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FOOD INFLATION AND MONETARY POLICY IN NIGERIA: EVIDENCE FROM NONLINEAR ARDL TECHNIQUE

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Abstract

Given the importance of food prices on the overall inflation dynamics in Nigeria and the need for monetary policy decisions to be guided by the knowledge of asymmetric effects of positive and negative change of monetary policy, this paper applied Nonlinear ARDL modeling technique to investigate the asymmetric effects of monetary policy on food price in Nigeria, using monthly data from September 2005 to August 2022. The results reveal the existence of short-run and long-run asymmetries in the effects of monetary policy changes on food inflation in Nigeria. The findings also provide empirical evidence that, food inflation is further destabilizing by contractionary monetary policy. Based on the findings, the paper recommends that, fiscal policy must be used to complement monetary policy in stabilizing food prices in a manner that would not require an overly contractionary monetary policy in Nigeria.

Keywords: Food inflation, Monetary policy, Nonlinear ARDL, Nigeria

1. **Introduction**

The effect of food prices on the overall inflation dynamics of countries is well acknowledged in the literature (Anand et al., 2015; Catao and Chang, 2015 & Hammoudeh et al., 2015). For inflation targeting central banks in particular, food prices pose a challenge not only for the overall inflation but also prevent the forecasting accuracy meant to inform policy stance (Hammoudeh et al., 2015). As a result, central banks that target inflation give a considerable attention to food price evolution (Anand et al., 2015). However, various studies recognizes that the extent of the effect of food inflation on the overall inflation dynamics is a function of income levels of countries (Pourroy et al., 2016), and the proportion of food in the consumption basket of the country (Catao and Chang, 2015). For developing and low income economies where food occupies a significant portion of the consumption basket and where expenditure on food takes a substantial proportion of the already meagre income, rising food prices is important not just for the current inflation but also underpins future inflation through expectations and wage negotiations (Anand et al., 2015 & Pourroy et al., 2016). Importantly, Hanif (2012) reckons that because expenditure on food by households in low income economies is enormous (based on Engel's law), rising food prices affect their welfare.

A critical question that has been posed in the literature is whether food inflation should inform monetary policy stance. The argument is that because food price effects are transitory, driven by supply side shocks and exhibit extreme volatility (Alper et al., 2016 & Anand et al., 2015;), it falls beyond the control of monetary policymakers. A counter argument in the literature has been that demand side factors such as income (Šoškić, 2015) can also drive up prices of food

and for which aggregate demand moderation (within the remit of central banks) can prove to be an effective remedy.

An important consensus in the literature is that because expenditure on food in low income economies is enormous and the fact that food dominates their consumption baskets, to ignore food inflation in such countries is to erroneously estimate the living cost and the prices that ordinary households encounter in these countries (Alper et al., 2016). Prices of food are therefore very prominent in the inflation dynamics and policy stance of central banks in these countries, especially the inflation targeting central banks. Indeed, the theoretical literature (Anand et al., 2015; Catao and Chang, 2015; Pourroy et al., 2016;) posit that monetary policy can only deliver true welfare maximization in low income economies and those with dominance of food in the consumption basket by targeting headline inflation that includes food.

While theoretical literature (Pourroy et al., 2016; Anand et al., 2015; Catao and Chang, 2015) provide the foundation for optimal monetary policy to impact food inflation, empirical investigation into this nexus remains limited (Bhattacharya and Jain, 2019). A considerable amount of the empirical literature (for instace, Hammoudeh et al, 2015; Scrimgeour, 2014; Anzuini et al, 2010; and Akram, 2009) have looked at monetary policy and commodity price index. Few studies (Hammoudeh et al, 2015; and Akram, 2009) have gone beyond the commodity price index to look at the effect of monetary policy on disaggregated components such as food and oil. Even so, the focus has been the context of the United States and a selected advanced and emerging economies (Bhattacharya and Jain, 2019; Hammoudeh et al, 2015; Scrimgeour, 2014 & Akram, 2009).

Meanwhile, Africa, where poverty levels are high and dominance of food in the consumption basket is a common phenomenon, remains unexplored empirically. In Sub Saharan Africa, food constitutes 40% of the consumption basket as compared to 15% in the advanced economies (Alper et al., 2016). Additionally, the prevalence of poverty in Africa means that food is a major priority and a colossus in the overall expenditure of households. Out of the 736 million extremely poor individuals across the world, as many as 413 million (more than half) lived in Sub-Saharan Africa alone as at 2015 (World Bank, 2018, 2019). In addition, out of the 28 countries regarded as poorest in the world, as many as 27 countries (representing 96.4%) are located in Sub-Saharan Africa (World Bank, 2018, 2019). Understanding the monetary policy-food price nexus in the context of Sub-Saharan Africa and an explicit inflation targeting country in particular could not be more critical. While studies by Alper et al. (2016) and Rangasamy (2011) in the context of Africa provide important insight on food inflation and its dynamics, they failed to explicitly model the impact of monetary policy on food inflation.

