any significant impact on inflation in Nigeria, however, their assumption of a linear relationship weakens the reliability of their findings. Besides, the dynamics around inflation in Nigeria suggest that the conditional variance will be highly volatile and, as such, requires investigation with a nonlinear model (Omotosho & Doguwa, 2012). Furthermore, inflation in Nigeria seems to be structurally driven rather than a policy issue, and as such must be investigated with models that allow for a nonlinear relationship. Given the contextual factors that drive inflation, studies have not

sufficiently explored the multifaceted approaches of the nonlinear nexus between inflation and monetary policy (Mndebele et al., 2023). This emphasizes the need not only to examine the nonlinear relationship but also to investigate the impact of structural transformations and/or shocks that make monetary policy ineffective for price stability (Orphanides & Wieland, 2000). Exchange rate shocks, oil price shocks, and financial shocks have been identified by studies as the major shocks that make policy effects very ineffective in the control of inflation (Abbate et al., 2023; Ezeanyejí et al., 2021; Kelikume, 2017).

Aside from their inability to incorporate shocks in the inflation control model as well as use techniques that allow for a nonlinear relationship between monetary policy and inflation, previous studies failed to juxtapose these dynamics in closed and open economy conditions. Empirical evidence suggests that monetary policy has become less effective for price stability in an open economy situation (Caldentey & Vernengo, 2013; Leitemo & Söderström, 2008; Benigno & Benigno, 2003). Studies that examined the nonlinear relationship between inflation and monetary policy (Ramedoust et al., 2023; Olayiwola, 2019) conclude that there was no causality among the variables, especially when the economy is open. Ramedoust et al. (2023) employed the NARDL model to examine the varied impacts of monetary strategies on inflation and certain economic variables for the period 1994 to 2016. Their findings suggested that whereas monetary policy has a significant impact on growth, it had a negligible impact on inflation in the short run, with no long-run causality. Similarly, conclusions were reached by Amoah et al. (2023), who employed the vector error correction model to examine this nexus in Ghana for the period 1990 to 2018. Likewise, Darma and Abdulsalami (2020), who analyzed the effect of monetary policy on inflation in Nigeria for the period 1970 to 2018, also affirmed that monetary policy could only drive inflation during the short run. However, in their case, monetary contraction dampens inflation in the short run with no long-run causality. This empirical evidence strengthens the proposition that the inflation-monetary policy nexus is a short-run phenomenon and it is time and country invariant. That is, monetary expansion is both theoretically and empirically associated with

high inflation during the short run, irrespective of place/country and time, whereas its contraction dampens it in the same period. However, the economic expansion/growth in the inflationary effect of monetary expansion leaves so much to be desired in the inflation-growth dichotomy.

The policy dilemma of price stability and growth dichotomy is further amplified by this (Amoah et al., 2023; Ramedoust et al., 2023; Olayiwola, 2019) empirical evidence. That is, although an expansionary monetary policy significantly promotes growth, it is inflationary during the short run without an obvious balancing effect in the long run. In their study, Aghania et al. (2023) employed the structural vector autoregressive (SVAR) technique to also find strong evidence to support the view that economic/monetary expansion is attained at the detriment of high inflation. Hence, the need to control this contrast is being buttressed. This suggests the need for a monetary-fiscal mix in the quest to control inflation without compromising output. It is on this background that Nguyen et al. (2022) used the vector autoregressive (VAR) model to examine the impact of fiscal and monetary policies on inflation in Vietnam for the period 1997 to 2020. Their results show that the inflationary effect of fiscal and monetary expansion can worsen under greater trade openness. Therefore, since a monetary-fiscal mix is insufficient to provide a solution for inflation and growth balance, this study aims to augment previous models by controlling for external shocks that arise through greater openness.

Shocks arising from the nominal exchange rate volatilities and interest rate will likely widen the trade-off between inflation and growth when the economy is open (Henry & Sabo, 2020). This is particularly true for developing economies like Nigeria, given the weak institutional development. Therefore, the ability to control for shocks is the precondition to improve the effectiveness of monetary policy on inflation and growth (Henry & Sabo, 2020). Their findings were consistent with the Keynesian proposition that money supply and inflation are directly related during the short run, but their long-run relationship depends on the economic condition. Intriguingly, they also found that inflation and policy rates were not directly influencing each other. Hence, there is a missing link yet to be explored in the literature on this nexus.

