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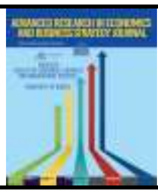

Effect of Monetary policy on food inflation in Nigeria: Evidence from Quantile Regression Model

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ABSTRACT

This study examines the effect of monetary policy on food inflation in Nigeria using a quantile regression model and monthly data from January 2004 to October 2021. The results of the study reveal that food inflation falls by 0.41 and 0.69 percent at the 25th and 50th quantiles, respectively, following a restrictive monetary policy by the apex bank in Nigeria. As the exchange rate depreciates, food inflation rises by 8.92 percent at the 25th quantile, 12.6 percent at the median, and later falls to 16 percent at the 90th quantile. The real GDP is significant across all quantiles. Lastly, the oil price is positive and significant at the OLS estimate and the 90th quantile. The study recommends unconventional monetary policies for improving supply chain of agricultural products.

Keywords: Food inflation, Monetary policy, Quantile regression

JEL Classification: E52, Q18.

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1. INTRODUCTION

The influence of food inflation on a country's total inflation expectations is widely documented in monetary literature (Hammoudeh Nguyen & Sousa, 2015; Anand, Prasad, & Zhang, 2015). (Pourroy, Carton, & Coulibaly 2016) suggest that the magnitude of food inflation's influence on total inflation is a consequence of a nation's wage rates as well as the quantity of food in the nation's CPI baskets. In developing and low-income countries, high food costs are essential not only for core inflation but also for prospective inflation via anticipations and wage rates. In these countries, food accounts for a major fraction of the CPI basket, and expenses on food consume a sizable percentage of already meagre earnings (Anand et al., 2015). Additionally, Hanif (2012) believes that high food prices are detrimental to the wellbeing of poor families since their consumption expenses are so high. There is a consensus among economists of the Keynesian tradition that central banks should not react to fluctuations in food and energy costs because such fluctuations are often swiftly reverted and very unpredictable (Mishkin, 2007; Kiley, 2008). While most monetary authorities start targeting overall inflation, their policy decisions are frequently impacted by measures of "core" inflation, which exclude the impact of food and energy costs and are considered to offer a clearer picture of underlying price trends.

Inflation indicators ignoring food and fuel costs are used to determine monetary policy stances in a rising range of emerging market markets (EMs) and developing countries, including more subsequently in a handful of Sub-Saharan African countries with maturing monetary systems. Certainly, central banking in sub-Saharan Africa has changed dramatically during the last few years. The policy rates were generally governmentally regulated before the 1990s, and monetary authorities were required to follow the government policies, which largely guided monetary policy to meet government-financing shortfalls. Moreover, parallel forex was also common, indicating exchange rate regulations in the framework of monetary support for massive government deficits. Nevertheless, there have also been two significant breakthroughs in Sub-Saharan Africa lately. The first was the shift towards more flexible exchange rate regimes, and the second was that in most nations, price stability became the de jure primary goal of central banks. As a response to these modifications, Sub-Saharan Africa's central banking structures are becoming more coordinated with those of developed nations (Ajakaiye and O'Connell, 2011; IMF, 2014).

Should food price increases dictate central bankers' positions is a vital subject that has been raised in recent literary work by Iddrisu and Alagidede (2020). The idea is that central bankers have little influence on food price effects since they are transitory, influenced by supply-side shocks, and show excessive instability (Alper et al., 2016; Anand et al., 2015). A competing point in the empirical literature is that demand-side factors like income (Šoškić, 2015) can also influence higher food costs, and thus aggregate demand moderation (within central bank jurisdiction) can be an effective remedy. An accord in the literature is that food expenses by households in developing countries is tremendous, and it dominate household's consumption, ignoring this, would be a bias in assessing the standard of living in these countries (Alper et al., 2016).

All whilst, in Sub-Saharan Africa, where poverty rates are large and food dominance in the CPI basket is common, food accounts for about 40% of the CPI basket, despite the fact that the number of poor people in Africa means that food is a primary concern and a huge priority in family spending. As of 2015, 413 million people (more than half) of the world's 736 million extremely poor people reside in Sub-Saharan Africa alone (World Bank, 2018). Furthermore, 27 of the 28 world's poorest economies (about 96.4 percent) are in sub-Saharan Africa (World Bank, 2018). The importance of grasping the monetary policy-food price connection in Sub-Saharan Africa, and specifically in Nigeria, cannot be overstated.