The argument in the literature that food inflation exhibits extreme volatilities especially when driven by extreme weather and other supply side shocks (Alper et al., 2016; Anand et al., 2015; Šoškić, 2015) implies that food price distribution necessarily exhibits tail dynamics which mean-based approaches such as linear ARDL would naturally be incapable of capturing. Meanwhile, such tail dynamics are likely to exert substantial effect on the overall inflation trajectory and pose enormous risk to the achievement of the inflation targets. An approach that is more robust to tail dynamics would prove to be invaluable.

This paper makes a number of contributions to the literature. To the best of our knowledge, this study becomes the first in the literature to provide evidence on an explicit relationship between food inflation and monetary policy in Nigeria. Given the argument in the theoretical and empirical literature that low income levels, dominance of food in the consumption basket and the proportion of food expenditure in the total household expenditure are pivotal factors in the relationship between food inflation ad monetary policy then the current study in the context of Africa where these factors are more pronounced than anywhere else in the world is a bold step in the literature.

Thus, the objective of this study is to examine the effect of monetary policy on food inflation in Nigeria by using nonlinear ARDL technique. After this introduction, the rest of the paper is structured as

follows: the second section is on the review of related literature. The third section presents the methodology of the paper. The fourth part discusses the empirical results. The last section summarizes the main findings, conclusion and provides policy recommendations.

2. Literature Review

2.1 Theoretical Framework

The theoretical underpinning of this study takes its root from the quantity theory of money, which in its simplest form states that changes in the general level of commodity prices are determined primarily by changes in the quantity of money in circulation (Ismaya & Anugrah (2018). This theory dates back at least to the mid-16th century when the French social philosopher Jean Bodin first attributed the price inflation then raging in Western Europe to the abundance of monetary metals imported from the mines of the Spanish colonies in South America (Humphrey, 1974). After undergoing considerable refinement, elaboration, amendment, and extension in the late 17th and 18th centuries, the quantity theory was integrated into the mainstream of orthodox monetary tradition and forming the central core of 19th century classical monetary analysis (Humphrey, 1974).

Essentially the quantity theory of money is a hypothesis about the main cause of changes in the value or purchasing of money. According to the theory, changes in the value of money are determined chiefly by changes in the quantity in circulation. When money becomes abundant, its value or purchasing power falls, consequently the commodity prices rises. Conversely, if money becomes scarce, its purchasing power rises and general prices falls (Ismaya & Anugrah , 2018). In short, quantity theory states that the stock of money (M) is the main determinant of price level (P). This can be presented mathematically in equation (1):

$$PT = MV \quad (1)$$

Where P - is the Price level; T – is the rate of Transaction M - is the money supply; V - is the velocity of circulation (i.e. the rate at which money changed hands in the society). Given the assumption that 'V' and 'T' are constant, the price level 'P' varies directly with the amount of change in money supply.

2.2 Empirical Review

The empirical question of whether monetary policy stabilizes food inflation has been explored, although limited not only in terms of the volumes of research but also largely skewed to the context of advanced and selected emerging economies. For instance, Hammoudeh et al. (2015) used data in quarterly frequency from quarter one of 1957 to quarter three of 2008 with the SVAR estimation technique. The authors studied the monetary policy impact on index of commodity prices (aggregate level) as well as the prices of the individual components including food (disaggregated level) in the United States. They found that when monetary policy is restrictive in the United States, the effect on the total prices of commodities is negative and significant, although such an effect occurs with significant number of lags. On the disaggregated front, they found that an increase in the monetary policy rate impacts food inflation positively and the impact is persistent.

The authors who found monetary policy to have significant effect on the prices of commodities such as Scrimgeour (2014) and Hammoudeh et al. (2015) established three main channels for this effect. The first is that when monetary policy is restrictive, the cost of storage becomes prohibitive, occasioning stock depletion and increasing the supply of these commodities. The second channel works such that a monetary policy rate hike makes interest bearing assets such as treasury bills attractive and therefore speculators adjust their investment portfolios by reducing holdings of commodities and in turn hold interest bearing assets. The third channel, emphasized by Scrimgeour (2014), relates to the channel of aggregate demand (Bhattacharya & Jain, 2020).

Monetary policy can reduce food inflation through the moderation of aggregate demand in the economy (Bhattacharya and Jain, 2020). On the basis of the Engel's law however, the effect of a restrictive monetary policy on non-food inflation would be greater than the effect on food inflation. In addition, the effect of a restrictive monetary policy on consumption of food

could be significantly less in countries where food dominates the consumption basket and particularly when the majority of the population live and consume food at the level of subsistence. Such a restrictive policy would then have its impact felt on the prices of non-food instead. As a result, the consumption pattern and the developmental stage essentially inform the extent of restrictive policy impact (Bhattacharya & Jain, 2020). Invariably therefore, if monetary policy responds in the wake of rising food prices, the combined effect on the non-food prices and to some extent the food prices would then have an impact on the overall inflation.