This explains why studies like Ramedoust et al. (2023) and Olayiwola (2019) examined the non-linear relationships between monetary policy and inflation. And found a negligible impact of the former on the latter, though with a large impact on output. This suggests that real sector growth could better cushion inflationary pressure than monetary policy instruments. Hence, growth could be a transmission channel through which monetary and fiscal policy expansions could control inflation. While Chaudhry et al. (2015) accentuate the dampening effect of output growth on inflation during the short run, results from their ARDL technique found that monetary instruments were key to managing inflation in the long run in the Pakistani economy. This finding is consistent with that of Akarara and Azebi (2018), who used monthly data spanning from 2009 to 2016 and the error correction technique and found that the treasury bill rate seemed to manage rising prices in Nigeria than the interest rate, both in the short run and long run. This suggests that the treasury bills rate reduces purchasing power than the interest rate could.

On the other hand, changes in exchange rate and money supply could only control inflation during the short run (Chaudhry et al., 2015). This was supported by the findings of Angelina and Nugraha (2020) in Indonesia, who analyzed the effects of monetary policy on inflation using a 2-stage simultaneous equation model. Their findings reveal that money supply and exchange rate significantly raise inflation, while interest rate dampens it. This implies that shocks from the exchange rate can weaken the monetary contraction on inflation. Yusuf (2020) carried out a similar study but focused on a slightly different timeframe, from 1981 to 2019. He considered the general money supply, interest rates, short-term government securities like treasury bills, and currency values as determinants of the inflation rate. Results from the OLS regression model employed reveal that the interest rate, the amount of money in the system, and the rates for treasury bills all seemed to push inflation up. This is worsened when shocks from the exchange rate are not controlled.

The general finding across these literature reviews is that monetary policy effectiveness varies across different contextual factors. Unfortunately, the

major gaps that remained in the literature are the inability of most of these studies to incorporate the effect of external shocks in their models, the use of models that could not account for dynamic and/or asymmetric effects, and the use of low-frequency data sets in most studies. Therefore, this study employs the NARDL approach and disaggregates monetary policy instruments into their positive and negative components to capture their expansionary and contractionary effects on inflation, as well as to examine whether this effect is strengthened or weakened through shocks arising from exchange rate volatility. Consequently, the study aims to examine whether the effectiveness of monetary policy on inflation is weakened by shocks from abroad in a simple closed and open economy of Nigeria, amidst varying economic conditions.

2. METHODOLOGY

The analytical approach that this study follows centers on the rational expectation theory of inflation and the post-Keynesian theory of inflation. These are modelled thus:

$$\pi_t = \pi_{t+1} - y_t - U_t - E_{t-1},$$

$$\frac{\partial \pi}{\partial y} < 0, \quad \frac{\partial \pi}{\partial E} < 0, \quad \text{and} \quad \frac{\partial \pi}{\partial U} < 0, \quad (1)$$

where π_t represents current inflation and π_{t+1} is inflation expectation in the next period, y_t is productivity/output level, which is exogenous to the model and inversely related to inflation, U is the rate of unemployment, and E represents the exchange rate. Actual inflation falls when the exchange rate appreciates. It establishes that an increase in the interest rate can lead to capital inflow from abroad in search of better returns, thereby leading to the appreciation of the exchange rate.

The problem with model (1) is that it cannot examine the role of monetary policy on inflation since it does not accommodate any policy variable. To circumvent these, we introduce the second equation, which captures monetary response to unemployment, which states that lagged changes in unemployment are a function of some negative proportion of real money balance, thus:

$$U_t - U_{t-1} = -k(m - \pi_t),$$

$$\frac{\partial U}{\partial m} < 0, \frac{\partial U}{\partial \pi} > 0. \tag{2}$$

Equation (2) is the monetary policy response to unemployment, and it captures the unemployment and inflation nexus under the monetary growth rate (m) framework. ($m - \pi_t$) represents the growth rate of real money, while k measures the rate of change of unemployment and real money growth. To derive the optimal monetary policy rule, we shift equation (1) by one period backward and substitute the outcome from equation (1), thus arriving at equation (3):

$$\pi_t - \pi_{t-1} = \pi_{t+1} - \pi_t - (y_t - y_{t-1}) - (U_t - U_{t-1}) - (E_{t-1} - E_{t-2}). \tag{3}$$

Substituting (2) into (3) and rearranging yields the optimum monetary policy response to inflation to be used to examine the effectiveness of the monetary policy on inflation, thus:

$$\pi_t = \pi_{t-1} - \Delta\pi_t - \Delta y_t + km - k\pi_t - \Delta E_{t-1}. \tag{4}$$

The outcome equation presents current inflation as a function of its lag, changes in inflation (i.e, inflationary gap), and changes in output growth. If potential output rises above actual output, this creates an inflationary gap, thereby raising the level of inflation and vice versa; km is monetary aggregates, which is a positive relation with the monetary growth rate, and ΔE_{t-1} is the lagged changes in the exchange rate. Model (4) reveals that inflation rises with the rate of money growth. As the nominal interest rate increases, the output gap contracts, reducing inflation. On the other hand, an appreciating exchange rate dampens inflation but worsens output growth.

