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Effects of International Market Dynamics on Food Prices and Volatilities: A Panel Analysis of Rice and Beef in Nigeria

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Abstract
This study looks at the influence of foreign market dynamics on domestic food prices and volatility in Nigeria, utilising rice and beef as examples of calories and basic protein-rich commodities. The research employed data from 2004 to 2024, including international pricing indices, exchange rates, inflation rates, and yearly human population. The double-log model and Pearson correlation were employed to investigate the relationship between the variables, and price volatility trends were also determined. The findings indicate that exchange rate fluctuations and inflation are emerging as significant transmission mechanisms. While local output of grains and meat moderated price levels, and it was inadequate to offset foreign shocks. The volatility assessment also revealed that global market changes worsened domestic price instability, posing threats to food affordability and accessibility. The report highlights Nigeria's susceptibility to global food market shocks, emphasising the importance of strong macroeconomic policies, increased local production capacity, and strategic food stockpiles. These measures are critical for reducing reliance on imports, stabilising food prices, and improving food security in the face of increasingly linked global commodities markets. Given these findings, there is a critical need for strategic policy activities such as exchange rate stabilisation, increased domestic food production, effective price stabilisation mechanisms, and regional food buffer systems. Reducing Nigeria's reliance on food imports and strengthening domestic value chains will help lessen the impact of global market volatility on food prices, hence boosting food security and economic resilience.
Keywords: global, food prices, market dynamics, rice, meat, volatility, production.
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1. Introduction

Agriculture plays a central role in Nigeria's economy, serving as key source of employment, food security, and income generation (Nwofoke, et al., 2024, and Ake, et al., 2023). Among the numerous food commodities in the country, rice and beef are particularly significant due to their centrality in the average Nigerian diet. Rice has emerged as a staple food, consumed across all socio-economic classes, while beef serves as a major source of protein, contributing to national nutritional intake (Adenikinju et al., 2021; and Ogunniyi et al., 2019). The dynamic interplay between demand, supply, and market shocks renders the prices of these commodities susceptible to volatility, with implications for producers, consumers, and policymakers. The prices of staple food commodities such as rice and beef are critical indicators of food security and economic stability in Nigeria (Opayemi, 2022). As the largest economy in Africa, Nigeria faces significant challenges in maintaining stable food prices due to fluctuating international market dynamics, including supply chain disruptions, exchange rate volatility, inflation, policy shifts, and climatic variability. These factors collectively influence the pricing structures of essential commodities in the country (FAO, 2021; NBS, 2023).

Recent studies have shown that rice, a food staple in Nigeria, is particularly prone to changes in international trade policy, exchange rate fluctuations, and import tariffs. For example, Ayanwale et al. (2020) reported that the depreciation of the Naira and restrictive import policies significantly contributed to the rise in rice prices, especially in urban markets. Also, disruptions in local rice production due to insecurity in key food-producing areas and flooding in the country have compounded the problem (Yahaya and Abdulrahman, 2022).

Similarly, the beef market in Nigeria exhibits considerable volatility. The livestock sector faces structural inefficiencies, including poor infrastructure, limited access to veterinary services, and nomadic pastoral systems,

which contribute to inconsistent supply and fluctuating prices (FAO, 2022). Moreover, the recurring farmer-herder conflicts in the North-Central and North-West regions of Nigeria have disrupted the beef supply chain, further exacerbating price volatility (Okoli and Nnaemeka, 2020). Demand-side pressures, including rising incomes and urbanization, continue to influence beef consumption patterns and pricing dynamics. The beef market in Nigeria is shaped by both supply-side constraints and demand-side pressures. Livestock production in northern Nigeria, which supplies the majority of the country's beef, is frequently disrupted by farmer-herder conflicts, climate-induced migration, and poor infrastructure (Tenuche and Ifatimehin, 2021). These factors not only reduce the quantity of beef supplied to southern urban markets but also increase transaction costs, thereby raising retail prices. Moreover, the demand for beef continues to rise in response to population growth and changing dietary patterns, putting upward pressure on prices (Ogunniyi et al., 2019).

According to Osadebamwen (2015), market integration, price transmission mechanisms, and seasonal variations are crucial in understanding the behaviour of food prices in Nigeria. For instance, Olayemi et al. (2023) used vector autoregression models to demonstrate how shocks in transportation costs and fuel prices ripple through the value chains of rice and beef, leading to price volatility in regional markets. High price volatility can hinder effective market functioning, discourage investment, and negatively impact food security, particularly for low-income households (World Bank, 2021). Given the socio-economic significance of rice and beef, understanding their underlying market dynamics and volatility patterns is essential for formulating effective agricultural and trade policies. This is particularly relevant in Nigeria, where inflationary pressures and foreign exchange instability further complicate food pricing mechanisms (National Bureau of Statistics (NBS) 2023).