Some of the empirical studies in recent times have been dedicated to the effects of the Covid-19 pandemic and the Russia-Ukraine war as factors that drives global inflation. Caporale, et al. (2022) analyzed the possible effects of the Covid-19 pandemic and the Russia-Ukraine war on the degree of inflation persistence in both the euro zone and the European Union as a whole (EU27). For this purpose, the authors used monthly data on the harmonized index of consumer prices (HICP) from September 1997 to August 2022 and a fractional integration model is estimated. The result revealed that, exogenous shocks of Covid-19 pandemic and the Russia-Ukraine war have significant impact on macroeconomic variables such as inflation. Jagtap et al. (2022) also examined the implications of Russia-Ukraine conflict on the global food supply chains. A PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach, including grey literature, was deployed to investigate six key areas of the food supply chains that would be impacted most due to the ongoing war. Findings include solutions and strategies to mitigate supply chain impacts such as alternative food raw materials, suppliers and supply chain partners supported by technological innovations to ensure food safety and quality in warlike situation.

Other studies examined the factors that determine food inflation. For instance, Ismaya and Anugrah (2018) investigate the determinants of food inflation in Indonesia using quarterly data (2008: Q1 to 2017: Q4) and a GMM estimator. The finding shows that food price inflation in Indonesia is significantly determined by both backward-looking and forward-looking expectations, food production, GDP in agriculture sector, infrastructure, food import, domestic oil price, credit to agriculture sector and seasonal event (Ramadhan-Eid). Using quarterly data from quarter one of 2006 to quarter two of 2016 and relying on panel VAR estimation technique, Bhattacharya and Jain (2020) studied how effective monetary policy is in providing stability in the prices of food. The authors considered a set of developed and emerging countries and explored the effectiveness of the channels of aggregate demand and cost of production. The authors find food inflation to be positively impacted by a restrictive monetary policy that is unexpected for both the emerging and developed countries. Specifically, the authors observed that when inflation momentum in the country is underpinned by food inflation, then a restrictive monetary policy destabilizes both the food and general inflation. Similarly, Bhattacharya and Gupta (2018) examined the factors that drive food inflation and the impact of food inflation in the context of India. They found that whiles food inflation is significantly impacted by wages in the agricultural sector; the effect of prices of fuel on food inflation is moderate.

These studies have all been focused on advanced economies and selected emerging economies. Africa has not been explored, to the extent that I know. Meanwhile, it is the content where food dominates the consumption basket and household total expenditure tend to be skewed heavily towards food. Importantly, it is also the continent where poverty levels are high and therefore hikes in prices of food exacerbate the already precarious situation. In Nigeria for instance, as indicated earlier, a quarter of the country's population wallow in food poverty (World Bank, 2019). The existing literature is also limited in terms of the estimation techniques (VAR and linear ARDL) which capture only linear relationship. The technique also fails to deal with the tail dynamics of the distribution of food prices which is known to exhibit extreme volatilities. The technique also assumes symmetry in the face of complexities in real world and the observed asymmetry in the relationship between macroeconomic variables and the behaviour of monetary policy in particular.

In Africa, Iddrisu and Alagidede (2020) examined the impact of monetary policy on food inflation in South Africa using monthly data from January 2002 to November 2018 and employing a quantile regression procedure. The authors found that rising food prices are destabilized even further by restrictive monetary policy. Specifically, they found that at the 25th quantile, food prices increase by 0.52% following a 1% monetary policy restriction. Thus, food prices become 0.52% more expensive in South Africa following a 1%increase in monetary policy rate with a consequential increase in overall inflation given the dominance of food in the CPI basket of the country. The same authors, Iddrisu and Alagidede (2021) also explored the empirical evidence on monetary policy-food inflation nexus in the context of Ghana using quantile regression approach and monthly data spanning the period from January 2002 to November 2018. They found that contractionary monetary policy destabilizes food prices, particularly at the 20th, 25th, 30th, 35th, 40th, and the 45th quantiles of food price distribution.

For the Nigerian context, there are only two studies (Akinbode et al., 2021; and Ashiru, 2022) related to the subject of food inflation-monetary policy nexus, to the extent that I know. However, these two studies do not explicitly look at the effects of monetary policy on food inflation. For instance, Akinbode et al., (2021) examined the effect of key macroeconomic variables on food price in Nigeria using annual data from 1980 to 2018 and analyzed the data within the traditional ARDL framework. The bound test result revealed the presence of long run relationship among the variables. They also found that the money supply, exchange rate and crude oil prices have positive effect on food price in Nigeria both in the short-run and long-run.

