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Original Research Article

Macroeconomic Drivers of Food Price Volatility in Nigeria: Evidence from Maize and Rice Markets

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Abstract: The study focused on determining the factors affecting food price volatility in Nigeria between January 1990 and December 2025. The data for the analysis was a monthly secondary time series data obtained from Central Bank of Nigeria (CBN), National Bureau of Statistics (NBS), World Bank and International Monetary Fund (IMF). The aims of the study were to determine the trend and patterns of fluctuations of food prices, that is maize and rice, as well as the impact of some economic factors, exchange rate, inflation, crude oil price and GDP per capita, on food price volatility in Nigeria. The two types of econometric models used were; Standard Generalized Autoregressive Conditional Heteroskedasticity (GARCH)(1,1) and GARCH-X. The results showed that there was significant volatility clustering with high persistence ($\alpha + \beta = 0.966$) and the half-life is about 20 months. The exchange rate had the most impact (0.051 maize, 0.068 rice), then inflation (0.011 maize, 0.016 rice) and crude oil price (0.019 maize, 0.027 rice), while GDP per capita reduced volatility (-0.007 maize, -0.011 rice). With the inclusion of economic variables in the model, persistence reduced to 0.881 and 0.872 for maize and rice, respectively, with half-life reducing to roughly 5.5 and 5.1 months, respectively, showing that most of the volatility persistence observed in Nigerian food markets is a result of movements in underlying macroeconomic variables. The study recommends that the Federal Government focus on stabilizing the exchange rate, and that the Central Bank of Nigeria align its monetary policies with those of agriculture.

Keywords: Food Price Volatility, GARCH, Exchange Rate, Inflation, Crude Oil Price, GDP per Capita, Nigeria.

INTRODUCTION

One of the most persistent and destabilizing phenomena in the agrarian economies in sub-Saharan Africa has been food price volatility. In Nigeria, which has about 25% national GDP from agricultural sector and a large percentage of the populace employed in the agriculture sector, the stability in food prices is intrinsically tied to household welfare, macroeconomic health and national food security (Odion *et al*., 2025). Difficulties for farmers to plan production, traders to manage stocks and consumers to make decisions about the kind and quantity of food consumed, when food prices are fluctuating in an unstable manner. This issue has drawn attention in several stages of price surge (2007-2011) and was also aggravated by the COVID-19 pandemic and the Russia-Ukraine conflict (Yenibehit *et al*., 2024).

Food Price Volatility has significant welfare consequences. Prices are crucial messages to producers and consumers and help them to make decisions on production, consumption and the allocation of resources (Ahmad *et al*., 2024). If prices get too volatile, these signals get distorted and result in inefficiencies throughout the supply chain. Empirical data reveal that the food price volatility perception significantly impacts the quality of household food consumption, especially with poverty level, residence location and gender being significant determinants (Tsambou *et al*., 2025). These groups are significantly affected disproportionately, including female headed households, rural residents and low income groups. Increases in food prices affect the rural and lower-income population the most, especially on cereal and animal product prices (Vorsah, 2025).

In addition to the effects on household welfare, food price volatility has substantial costs for the agricultural value chain. In Nigeria, the farmers who produce food are most often smallholder farmers without access to real time market price data, and instead, use

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historical prices seen in local markets to inform their decisions on when, what, where and at what price to sell their produce (Odion *et al*., 2025). This information gap is a cause of sub-optimal decisions, causing food loss, lost income and poverty perpetuation. Smallholder farmers in Nigeria are poorly paid, with around 70% living below the poverty line (less than $1.9 per day) and this is directly influenced by poor ability to successfully navigate volatile markets. To address this, researchers have developed tools that can predict prices using machine learning, yet, to be effective, they need to have a thorough understanding of the factors that determine price volatility. To respond to that, researchers have designed machine learning-driven price prediction systems that must have a solid grasp of the factors influencing price volatility.

Volatility of food prices in Nigeria is not uniform but varies from commodity to commodity, region to region and over time. This study found that tomatoes have the highest volatility persistence followed by yam, and the lowest volatility persistence for processed food items (yellow garri and imported rice) (Essien *et al*., 2024). The poultry sector, particularly, has experienced price instability which has been associated with exchange rate volatility and inflation, as reported in the long run; exchange rate volatility has been found to have a positive impact on price volatility in the poultry sector (Edoja *et al*., 2026). Analyses of the aggregate data may fail to capture important heterogeneities between food items, which are important to consider in developing specific interventions.