This paper seeks to contribute to the growing body of knowledge on food market behaviour in Nigeria by exploring the effects of international market dynamics on food prices and volatilities through a panel analysis of rice and beef in Nigeria**.** The specific objectives of this paper are to:

i. examines the impact of macroeconomic and sector-specific factors influencing price behaviour in the rice and beef market;
ii. examine the degree of market integration between these commodities, including any lead-lag relationships;
iii. discusses policy implications, including stabilization mechanisms, information systems, and infrastructure in the rice and beef markets.
iv. Provide empirical evidence to guide policy recommendations and enhance market resilience and food security in Nigeria.

Theoretical Framework

The following theories and hypotheses were relevant in this study, and were applied to the investigation. The Law of One Price (LOP) or Purchasing Power Parity (PPP). This theory holds that, in the absence of trade barriers and transportation costs, similar items should be priced the same in various markets when represented in a common currency (Froot and Rogoff, 1995). The importance of this hypothesis is that international price fluctuations for rice and beef can be conveyed to domestic markets via trade integration.
Price Transmission Theory. This theory describes how global market shocks (exchange rate fluctuations, worldwide demand/supply shifts) are communicated to domestic markets, particularly for tradable items such as rice and cattle (Conforti, 2004).
Market integration theory. According to this idea, if domestic and international markets are interconnected, shocks in foreign markets (such as export prohibitions or demand surges) affect domestic prices (Barrett 2001).
Food sovereignty and dependency theory. Highlights the susceptibility of import-dependent nations like Nigeria to global price swings, particularly for basic and protein-rich commodities such as rice and cattle (Patel, 2009).
Speculative and Financialisation Theory. According to Gilbert and Pfuderer (2014), speculative trading and financial players impact global commodities markets, including food. As a result, volatility increases.

2. Methodology

The study was conducted in Nigeria, located in West Africa. This country is the most populous country on the continent with an estimated population exceeding 220 million people (World Bank, 2023). The country spans a geographical area of approximately 923,769 square kilometers, bordered by Benin to the west, Niger to the north, Chad to the northeast, Cameroon to the east, and the Atlantic Ocean to the south. Nigeria's climate ranges from equatorial in the south to arid in the north, supporting diverse agro-ecological zones that influence agricultural production patterns across the country (FAO, 2022). Agriculture plays a vibrant role in Nigeria’s economy, employing about 35 percent of the labour force and contributing approximately 25 percent to the

national GDP (National Bureau of Statistics, NBS, 2023). Key staples produced include rice, maize, cassava, and yams, while cattle, goats, sheep, and poultry are also commonly reared by farmers in the country (USDA, 2022).

Due to her dependence on food imports and the integration of local markets with global value chains, Nigeria's food prices are increasingly vulnerable to international market dynamics such as exchange rate fluctuations, global commodity price shocks, and trade policy shifts (Adewuyi et al., 2021). Nigeria's food market is characterized by a complex structure involving both formal and informal sectors. Urban markets, in particular, are responsive to global price signals due to the higher prevalence of imported goods, while rural markets are more influenced by domestic production cycles (Ajayi et al., 2020). The country's strategic position as both a regional economic hub and a major food importer in Sub-Saharan Africa makes it an important case study for understanding the transmission of international market signals into domestic food prices.

This study used a quantitative research approach, including panel data econometric methodologies, to examine the influence of global market dynamics on food prices and volatility in Nigeria. The study focuses on two essential commodities: rice and beef, which serve as key food staples in the diet of the people. In reality, panel data captures both cross-sectional (across geographical zones or states) and time-series (over the years) fluctuations, resulting in more meaningful data, greater variability, and higher degrees of freedom (Baltagi, 2008). The data for this study were taken from Nigeria's annual time series data, which spans 2004–2024.
In particular, data on food prices were obtained from the National Bureau of Statistics (NBS) yearly publications, the FAO Food Price Index (FFPI), and the World Bank Commodity Prices for rice and meat while data on exchange rates was provided by the Central Bank of Nigeria (CBN). The World Bank WDI maintains macroeconomic controls on inflation, the consumer food price index, imports, and the annual human population. The data were analyzed using Eviews.