Ashiru (2022) on the other hand considered the implications of money supply movement on food inflation in Nigeria using monthly data spanning from 1996:01 to 2021:12 and employed linear ARDL estimation technique. The author finds that food inflation in Nigeria has been largely influenced by the movement of money supply. Specifically, broad money supply (M2) was found to have a positive impact on food inflation in Nigeria. The author also found that the first and second lags of food inflation have positive effect on the current inflation. Finally, the author found that in view of the fact that prices of food also affect other constituents of the CPI basket, monetary policymakers should accord it all the importance it deserves in arriving at their policy stance.

So, although these two studies in the Nigerian context provide important insight into the concept of food inflation, they fall short of explicitly examining the monetary policy-food inflation nexus. This is where I situate my work as I provide evidence in the context of Nigeria and deploy an estimation technique that is capable of overcoming the limitations of the traditional linear ARDL technique outlined earlier.

3. Methodology

3.1 Data and Sources

This study utilized the data in monthly frequency from September 2005 to August 2022. Although explicit inflation targeting in Nigeria started in 2009, this study chooses to start the data from 2005 in view of the data intensity of the estimation model. Importantly, data on monetary policy rate which reflects monetary policy stance predate the start of explicit inflation targeting in Nigeria. Indeed, the Central Bank of Nigeria had been practicing implicit inflation targeting since 2005, and so, the monetary policy rate has been available as a policy tool even before the explicit targeting framework. Similarly, data on food inflation have also been available prior to both the implicit and explicit inflation targeting periods.

The variables in the model include: food inflation rate; monetary policy rate; real exchange rate, broad money supply and world food price index. The choice of these variables is informed by the literature (Hammoudeh et al., 2015; Bhattacharya & Gupta, 2018, Bhattacharya & Jain, 2020; Iddrisu & Alagidede 2021).

The data on food inflation rate, monetary policy rate and real exchange rate are obtained from Statistics Database of the Central Bank of Nigeria (CBN, 2022a). Similarly, the data on the components of broad Money supply are sourced from Central Bank of Nigeria Money and Credit Statistics (CBN, 2022b). While the data on

world food price index is obtained from the United Nation's Food and Agriculture Organization (FAO, 2022).

3.2 Variables Measurement

Food inflation rate is measured in percentage (%) as measured by the primary source. It represents the change in the food and non-alcoholic beverages price index in a particular month from the same month in the previous year.

Monetary policy rate is measured in percentage (%) and is an interest rate that monetary authority (i.e.: Central Bank of Nigeria) sets in order to influence the evolution of the main monetary variables in the economy (e.g.: consumer prices, exchange rate or credit expansion, among others).

Broad money is a category for measuring the amount of money circulating in an economy. It is defined as the most inclusive method of calculating a given country's money supply and includes narrow money (Currency outside Banks and Demand Deposits) along with other assets that can be easily converted into cash (Quasi Money) to buy goods and services.

Exchange rate is measured as the rate of the Nigerian Naira exchange to the United States Dollar. The dollar is the dominantly traded foreign currency in Nigeria.

World food price index is measured in index as per the primary source. It captures global food price movements. The FAO Food Price Index (FFPI) is a measure of the monthly change in international prices of a basket of food commodities.

3.3 Model Specification

Following the seminal work of Shin and Greenwood (2014) and recent previous studies of Akinbode et al., 2021; Iddrisu & Alagidede (2021) and Ashiru (2022), the functional form of the model is specified in equation (2):

$$FINFL_t = f(MPR_t,\ MSUP_t,\ EXCH_t,\ WFPI_t) \quad (2)$$

where, FINFL is food inflation rate; MPR is monetary policy rate; BMSR is the rate of broad money supply, EXCH is exchange rate and WFPI is the world price index. This functional form of the baseline model is expressed in mathematical form in equation (3).

$$FINFL_t = \alpha_0 + \alpha_1 MPR_t + \alpha_2 BMSR_t + \alpha_3 EXCH_t + \alpha_4 WFPI_t \quad (3)$$

In equation (3), α_0 is the intercept while, α_2 is the elasticity measure of the broad money supply with respect to food inflation. Hence, the model is now expressed in econometric form as:

$$FINFL_t = \alpha_0 + \alpha_1 MPR_t + \alpha_2 BMSR_t + \alpha_3 EXCH_t + \alpha_4 WFPI_t + \varepsilon_t \quad (4)$$

3.4 Model Estimation Procedures

The methodological approaches used in this paper are in three steps. The first step is pre-estimation diagonestics. This involves the conduct of unit root tests to establish the stationarity property of the data. In this regard, Kapetanios, Shin & Snell (KSS, 2003) and Kapetanios & Shin (KS, 2008) nonlinear unit root tests are employed. The second step is the estimatin of the short-run and long-run parameters of the model using nonlinear autoregressive distributed lag (NARDL) modelling approach developed by Shin et al. (2014). Finally, the third step is the post-estimation diagnostics to ensure the fitness of the model and enable the result to be relevant for policy recommendation. The post-diagnostic tests conducted are: Normality, serial correlation, heteroskedasticity, model specification and stability tests.