Furthermore, volatility is market and border bound. Interdependence has been well documented between agricultural commodities in Nigeria, with both trends and bursts of return and volatility spillovers (Fasanya & Odudu, 2020). Among the commodities, price interconnectedness was estimated as 75% through the study of price inflation (Balcilar & Bekun, 2020). At the international level, foreign meat markets' volatility has been found to be transferred to domestic markets, where the return of crude oil and exchange rates are of importance (Yenibehit *et al*., 2024). In this complex context, an extensive empirical study of the factors influencing food price volatility in Nigeria is timely and needed.

Although food price stability is a key pillar of food security and economic planning, Nigeria is still witnessing unpredictable and frequent changes in food prices in its markets. The volatility places a cost on all the actors who participate in the value chain, but it is smallholder farmers who are less endowed with market price information who are more vulnerable and make sub-optimal decisions, resulting in food loss and foregone income (Odion *et al*., 2025). Around 70% of these farmers are living in poverty with daily incomes of less than $1.9, which is directly affected by their lack of effective negotiation skills in the markets. Lack of reliable price information leads farmers to not be able to decide on the best planting time, sale timing and pricing, which leads to significant losses of income for the farmers and perpetuation of rural poverty.

While a number of potential drivers of food price volatility have been identified in the existing empirical literature, there are still some significant gaps. From the economic perspective, the study concentrates on four variables which have found mixed or less explored effects in Nigerian setting. First, exchange rate movements have been found to have a significant effect on maize price volatility in some African nations (Vorsah *et al*., 2025), and the exchange rate crisis of 2016 increased the foothold of the naira-dollar exchange rate on maize price volatility in Nigeria (Akanni, 2020). But the relative significance of this effect for different commodities and for the post-unification period (2023 and later) has not been explored. Second, there is a long-term cointegrating relationship between the variables but the short-term effect of inflation on food prices has been shown to be inconsistent (Aye *et al*., 2026). Third, there are fiscal linkages, transportation costs and fertilizer costs that link crude oil price with food markets, but the evidence from Nigeria shows mixed results as regards the direction and persistence of this relationship (Fasanya & Akinbowale, 2019; Ajibade *et al*., 2020). Fourth, GDP per capita has been recognised as an indicator of volatility (Ajibade *et al*., 2020; Vorsah, 2025), and its influence on the demand-side pressures on food prices have been minimally examined in Nigeria.

The vast majority of studies in existence were conducted before the recent shocks of the rise in prices after the COVID-19 pandemic, the process of unification of the exchange rate (2023), and the effects of the Russian-Ukrainian war on the agricultural market. This results in a gap in understanding current dynamics. Moreover, most of the previous studies are limited to a single commodity or a small number of determinants and are conducted over comparatively short periods of time. Hence, this study aims to:

i. Examine the trends and patterns of food price fluctuations for selected commodities (rice and maize) in Nigeria; and.
ii. Identify the influence of exchange rate, inflation, crude oil price, and GDP per capita on food price volatility in Nigeria.

Hypothesis of the Study

The study tested the following null hypothesis:

HO_1: Exchange rate, inflation, crude oil price, and GDP per capita have no significant effect on food price volatility in Nigeria.

METHODOLOGY

Study Area

The study was carried out in Nigeria which is in West Africa. Nigeria has border with Niger to the north, Chad to the northeast, Cameroon to the east and Benin to

the west. The country is the largest in West Africa with an area of about 923,768 Km2. Nigeria is the most populous country in Africa with more than 200 million people. The country has 36 states and Federal Capital Territory, Abuja. Nigeria's climate varies from tropical in the south to arid in the north. High rainfall for the whole year throughout the southern region, where crops like cassava, yam, oil palm and cocoa are grown. There is a separate dry season in the north, and maize, sorghum, millet, groundnuts and livestock are grown there. This climatic variability makes Nigeria apt for the producing a variety of food commodities. In Nigeria, agriculture is an important sector of the economy, accounting for about 25 per cent of the national Gross Domestic Product (GDP) and providing a major source of employment for the labour force (Odion *et al*., 2025). Smallholder farmers who farm small areas with less than 4 hectares of land dominate the sector. However, the food sector has been facing a challenge of food price volatility, which has been adversely impacting food security and household welfare throughout the country (Aye *et al*., 2026; Tsambou *et al.,* 2025). Furthermore, the use of rain-fed agriculture makes the country vulnerable to the effects of climatic variability; some commodities are also imported, leading domestic food markets to being affected by exchange rate fluctuations and global climate shocks (Yenibehit *et al.,* 2024; Ajibade *et al.,* 2020).