Model specification

PMEAT = *f*(MEATOUTP, CPI, IMPRATE, EXCHRATE, INFRATE, POP) (1)
PRICE = *f*(RICEOUTP, CPI, IMPRATE, EXCHRATE, INFRATE, POP) (2)
Where;
PMEAT = Price of meat (N/Kg)
MEATOUTP = Meat production output (MT)
CPI = Consumer food price index
IMPRATE = Import rate (1,000 MT)
EXCHRATE = Exchange rate (Naira/Dollar)
INFRATE = Inflation rate (%)
POP = Annual human population (Million)
PRICE = Price per 50kg rice bag
RICEOUTP = Rice production output (MT)
Equations (1) and (2) were transformed into Log functional form:

$$lnPMEAT = \beta_0 + \beta_1 lnMEATOUTP + \beta_2 lnCPI + \beta_3 lnIMPRATE + \beta_4 lnEXCHRATE + \beta_5 lnINFRATE + \beta_6 lnPOP + \mu \quad (3)$$

$$lnPRICE = \beta_0 + \beta_1 lnRICEOUTP + \beta_2 lnCPI + \beta_3 lnIMPRATE + \beta_4 lnEXCHRATE + \beta_5 lnINFRATE + \beta_6 lnPOP + \mu \quad (4)$$

Where;
lnPMEAT is the logarithm of the price of meat (N/Kg)
lnMEATOUTP is the logarithm of the meat production output (MT)
lnCPI is the logarithm of the consumer food price index
lnIMPRATE is the logarithm of the import rate (1,000 MT)
lnEXCHRATE is the logarithm of the exchange rate (Naira/Dollar)
lnINFRATE is the logarithm of the inflation rate (%)
lnPOP is the logarithm of the annual human population (Million)
lnPRICE is the logarithm of the price per 50kg rice bag
lnRICEOUTP is the logarithm of the rice production output (MT)
β_0 is the constant
β_1-β_6 are the coefficients of the estimation
μ is the error term

3. Results and Discussion

Table 1: Summary of descriptive statistics of meat variables

Variables	PMEAT	MEATOUTP	CPI	IMPRATE	EXCHRATE	INFRATE	POP
Mean	1191.19	2164916.0	131.79	2129.95	303.26	15.08	176.63
Median	789.34	2164916.0	127.00	2100.00	158.55	12.50	175.48
Maximum	5633.00	3953205.0	175.00	3200.00	1483.00	39.84	220.69
Minimum	341.66	1018040.0	100.00	1369.00	118.55	5.40	136.76
Std. Dev.	1232.01	808208.8	23.50	497.11	310.35	7.77	25.93
Skewness	2.52	0.23	0.39	0.29	2.89	1.67	0.11
Kurtosis	9.24	2.23	1.90	2.32	11.23	6.04	1.82
Jarque-Bera	56.36	0.71	1.61	0.70	88.57	17.87	1.27
Probability	0.0000	0.7015	0.4482	0.7041	0.0000	0.0001	0.5303
Sum	25014.97	45463240	2767.50	44729.00	6368.40	316.64	3709.20
Sum Sq. Dev.	30356828	1.31E+13	11046.79	4942371.0	1926385.0	1207.80	13442.15
Observations	21	21	21	21	21	21	21

Table 1 provides a summary of the descriptive statistics of meat variables. PMEAT (price of meat (₦/Kg)) has a mean of ₦1,191, indicating a high average price per kg. The data is skewed right (2.52), indicating some very high meat prices, and has a kurtosis of 9.24, indicating hefty tails. Jarque-Bera (JB) had a value of 56.36 and a p-value of 0.000, indicating that meat prices were not regularly distributed. However, MEATOUTP (meat production output (MT)) mean and median are both 2164916, with minor skewness (0.23) and kurtosis (2.23), indicating that meat production output remained steady across the years under review. Import rate, JB (0.71) showed a p-value of 0.7015, indicating that meat production is regularly distributed. The CPI (consumer food price index) mean was 131, modestly skewed (0.39), and with a kurtosis of 1.90; there were no significant deviations, indicating the consumer food price index level. JB (1.61) has a p-value of 0.4482, indicating that the consumer food price index is normally distributed.

