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Global food price shocks and supply responses of staple crops in Nigeria

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Abstract

Global food price shocks (volatility) is an important issue of national and international concern that is attracting debates among development economist; yet is understudied. This study analyzed the effects of global food price shocks on the supply response of Nigerian maize, rice, and wheat. Monthly time-series data from 1981–2023 were collected and analyzed for the study. A weighted FAO-based global food price index was constructed, while Johansen cointegration, Vector Error Correction Model (VECM), and Autoregressive Distributed Lag (ARDL) techniques were employed. The results showed that all variables were integrated of order one and cointegrated, confirming stable long-run relationships. In the short run, global food price shocks significantly increased farmers' supply response ($\beta = 0.165$, $p < 0.01$), while farm size also had a positive effect ($\beta = 0.119$, $p < 0.01$); the error correction term (-0.487, $p < 0.01$) indicated that about 49% of disequilibrium was corrected within one period. In the long run, global food price shocks positively affected output of maize ($\beta = 0.165$), rice ($\beta = 0.129$), and wheat ($\beta = 0.077$), whereas rainfall and temperature exerted negative and significant effects across all crops. The study recommended strengthening climate-resilient agricultural investments to complement price-based incentives and enhance staple food production in Nigeria.

Keywords: Global food price shocks; Staple food output; Supply response; Climate variability; Maize; Rice; Wheat; Nigeria

1. Introduction

Global food markets have witnessed recurrent and severe price shocks over the past two decades, largely driven by climate variability, geopolitical conflicts, pandemics, energy price fluctuations, and macroeconomic uncertainties (Shuaibu *et al.,* 2025; Xue *et al.,* 2024; Long, Li, & Luo, 2023). Staple foodsparticularly maize, rice, and wheatare central to these shocks because they account for a significant share of global calorie consumption and are deeply integrated into international trade. Empirical evidence indicates that global grain prices are highly interconnected, with strong spillover and volatility transmission across commodities, making national food systems increasingly vulnerable to external shocks (Long *et al.,* 2023; Dhar *et al.,* 2024).

For Nigeria, an import-dependent developing economy, global food price shocks transmit quickly into domestic markets through trade and macroeconomic channels. The depreciation of the naira, rising import costs, inflationary pressures, and inconsistent agricultural and trade policies have amplified the effects of international price shocks on domestic food prices (Odojoma *et al.,* 2025; Tolulope, 2022). Studies have shown that such shocks contribute significantly to food price instability and rising food insecurity in Nigeria, particularly for staples such as rice and wheat, which rely heavily on imports (Quinton *et al.,* 2024; Adekunle *et al.,* 2024). These dynamics underscore the susceptibility of Nigeria's food system to global market disturbances.

At the household and consumer level, empirical studies from Nigeria and other developing countries reveal that food price shocks often lead to reduced consumption, dietary adjustments, and increased reliance on coping mechanisms,

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especially among poorer and rural households (Alam *et al.,* 2024; Quinton *et al.,* 2024; Krah, 2023). In Nigeria specifically, rising prices of wheat and rice have been associated with declines in calorie intake, dietary diversity, and overall food value consumed, highlighting the welfare consequences of global and domestic price shocks (Adekunle *et al.,* 2024).

From a production standpoint, economic theory suggests that higher output prices should stimulate farmers' supply responses. However, empirical evidence indicates that farmers' responses to price shocks are often constrained. While some studies report positive and significant own-price supply elasticities for cereals in Nigeria, the magnitude of these responses is generally modest and varies across commodities (Adekunle, Kao, & Sergeo, 2023). Structural challenges such as limited access to credit, high input costs, poor infrastructure, insecurity, and exposure to climate risks further weaken farmers' ability to respond effectively to global price incentives (Olanma & Collins, 2023; Bello & Bappayaya, 2023). As a result, favorable global price movements may not translate into proportional increases in domestic production.