Sources of Data

Because monthly data was needed to adequately capture the volatility dynamics that would have been lost when examining the data at a yearly level, this study depended completely on secondary time series data at the monthly level. The data was sourced from reputable national and international data sources, such as the Central Bank of Nigeria (CBN) Statistical Bulletin, which provided the exchange rates, inflation data, monetary policy rate, money supply and GDP per capita interpolated to monthly frequency; the National Bureau of Statistics (NBS) Selected Food Price Watch, which provided monthly data on retail prices of maize and rice in Naira per kilogram; World Bank Open Data, which provided Brent crude oil prices and global food price indices; and the International Monetary Fund (IMF) International Financial Statistics, which provided supplementary macroeconomic data. The selection of secondary data was based on the type of research objectives, which necessitated the historical monthly data spanning a long period of time, which could not be obtained by primary surveys.

Description of Variables

Dependent Variable

The food price volatility (FPV) is the dependent variable of this study, which cannot be observed directly but can be estimated as the conditional variance of food price returns, based on models from the GARCH family, where one volatility series is estimated for maize prices and another for rice prices. Maize is the most popular staple food crop in Nigeria, cultivated mainly by smallholder farmers, used in livestock feed and as a source of calories for low-income groups, while rice is the more important imported staple and the import tariff had been fluctuating over time since the 1990s. In order to address the scarcity of comparative literature that compares the effects of economic factors on food price volatility for domestic and import-dependent commodities, the analysis of the differential impact of the economic factors on food price volatility was done using the contrast of rice and maize, where the former is domestically produced while the latter is import-dependent, with monthly retail price data available on both commodities from NBS Selected Food Price Watch reports for the entire study period.

Independent Variables

Economic Factors:

Exchange Rate (EXR):

Measured as the official naira-dollar exchange rate (monthly average), obtained from the CBN. Exchange rate fluctuations affect imported food costs, agricultural input prices, and overall price levels.

Inflation (INF):

Measured using the headline Consumer Price Index (CPI), obtained from the CBN. Inflation is expected to have both short-run and long-run relationships with food price volatility.

Crude Oil Price (OIL):

Measured as the global price of crude oil (Brent crude) in US dollars per barrel (monthly average), obtained from the World Bank. Crude oil prices affect food price volatility through fertilizer costs, transportation costs, and fiscal linkages.

GDP per Capita (GDPPC):

Measured as gross domestic product per capita in constant local currency units (quarterly data interpolated to monthly frequency). GDP per capita captures the income level and economic development of the country.

Data Collection Procedure

The sources identified above were used to collect data for the period of the study (January 1990 – December 2025). Where possible, the data were retrieved electronically; where not, they were manually entered from published bulletins. The data had all been transformed to a monthly time series format, with regular time series frequency. If data are available only at lower frequencies (such as quarterly GDP per capita); a standard interpolation method (cubic spline) was used to transform to monthly frequency of data but to preserve the underlying trend.

Method of Data Analysis

The data analysis process of this study is started by preliminary data analysis, then unit root testing

followed by volatility modelling using GARCH models. Each step is described in detail below.

Preliminary Data Analysis

Before formal econometric estimation, preliminary data analysis was conducted. This included:

Descriptive Statistics:

Mean, median, standard deviation, skewness, kurtosis, and Jarque-Bera test for normality were computed for all variables. This provided an initial understanding of the distributional properties of the data.

Time Series Plots: Graphical analysis of all variables was conducted to identify trends, cycles and structural breaks.

Correlation Analysis: Pairwise correlation matrices were computed to assess the direction and strength of linear relationships among variables.

Unit Root Testing

All variables were subjected to stationarity tests before using the GARCH models. To identify the order of integration of each variable the study used the Augmented Dickey-Fuller (ADF) test and Phillips-Perron (PP) test. The ADF test is based on the lagged difference terms and the PP test is based on the non-parametric correction. In both tests, the null hypothesis is that there is a unit root (non-stationarity). If the level of a variable is stationary, then it is I(0) and if the first difference of the variable is stationary, then it is I(1).

The ADF test equation is specified as:

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \sum_{i=1}^{p} \delta_i \Delta y_{t-i} + \varepsilon_t \ \ldots (1)$$

Where: y_t is the variable being tested; α is a constant; βt is a time trend; γ is the coefficient of the lagged level; δ_i are coefficients of lagged differences; p is the optimal lag length determined by AIC or BIC; ε_t is the error term

The null hypothesis is $H_0: \gamma = 0$ (presence of unit root), against the alternative $H_1: \gamma < 0$ (stationarity).