IMPRATE (import rate (1,000 MT)) of beef mean was found to be ₦2,129, which reflects import dominance. Also, the low values of skewness (0.29) and kurtosis (2.32) indicates a normal distribution of meat import rates into the nation. The import rate JB was 0.79 with a p-value of 0.7041, implying that it followed a normal distribution. The average exchange rate (Naira/Dollar) was ₦303.26, with a wide variation (min = ₦118.55, peak = ₦1,483.00) showing currency decline. The skewness of 2.89 suggests that the currency rate is strongly skewed to the right, indicating huge spikes in the exchange rate in Nigeria. Furthermore, the kurtosis score of 11.23 denotes severe outliers. Import rate, JB (88.57) had a p-value of 0.0000, indicating that the exchange rate is not regularly distributed. INFRATE (inflation rate (%)) had a mean of 15%, indicating mild inflation across the years under study. Skewed (1.67) right and high kurtosis (6.04) indicate that certain years had extremely high inflation. JB (17.87) had a p-value of 0.0001, indicating that the inflation rate was not regularly distributed. POP (annual human population (million)) has a mean of 176.6 million, which follows Nigeria's population growth tendency. Minimal skew (0.11) and low kurtosis (1.82) indicate a progressive increase while JB (1.27) had a p-value of 0.5303, indicating that the population was normally distributed.

In summary, economic indices such as currency rate, meat price, and inflation rate exhibited non-normality and excessive volatility, implying economic instability during some periods. Variables such as the consumer food price index, meat output, and population were more stable and showed more consistent patterns. The exchange rate had the widest dispersion and severe outliers, which are most often caused by macroeconomic shocks or currency depreciation. As a result, the variables were transformed into logarithms to eliminate abnormalities and ensure that all variables had mean values.

Table 2: Summary of descriptive statistics of rice variables

Variables	PRICE	RICEOUTP	CPI	IMPRATE	EXCHRATE	INFRATE	POP
Mean	18800.00	3796619.0	131.79	2129.95	303.26	15.08	176.63
Median	10000.00	3782000.0	127.00	2100.00	158.55	12.50	175.48
Maximum	105000.0	5607000.0	175.00	3200.00	1483.00	39.84	220.69
Minimum	4400.00	2000000.0	100.00	1369.00	118.55	5.40	136.76
Std. Dev.	22373.09	1312329.0	23.50	497.11	310.35	7.77	25.93
Skewness	3.00	0.01	0.39	0.29	2.89	1.67	0.11
Kurtosis	11.81	1.43	1.90	2.32	11.23	6.04	1.82
Jarque-Bera	99.34	2.16	1.61	0.70	88.57	17.87	1.27
Probability	0.0000	0.3394	0.4481	0.7041	0.0000	0.0001	0.5303
Sum	394800.0	79729000	2767.50	44729.00	6368.40	316.64	3709.20
Sum Sq. Dev.	1.00E+10	3.44E+13	11046.79	4942371.	1926385.	1207.80	13442.15
Observations	21	21	21	21	21	21	21

Table 2 shows the summary descriptive statistics for rice variables using time series data from 2004 to 2024 (with 21 observations). Over the past 21 years, the average Naira price per 50kg rice bag (PRICE) was ₦18,800. When the data is sorted, the middle value is returned. If there is skewness, the median may deviate from the mean. From the results, PRICE maintained a median of ₦10,000.00, indicating much lower value than the mean, and showing positive skew (supported by skewness value). From the maximum and minimum values in the dataset, prices varied from ₦4,400.00 to ₦105,000.00, demonstrating volatility, particularly when contrasted to other variables. The standard deviation represents the average difference from the mean. A high value indicates substantial volatility. PRICE (₦22,373.09) and EXCHRATE (₦310.35) were found to have significant spreads.

Skewness quantifies asymmetry. Positive skew indicates a lengthy right tail. PRICE (price in ₦ per 50kg rice bag) and EXCHRATE (exchange rate (Naira/Dollar)) are substantially skewed (>2), indicating that a few high values push the average exchange rate up. Kurtosis indicates how 'peaked' the distribution is. The kurtosis of the normal distribution was found to be 3. PRICE and EXCHRATE are leptokurtic (>3), with strong peaks and fat tails that indicates outliers or volatility. The Jarque-Bera test statistic combines skewness and kurtosis. PRICE (price in ₦ per 50kg rice bag), EXCHRATE (exchange rate in Naira/Dollar), and INFRATE (inflation rate in %) all had p-values < 0.05, indicating substantial deviation from normalcy. Whereas RICEOUTP (rice production output (MT)), CPI (consumer food price index), IMPRATE (import rate (1,000 MT)), and POP (annual human population (Million)) did not differ substantially from normalcy (p > 0.05), this aligns with the findings of Ayanwale, et al (2020).