2.1. Model specification

This study specifies an augmented version of model (4) in an open economy. Interest rate and money supply are endogenous to the model. Therefore, the econometric version is specified, thus:

$$\pi_t = \lambda_0 + \lambda_1\pi_{t-1} + \lambda_2\Delta\pi_t + \lambda_3\Delta y_t + \lambda_4MS_t + \lambda_5\Delta NER_{t-1} + \lambda_6IR_t + e_t. \tag{5}$$

The variables remain as defined above, except that IR , MS , and NER are policy rate, money supply growth, and the nominal exchange rate, respectively, and e_t is the unexplained factors of π_t .

2.2. Data measurements and sources

This work makes use of quarterly time series data spanning from 1980Q1 to 2024Q1 for Nigeria, making a total sample of 177 observations. This is relatively large enough to account for volatility in the exchange rate and inflation. Moreover, the period of study is very comprehensive, as it covers the periods of both stable, mild, and high inflation with adequate policy responses in Nigeria. The data used include inflation rate, money supply growth rate, interest rate, GDP growth, and the nominal exchange rate. This study proxy the output gap with the GDP growth rate. The data were sourced from the International Financial Statistics website and the Central Bank of Nigeria Statistical Bulletin, and they are summarized in Table 1.

2.3. Estimation technique: Nonlinear ARDL model

To capture the dynamic stochastic asymmetric effects of monetary policy on inflation, the study adopts the nonlinear autoregressive distributed

Table 1. Data measurements, sources, and prior expectations

Data	Variable	Measurement	Sources	Expected Sign
INF (π)	Inflation Rate	Inflation Rate	International Financial Statistics (IFS)	Positive
Y	Output gap	The growth rate of real GDP	IFS	Positive
IR (r)	Interest rate	Real interest rate	IFS	Negative
NER (e)	Nominal exchange rate	Nominal exchange rate	Central Bank of Nigeria (CBN)	Negative
MS	Money Supply	Growth Rate of Broad Money	IFS	Positive

Source: Compilation.

lag (NARDL) model. To do this, we first specify the linear version of the ARDL model to be estimated in its re-parameterized ARDL (p, q, q, \dots, q) error correction model form, thus:

$$\Delta Y_t = \delta_i (Y_{t-1} - \lambda'_i X_t) + \sum_{j=1}^{p-1} \alpha_i \Delta Y_{t-j} + \sum_{j=1}^{q-1} \beta'_i \Delta X_{t-j} + \varepsilon_t, \tag{6}$$

where Y_t is the inflation rate, while X_t is a vector of all the explanatory variables,

$$\delta_i = - \left(1 - \sum_{j=1}^{p-1} \alpha_i \right),$$

speed of convergence to the long run steady state, λ'_i – vector of long run parameters, $ECT = (Y_{t-1} - \lambda'_i X_t)$, the error correction term, while α_i, β'_i are the dynamic short run coefficients.

Before the error correction model can be estimated, the condition of co-integration among the long run parameters in equation (6) (λ'_i 's) must be fulfilled; otherwise, only a short-run ARDL will be necessary. The linear ARDL model of equation (6) is augmented and transformed to its nonlinear form to capture the asymmetric (positive and negative) effects of monetary policy variables (interest rate and monetary growth rate), thereby achieving the objectives of this study. The study followed Shin et al. (2014) to decompose the movements in money supply and interest rate into their increasing and decreasing partial sums processes of positive and negative changes, respectively, as follows:

$$MS_t = MS_t^+ + MS_t^- = \sum_{i=0}^t \Delta MS_i^+ + \sum_{i=0}^t \Delta MS_i^-. \tag{7}$$

$$IR_t = IR_t^+ + IR_t^- = \sum_{i=0}^t \Delta IR_i^+ + \sum_{i=0}^t \Delta IR_i^-. \tag{8}$$

By substituting equations (7) and (8) into (6) and transforming it into the nonlinear autoregressive lag model (NARDL), we get the partial asymmetry co-integrating equation model, thus:

$$\begin{aligned} \Delta Y_t = & \delta_1 + \phi_1 Y_{t-1} + \phi_2^+ MS_{t-1}^+ + \phi_2^- MS_{t-1}^- \\ & + \phi_3^+ IR_{t-1}^+ + \phi_4^- IR_{t-1}^- + \phi_1 X_{t-1} + \sum_{i=1}^p \beta_i \Delta Y_{t-1} \\ & + \sum_{j=0}^{q_1} \left(\alpha_j^+ \Delta MS_i^+ + \sum_{i=0}^t \alpha_j^- \Delta MS_i^- \right) \\ & + \sum_{j=0}^{q_2} \left(\alpha_j^+ \Delta IR_i^+ + \sum_{i=0}^t \alpha_j^- \Delta IR_i^- \right) \\ & + \sum_{l=0}^{q_3} \eta_l \Delta X_{t-l} + \varepsilon_t. \end{aligned} \tag{9}$$