3.4.1 Nonlinear Autoregressive Distributed Lagged (NARDL)

To determine the existence of cointegration relationship among the variables in the model and estimate the short-run and long-run coefficients, this study employed Nonlinear ARDL approach. NARDL was developed by Shin et al. (2014) and it is an extension of the traditional linear ARDL-ECM technique of Pessaran et al. (2001) into regression context. This new methodology is used

when the conditions or assumptions of linear ARDL (such as linearity, normality and homoscedasticity) are not met (Cho et al. (2015). The NARDL approach to cointegration has certain advantages over other cointegration procedures. For instance, it addresses endogeneity bias and makes it possible to simultaneously estimate the long-run and short-run parameters of the model. The technique is also applicable irrespective of the order of integration of the variables considered. These adventages make NARDL attractive and applicable to different type of data.

Since NARDL is an extension of a linear ARDL, let us first start with the following standard linear ARDL model:

$$\Delta FINFL_t = \alpha_0 + \alpha_1 FINFL_{t-1} + \alpha_2 MPR_{t-1} + \alpha_3 BMSR_{t-1} + \alpha_4 EXCH_{t-1} + \alpha_5 WFP_{t-1} + \sum_{i=1}^{p} \beta_1 \Delta FINFL_{t-i} + \sum_{i=0}^{q} \beta_2 \Delta MPR_{t-i} \sum_{i=0}^{r} \beta_3 \Delta BMSR_{t-i} + \sum_{i=0}^{s} \beta_4 \Delta EXCH_{t-i} + \sum_{i=0}^{t} \beta_5 \Delta WFINFL_{t-i} + \varepsilon_t \quad (5)$$

Where FINFL (dependen variable) is the food inflation rate; while the independent variables: MPR is the monetary policy rate; BMS is the broad money supply, EXCH is the exchange rate and WFPI is the world price index and ε_t represents the white noise error term. Following Bahmani-Oskooee and Fariditavana (2016), this study formulated the nonlinear ARDL food inflation model by decomposing the monetary policy rate (MPR) and broad money supply rate (BMSR) into positive (increase) and negative (decrease) partial sums as follows:

$$MPR_t = MPR_0 + MPR_t^+ + MPR_t^- \quad (6)$$

$$BMSR_t = BMSR_0 + BMSR_t^+ + BMSR_t^- \quad (7)$$

Where $MPR_t^+ + MPR_t^-$ and $BMSR_t^+ + BMSR_t^-$ are the partial sums of the positive and negative changes in $MPR_t \; and \; BMSR_t$ respectively. They are defined as follows:

$$\mathrm{MPR}_t^{+ve} = \sum_{i=1}^{t} \Delta \mathrm{MPR}_t^{+ve} = \sum_{i=1}^{t} max(\mathrm{MPR}_{i,} 0) \quad (8)$$

And

$$\mathrm{MPR}_t^{-ve} = \sum_{i=1}^{t} \Delta \mathrm{MPR}_t^{-ve} = \sum_{i=1}^{t} min(\mathrm{MPR}_i, 0) \quad (9)$$

$$\mathrm{BMSR}_t^{+ve} = \sum_{i=1}^{t} \Delta \mathrm{BMSR}_t^{+ve} = \sum_{i=1}^{t} max(\mathrm{BMSR}_{i,} 0) \quad (10)$$

And

$$\mathrm{BMSR}_t^{-ve} = \sum_{i=1}^{t} \Delta \mathrm{BMSR}_t^{-ve} = \sum_{i=1}^{t} min(\mathrm{BMSR}_i, 0) \quad (11)$$

Following Shin et al. (2014), equation (5) should be expressed in NARDL framework as follows:

$$\Delta FINFL_t = \alpha_0 + \alpha_1 FINFL_{t-1} + \alpha_2 {MPR_t^{+ve}}_{t-1} + \alpha_3 {MPR_t^{-ve}}_{t-1} + \alpha_4 {BMSR_t^{+ve}}_{t-1} + \alpha_3 {BMSR_t^{-ve}}_{t-1} + \alpha_5 EXCH_{t-1} + \alpha_6 WFP_{t-1} + \sum_{i=1}^{p} \beta_1 \Delta FINFL_{t-i} + \sum_{j=0}^{q} \beta_2 \Delta {MPR_t^{+ve}}_{t-i} + \sum_{j=0}^{r} \beta_3 \Delta {\mathrm{MPR}_t^{-ve}}_{t-i} + \sum_{j=0}^{q} \beta_4 \Delta {BMSR_t^{+ve}}_{t-i} + \sum_{j=0}^{r} \beta_5 \Delta {\mathrm{BMSR}_t^{-ve}}_{t-i} + \sum_{k=0}^{s} \beta_6 \Delta EXCH_{t-i} + \sum_{k=0}^{t} 7\, \Delta WFP_{t-i} + \varepsilon_t \quad (12)$$