While a number of studies have been carried out to investigate the food inflation nexus in Nigeria (e.g., Olayungbo 2021; Binuomote and Odeniyi 2013; Udoh and Egwaikhide 2012), these studies mostly looked at the effect of oil prices on food inflation in Nigeria. Notwithstanding, in this paper, a quantile regression model proposed by Koenker (2005) is used to investigate the effect of monetary policy on food inflation in Nigeria.

The rest of this paper is set out as follows: The literature review is presented in Section 2. The data and methodology used in this research are succinctly described in Section 3. The empirical results of the analysis are reported in Section 4, and the study is concluded in Section5.

2. LITERATURE REVIEW

Iddrisu and Alagidede (2020) used quantile regression to assess the impact of monetary policy on food inflation in South Africa. According to their findings, monetary policy has a favourable impact on food prices that is consistent throughout all the quantiles. As a result, if monetary policy is tight, the nation's increasing food costs will be disrupted even more.

Bhattacharya and Jain (2020) investigated the effectiveness of monetary policy in maintaining food prices using quarterly data from developed and emerging nations and a panel VAR approach. The findings imply that a tight monetary policy, which is unusual for both emerging and advanced economies, has a favourable effect on food inflation. In particular, the researchers noted that when an actual inflation impetus is fueled by food inflation, a tight monetary policy distorts both food inflation and total inflation.

Ginn and Pourroy (2019) used dynamic general equilibrium (DSGE) model for middle income countries and showed that a coordinated response of government and monetary policy through subsidized pricing may boost welfare in the midst of financially restricted consumers and families with a major proportion of consumption expenditure. Subsidy soften prices and expenditures, notably for financially constrained families.

Alper et al. (2017) use disaggregated CPI baskets to examine food price patterns in Sub-Saharan Africa (SSA) from 2000 to 2016. Inflationary pressures appear to have become less persistent from 2009 onwards, possibly due to subsequent changes in monetary policy approaches. They further discovered that in SSA, high food prices are mostly influenced by non-tradable foods, with only a partial pass-through from global food and fuel prices, as well as exchange rates, to local food prices.

On data from the United States, Adjemin et al (2023) investigated the factors affecting food inflation by using a structural VAR model with monthly data from 2004 to 2022. Although the findings showed that supply-side factors are the most dominant at influencing food inflation, however, money supply indicates a strong correlation with recent food price increase. IN addition, Awokuse (2005) used vector autoregression (VAR) and directed acyclic graph theory to look into the effects of macroeconomic variables on agricultural prices based on US data from 1975 to December 2000. According to the study, the money supply's effect on agricultural prices was negligible. The exchange rate, which is demonstrated to be directly correlated with interest rates, is the main macroeconomic policy tool that influences agricultural prices. Exchange rates and industrial (input) prices account for much of the variation in agricultural prices.

Hammoudeh et al. (2015) estimated a structural VAR model and quarterly data from 1957Q1 to 2008Q3 and reported a price puzzle in the classification of products in the United States. According to the results, a prolonged increase in food prices is followed by a monetary tightening. A contractionary monetary policy is believed to inflate all agricultural prices due to several probable factors like speculation, high inflation, increased production costs, and overshooting.

According to Šoškić (2015) on the impact of inflation on food prices in Serbia, rising aggregate demand, which is supported by higher earnings, can cause higher food costs. Pourroy et al. (2016) point out that food prices are not solely influenced by climatic influences; other factors are involved in agricultural price changes. These include increased aggregate demand as a result of rising incomes, higher costs to farmers as a result of unpredictable oil prices, enacted trade barriers, and commodity speculators' activity.

Anand et al. (2014) estimated a general equilibrium model using the Bayesian technique to assess the role of monetary policy on food inflation in India. As per their analysis, food inflation falls subsequent to a contractionary monetary policy by the Reserve Bank of India.

3. METHODOLOGY

3.1 Data

The data for this study is monthly. The variables include food inflation (FOODINF); the monetary policy rate (MPR); the logarithm of exchange rate (LEXR); the log of real GDP (RGDP) as a measure of economic activity; the logarithm of global food price index (LGFPI); and the logarithm of crude oil price (LOP) spanning from January 2004 to October 2021. Since real GDP is unavailable on monthly dataset, the annual data was decomposed into monthly observations. All the variables are sourced from the Central Bank of Nigeria (CBN), except for the price of crude oil that is downloaded from the Energy Information Administration (EIA) and the global food price index that is sourced from the Federal Reserve Bank of St. Louis.