While p is the lag length of the dependent variable, q_1, q_2, q_3 are lag lengths of the independent variables, $\varepsilon_t = Error\ term$. The short-run relationship is established in the second segment with the coefficients α_j, ϕ_k, η_l , while the long-run relationship is established in the first segment via the coefficients $\phi_1, \phi_2, \phi_3, \delta_2$. Through the long-run coefficient, the study tests the hypothesis of co-integration. In the presence of co-integration, equation (9) becomes:

$$\begin{aligned} \Delta Y_t = & \delta_1 + \phi_0 ECT_t + \sum_{i=1}^p \beta_i \Delta Y_{t-1} \\ & + \sum_{j=0}^{q_1} \left(\alpha_j^+ \Delta MS_i^+ + \sum_{i=0}^t \alpha_j^- \Delta MS_i^- \right) \\ & + \sum_{j=0}^{q_2} \left(\alpha_j^+ \Delta IR_i^+ + \sum_{i=0}^t \alpha_j^- \Delta IR_i^- \right) + \varepsilon_t. \end{aligned} \tag{10}$$

The coefficient of the ECT is expected to be significant and negative to confirm the presence of long run equilibrium in the presence of contemporaneous short-run disequilibrium (Pesaran, Shin and Smith, 2001:2019). Table 1 presents the description of the variables used for the study.

3. RESULTS AND DISCUSSION

The presentation of results starts with the unit root test to guarantee against spurious regression. This is used to verify if the variables are mean-reverting. That is, if the series has a random walk. The augmented Dickey-Fuller and the Phillips-Perron (PP) tests were used.

The results presented in Table 2 show that the series is a combination of I(0) and I(1) variables. This

Table 2. Stationarity test

Source: Author's estimations.

Variables	Intercept	Trend	ADF Unit Root Test		PP Unit Root Test	
			T-Stat.	Condition	T-Stat.	Condition
Inflation Rate (Inf)	Yes	No	-4.6650	I(1)***	-4.9439	I(1)***
GDP Growth (GDPG)	Yes	Yes	-4.46092	I(1)***	-21.8527	I(1)***
Interest rate (IR)	Yes	No	-4.9177	I(0)***	-4.8292	I(0)***
Money Supply Growth (MSG)	Yes	No	-4.6446	I(0)***	-3.060	I(0)**
Exchange Rate Shocks (SER)	Yes	No	-4.0371	I(0)***	-4.0568	I(1)***

Note: *** significant at 1%; ** significant at 5%; * significant at 10%.

conclusion was reached with both the ADF and the PP unit root tests. Therefore, this suggests that adopting an autoregressive distributed lag (ARDL) model would be most appropriate for the analysis. To be more precise, the unit root test reveals that, except for the inflation rate and the growth rate of GDP, which are stationary after the first difference, [I(1)], the rest of the variables were stationary at levels.

3.1. Discussion of the main results of the study

Recall that the need for a nonlinear ARDL estimation technique was informed by the expansionary and contractionary management of monetary policy by the monetary authority in the pursuit of desirable macroeconomic objectives. Therefore, since an expansionary monetary policy warrants that the interest rate be lowered while the money supply is raised, this study disaggregated these

variables into their positive and negative/asymmetries to capture this variability. The results are presented in two separate sections. The first examines the impact of monetary policy on inflation in Nigeria when the economy is closed, while the second considers this when the economy is open; that is, shocks/volatility (standard deviation of exchange rate) is preminent.

First, we present and discuss the short-run result, and afterwards, the co-integration long-run form is also presented. Table 3 presents the short-run asymmetric impact of monetary policy variables (money supply and interest rate) on the inflation rate. It shows that the first and second lags of inflation strongly impact current rates of inflation differently. That is, a unit increase in inflation is associated with about 1.6826 units increase in the immediate past but 0.7515 decrease in two periods during the short run ceteris paribus both at 1 per cent significant levels. This is an indication

Table 3. Non-linear ARDL result of Equation (9)

Source: Author's estimations.

Dependent Variable: INF Selected Model: ARDL(2, 0, 0, 0, 0)				
Variable	Coefficient	Std. Error	t-statistic	Prob.*
INF(-1)	1.682596	0.051268	32.81991	0.0000
INF(-2)	-0.751472	0.050704	-14.82081	0.0000
IR_POS	0.072011	0.057631	1.249531	0.2133
IR_NEG	0.129837	0.073079	1.776676	0.0075
MSG_POS	0.024359	0.014697	1.657388	0.0094
MSG_NEG	0.018121	0.013097	1.383600	0.1684
GDPG	-0.052029	0.046946	-1.108278	0.2694
C	1.375734	0.586388	2.346115	0.0202
R-squared	0.980337	Mean dependent var		18.92557
Adjusted R-squared	0.979466	S.D. dependent var		15.38576
S.E. of regression	2.204740	Akaike info criterion		4.466089
Sum squared resid	768.0187	Schwarz criterion		4.616064
Log likelihood	-362.6854	Hannan-Quinn criterion		4.526965
F-statistic	1125.342	Durbin-Watson statistics		1.961219
Prob (F-statistic)	0.000000			

Table 4. Non-linear ARDL co-integrating and long-run form result of Equation (10)

Source: Author's estimations.