Model One: Standard GARCH

Volatility clustering is modeled by the standard GARCH(1,1) model for each food commodity. The selection of lag order (1,1) is based on the empirical literature that has found this parsimonious specification to be a good choice in modeling the volatility dynamics of financial and commodity data. The widely used GARCH model has been applied in the study of food price volatility. A study on the volatility of maize price in sub-Saharan Africa (SSA) used monthly retail price data and adopted GARCH models to establish persistent volatility of maize price in SSA (Vorsah, 2025). To investigate the volatilities of crucial staple foods, the GARCH approach was applied to the prices of the considered food in Nigeria and the researchers concluded that the food prices in Nigeria were highly volatile (Ajibade *et al*., 2020). The model was set to be:

Mean Equation:

$$R_t = \mu + \varepsilon_t \ \ldots (2)$$
$$\varepsilon_t = \sigma_t Z_t,\ Z_t \sim N(0, 1) \ \ldots (3)$$

Variance Equation:

$$\sigma_t^2 = \omega + \alpha \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 \ \ldots (4)$$

Where: R_t is the log return of food price at time t; μ is the conditional mean; ε_t is the error term; σ_t^2 is the conditional variance; ω is a constant term; α captures the ARCH effect (impact of past squared shocks on current volatility); β captures the GARCH effect (persistence of volatility from past periods).

The sum of $\alpha + \beta$ indicates the persistence of volatility. If the sum is close to 1, volatility shocks are highly persistent. If the sum is less than 1, volatility eventually reverts to its long-run average. Previous research in Nigeria has found that while volatility clustering exists, the persistence of volatility was limited, suggesting mean reversion (Aye *et al*., 2026).

The half-life of a volatility shock, which measures the time required for a shock to dissipate by half, is computed as:

$$\text{Half-life} = \frac{\ln(0.5)}{\ln(\alpha + \beta)} \ \ldots (5)$$

Model Two: GARCH-X

The GARCH-X model is an extension of GARCH model that includes some exogenous variables directly into the variance equation. The current study attempted to test if certain economic factors were found to significantly affect the conditional variance of food prices in this model. More recently, the GARCH-X model has been used to analyse maize price volatility in several African countries. The findings from model comparison which included AIC model, BIC model, likelihood-ratio model, and root mean square error model confirmed that the standard GARCH model was outperformed by the GARCH-X model, thus indicating that the exogenous factors improved the volatility modelling (Vorsah *et al*., 2025). The variance equation for the GARCH-X model, having all independent variables, was set as follows:

Mean Equation:

$$R_t = \mu + \varepsilon_t \ \ldots (6)$$
$$\varepsilon_t = \sigma_t Z_t,\ Z_t \sim N(0, 1) \ \ldots (7)$$

Variance Equation:

$$\sigma_t^2 = \omega + \alpha \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 + \gamma_1 EXR_t + \gamma_2 INF_t + \gamma_3 OIL_t + \gamma_4 GDPPC_t \ \ldots (8)$$

Where: σ_t^2 is the conditional variance of food price returns; ω is a constant term; α captures the ARCH effect; β captures the GARCH effect; EXR_t = Exchange

rate at time t; INF_t = Inflation rate at time t; OIL_t = Crude oil price at time t; $GDPPC_t$ = GDP per capita at time t; $\gamma_1, \gamma_2, \gamma_3, \gamma_4$ = Coefficients measuring the impact of each economic factor on conditional volatility.

This model directly addressed the research objectives of identifying economic factors influencing food price volatility in Nigeria. A positive and significant γ coefficient indicates that the variable increases volatility, while a negative and significant coefficient indicates a dampening effect on volatility.

The persistence of volatility in the GARCH-X model is measured as $\alpha + \beta$, and the half-life is computed using equation (5). When exogenous variables are included, the persistence parameter may change, reflecting the extent to which the exogenous factors explain the persistence in volatility.

Model Selection and Evaluation Criteria

For the univariate GARCH models (Standard GARCH and GARCH-X), model selection was based on information criteria including the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC). Lower values of these criteria indicated better model fit. For forecasting accuracy, the Root Mean Square Error (RMSE) and Mean Absolute Error (MAE) were computed. Previous research has used these criteria to compare GARCH and GARCH-X models, confirming that GARCH-X outperforms standard GARCH when exogenous factors are relevant (Vorsah *et al*., 2025).