In summary, PRICE was extremely skewed and variable. Large values (perhaps due to recent inflation) caused the distribution to deviate from normal. EXCHRATE was extremely skewed and variable, possibly owing to currency devaluation. POP, IMPRATE, and CPI were quite consistent and typically distributed. These results are expected because rice is an essential food staple in Nigeria. According to Edaba et al (2024), rice appears to be gaining grounds as a very essential food alternative in Nigeria due to its accessibility and the increase in its economic importance, as a major source of metabolic energy.

Table 3: Factors influencing the price of meat in Nigeria

Variable	Coefficient	Std. Error	t-Statistic	Sig.
Constant	-11.7572***	2.1768	-5.4011	0.0001
LMEATOUTP	0.3247***	0.0633	5.1259	0.0002
LCPI	5.8241***	1.7789	3.2741	0.0055
LIMPRATE	0.3313***	0.1168	2.8374	0.0132
LEXCHRATE	0.4515***	0.1093	4.1307	0.0010
LINFRATE	0.0558	0.0782	0.7131	0.4875
LPOP	-3.8076*	1.9504	-1.9522	0.0712

R-squared	0.9919	Mean dependent variable	6.7707
Adjusted R-squared	0.9884	S.D. dependent variable	0.7385
S.E. of regression	0.0795	Akaike info criterion	-1.9662
Sum squared resid	0.0884	Schwarz criterion	-1.6180
Log likelihood	27.645	Hannan-Quinn criterion.	-1.8906
F-statistic	285.6448	Durbin-Watson stat	2.1086
Prob(F-statistic)	0.0000		

***, **, and * Significant at 1%, 5%, and 10% level of probability respectively

Table 3 shows the outcome of a multiple linear regression model using the Ordinary Least Squares (OLS) approach. The R-squared value of 0.9919 suggests that this model explains 99.19% of the variability in meat prices, which was very strong. The adjusted R^2 of 0.9884 indicates an excellent model, even after accounting for the number of predictors. The F-statistic of 285.64 with $p < 0.000$ shows that the model was extremely significant. Durbin-Watson of 2.11, which was near to 2, implies that there was no autocorrelation in the residuals (excellent). The S.E. of regression was 0.0794, indicating that the predictions were close to the actual values.

From Table 3, LMEATOUTP (Log of meat output (MT)) had a coefficient of 0.3247 and was statistically significant at the 1% level, suggesting that a 1% increase in meat output results in a 0.33% rise in meat price, which might be attributed to a demand-driven market or supply chain inefficiencies. Ogunniyi, et al (2019), reported that price is an important determinant of demand for meat. The LCPI (Log of Consumer Food Price Index) had a coefficient of 5.8241 and was statistically significant at the 1% level. Suggests that a 1% rise in the consumer food price index was connected with a 5.82% increase in meat pricing. LIMPRATE (Log of import rate (1,000 MT)) had a coefficient of 0.3313 and was statistically significant at the 1% level. This indicates that a 1% rise in the import rate raises beef prices by 0.33%. LEXCHRATE (Log of exchange rate (Naira/Dollar)) had a coefficient of 0.4515 and was statistically significant at the 1% level. This finding indicates that a 1% depreciation in the naira (higher exchange rate) raises meat prices by 0.45%. In addition, LPOP (Log of yearly human population (Million)) with a coefficient of -3.8076 was slightly statistically significant at 10% ($p = 0.0712$). The interpretation of this result is that for every unit increase in population, meat prices are likely to fall by 3.81 units; this might be due to scalability effects or dynamics in the market (a larger market equals price smoothing).

Table 4: Factors influencing the price of rice in Nigeria

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Sig.**
Constant	-1.6638	2.7963	-0.5950	0.5613
LRICEOUTP	-0.426	0.3749	-1.1367	0.2747
LCPI	0.4473	3.0896	0.1448	0.8870
LIMPRATE	0.1947	0.2021	0.9634	0.3517
LEXCHRATE	0.9292***	0.1944	4.7799	0.0003
LINFRATE	-0.1326	0.1352	-0.9805	0.3435
LPOP	1.7817	3.8126	0.4673	0.6475

R-squared	0.9784	Mean dependent variable	9.4834
Adjusted R-squared	0.9691	S.D. dependent variable	0.7738
S.E. of regression	0.13600	Akaike info criterion	-0.8910
Sum squared resid	0.2590	Schwarz criterion	-0.5429
Log likelihood	16.3560	Hannan-Quinn criterion.	-0.8155
F-statistic	105.5545	Durbin-Watson stat	1.7436
Prob(F-statistic)	0.0000		