An error correction form of this model can be expressed as follows:

$$\Delta FINFL_t = \alpha_0 + \sum_{i=1}^{p} \beta_1 \Delta FINFL_{t-i} + \sum_{j=0}^{q} \beta_2 \Delta {MPR_t^{+ve}}_{t-i} + \sum_{j=0}^{r} \beta_3 \Delta {\mathrm{MPR}_t^{-ve}}_{t-i} + \sum_{j=0}^{q} \beta_4 \Delta {BMSR_t^{+ve}}_{t-i} + \sum_{j=0}^{r} \beta_5 \Delta {\mathrm{BMSR}_t^{-ve}}_{t-i} + \sum_{k=0}^{s} \beta_6 \Delta EXCH_{t-i} + \sum_{k=0}^{t} 7\, \Delta WFP_{t-i} \lambda_1 ECT_{t-1} + \varepsilon_t \quad (13)$$

The decision rule for nonlinear ARDL bounds tests is that, if the computed F-statistic is greater than the upper bound [I(1)], the null hypothesis of no cointegration between the variables is rejected. But if the computed F-statistic is smaller than the lower bound [I(0)], the null hypothesis of no cointegration between the variables is accepted. In the event that the F-statistic falls between I(0) and I(1), the inference will be inconclusive.

4. Results and Discussion

4.1 Descriptive statistics

The descriptive statistics of the series are presented in table 1. Food inflation (FINFL), characteristically, exhibited substantial swings over the period under review: falling to as low as 3.69% in July 2006 and rising to as high as 29.47% in September 2005. The accompanying standard deviation from a mean of 13.16%, unsurprisingly, is as high as 5.34. Similarly, the world food price index (WFPI) ranged from 68.41% in September 2005 to 159.71% in March 2022, with an average price index of 98.92% and a standard deviation of 19.46. Monetary policy rate averaged 12.00% over the period, ranging from a minimum of 6.00% (from June 2009 to July 2010 to a maximum of 15.5% (in September 2022).The average rate of broad money supply (BMSR) over the period is 1.54%, peaking at 48.49% in March 2006. Exchange rate of the Nigerian currency (EXCH) to the US dollar averaged 110.07 over the period, weaking to 60.59 in November 2005 from 173.52 Naira to US dollar in April 2022.

Table 1: Descriptive Statistics

Variables	FINFL	MPR	BMSR	EXCH	WFPI
Mean	13.1648	11.4571	1.5404	110.0680	105.4307
Medium	13.2900	12.0000	0.9670	100.9834	98.9248
Maximum	29.4700	15.5000	48.4942	173.5207	159.7132

Minimum	-3.6900	6.0000	-24.9286	60.5967	68.4124
Std. Dev.	5.3401	2.4366	5.1421	25.0976	19.4640
Skewness	-0.4017	-0.9625	3.3560	0.3910	0.3217
Kurtosis	3.7060	2.9525	39.2580	2.4806	2.6455
Jarque-Bera	9.7228	31.5194	11557.4000	7.4911	4.5871
Probability	0.0077	0.0000	0.0000	0.0236	0.1009
Observations	204	204	204	204	204

Sources: Authors' computation (2023)

4.2 Results of Unit Root Tests

Table 2 shows the results of Kapetanios, et al. (KSS, 2003) and Kapetanios & Shin (KS, 2008) nonlinear unit root tests. Both KSS and KS unit root tests revealed that FINFL, BMSR, EXCH and WFPI are not stationary at level. However, after taking the first difference the variables became stationary. This implies that the variables are integrated of order one, I(1). While MPR was found to be stationary at level. Therefore, it is integrated of order zero I(0).

Table 2: KSS and KS Unit Root Tests Results

	KSS		KS		
Variables	Level	First difference	Level	First difference	Stationarity Status
FINFL	-1.384	-4.726***	-0.761	-3.449***	I(1)
MPR	-3.245***	-3.882***	-3.088***	-3.812***	I(0)
BMSR	-0.536	-3.527**	-0.364	-3.506***	I(1)
EXCH	-2.468	-3.001**	-1.261	-2.663*	I(1)
WFPI	-2.025	-6.192***	-1.771	-6.162 ***	I(1)

*Note: The maximum lag used is 3; both intercept and trend are used in the estimations; *** and ** indicate statistically significance at 1%, and 5% respectively.*

Base on the results of the unit root tests conducted, it is plausible to conclude that the series are integrated of different order (i.e: I[0] & I[1]). This justified the adoption of nonlinear ARDL to test for cointegration relationship among the variables.