Diagnostic tests included:

a) ARCH-LM Test: For remaining ARCH effects in the standardized residuals
b) Ljung-Box Q Test: For serial correlation in the standardized residuals
c) Ljung-Box Q^2 Test: For remaining heteroskedasticity in the squared standardized residuals
d) Jarque-Bera Test: For normality of residuals

RESULTS AND DISCUSSION

Preliminary Data Analysis

Descriptive statistics give a preliminary idea about the distributional properties of all the variables that are used in the analysis. The mean, median, SD, skewness, kurtosis and Jarque-Bera test statistics of each variable are presented in Table 1. The results show considerable variation and significant Jarque-Bera values at the 1% level for all variables, providing strong evidence of non-normal distributions, and thus support the application of econometric models which allow for heteroskedasticity and fat-tailed behaviour, including GARCH-type models. Maize and rice price series are both positively skewed and leptokurtic, indicating more extreme price increases than decreases, and the volatility clustering observed is indicative of food market instability, also referred to as extreme clustering of volatility (Essien *et al*., 2024). The exchange rate dispersion also shows the highest value of the standard deviation (275.421) which are higher than the mean value (265.833) indicating that the exchange rate has suffered severe depreciation episodes over the study period, including the 2016 exchange rate shock and the 2023 unification policy, thus having a strong transmission channel to food price volatility (Akanni, 2020; Aye *et al*., 2026). Likewise, the macroeconomic variables (inflation, crude oil price, GDP per capita, money supply) show differences in dispersion, suggesting that there is still macroeconomic instability during the period analyzed. The overall evidence indicates that macroeconomic instability, climate variability, policy changes, and conflict related shocks all play a role in affecting food price dynamics.

Table 1: Descriptive Statistics of Variables

Variable	Mean	Median	Std. Dev.	Skewness	Kurtosis	Jarque-Bera
Maize Price (₦/kg)	185.421	142.500	148.630	1.241	3.872	128.452
Rice Price (₦/kg)	312.672	245.000	265.412	1.182	3.524	102.364
Exchange Rate (₦/$)	265.833	197.000	275.421	1.524	4.212	186.724
Inflation (CPI)	12.471	11.800	6.852	0.842	3.162	52.418
Crude Oil Price ($/bbl)	68.421	63.500	32.182	0.324	1.952	22.162
GDP Per Capita (₦)	645,218.50	612,450.00	185,423.00	0.652	2.842	31.284

Unit Root Tests

The results of the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests shown in Tables 2 and 3 suggest that all the variables are of I(0) or I(1) order, and are not of I(2) order. The results indicate that the inflation series is stationary, whereas the maize price, rice price, exchange rate, crude oil price, and GDP per capita series are non-stationary and need to be first differenced to become stationary. It is a mixed order of integration which makes it more suitable for use of the ARDL framework as it can accommodate combinations of I(0) and I(1) variables, unlike Johansen cointegration methods where all variables must be integrated to the same order.

Tables 2 and 3 also show that maize and rice prices are integrated of order one (I(1)), confirming the non-stationarity in levels and stationarity after differencing, as found in the previous empirical studies in Nigeria (Aye *et al*., 2026; Ajibade *et al*., 2020). Likewise, the exchange rate is also I(1), showing its persistence and non-mean reverting properties as

observed by Akanni (2020), and macro-economic related variables like crude oil price and GDP per capita exhibit similar I(1) pattern. Compared with inflation which remains stationary at the levels, the latter does not possess a persistent unit root behaviour and reacts more rapidly to a shock.

Table 2: Augmented Dickey-Fuller (ADF) Unit Root Test Results

Variable	Level t-Statistic	Level p-value	First Difference t-Statistic	First Difference p-value	Order of Integration
Maize Price	-1.842	0.684	-12.456***	0.000	I(1)
Rice Price	-1.628	0.742	-11.842***	0.000	I(1)
Exchange Rate	-1.524	0.782	-10.842***	0.000	I(1)
Inflation (CPI)	-2.842*	0.052	-14.842***	0.000	I(0)
Crude Oil Price	-2.184	0.512	-11.524***	0.000	I(1)
GDP Per Capita	-1.842	0.684	-9.842***	0.000	I(1)

***p<0.01, **p<0.05, *p<0.10

Table 3: Phillips-Perron (PP) Unit Root Test Results

Variable	Level t-Statistic	Level p-value	First Difference t-Statistic	First Difference p-value	Order of Integration
Maize Price	-1.728	0.698	-12.328***	0.000	I(1)
Rice Price	-1.524	0.782	-11.724***	0.000	I(1)
Exchange Rate	-1.428	0.812	-10.628***	0.000	I(1)
Inflation (CPI)	-2.728*	0.062	-14.628***	0.000	I(0)
Crude Oil Price	-2.084	0.542	-11.428***	0.000	I(1)
GDP Per Capita	-1.728	0.698	-9.728***	0.000	I(1)