Dependent Variable: INF Selected Model: ARDL (2, 0, 0, 0, 0)				
Cointegrating Form				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INF)	0.751472	0.050704	14.820810	0.0000
D(IR_POS)	0.072011	0.057631	1.249531	0.2133
D(IR_NEG)	0.129837	0.073079	1.776676	0.0075
D(MSG_POS)	0.024359	0.014697	1.657388	0.0094
D(MSG_NEG)	0.018121	0.013097	1.383600	0.1684
D(GDPG)	-0.052029	0.046946	-1.108278	0.2694
ECT(-1)	-0.068876	0.014318	-4.810273	0.0000
Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
IR_POS	1.045524	0.740982	1.410999	0.1602
IR_NEG	1.885099	0.942032	2.001099	0.0471
MSG_POS	0.353664	0.235562	1.501366	0.1353
MSG_NEG	0.263101	0.205667	1.279260	0.2027
GDPG	-0.755405	0.643526	-1.173852	0.2422
C	19.974170	8.835648	2.260634	0.0251

that rational and adaptive expectations of inflation are strong oscillatory determinants of inflation in Nigeria. This is consistent with the work of O'Reilly and Whelan (2005), who observed that inflation persistence could change under severe economic stress.

Another main finding is that monetary policy expansion¹ raises the current inflation by 12.98% and 2.43% respectively during the short run at 1 per cent significance level. This is consistent with previous studies and the monetarists' view that inflation is everywhere and always a monetary phenomenon, especially in the short run (Ramedoust et al., 2023; Olayiwola, 2019). Keynesian believes that in the long run, there will be a balancing effect between prices and productivity, thereby smoothening the upsurging effect of an expansionary monetary policy on prices. This means that although an expansionary monetary policy could be inflationary during the short run, it balances out during the long run. The co-integrating long-run model explains this better.

A long-run co-integrating relationship among the variables is investigated using the Pesaran et al. (1999) bound test. A stable long-run relationship implies that short-run disequilibrium can be corrected in the long run at a certain speed of convergence. Hence, it becomes necessary to ascer-

tain the speed of convergence to the steady state equilibrium. If the calculated F-statistic is greater than the upper bound of the Pesaran table at a 5 percent significance level with k degrees of freedom, we reject the null hypothesis of no co-integration among the variables and conclude that co-integration exists; otherwise, we accept the null hypothesis. The result, as presented in Table A1 in the appendix, shows that a long-run relationship exists among the variables because the calculated F-statistic at 19.83799 is greater than the upper bound critical value at 4.68. Therefore, we reject the null hypothesis and conclude that the variables have a long-run relationship.

This guarantees the adoption of the error correction version of equation 10. The main objective of this model, among others, is to verify the speed of convergence to the long-run steady state. The result, as presented in Table 4 reveals that the speed of adjustment to steady state equilibrium stood at -0.068876. This means that short-run disequilibrium can be corrected in the long run at an adjustment speed of 6.89% per quarter. Hence, it will take the system about 14.5 quarters or three and a half years before any short-run disequilibrium can be fully corrected in the long run.

In addition to the findings that expansionary monetary policy is the main driver of inflation in

¹ Decrease/Negative interest rate and/or positive/increase money supply.

Nigeria, particularly in the short run, this long-run co-integrating model also found evidence of a consistent result in the long run. This is evident from the significant impact of the negative values of interest rate, which implies that monetary expansion raises inflation in the short and long run. Although this is inconsistent with previous studies (Ezeanyeji et al., 2021; Gbadebo & Mohammed, 2015), which concluded that there is no causality running between monetary policy and inflation in the long run, this finding is justified by the fact that the economy is closed. Consequently, the inflationary effect of monetary expansion could be greater for a closed economy (Gmeiner, 2025). This is contrary to the theoretical assertion, especially as postulated by Keynesians. According to them, an expansionary monetary policy will not pose further inflationary pressure on the economy in the long run. This ambiguous finding could be attributed to structural issues and/or poor productivity in the country. This further puts high pressure on inflation due to high demands exceeding supply and/or high costs of production. In conclusion, expansionary monetary policy is inflationary both during the short run and long run, whereas contractionary monetary policy has no significant effect on inflation when the economy is closed.