4.3 Non-Linear ARDL Cointegration Test Result

Having ascertained the stationarity status of the variables, this paper employed non-linear ARDL bounds test in order to find out whether there is cointegration (long-run) relationship among the variables. The result of the bounds test in table 3 shows that F-statistic of (7.306) is greater than the upper bounds even at 1% level of significant. Therefore, alternative hypothesis is accepted thereby rejecting the null hypothesis of no cointegration and conclude that there is a cointegration (long run) relationship among the variables in the model.

Table 3: Results of Bounds Test for Cointegration

		Critical values at 1%		
Model	F-statistics	Lower bound	Upper bound	Cointegration Status
FINFL=F(MPR^+,MPR^-,$BMSR^+$,$BMSR^-$,EXCH,WFPI)	7.306	2.96	4.26	Cointegrated

Sources: Authors' computation (2023)

4.4 Results of Long-run and Short-run Estimates

Table 4 reported the estimated coefficients of the model. Thus, the results of the long-run and short-run estimated coefficients of the asymmetric effects of monetary policy on food inflation in Nigeria are reported in panel A and B respectively. The long-run result in Table 4 panel A revealed that holding other factors constant, a positive change of monetary policy rate (MPR^+), i.e, an increase in monetary policy rate by 1% will leads to an increase in food prices by 0.17%. Thus, food prices become 0.17% more expensive in Nigeria following a 1% increase in monetary policy rate with a consequential increase in overall inflation given the dominance of food in the CPI basket of the country. This result of destabilizing effect of increase in monetary policy rate on food inflation and potentially the overall inflation is consistent with the findings of Bhattacharya and Jain (2019); Iddrisu and Alagidede (2020 & 2021). The argument in the literature is that following a increase in MPR resulting from contractioary monetary policy, the cost of capital of firms that produce non-food items increases in view of the capital intensive nature of these firms, leading to increases in the prices of products produced by these firms. In the face of rising cost of capital, the firms tend to use more of labour relative to capital which then pushes wages upwards (Iddrisu & Alagidede, 2021). Given that food-producing firms rely heavily on labour, the increasing wages (emanating from the non-food sector) spread to other sectors leading to rising labour cost, the cost of production of food-producing firms and the prices of food eventually (Bhattacharya and Jain, 2019).

Another arguement is that where monetary policy is dominated by fiscal policy, monetary policymakers are confronted with substantial constraints in the conduct of monetary policy. A restrictive monetary policy designed to reduce growth of money and inflation would rather induce spiraling public debt levels as bond financing becomes the alternative route for financing fiscal deficits. The rise in public debt levels then heightens debt servicing and feeds into future budget deficits with concomitant effect on growth of money and future inflation. So while the restriction in the monetary policy may have been intended to curb inflationary momentum, it may actually fuel further inflation in a setting where fiscal policy is dominant (Iddrisu and Alagidede, 2021). However, a negative change of monetary policy rate (MPR^-), i.e, a decrease in monetary policy rate was found to have insignificant effect on food inflation in Nigeria.

Table 4: Estimated Coefficients of the Long-run and Short-run

Panel A: Long-run Coefficients - Dependent variable is Food Inflation				
Regressors	Coefficient	Standard Error	t-Statistic	Prob.
MPR^+	0.166	0.161	1.033	0.000
MPR^-	0.178	0.153	1.164	0.246
$BMSR^+$	0.899	0.079	11.416	0.000
$BMSR^-$	-0.296	0.106	-2.779	0.006
EXCH	0.219	0.062	3.527	0.000
WFPI	0.252	0.0781	3.228	0.001
Panel B: Short-run Coefficients - Dependent variable is Δ Food Inflation				
C	0.788	0.289	2.731	0.014
ΔMPR^+	0.286	0.099	2.890	0.010
ΔMPR^-	1.439	0.242	5.952	0.000
$\Delta BMSR^+$	9.853	5.526	1.783	0.092
$\Delta BMSR^-$	-0.065	0.103	-0.631	0.529
ΔEXCH	-0.155	0.078	-2.013	0.045
ΔWFPI	0.591	0.162	3.635	0.000

ECT_{t-1}	-0.847	0.136	-6.228	0.000
R^2	0.859			
Adjusted R^2	0.756			
F-stat	5.911			0.000
D.W-stat	2.094			

Source: Researchers' computation (2023)

On the other hands, the results show that, a positive change of broad money supply rate ($BMSR^+$), i.e, an increase in broad money supply has positive and statistical significant effect on food inflation in Nigeria. Specifically, increasing broad money supply by 1% will leads to an increase in food prices by 0.90%. Thus, food prices become 0.90% more expensive in Nigeria following a 1% increase in broad money supply. However, decrease, in broad money supply ($BMSR^-$) was found to reducing effect o food inflation in Nigeria. Specifically, decreasing broad money supply by 1% will leads to a decrease in food prices by 0.29%. Hence, the current contractioary monetary policy measures taken by the CBN through Naira redesigning and reducing the volume of money in circulation if properly implemented will reduce the food price in Nigeria.