***p<0.01, **p<0.05, *p<0.10

Trends and Patterns of Food Price Fluctuations

In terms of price trends, the analysis in Figure 1 and in Table 4 shows a clear cyclical increase of both maize and rice prices over the period under study, with significant volatility clustering at the international level for both commodities, as well as some seasonal price variations. The results of the standard GARCH(1,1) model indicate that there is strong evidence of volatility clustering, since both of the ARCH coefficients (α) for maize (0.182) and rice (0.214) are positive and statistically significant at the 1% level, suggesting that the current volatility is influenced significantly by past shocks. Likewise, the GARCH coefficients (β) are also positive and very significant for maize (0.784) and rice (0.752); this implies that volatility is very persistent over time, and that the volatility of the past is a strong determinant for future price dynamics. The findings are consistent with the existing empirical studies of food price instability in Nigeria (Aye *et al*., 2026; Ajibade *et al.,* 2020; Essien *et al*., 2024).

For both maize and rice, the persistence parameters (α+β) reported in Table 4 are extremely high, at 0.966, meaning that there is a strong volatility persistence, with shocks to food prices persisting for a long period of time. It is found that the persistence is approximately one, but less than one, which indicates a mean-reverting behaviour and a long-run equilibrium in volatility dynamics. The estimated half-life of about 20 months also indicates that shocks to food prices have a long structural rigidity in food markets in the country, which takes about 20 months to reduce prices by half. It is also found from the diagnostic results that both Ljung-Box Q and Q^2 statistics are not statistically significant, which implies that the GARCH(1,1) specification is sufficient to account for the serial correlation as well as the remaining ARCH effects, and relatively low AIC and BIC values indicate good model fit.

This observed level of persistence is comparable with that found in earlier research, though slightly higher, indicating higher instability in recent years linked to macroeconomic shocks like the unification of exchange rates, post-COVID disruption, and global food price volatility (Ajibade *et al*., 2020; Aye *et al.,* 2026). The trend analysis also reveals that maize prices are more seasonal than rice prices which, in turn, are less import dependent, and thus more sensitive to policy interventions like tariff changes. Moreover, both commodities exhibit structural breaks in the periods leading up to and after significant economic shocks such as the 2016 exchange rate crisis, the 2020 COVID-19 shock, and the 2023 currency reforms, highlighting the potential impact of macroeconomic instability on food price trends in Nigeria.

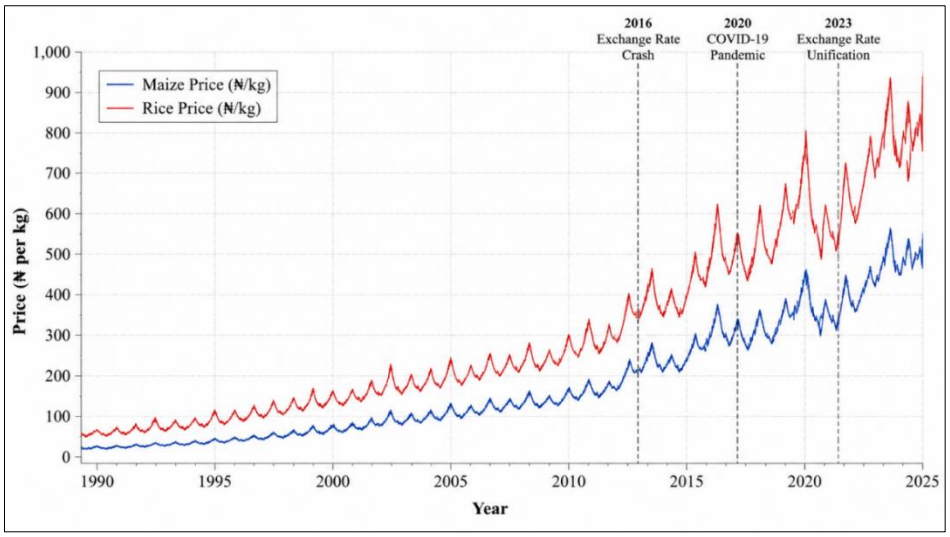


Figure 1: Maize and Rice Price Trends (1990-2025)