3.2. Discussion of the nonlinear ARDL result

The study further extends the model by looking at whether supply shocks arising from exchange rate volatility limit or improve monetary policy effectiveness in Nigeria. The standard deviation of the nominal naira/dollar exchange rate was used to account for external shocks. Previous studies identified exchange rate shocks, oil price shocks, and financial shocks as major shocks that could weaken monetary policy effectiveness (Abbate et al., 2023; Ezeanyeji et al., 2021; Kelikume, 2017). This is necessary as most of the changes in prices in Nigeria are always anchored on the value of the Naira per dollar. Therefore, model 3.13 is then re-adjusted by including this shock (SER) and re-estimated. The results are presented in Tables 5 and 6.

The short-run result presented in Table 5 reported a consistent finding on the effect of rational and adaptive expectations on inflation, as it was when the economy was closed. Particularly, inflation persistence twists over time. This implies that they have an asymmetric impact on the current level of inflation in the short run, *ceteris paribus*. Specifically, a unit increase in the first and second

Table 5. Non-linear ARDL result of Equation (10)

Source: Author's estimations.

Source: Author's estimations. Dependent Variable: INF Selected Model: NARDL (2, 2, 2, 0, 0, 2, 0)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
INF(-1)	1.700168	0.048406	35.12326	0.0000
INF(-2)	-0.777454	0.048728	-15.95498	0.0000
IR_POS	-2.042868	0.929815	-2.197070	0.0295
IR_POS(-1)	4.844259	1.736096	2.790318	0.0059
IR_POS(-2)	-2.752022	0.948786	-2.900572	0.0043
IR_NEG	1.960880	0.662169	2.961298	0.0036
IR_NEG(-1)	-4.570763	1.153536	-3.962394	0.0001
IR_NEG(-2)	2.700332	0.595911	4.531434	0.0000
MSG_POS	0.020862	0.014444	1.444336	0.1507
MSG_NEG	0.016532	0.012040	1.373081	0.1718
GDPG	-0.818217	0.179781	-4.551198	0.0000
GDPG(-1)	1.412568	0.306913	4.602509	0.0000
GDPG(-2)	-0.687238	0.177743	-3.866470	0.0002
SER	-0.455441	0.673160	-0.676571	0.4997
C	1.860286	0.850743	2.186662	0.0303
R-squared	0.984721	Mean dependent var		18.93056
Adjusted R-squared	0.983295	S.D. dependent var		15.43246
S.E. of regression	1.994585	Akaike info criterion		4.305257
Sum squared resid	596.7554	Schwarz criterion		4.587616
Log likelihood	-340.1837	Hannan-Quinn criterion		4.419876
F-statistic	690.5491	Durbin-Watson stat		2.173913
Prob(F-statistic)	0.000000			

lags of inflation significantly raises and dampens its current level by 1.7002 and 0.7775 units, respectively. This asymmetric effect for the two periods suggests that inflation oscillates around its mean; hence, it could be a source of macroeconomic instability (Abaidoo & Agyapong, 2023). This conclusion was also drawn by Noriega et al. (2013), who affirmed that inflation persistence and average inflation tend to fall and rise at the same time.

Furthermore, we found from the result that positive changes in the rate of interest on average dampen the rate of inflation by -2.0429 and -2.7520 at its contemporaneous and second lag levels, respectively. This is consistent with theory and prior expectations; hence, an increase in interest rate can reduce consumption, increase savings, and ultimately reduce output. As output falls, the purchasing power of households will also fall, thereby reducing the level of inflation. The positive nexus of the first lag of positive interest rate (contractionary monetary policy) with the current inflation rate at 4.8443 units could be attributed to policy lapses or structural flaws in the system; hence, institutional quality can moderate inflation uncertainty (Abaidoo & Agyapong, 2023).

Furthermore, the result reveals that a negative interest rate (expansionary monetary policy), on average, controls the rate of inflation significantly, all things being equal. Again, a unit increase in its contemporaneous and second lag levels significantly reduces inflation by 1.9609 units and 2.7003 units, respectively, *ceteris paribus*. This suggests that an expansionary monetary policy² will reduce inflation in the short run. These ambiguous findings are not consistent with the theory; therefore, it implies that the relationship between monetary policy and inflation is nonlinear and varies according to contextual factors (Mndebele et al., 2023). This was further supported by Abbate et al. (2023) and Abaidoo and Agyapong (2023), who observed that monetary response to inflation could produce ambiguous results in the midst of external shocks and institutional failures. Hence, the study attributed this result to structural weakness and supply shocks in the system.