Moreover, the results revealed that other variables in the model (i.e. EXCH and WFPI) have positive and statistical significant on food inflation in Nigeria in the long-run. Specifically, increasing exchange rate ad world food iflation by 1% will leads to an increase in food prices by 0.22% and 0.25% respectively.

Turning to short-run, the results is consistent with the long-run. A positive chage of monetary policy rate and broad money supply have corresponding positive effect and statistical significance on food inflation in Nigeria. This implies that an increase in monetary policy rate and broad money supply will lead to increase in food inflation in Nigeria. The coefficient of the error correction term lagged by one period (ECTt-1) is less than one, negative and significant at 1%, therefore meets our expectation. This result demonstrates that 84.7% of any deviations from the equilibrium will be corrected within one month

4.5 Results of Diagnostic Tests

The results of diagnostic tests reported in table 6 reveal that the model with break dummy passed all the tests: including normality, serial correlation, heteroscedasticity and functional form. However, the model without break dummy, failed heteroscedasticity test.

Table 5: NARDL-ECM model diagnostic tests

Test Statistic	Model without Break	Model with Break
Normality: Jarque-Bera	0.844[0.656]	0.483[0.786]
Serial Correlation: Breush-Godfrey	0.181[0.836]	0.579[0.572]
Heteroskedasticity: Breush-Pagan-Godfrey	2.494[0.045]	1.888[0.112]
Functional Form: Ramsey Reset	0.024[0.879]	0.023[0.881]

Source: Researchers' computation (2023)

4.6 Results of Model Stability Tests

In an attempt to check the stability property of the estimated parameters, the cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares of recursive residuals (CUSUMQ) tests were conducted. The plots of both CUSUM and CUSUMQ are within the boundaries (see Figure 1 and 2). These indicate that the model is stable in the long-run.

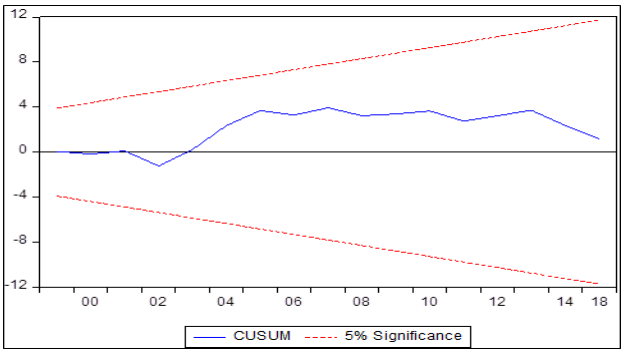

Figure:1 Plots of cumulative sum of recursive residuals

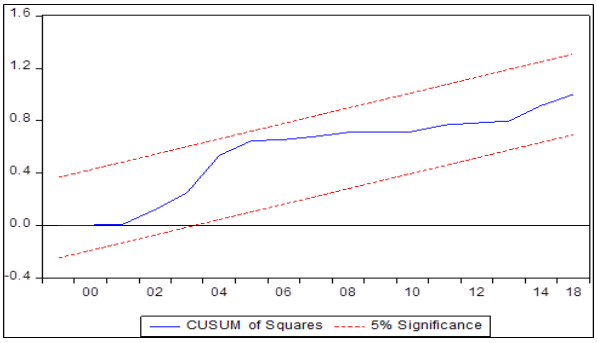

Figure: 2 Plots of cumulative sum of squares of recursive residuals

5. Conclusion and Recommendations

This paper has employed nonliner unit root and nonlinear ARDL cointegration tests to examine the impact of monetary policy on food inflation in Nigeria using monthly data from September 2005 to August 2022. The paper found the evidence of asymmetric cointegration relationship between monetary policy tools and food inflation in Nigeria. Based on the findings, it is concluded that restrictive monetary policy (i.e increasing monetary policy rate and decreasing broad money supply) have positive and significant effect on food inflation in Nigeria both in the short-run and in the long-run. Among other things, the paper recommends that, fiscal policy must be used to complement monetary policy in stabilizing food prices in a manner that would not require an overly contractionary monetary policy in Nigeria. The argument is that fiscal policy in the form of food price subsidy enables consumption and prices of food to be smoothened. By smoothening consumption and prices of food, monetary policy may not have to be overly restrictive.

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