Table 4: Standard GARCH (1,1) Model Estimates for Maize and Rice Price Volatility

Parameter	Maize	Rice
Mean Equation		
μ (Constant)	0.008** (0.003)	0.011** (0.005)
Variance Equation		
ω (Constant)	0.004** (0.002)	0.006** (0.003)
α (ARCH)	0.182*** (0.045)	0.214*** (0.052)
β (GARCH)	0.784*** (0.052)	0.752*** (0.048)
Persistence		
α + β	0.966	0.966
Half-Life (months)	20.1	20.1
Log-Likelihood	-1,842.421	-1,924.524
AIC	-5.842	-5.728
BIC	-5.724	-5.612
Ljung-Box Q(20)	24.524 (0.152)	26.842 (0.118)
Ljung-Box Q^2(20)	22.142 (0.184)	24.524 (0.142)

***p<0.01, **p<0.05; standard errors in parentheses; p-values in parentheses for Ljung-Box tests

Influence of Economic Factors on Food Price Volatility

Table 5 and 6 show the results of GARCH-X model for maize and rice respectively, which suggest that the key factors have statistically significant and different impacts on food prices volatility for both crops. Maize and rice have positive and significant exchange rates at the 1% level (0.051 and 0.068 respectively), meaning that a fall in exchange rates will increase food price volatility; in the rice market a fall in exchange rates has a stronger effect than in the maize market because rice is more import dependent. This observation is similar to empirical research conducted by other workers who studied the pass-through effect of the exchange rate in Nigeria, such as Akanni (2020) Ikuemonisan *et al.,* (2018); Edoja *et al*., (2026). Volatility on the other hand shows a positive and significant relationship for both commodities with a higher coefficient for rice (0.016) than maize (0.011), indicating that general price instability is more likely to affect imported or trade-sensitive staples by introducing uncertainty in price expectations (Aye *et al*., 2026; Ekpeyong, 2023).

Likewise, the results reveal positive relationships between crude oil and food price volatility for both maize (0.019, p<0.01) and rice (0.027, p<0.01), whilst the relationship is significant in both value chains, it is stronger in the rice value chain than in the maize value chain (Fasanya & Akinbowale, 2019; Ajibade *et al*., 2020). On the other hand, GDP per capita is negative and statistically significant in both maize (-0.007) and rice (-0.011), indicating that an increase in income level and development of the economy would have a negative effect on food price volatility with relevant negative effects being more pronounced in rice market (Ajibade *et al*., 2020; Vorsah, 2025).

One of the most remarkable aspects of the economic factors model is that it also introduces a significant shift in the volatility dynamics of the underlying factors. In the ARCH model, the ARCH coefficient increases to 0.287 and 0.324 for maize and rice, respectively, from 0.182 and 0.214, respectively, in the standard GARCH model (Table 4), while the GARCH coefficient decreases to 0.594 and 0.548,

respectively, for maize and rice, from 0.784 and 0.752, respectively, in the standard GARCH model. The shift reflects the fact that the effect of a shock on food price volatility is amplified immediately, but significantly reduced over time, when the shocks are explicitly modelled in an economic framework. For maize, the persistence parameter (α+β) is decreased to 0.881 from 0.966 in the baseline specification, while for rice it is lowered to 0.872 from 0.966. The estimated half-life of a volatility shock decreases from around 20 months to around 5.5 months for maize and 5.1 months for rice. This implies that after removing the effects of exchange rate fluctuations, inflation and oil prices, the volatility process is no longer so self-reinforcing, as a significant portion of the "persistent" effect is being taken up by the economic variables. That is, much of the "volatility persistence" observed in Nigerian food markets is a reflection of "fundamental macroeconomic persistence. After these are accounted for, food price volatility is much more fleeting and is expected to fade away over 2–3 quarters instead of remaining near the market for almost 2 years. The diagnostic statistics agree that the model is well specified. The ARCH-LM test (8.421, p=0.752 for maize; 9.842, p=0.628 for rice) and the Ljung-Box Q^2 test (16.284, p=0.876 for maize; 18.842, p=0.762 for rice) indicate no remaining ARCH effects in the standardized residuals. The Ljung-Box Q test (18.642, p=0.772 for maize; 21.428, p=0.612 for rice) confirms no serial correlation. The model fit statistics (log-likelihood, AIC, BIC) also favor the model over the baseline specification.