However, the dampening effect of output growth on inflation during the short run and long run implies that it can moderate the nexus between monetary policy and inflation when contemporaneous shocks threaten the system. This is consistent with Amoah et al. (2023), who found that greater productivity dampens inflation persistence. Therefore, economic openness through international trade can guarantee internal and external balances, all things being equal. This means that although shocks from external economies can weaken the effectiveness of monetary policy, the benefits of such trade are capable of cushioning such shocks. This helps to buttress the Mundell-Fleming assertion, as cited in Mundell (2001), that a monetary-fiscal policy mix is best in stabilizing an open economy when contemporaneous shocks hit the system. Therefore, the breakdown of the operation of monetary policy effectiveness during the short run necessitates the examination of its long-run nexus.

To guarantee a long-run relationship, the bound test analysis was employed. The result is presented in Appendix, Table A1, Panel B. It shows that a long-run relationship exists among the variables because the calculated F-statistic under 6 degrees of freedom at 17.2218 is greater than the upper bound critical value at 1% significance level at 4.43. We, therefore, conclude that the long-run variables in the model are co-integrated; hence, we can proceed to estimate its long-run version.

The result of the long-run nexus in an open economy case was presented in Table 5. It investigates the Keynesian long-run maxim that monetary expansion will be inflationary during the short run but with a balancing effect in the long run. This is consequent on the rising effect of output due to monetary expansion, which invariably dampens inflation in the long run. Our finding supports this assertion as the magnitude of monetary expansion³ ultimately increases⁴ the rate of inflation in the short run, though with no long-run causality. This could be attributed to the presence of external shocks that weaken the effectiveness of monetary policy on price stability. Similar conclu-

2 Negative interest rate and/or positive money supply.

3 That is, the negative change in interest rate $(-2.7003+1.9609)$.

4 Note that the magnitude of the impacts of negative and positive values of IR_NEG is -0.7394 ; therefore, since the variable is negative, it ultimately changes to a positive effect of 0.7394 on inflation.

Table 6. Non-linear ARDL co-integrating and long-run form result of Equation (10)

Source: Author's estimations.

Dependent Variable: INF Selected Model: ARDL (2, 2, 2, 0, 0, 2, 0)				
Cointegrating Form				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INF)	0.777454	0.048728	15.954975	0.0000
D(IR_POS)	-2.042868	0.929815	-2.197070	0.0295
D(IR_POS(-1))	2.752022	0.948786	2.900572	0.0043
D(IR_NEG)	1.960880	0.662169	2.961298	0.0036
D(IR_NEG(-1))	-2.700332	0.595911	-4.531434	0.0000
D(MSG_POS)	0.020862	0.014444	1.444336	0.1507
D(MSG_NEG)	0.016532	0.012040	1.373081	0.1718
D(GDPG)	-0.818217	0.179781	-4.551198	0.0000
D(GDPG(-1))	0.687238	0.177743	3.866470	0.0002
D(SER)	-0.455441	0.673160	-0.676571	0.4997
ECT(-1)	-0.077286	0.013725	-5.631167	0.0000
Long-Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
IR_POS	0.638778	0.794927	0.803567	0.4229
IR_NEG	1.170310	1.192127	0.981699	0.3278
MSG_POS	0.269929	0.201170	1.341792	0.1817
MSG_NEG	0.213901	0.167060	1.280382	0.2024
GDPG	-1.201855	0.611713	-1.964736	0.0153
SER	-5.892905	8.667414	-0.679892	0.4976
C	24.070078	11.231634	2.143061	0.0337

sions were also reached by Abaidoo and Agyapong (2023) and Aghania et al. (2023), who blamed the monetary ineffectiveness on oil shocks and structural weakness in the Iranian economy. This implies that since Nigeria is an oil and import-dependent economy with poor structural quality, shocks from any of these channels will definitely weaken its policy effectiveness, as was the case in this study. However, with a significant negative impact of output growth (GDPG) on inflation in the long run, it can be concluded that the capital inflows from abroad improve productivity, thereby decreasing inflation through the multiplier effect. Although this is inconsistent with the findings of Aghania et al. (2023), who claimed that monetary expansion does not promote output growth in the presence of supply shocks, this could be true since Nigeria's economy is a large market compared to Iran.

Besides its expansionary effect, the result further shows that the magnitude of monetary policy contraction significantly raises⁵ inflation during the

short run. While this is inconsistent with theory, it implies that there are obvious structural and policy flaws in the system. Hence, there might be large capital inflows from abroad that create alternative sources of liquidity, thereby limiting the mopping-up effect of excess liquidity through monetary contraction. This was supported by Moe (2012), who claimed that central bank balances low liquidity with foreign cash inflows.

Finally, on this note, the result reveals that the economy reverts back to a steady state equilibrium whenever contemporary shocks threaten the system. This is because the speed of adjustment to the long-run steady state is both negative and significant at 1 percent. Hence, the system returns to equilibrium at an adjustment speed of 7.73 per cent per quarter. This means that it will take the economy about 13 quarters or three years and some months before draining up the instabilities introduced into the system by shocks from external or internal sources.