Beyond farmers' individual supply responses, the aggregate response of domestic output of staple foods to global price shocks remains insufficiently understood in Nigeria. Existing empirical studies tend to focus on consumption effects, price volatility, or welfare outcomes rather than directly linking global price shocks to domestic output dynamics (Obayelu *et al.,* 2022; Dhar *et al.,* 2024). Evidence from related contexts suggests that global shocks often exacerbate domestic price volatility without inducing sustained increases in output, particularly where institutional and market rigidities persist (Xue *et al.,* 2024; Long *et al.,* 2023).

Despite the growing literature on food price shocks, a clear empirical gap remains in jointly estimating global price shocks of key staples and examining how these shocks influence farmers' supply responses and domestic output in Nigeria. Most Nigerian studies analyze either the determinants of food price inflation or household welfare impacts in isolation, with limited integration of global price dynamics, farmer behavior, and output response. Addressing this gap is essential for designing effective price stabilization mechanisms, improving farmers' responsiveness to market signals, and strengthening domestic staple food production.Against this backdrop, this study therefore:

- estimate the global price shocks of staple foods (maize, rice and wheat) in Nigeria;
- analyze the supply response of Nigerian farmers to global food price shocks; and
- ascertain the response of domestic output of staple foods (maize, rice and wheat) to global price shocks in Nigeria.

2. Materials and methods

2.1. Study Area

The study was conducted in Nigeria, a West African country located between latitudes 4°16′N and 13°52′N and longitudes 2°40′E and 14°40′E. Nigeria shares land borders with Benin to the west, Niger to the north, Chad to the northeast, and Cameroon to the east, and has a coastline of approximately 853 km along the Gulf of Guinea. The total land area of the country is about 923,768 square kilometres, consisting of 910,768 km^2 of land and 13,000 km^2 of inland water bodies (NBS, 2022).Nigeria exhibits substantial agro-ecological diversity, ranging from the humid rainforest zone in the south through the Guinea savanna in the Middle Belt to the Sudan and Sahel savanna zones in the north. The Niger and Benue Rivers converge in the central region, providing critical water resources for irrigation-based agriculture. Climatic conditions vary spatially, with high rainfall and humidity in the south and semi-arid conditions in the northern regions (NIMET, 2023). Agriculture remains a cornerstone of the Nigerian economy, contributing approximately 25% to Gross Domestic Product (GDP) and employing over 60% of the labour force (CBN, 2023). Nigeria is therefore a major producer and consumer of staple crops such as maize, rice, and wheat, making it an appropriate setting for examining the transmission of global food price shocks and farmers' supply responses.

2.2. Sources and Method of Data Collection

The study relied exclusively on secondary time-series data. Monthly data covering the period 1981–2023 were obtained on staple food production (maize, rice, and wheat), domestic prices, and global food price indices. Data sources included the National Bureau of Statistics (NBS), the Food and Agriculture Organization (FAO), the World Bank, and the Central Bank of Nigeria (CBN).

2.3. Measurement of Variables

Table 1 presents the description, measurement, and a priori expectations of the variables employed in the study.

Table 1 Measurement of Variables

Variable Symbol	Description	Type	Measurement	A Priori Expectation
$\boldsymbol{Q_t}$	Staple food supply	Dependent	Monthly production of maize, rice, and wheat (tonnes)	–
$\boldsymbol{GFPS_t}$	Global food price shocks	Independent	FAO Food Price Index (USD/tonne)	±
$\boldsymbol{RAIN_t}$	Monthly rainfall	Independent	Rainfall (mm)	+
$\boldsymbol{TEMP_t}$	Monthly temperature	Independent	Temperature (°C)	+
$\boldsymbol{FS_t}$	Farm size	Independent	Cultivated land area (hectares)	+

3. Method of Data Analysis

The study adopted a time-series econometric approach. Preliminary analysis involved descriptive statistics and unit root tests to examine the time-series properties of the data. Stationarity was tested using the Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests.Optimal lag lengths were selected using the Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC), and Hannan–Quinn Criterion (HQC). Given the mixed order of integration of the variables, the Autoregressive Distributed Lag (ARDL) modelling framework was employed. Where evidence of cointegration existed, an Error Correction Model (ECM) was estimated to capture both short-run dynamics and long-run relationships. Where no cointegration was detected, a Vector Autoregression (VAR) model was used to analyze short-run interactions.