3.2 Unit root tests

Prior to estimating the quantile regression model, the study tested for the stationarity of the variables under consideration using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) test statistics identified by Dickey and Fuller (1981) and Phillips and Perron (1988), respectively. The ADF and PP tests were carried out using both intercept and trend, as presented in equation 1 below:

$$\Delta Y_t = \alpha + \theta t + \delta Y_{t-1} + \sum_{i=1}^{n} \beta_i \Delta Y_{t-i} + \epsilon_t \qquad (1)$$

Where; Δ is a first difference operator, Y_t is variable under consideration, t is the time trend, α is the intercept, Y_{t-1} is the lag variable under consideration, ΔY_{t-1} is the first difference lag variable that addresses the serial correlation difficulty (Dickey & Fuller, 1979), n is the optimum number of lags length selection, ϵ_t is the while noise error term.

3.3 Specification of the Quantile regression model

A quantile regression model introduced in Koenker (2005) is specify as:

$$y_t = x_t'\beta + \varepsilon_t \quad (2)$$

$$E\left({}^{y_t}/_{x_t}\right) = x_t'\beta \quad (3)$$

$$Q_{yt}\left({}^{\delta}/_{x_t}\right) = x_t'\beta_\delta \quad (4)$$

$$\beta_\delta = \beta + \theta u^{-1}(\delta) \quad (5)$$

Where β is the vector of unknown coefficients related to the interested quantile in equation 2 while equation 3 represent the marginal effects at a specific quantile of interest. Whilst, δ denotes the quantile to be estimated given the covariates as $Q_{yt}({}^{\delta}/_{x_t})$ and ε_t is the error term which is independent and identically distributed (IID). The sample is partitioned on the response coefficient of 25th, 50th, 75th and 90th quantiles respectively because of its enormousness, ensuring that all quantiles have ample sample from the 208 observations to circumvent the difficulties of degrees of freedom and spurious regression.

Unlike the OLS that minimizes the sum of squares, the quantile regression minimizes the median which is also called least absolute-deviation regression as follows:

$$\sum_{t=1}^{T} \delta \left| \varepsilon_t \right| + \sum_{t=1}^{T} (1-\delta) \left| \varepsilon_t \right| \quad (6)$$

As such, a symmetric penalty is given as $\delta|\varepsilon_t|$ for under prediction and $(1-\delta)$ for over prediction. This is to allow for simultaneous measurement of both upward and downward response of policy target to induced changes in monetary policy. The δ^{th} quantile regression estimator $\hat{\beta_\delta}$ minimizes over β_δ the objective function.

$$Q(\beta_\delta) = \sum_{t=1}^{T} \delta_{\; y_t \geq x_t\beta} \quad |y_t - x_t'\beta_\delta| + \sum_{t=1}^{T} \delta_{\; y_t < x_t\beta} \quad (1-\delta)||y_t - x_t'\beta_\delta| \quad (7)$$

Where $0 < \delta < 1$.

The rationale for using the quantile regression method is that it captures asymmetry in the monetary policy-food inflation nexus, which is a substantial divergence from the prior research, which presumes symmetry in the methodologies used. As a result, the quantile regression is more useful since it reveals the changing relationship between the regressors and the dependent variable throughout different sections of the latter's distribution. Benoit and Poel (2017). The quantile regression technique is also resistant to error-term heteroscedasticity (Yang et al., 2015). Where outliers or considerable deviations are unavoidable, mean-based techniques like OLS and VAR become ineffective (Benoit and Poel, 2017), and quantile regression becomes more efficient.

4. RESULTS AND DISCUSSION

4.1 Descriptive statistics

Table 1 provides the descriptive statistics of the variables in their first difference. The monetary policy rate has the highest mean value of 0.024155, rising on average of 2.4 percent per month while food inflation has a mean value of 0.001546, rising on average of 0.155 percent per month. Based on the standard deviation, food inflation, the policy rate and the exchange rate are the most volatile variables (in that order).