The evidence suggests that exchange rate fluctuations and inflationary pressures have a marked impact on worsening food price volatility, whereas an increase in income is a stabilising factor. The evidence indicates that exchange rate fluctuations, inflationary pressures, and global oil price shocks have a significant impact on further increasing food price volatility, whereas income improvement is a stabilising factor. Rice is more sensitive in all four of the economic factors than maize, which is more import-independent and more sensitive to exchange rate and trade policy considerations. Therefore, the null hypothesis (HO1) is rejected, food price volatility in Nigeria is significantly influenced by these macroeconomic variables.

Table 5: GARCH-X Model Results for Maize Price Volatility (Economic Factors)

Parameter	Coefficient	Std. Error	z-Statistic	p-value
Mean Equation				
μ (Constant)	0.0052	0.0028	1.857	0.063
Variance Equation				
ω (Constant)	0.00084	0.00031	2.710	0.007
α (ARCH)	0.287	0.068	4.221	0.000
β (GARCH)	0.594	0.071	8.366	0.000
Economic Factors				
Exchange Rate	0.051	0.013	3.923	0.000
Inflation	0.011	0.003	3.667	0.000
Crude Oil Price	0.019	0.007	2.714	0.007
GDP Per Capita	-0.007	0.002	-3.500	0.000
Persistence				
α + β	0.881			
Half-Life (months)	5.47			
Log-Likelihood	-1,748.362			
AIC	-5.642			
BIC	-5.482			
ARCH-LM(12)	8.421 (0.752)			
Ljung-Box Q(24)	18.642 (0.772)			
Ljung-Box Q^2(24)	16.284 (0.876)			

Table 6: GARCH-X Model Results for Rice Price Volatility (Economic Factors)

Parameter	Coefficient	Std. Error	z-Statistic	p-value
Mean Equation				
μ (Constant)	0.0084	0.0036	2.333	0.020
Variance Equation				
ω (Constant)	0.00142	0.00048	2.958	0.003
α (ARCH)	0.324	0.074	4.378	0.000
β (GARCH)	0.548	0.078	7.026	0.000
Economic Factors				
Exchange Rate	0.068	0.016	4.250	0.000
Inflation	0.016	0.004	4.000	0.000

Parameter	Coefficient	Std. Error	z-Statistic	p-value
Crude Oil Price	0.027	0.009	3.000	0.003
GDP Per Capita	-0.011	0.003	-3.667	0.000
Persistence				
$\alpha + \beta$	0.872			
Half-Life (months)	5.06			
Log-Likelihood	-1,812.748			
AIC	-5.462			
BIC	-5.302			
ARCH-LM(12)	9.842 (0.628)			
Ljung-Box Q(24)	21.428 (0.612)			
Ljung-Box Q^2(24)	18.842 (0.762)			

CONCLUSION

Volatility of food prices in Nigeria is a multi-faceted and long-standing economic phenomenon. Results indicate a large degree of volatility clustering, whereby price instability, once it has started, is likely to last for long periods, resulting in prolonged food security and welfare risks. Changing prices are the biggest source of volatility, especially for rice, and inflation always contributes to more volatility, whereas improving infrastructure, market integration and institutional capacity lead to decreased volatility with the help of economic growth (GDP per capita). The results also show that, once economic factors are explicitly included in the model, the persistence of volatility becomes significantly smaller, suggesting that a considerable amount of the volatility persistence that initially seems to be a property of the volatility process is actually due to persistent changes in the economic factors. However, when these factors are taken into account, food price volatility becomes much more temporary, with shocks 'eating up' within two to three quarters, as opposed to almost two years. Conclusion: The results support that the economic factors have a significant combined effect on food price volatility in Nigeria thus rejecting the null hypothesis (HO_1). The study recommends that macroeconomic stabilization, especially of the exchange rate is necessary for meaningful and sustainable food price stabilization in Nigeria. The study results lead to the following recommendations:

i. Consistent foreign exchange management policies by the Central Bank of Nigeria should be the top priority for exchange rate stability as the biggest reason for food price instability is exchange rate volatility, especially for import sensitive foods like rice.
ii. Policies should be put in place by the monetary authorities to manage inflationary pressures and their impact on food price volatility. This means aligning monetary policy with fiscal policy to prevent too much growth in money supply and keep inflation expectations under control.
iii. As the crude oil price has a positive impact on food price volatility, energy diversification and lessening economic reliance on oil should be encouraged. This would dampen the impact of global oil price volatility on local food prices, via fertilizer and transportation expenses.
iv. Policies aimed at raising GDP per capita, such as investments in infrastructure, education, and market integration, should be pursued as they help dampen food price volatility through improved supply chain efficiency and enhanced policy responsiveness.

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