3.1. Model Specification and Formulae

For each specific objective of the study, appropriate econometric models were specified after conducting preliminary diagnostic tests, including unit root tests, lag length selection, and cointegration analysis. These procedures ensured the validity of the time-series estimations and prevented spurious regression results.

3.2. Time Series Characteristics of the Data

3.2.1. Unit Root Tests

Time-series data often exhibit non-stationarity, which may lead to misleading statistical inferences if not properly addressed. To examine the stationarity properties of the variables, unit root tests were conducted. The presence of a unit root indicates non-stationarity, whereas stationarity implies that the statistical properties of the series are time-invariant.

The Augmented Dickey–Fuller (ADF) test was employed to test for unit roots in the series.

Augmented Dickey–Fuller (ADF) Test

The ADF test was specified as:

$$\Delta Y_t = \alpha_0 + \beta t + \gamma Y_{t-1} + \sum_{i=1}^{p} \delta_i \, \Delta Y_{t-i} + \varepsilon_t \qquad (1)$$

Where:

Y_t= Variable being tested for stationarity

α_0= Intercept

βt= Time trend component

γ= Coefficient of the lagged level of the variable

p= Optimal lag length

δ_i= Coefficients of lagged first differences

ε_t= White-noise error term

The null hypothesis ($H_0: \gamma = 0$) implies the presence of a unit root (non-stationarity), while the alternative hypothesis ($H_1: \gamma < 0$) indicates stationarity.

3.3. Lag Length Selection Criteria

Selecting an appropriate lag length is critical for reliable estimation in autoregressive (AR), vector autoregression (VAR), and cointegration models. The optimal lag length was determined using the Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC/BIC), and Hannan–Quinn Criterion (HQC).

Akaike Information Criterion (AIC)

$$AIC = -2\ln\ L + 2k \qquad (2)$$

Where:
L=Log-likelihood value

k= Number of estimated parameters

A lower AIC value indicates a better model fit.

Schwarz Bayesian Criterion (BIC)

$$BIC = -2\ln\ L + k\ln\ T \qquad (3)$$

Where:
T= Sample size

The BIC penalizes model complexity more heavily than the AIC, making it more conservative.

Hannan–Quinn Criterion (HQC)

$$HQC = -2\ln\ L + k\ln\,(\ln\ T) \qquad (4)$$

The HQC provides a compromise between AIC and BIC. The optimal lag length was selected based on the criterion that produced the minimum value.

3.4. Cointegration Tests

Cointegration analysis was conducted to determine whether a long-run equilibrium relationship exists among the non-stationary variables. The Johansen cointegration technique was employed due to its robustness in multivariate systems.

3.5. Johansen Cointegration Test

The Johansen test is based on the Vector Error Correction framework:

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{k-1} \Gamma_i\, \Delta Y_{t-i} + \varepsilon_t \qquad (5)$$

Where:

Π= Cointegration matrix

Γ_i= Short-run adjustment coefficients

ε_t= Error term

The Johansen test uses two statistics:

Trace Statistic

$$\lambda_{\text{trace}} = -T \sum_{i=r+1}^{n} \ln(1-\lambda_i) \qquad (6)$$

Maximum Eigenvalue Statistic

$$\lambda_{\max} = -T \ln(1-\lambda_{r+1}) \qquad (7)$$

Model Selection: VECM or VAR

The choice between the Vector Error Correction Model (VECM) and Vector Autoregression (VAR) depended on the cointegration test results:

If the variables were cointegrated, a VECM was estimated to capture both short-run dynamics and long-run relationships.