***, **, and * Significant at 1%, 5%, and 10% level of probability respectively

Table 4 depicts the results of a multiple linear regression using the OLS technique, with the log of PRICE (LPRICE) as the dependent variable and numerous additional log-transformed variables as independent (explanatory). The model explained 97.8% of the variance in LPRICE (R-squared = 0.9784), showing a very strong match. Adjusted R-squared (0.9691) for numerous predictors was quite high, suggesting that the model was not overfitting. The regression's F-statistic (105.5545) and Prob(F-statistic) of 0.0000 demonstrate its statistical significance and validity. Durbin-Watson (1.74) was close to 2, indicating that there was no significant autocorrelation in residuals, which appears to be positive. In addition, the LEXCHRATE (log exchange rate) showed a positive and greatly significant effect on LPRICE (rice price). A 1% increase in the exchange rate (i.e., currency depreciation) raised the price of rice by 0.93%, and its in conformity with the results of Adewuyi, et al (2021).

Table 5: Residue diagnosis of meat and rice variables

Diagnosis	**Meat**		**Rice**	
	Coef.	**Prob.**	**Coef.**	**Prob.**
Breusch-Pagan-Godfrey test: Heteroskedasticity	0.4918	0.8041	0.3422	0.9029
Breusch-Godfrey Serial test: Correlation LM	0.4618	0.6409	0.3099	0.7392
Jarque-Bera test: Normality	0.9902	0.6095	0.2772	0.8706

Table 5 outlined the diagnostic tests employed in determining if the conventional linear regression model's assumptions were valid. The Breusch-Pagan-Godfrey test was used to test the null hypothesis (H_0) that errors are homoskedastic (without heteroskedasticity). In this situation, we cannot reject H_0 if the p-value appears greater than 0.05, thus indicating no heteroskedasticity. The implication of this outcome is that the model's error variance was constant, and therefore good. The Breusch-Godfrey Serial test tested the null hypothesis (H_0) of no serial correlation in residuals. In this case, we cannot reject H_0 if the p-value was greater than 0.05. As a result, there was no autocorrelation in the residuals, and it's a good indication, since it confirms to the classical model's independence assumption. The Jarque-Bera test was employed to test the null hypothesis (H_0) of residuals being regularly distributed. From the results, we cannot reject H_0 as the p-value was greater than 0.05. This demonstrates that the residuals are normally distributed, which meets the crucial condition for valid inference. These findings validate that the model used to estimate and infer meat prices is statistically accurate.

Table 5 outlines the diagnostic tests used to determine if the conventional linear regression model's assumptions are valid. The Breusch-Pagan-Godfrey test was employed to assess the null hypothesis (H_0) of the residuals being homoskedastic (good). From the results, we cannot reject the null hypothesis since the p-value (0.9029) was significantly bigger than 0.05; there was no indication of heteroscedasticity, and the model error variance remained steady across data, indicating strong OLS dependability. The Breusch-Godfrey Serial test was used to examine the null hypothesis (H_0) of no serial correlation in residuals. We conclude that there is no evidence of serial correlation because $p = 0.7392 > 0.05$, and we do not reject the null hypothesis. Thus, the model passed this test, indicating that the mistakes were not consistently associated across time, which is a positive indication. The Jarque-Bera test was employed to test the null hypothesis (H_0) of residuals being regularly distributed. Because the p-value of 0.8706 is significant, we cannot reject the null hypothesis, implying that the residuals are regularly distributed. These findings support the statistical validity and reliability of the model employed to estimate and infer rice prices.

Table 6: Pearson correlation of the price of meat and macroeconomic indicators

Variables	PMEAT	MEATOUTP	CPI	IMPRATE	EXCHRATE	INFRATE	POP
PMEAT	1						
MEATOUTP	-0.2408	1					
CPI	0.8105	-0.5615	1				
IMPRATE	0.1613	0.1855	0.1985	1			
EXCHRATE	0.9850	-0.2540	0.7640	0.0950	1		
INFRATE	0.9073	-0.3308	0.7080	0.0569	0.9065	1	
POP	0.7723	-0.5498	0.9936	0.2602	0.7247	0.6529	1

Table 6 displays the paired correlation coefficients for variables linked to meat pricing and macroeconomic indicators. Each value ranges from -1 to 1. PMEAT and CPI (0.8105), showing a high positive association. This suggests that as the overall price level (CPI) rises, so will meat prices rise. This outcome was expected given that food occupies a large component of the consumer price index. PMEAT and EXCHRATE (0.9850) show a substantial positive association. This shows that a weaker naira (higher exchange rate) dramatically raises meat prices, most likely owing to import reliance. PMEAT and INFRATE (0.9073) show a substantial positive connection. Thus, further suggesting that inflation directly affects meat costs, and aligning to the findings of USDA, (2025). PMEAT and POP (0.7723) showed a substantial positive association, implying that an increasing population will boost demand and put pressure on meat prices. PMEAT and IMPRATE (0.1613) shows a slight positive connection. This suggests that imports have little influence on pricing. PMEAT and MEATOUTP (-0.2408) show a negative connection. This indicates that when domestic meat production grows, meat prices fall (supply-side effect).