Table 1. Descriptive statistics

	FOODINF	MPR	LEXR	LGFPI	LRGDP	LOP
Mean	0.001546	0.024155	0.006138	0.003168	0.002704	0.001427
Median	0.000000	0.000000	0.000000	0.003421	0.000000	0.016383
Maximum	1.700000	2.750000	0.362877	0.078988	0.092586	0.469051
Minimum	-3.500000	-4.000000	-0.053424	-0.129191	-0.051340	-0.554785
S.D.	0.620499	0.536639	0.036758	0.031153	0.013769	0.111316
Skewness	-1.600959	-1.748828	5.826881	-0.440466	3.728849	-1.159960
Kurtosis	12.42622	24.24900	50.13560	4.033792	21.89457	9.632563
Obs.	208	208	208	208	208	208

4.2 Unit root tests result

Table 2 presents the conventional unit root tests. Given the test statistic, FOODINF is significant at 5 percent in level form under the two tests. Nevertheless, MPR, LEXR, LGFPI, and LRGDP are significant at 1 percent level after taking their first difference. The LOP is significant at 10 percent, in level form under the ADF test. Whilst FOODINF and LOP are stationary and integrated of order zero [i.e. I(0)] because their respective t-statistic is above their critical values in levels form, MPR, LEXR, LGFPI, and LRGDP are stationary and integrated of order one [i.e. I(1)] because their t-statistic is only above their respective critical values at first difference.

Table 2. Unit root tests

Variables	Levels		First Difference		Order of Integration
	ADF	PP	ADF	PP	
FOODINF	-3.9724**	-3.6878**	-4.5959*	-3.5801**	I(0)
MPR	-1.8947	-2.2678	-14.1320*	-14.3682*	I(1)
LEXR	2.8040	2.4775	-12.0545*	-12.0368*	I(1)
LGFPI	-2.6309	-2.2629	-8.9356*	-8.8941*	I(1)
LRGDP	-0.8645	-0.3971	-2.7279	-17.5093*	I(1)
LOP	-3.3121***	-2.7675	-10.3431*	-9.8252*	I(0)

Note: The order of integration is indicated by I(d), estimated with intercept and trend. The maximum lag is 14, chosen using Schwarz (1978) information criteria (SIC) for ADF test and Newey-West Bandwidth for PP test. Mackinnon (1996) critical values are given as -4.0063; -3.4332; -3.1404. Asterisks, *, **, *** shows that a variable is statistically significant at 1%, 5% and 10% levels respectively.

4.3 Empirical results

The empirical findings of the OLS and quantile regression are presented in Table 3. Given the OLS estimate, food prices decreased by 0.33% following a 1 percent rise in the monetary policy rate. However, the quantile regression estimates indicate the asymmetric effect of monetary policy on food prices that the OLS estimate fails to capture. The results showed that monetary policy is negative and statistically significant at the 25th and 50th quantiles, as food prices fell by 0.41% and 0.68%, respectively. This showed the impact of monetary policy on food prices that VAR and OLS approaches fail to grasp. For example, the fall in food inflation at the median (50th quantile) after a restrictive monetary policy suggests that the mean-based OLS approach understates the effect on food inflation by 0.35%. Furthermore, the negative correlation between monetary policy and food inflation is similar to (Rivai 2022). According to the literature, an increase in the monetary policy rate increases the cost of storage of agricultural commodities, inducing suppliers to reduce inventory, which improves available stocks. Also, the policy hike, incentivizes investors/speculators to reallocate their portfolios, such as moving from commodities to treasury bills. (Bhattacharya & Jain 2020). A different viewpoint in the literature demonstrated that contractionary monetary policy influences aggregate demand through money supply which further reduces commodity prices. (Scrimgeour, D. 2015). Keynes noted that the monetary policy rate tends to increase when the amount of money in circulation declines. Because of the multiplier effect, an increase in monetary policy rates will reduce investment levels, which will lower income, output, and employment due to the marginal efficiency of capital. An additional viewpoint in the food price literature is the argument that agricultural prices are low and remain in business following a restrictive monetary policy is because fiscal subsidies keeps them afloat. Monetary policy-makers face significant obstacle in implementing monetary policy in environments where fiscal policy predominates. For example, the Nigeria government offers to subsidize agriculture through the Growth Enhancement Support Scheme (GESS), an initiative designed to increase agricultural output by giving small- and medium-sized farmers subsidies for agricultural inputs. The Nigerian government stated in July 2021 that ₦12.3 billion ($30 million) in subsidy would be given to the agricultural sector (Global Trade Alert 2023). There have also been other energy subsidies in the country as well, albeit they are gradually being eliminated. Nigeria used to provide subsidies for electricity and kerosene in addition to the premium motor spirit (PMS), which has been in place since 1977. In 2016, the kerosene subsidy was eliminated. Nigeria likewise had an electricity subsidy up until recently; it has been in place since the privatization of the power industry in 2013. The 2022 pricing review resulted in the elimination of the electricity subsidies.