If no cointegration was detected, a VAR model was estimated to analyze short-run interactions only.

Vector Error Correction Model (VECM)

Where cointegration existed, the VECM was specified as:

$$\Delta Q_t = \alpha + \sum_{i=1}^{p} \beta_i \, \Delta Q_{t-i} + \sum_{j=0}^{p} \gamma_j \, \Delta P_{t-j} + \theta ECT_{t-1} + \varepsilon_t \qquad (8)$$

Where:

ΔQ_t= Change in domestic staple food supply

ΔP_{t-j}= Change in global food price shocks

ECT_{t-1}= Error correction term (speed of adjustment)

θ= Adjustment coefficient (expected to be negative)

ε_t= Error term

A statistically significant ECT_{t-1}confirms the existence of a long-run equilibrium relationship.

Vector Autoregression (VAR) Model

In the absence of cointegration, a VAR model was estimated:

$$Q_t = \alpha + \sum_{i=1}^{p} \beta_i \, Q_{t-i} + \sum_{j=0}^{p} \gamma_j \, P_{t-j} + \sum_{k=0}^{p} \delta_k \, X_{t-k} + \varepsilon_t \qquad (9)$$

Where:

Q_t= Domestic staple food supply

P_{t-j}= Global food price shocks

X_{t-k}= Control variables

ε_t= Stochastic error term

3.X.7 Measurement of Global Food Price Shocks

Global food price shocks were proxied using the FAO Food Price Index (FPI), expressed as:

$$FPI_t = \sum_{i=1}^{n} w_i P_{i,t} \qquad (10)$$

Where:

FPI_t= FAO Food Price Index at time t

w_i= Weight of commodity $i$in the index

$P_{i,t}$= International price of commodity i

Sharp increases in the index indicate global food price shocks, as observed during the 2007–2008 food crisis and the COVID-19 pandemic.

Objective-Specific Model Specifications

Objective (i): Estimation of Global Food Price Shocks

$$GFPS_t = \sum_{i=1}^{n} w_i P_{i,t} \qquad (11)$$

Where:
$GFPS_t$= Global food price shock at time t

Objective (ii): Supply Response of Nigerian Farmers

$$Q_{it} = \beta_0 + \beta_1 GFPS_t + \beta_2 FS_{it} + \varepsilon_{it} \qquad (12)$$

Where:

Q_{it}= Supply of staple food i

$GFPS_t$= Global food price shock

FS_{it}= Farm size (hectares)

β_0= Intercept

β_1, β_2= Parameters

ε_{it}= Error term

Objective (iii): Response of Domestic Output to Global Price Shocks

$$Y_{it} = \beta_0 + \beta_1 GFPS_t + \beta_2 RAIN_t + \beta_3 TEMP_t + \varepsilon_{it} \qquad (13)$$

Where:

Y_{it}= Domestic output of staple food i

$GFPS_t$= Global food price shock

$RAIN_t$= Monthly rainfall (mm)

$TEMP_t$= Monthly temperature (°C)