Table 7: Pearson correlation of the price of rice and macroeconomic indicators

Variables	PRICE	RICEOUTP	CPI	IMPRATE	EXCHRATE	INFRATE	POP
PRICE	1						
RICEOUTP	0.5885	1					
CPI	0.7511	0.9548	1				
IMPRATE	0.1204	0.1580	0.1985	1			
EXCHRATE	0.9965	0.6062	0.7640	0.0950	1		
INFRATE	0.8863	0.5522	0.7080	0.0569	0.9065	1	
POP	0.7138	0.9643	0.9936	0.2602	0.7247	0.6529	1

Table 7 shows a correlation matrix for factors linked to rice prices and macroeconomic indicators in Nigeria. Each coefficient, ranging from -1 to +1, indicates the degree and direction of the linear relationship between two variables. PRICE and EXCHRATE (0.9965) maintained a high positive association. This indicates that a naira depreciation (higher exchange rate) virtually raises rice prices, most likely owing to import dependency or cost-push inflation. Also, PRICE and INFRATE (0.8863) showed a high positive association. Inflation appears to be a significant driver of rice price increases. PRICE and CPI (0.7511) revealed a high positive association. The CPI revealed that the entire price level, and rice is a consistent component. PRICE and POP (0.7138) shows a significant association. This means that an increasing population raises demand and drives prices upward. PRICE and RICEOUTP (0.5885) shows a somewhat favourable association. This means that domestic output is growing in tandem with prices, potentially due to demand surpassing supply or higher input costs. PRICE and IMPRATE (0.1204) have an extremely poor association. This suggests that rice import levels have a minimal direct link with rice price patterns, which might imply that obstacles such as tariffs or exchange fees mitigate the price impacts.

Table 8: Pearson correlation of meat and rice output

Variable	MEATOUTP	RICEOUTP
MEATOUTP	1	
RICEOUTP	-0.7299	1

Table 8 shows the Pearson correlation matrix coefficient for MEATOUTP (meat production output (MT)) and RICEOUTP (rice production output). The diagonal values are one since any variable was fully connected with itself. The off-diagonal value was -0.7299, demonstrating a significant negative association between meat and rice production. A correlation of -0.7299 indicates that while meat output grows, rice production output decreases, and vice versa. This negative association might be attributed to conflicting uses of land or resources (for example, grazing against rice cultivation), government or market attention on one sector at the expense of the other, and climatic or seasonal conditions that impact each differently.

Table 9: Pearson correlation of meat and rice price

Variable	PMEAT	PRICE
PMEAT	1	
PRICE	0.9827	1

Table 9 shows the Pearson correlation matrix coefficient between PMEAT (price of meat per kilogramme) and PRICE (price per 50kg rice bag). The off-diagonal value was 0.9827, indicating a significant positive connection between meat and rice prices. A correlation coefficient of 0.9827 implies that if the price of meat rise, the price of rice would automatically increase, and vice versa. This is an almost perfect positive association, inferring that the two commodities trade closely together in the market, and further affirms that inflationary pressures affect all food prices; shared cost drivers which includes fuel, transportation, labour, or feed; market dynamics, such as when income rises and demand rises for both; and policy shifts or macroeconomic factors (such as exchange rates, subsidies, import bans).