Table 3. Quantile regression results

Variables	OLS	25th Quantile	50th Quantile	75th Quantile	90th Quantile
MPR	-0.334** (0.121)	-0.408** (0.107)	-0.681* (0.072)	-0.177** (0.077)	-0.062 (0.067)
LEXR	12.717* (1.256)	8.916* (1.103)	12.493* (0.744)	14.940* (0.795)	16.111* (0.688)
LGFPI	-5.036 (3.502)	3.007 (3.076)	-0.981 (2.073)	-0.648 (2.217)	-3.085 (1.919)
RGDP	-8.730** (2.587)	5.194** (2.272)	-10.775* (1.531)	-27.633* (1.638)	-32.802* (1.418)
LOP	3.103** (1.411)	1.868 (1.239)	2.1210 (0.836)	1.489 (0.894)	2.047*** (0.774)
Constant	55.351 (12.806)	-111.634* (19.153)	68.611* (12.907)	238.99* (13.81)	298.36* (11.94)
R-Squared	0.482				
Pseudo R-sq		0.423	0.416	0.417	0.497
Observations	208	208	208	208	208

Note: Standard errors (IID) in parenthesis. Asterisks, *, **, *** indicates that a variable is statistically significant at 1%, 5% and 10% levels of their respective p-values.

For the exchange rate, the variable is positive and statistically significant at the 1 percent significance level across all quantiles, respectively. Notably, as the exchange rate depreciates by a percentage, food inflation increases by 8.92 percent at the 25th quantile, 12.5 percent at the median, and 15 percent and 16 percent at the 50th and 90th quantiles, respectively. The impact of exchange rates on food costs is contingent on a single component. Nigeria depends on imports to make up for its deficiencies in food and agricultural output (mostly in the areas of wheat, rice, chicken, fish, and consumer-oriented foods).

Looking at the global food price index, the variable is statistically insignificant at both the OLS and quantile regression estimates. The insignificance between food inflation and the global food price index is anticipated due to the fact that the Nigerian agricultural sector is subsistence and segregated from the global market; as a result, changes in global pricing do not affect local prices.

For the real GDP, the variable is negatively significant at OLS and the quantile regression estimates except at the 25th quantile. Specifically, as real GDP rises by 1 percent, food prices rise by 5.2 percent at the 25th quantile, which is statistically significant at the 5% level. However, food prices fell by 10.8%, 27.6%, and 32.9% at the 50th, 75th, and 90threspectively at 1% level of significance. Furthermore, the fall in food inflation at the median and beyond demonstrates the recent contribution of agriculture to the GDP in Nigeria. The sector has contributed to about 30 percent of the total GDP since 2021.

In respect of the oil price, the variable is significant at the 5 percent significance level at the OLS estimate. However, the variable is only significant at the 1 percent level at the 90th quantile. Specifically, as oil prices increase by 1 percent, food inflation rises by 2.05%. This result can be linked to the impact of rising oil prices on food production costs. The long-run equilibrium between oil and food prices is further supported by the positive correlation. Prior research by Cha and Bae (2011) for the United States, Iddrisu and Alagidede (2020) for South Africa, and Ibrahim (2015) for Malaysia has backed up this claim of a strong effect of oil prices on food inflation.

5. CONCLUSION

In this study, a quantile regression model is used to examine the effect of monetary policy on food inflation in Nigeria. Food prices fell by 0.33% after a 1% increase in the monetary policy rate, according to the OLS estimate. However, the OLS estimate is unable to reflect the asymmetric impact of monetary policy on food prices, as indicated by the quantile regression estimates. The findings demonstrated that while food prices fell by 0.41% and 0.68%, respectively, monetary policy is statistically significant and negative at the 25th and 50th quantiles. This empirical finding is similar to Akram (2009) and Scrimgeour (2015). Looking at the exchange rate, it is both positive and statistically significant at the 1% level for all quantiles. Specifically, food inflation rises by 8.92 percent at the 25th quantile, 12.5 percent at the median, 15 percent at the 50th quantile, and 16 percent at the 90th quantile as the exchange rate depreciates by a percentage. The real GDP is statistically significant at both the OLS and quantile regression estimates, with the exception of the 25th quantile, whereas the global food price index is statistically insignificant at both of these estimates. With regard to the oil price, the OLS estimate indicates that the variable is significant at the 5 percent significance level. Based on the quantile regression estimate, the oil price is significant only at the 1 percent level at the 90th quantile.

Overall, the central bank's policy rate is believed to have little influence over food inflation because demand is essentially fixed. To ensure a sufficient and reliable supply chain, the study does, however, suggest appropriate interaction with fiscal policy and unorthodox monetary policy approaches.

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