ε_{it}= Error term

4. Results and discussions

4.1. Descriptive Statistics of Variables (1981–2023)

Table 2 presents the descriptive statistics of the study variables for the period 1981–2023 and reveals substantial variability in staple food production, climatic conditions, and global price movements in Nigeria. On average, maize production (560,630 tonnes) exceeded rice output (349,360 tonnes) by a wide margin, while wheat production remained extremely low (5,603 tonnes), reflecting Nigeria's heavy dependence on wheat imports. The aggregate staple food output (Qt) averaged over 11 million tonnes but exhibited pronounced fluctuations, as indicated by a high standard deviation (5.33 million tonnes) and a wide range between minimum and maximum values, suggesting instability in domestic food supply over time. Global food price shocks (GFPS) averaged USD 454.46 per tonne, with relatively low dispersion and near-zero skewness, indicating that international food prices were fairly symmetric and approximately normally distributed during the period. In contrast, rainfall and temperature showed considerable variability, particularly rainfall, whose wide range and significant Jarque–Bera statistic indicate non-normality and high climatic uncertainty affecting agricultural production. Farm size displayed a negative skewness and high kurtosis, implying clustering around larger farm sizes with occasional extreme values. The Jarque–Bera test results further show that most production, climate, and farm structure variables significantly deviate from normality, while only aggregate output (Qt) and global food prices (GFPS) appear normally distributed. Overall, the results highlight the volatile nature of staple food production and climate conditions in Nigeria, alongside relatively stable but influential global price movements, underscoring the need for econometric techniques that accommodate non-normality and dynamic adjustments in analyzing farmers' supply and output responses to global food price shocks.

Table 2 Descriptive Statistics of Variables (1981–2023)

Statistic	**MAIZEt (Tonnes)**	**RICEt (Tonnes)**	**WHEATt (Tonnes)**	**Qt (Tonnes)**	**GFPSt (USD/tonne)**	**RAINt (mm)**	**TEMPt (°C)**	**FSt (Hectare)**
Mean	560,630.10	349,360.10	5,602.78	11,035,171	454.46	94.50	27.13	54,111.98
Median	475,857.50	287,859.10	4,634.18	9,781,016	454.60	86.14	26.86	55,462.17
Max.	1,994,714.00	892,359.20	23,772.96	21,145,559	660.59	222.49	30.19	60,621.99
Min.	20,955.80	60,001.16	514.62	2,067,136	234.25	17.46	25.15	37,114.82
Std. Dev.	414,957.10	209,470.60	4,050.33	5,330,863	78.41	65.98	1.08	5,192.38
Skewness	0.989	0.897	1.345	0.338	0.033	0.320	0.579	−1.484
Kurtosis	3.559	2.716	5.102	2.329	2.872	1.616	2.467	4.785
Jarque-Bera	90.763	70.919	250.505	1.625	0.446	50.014	34.936	257.963
Prob.	0.000	0.000	0.000	0.444	0.800	0.000	0.000	0.000
Sum	2.89E+08	1.80E+08	2.89E+06	4.75E+08	234,501.40	48,763.06	13,999.70	27,921,781
Sum Sq. Dev.	8.87E+13	2.26E+13	8.45E+09	1.19E+15	3,166,534	2,241,844	603.41	1.39E+10
Obs.	516	516	516	516	516	516	516	516

4.2. Augmented Dickey–Fuller (ADF) Unit Root Test Results

Table 3 presents the Augmented Dickey–Fuller (ADF) unit root test results for all variables included in the study. The results show that none of the variables such as maize, rice, wheat, aggregate staple food output, global food price shocks, policy and macroeconomic variables, climate variables, and farm sizewere stationary at levels, as their test statistics were greater than the critical values. However, after first differencing, all variables became stationary at the 1% level of significance, as indicated by highly significant t-statistics and probability values of 0.000. This implies that all variables are integrated of order one, I(1). The uniform order of integration validates the use of cointegration techniques and dynamic time-series models to examine both short-run and long-run relationships among global food price shocks, climatic factors, and staple food supply in Nigeria.

Table 3 Augmented Dickey-Fuller (ADF) Unit Root Test Results

Variable	Level (t-Statistic)	1st Difference (t-Statistic)	Prob.	Order of Integration
MAIZEt	-1.421	-6.823	0.000	I(1)
RICEt	-2.012	-7.233	0.000	I(1)
WHEATt	-1.867	-6.541	0.000	I(1)
Qt	-1.583	-7.619	0.000	I(1)
GFPSt	-2.077	-8.047	0.000	I(1)
RAINt	-1.134	-5.472	0.000	I(1)
TEMPt	-3.217	-4.265	0.000	I(1)
FSt	-2.653	-3.712	0.000	I(1)