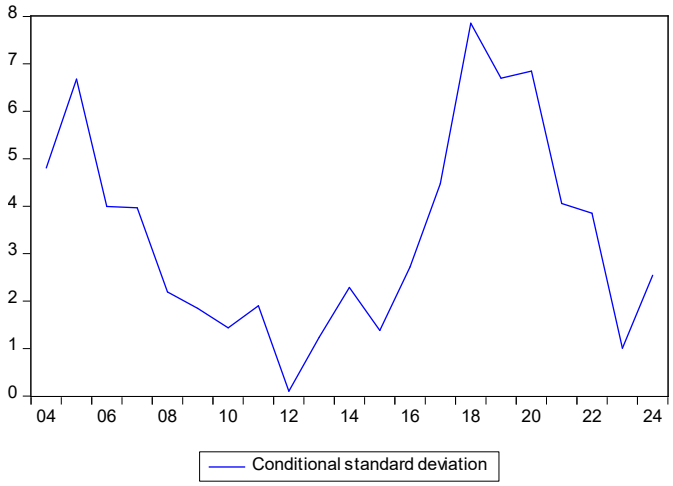

Figure 1: Volatility of the price of meat and rice over time

Figure 1 shows the measure of volatility across time. The Y-axis (vertical) depicts the conditional standard deviation, which is the estimated volatility of the series (rice and beef prices) at each time point. Higher levels indicate greater volatility in pricing. The X-axis (horizontal) shows time in years (2004-2024). High volatility occurred between 2018 and 2020. During this era, volatility increased substantially, with the conditional standard deviation reaching a peak of eight (8). This typically reflects a significant external shock, such as currency rate swings, inflation surges, or worldwide market disruptions (e.g., oil price collapse, COVID-19 pandemic). Also, there was moderate volatility between 2004 and 2016. There was also a variation in volatility between two (2) and six (6), suggesting significant unpredictability in the food price series. Low volatility periods (2012–2023). Around these years, the conditional standard deviation declined to near one, indicating reasonably steady pricing and decreasing uncertainty. A minor rise in volatility at the far right of the chart might indicate new risks or pressures influencing food price dynamics. The graphical illustration above indicates that Nigeria's rice and beef markets are sensitive to episodic shocks, necessitating structural adjustments to boost internal resilience.

4. Conclusion and Policy Recommendations

This study examined the effects of international market dynamics on food prices and volatilities in Nigeria, with a specific focus on rice and meat. Using panel econometric techniques on data spanning multiple years and regions, the analysis established that global factors, including international commodity prices, exchange rate fluctuations, and inflation, significantly influence domestic food prices and their volatility. Exchange rate depreciation emerged as a particularly strong driver of food price inflation, underscoring Nigeria's vulnerability to external shocks due to its high import dependence. Furthermore, inflation and population growth amplified domestic food price increases, while local production exerted a limited stabilizing effect. The volatility research also revealed that worldwide market shocks influence not just price levels but also price volatility, posing a threat to food security, particularly among low-income households. These findings lend credence to the theoretical viewpoints of the Law of One Price, Price Transmission Theory, and Food Dependency Theory, all of which highlight how global market integration and macroeconomic instability may transmit and exacerbate price shocks in domestic markets. Based on the study's results, many policy measures and strategic initiatives are proposed to alleviate the negative impacts of foreign market dynamics on food prices and volatility in Nigeria:

i. The Central Bank of Nigeria (CBN) should prioritise maintaining a stable currency rate to prevent growing food prices, particularly for rice and beef. This can be accomplished by boosting foreign reserves, promoting non-oil exports to improve foreign currency inflows, and enacting foreign exchange regulations that safeguard critical food imports.

ii. The relatively small but important effect of local production on food costs indicates the need to improve domestic output. By increasing investment in rice and animal cultivation with subsidised finance and inputs. By increasing access to modern agricultural technology and irrigation infrastructure. By improving agricultural extension services to boost production and value chain efficiency.

iii. High volatility indicates uncertain food prices, necessitating governmental interventions like subsidies, strategic reserves, or import adjustments. To mitigate price volatility, the government should set up and manage grain and livestock buffer stockpiles. Use strategic reserves to keep prices stable during times of international price shocks or supply disruptions.

iv. Implement food price monitoring and early warning systems to prevent and respond to price increases. Consider implementing short-term price limits or subsidies for disadvantaged groups during times of excessive international price volatility.

v. Inflation and population expansion contribute to rising food prices. To keep inflation under control, maintain strict monetary and fiscal policy. Investing in family planning, education, and rural development to alleviate long-term demand pressures. Create incentives for agro-processing and storage, such as tax breaks, subsidies, and public-private partnerships, to decrease post-harvest losses and stabilise supply.

vi. Diversify food import sources to mitigate price shocks from a single foreign market. Promote intra-African food commerce through ECOWAS and AfCFTA to help stabilise supply and regional food security.To defend Nigeria's food system from global market volatility, a multi-sectoral solution is needed, balancing macroeconomic stability with agricultural reform and social protection. Policymakers must take urgent action to decrease foreign reliance and create a robust, self-sufficient food economy. Implementing these ideas will help Nigeria's food system withstand external shocks, minimise food price volatility, and contribute significantly to attaining long-term food security.

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