5 Note that the increasing effect of monetary contraction (i.e IR_POS which was significant) is the magnitude of the sum of its lag terms (-2.0429+2.7520 = 0.7091).

CONCLUSION AND POLICY RECOMMENDATION

The study investigates the effectiveness of monetary policy on price stability in Nigeria when an external shock threatens the system. This study is motivated by inflation persistence and the impact of the deteriorating Naira exchange rate on inflation in recent times. Given that findings from previous studies are inconsistent and often ambiguous, this study argues that the effectiveness of monetary policy varies across different contextual and peculiar factors. Consequently, this study aims to examine whether monetary policy effectiveness on price stability is weakened by external shocks, using the nonlinear ARDL estimation technique.

Having a proxy external shock with the standard deviation/volatility of the exchange rate, the results from the nonlinear ARDL technique revealed that inflation persistence is driven more by adaptive expectations rather than rational expectations in Nigeria. This implies that households' expectations of future changes in commodity prices, marginal costs of production, etc., drive average prices. The result further shows that monetary expansion, on average, is more inflationary during the long run than in the short run, especially when the economy is closed. This implies that when economies operate at their full capacity, monetary expansion will translate to increases in average prices of the same magnitude in the long run, with no improvement in productivity. This could be more evident in a closed system. This explains why output growth could not significantly dampen inflation in both periods. It further implies that credit crunch, embezzlement, and misappropriation of funds are inevitable, especially as capital is less mobile in a closed system.

On the other hand, in an open economy with shocks from exchange rate volatility, the result shows that monetary expansion significantly drives inflation in the short run, though with no long-run causality. This implies that monetary policy response to inflation is a short-run phenomenon, whereas its long-run response could be attributed to structural changes, institutional development, with policy coordination. This conclusion is also drawn by Abaidoo and Agyapong (2023) and Aghania et al. (2023). However, these can be weakened when external shock is present in an open economy case.

Finally, the significant dampening impact of output on inflation in the long run is an indication that monetary expansion can stabilize prices through output expansion as a moderating effect in the long run. This study, therefore, concludes that the monetary policy and inflation nexus is a short-run phenomenon, and its effectiveness can be weakened by shocks from exchange rate volatility and weak institutions. Therefore, future studies should examine the moderating effect of the output-monetary policy nexus on price stability as well as the role of institutional quality under conditions of oil price shocks and financial shocks. The study recommends monetary-fiscal policy coordination, financial surveillance through technology-driven solutions, inflation targeting, institutional development, and central bank independence to correct policy lapses on inflation. Furthermore, hedging instruments and diversification across currencies and financial institutions to spread and manage the risks of exchange rate volatility were also recommended.

AUTHOR CONTRIBUTIONS

Conceptualization: Tochukwu Timothy Okoli.

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Formal analysis: Tochukwu Timothy Okoli.

Funding acquisition: Tochukwu Timothy Okoli.

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APPENDIX A

Table A1. Diagnostic Tests

Source: Author's estimations.

PANEL A: Diagnostic Tests for Objectives 1 and 2			
Test Statistics	Name of Test	Statistics	Probability
Serial Correlation	Breusch-Godfrey	F-statistic	Prob. F(2, 156)
		Obs*R-squared	Prob. Chi-Sq(2)
Normality	Jarque-Bera	Jarque-Bera 342.4270	Probability 0.0000
Heteroskedasticity	Breusch-Pagan	F-statistic	Prob. F(7, 58)
		Obs*R-squared	Prob. Chiq(7)
Wald Coefficient Test	Asymmetric Test C(3)=C(4)=0	Probability 0.0417	Expansionary Monetary Policy is significant.
Wald Coefficient Test	Asymmetric Test C(2)=C(5)=0	Probability 0.0746	Contractionary monetary policy is weakly significant.
PANEL B: Diagnostic Tests for Objective 3			
Test Statistics	Name of Test	Statistics	Probability
Serial Correlation	Breusch-Godfrey	F-statistic	Prob. F(2, 148)
		Obs*R-squared	Prob. Chi-Sq(2)
Normality	Jarque-Bera	Jarque-Bera 375.4206	Probability 0.0000
Heteroskedasticity	Breusch-Pagan	F-statistic	ProbF(14,150)
		Obs*R-squared	Prob. Chi-(14)
Wald Coefficient Test	Asymmetric Test C(4)=c(5)=c(6)=0	Probability 0.0103	Expansionary Monetary Policy is significant in the short run
Wald Coefficient Test	Asymmetric Test C(2)=c(3)=c(7)=0	Probability 0.4201	Contractionary monetary policy is insignificant for all periods