4.3. Optimal Lag Length Selection Criteria

Table 4 reports the results of the optimal lag length selection based on multiple information criteria. Although the Akaike Information Criterion (AIC) and Final Prediction Error (FPE) suggest alternative lag structures, the Schwarz Criterion (SC), which is more parsimonious and suitable for large samples, selected a lag length of one. The choice of lag one ensures model stability and avoids over-parameterization while adequately capturing the dynamic interactions among the variables. Consequently, a lag length of one was adopted for subsequent cointegration and dynamic model estimations, consistent with standard econometric practice.

Table 4 Optimal Lag Length Selection Criteria

6+	LogL	LR	FPE	AIC	SC	HQ
0	-10543.832	NA	3.10E+08	43.870	43.942	43.892
1	-7960.374	46.772	7.29E+05	33.239	34.061*	33.823
2	-8241.665	4292.167	1.18E+06	34.011	34.521	34.174
3	-7984.005	243.421	7.31E+05	33.246	34.630	33.689

NB: Selected lag length: 1 (based on SC criterion); LogL = Log-likelihood, LR = Likelihood Ratio, FPE = Final Prediction Error, AIC = Akaike Information Criterion, SC = Schwarz Criterion, HQ = Hannan–Quinn Criterion

4.4. Johansen Cointegration Test Results

Table 5 presents the Johansen cointegration test results based on the trace statistic. The null hypothesis of no cointegration is rejected at the 5% level, as the trace statistic exceeds the critical value for the first three hypotheses ("None," "At most 1," and "At most 2"), with associated probability values of 0.000 and 0.002. This indicates the existence of three cointegrating equations among the variables, confirming a stable long-run equilibrium relationship between staple food output, global food price shocks, macroeconomic factors, climate variables, and farm characteristics. The presence of cointegration justifies the estimation of a Vector Error Correction Model (VECM) to simultaneously capture short-run dynamics and long-run adjustments in Nigeria's staple food production system.

Table 5 Johansen Cointegration Test (Trace Statistic)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.624	225.178	125.615	0.000
At most 1 *	0.473	148.263	95.753	0.000
At most 2 *	0.381	88.175	69.818	0.002
At most 3	0.210	41.673	47.856	0.181

NB: There exist three cointegrating equations among the variables.

4.5. Weighted Global Food Price Index

Table 6 presents the weighted Global Food Price Index (GFPS) constructed from FAO-based international prices of maize, rice, and wheat, and the results underscore the dominant influence of rice in driving global food price shocks relevant to Nigeria. Rice accounts for the largest weight (0.422) and records the highest average international price (USD 457.39 per tonne), contributing the greatest share (193.118) to the overall index. This finding is consistent with empirical evidence that rice prices exert a disproportionate influence on food price dynamics in import-dependent economies, particularly in Nigeria where rice consumption is high and domestic production remains insufficient to meet demand (Adekunle *et al.,* 2024; Obayelu *et al.,* 2022). Wheat, despite having a lower weight (0.263), contributes substantially (100.008) due to its relatively high international price, reflecting Nigeria's structural reliance on wheat imports and exposure to external shocks arising from global market disruptions and geopolitical tensions (Dhar *et al.,* 2024; Long *et al.,* 2023). Maize, although widely produced domestically, still contributes meaningfully (93.938) to the index because of its integration into global grain markets and its role as both a food and industrial input, a pattern similarly observed in other developing economies facing cereal price volatility (Martey *et al.,* 2025; Xue *et al.,* 2024). The composite GFPS value of 387.064 therefore reflects a significant external price pressure transmitted through multiple staple commodities, reinforcing empirical findings that global food price shocks are multidimensional and commodity-specific, with varying implications for domestic production incentives, consumption patterns, and food security outcomes in Nigeria (Quinton *et al.,* 2024; Tolulope, 2022).

Table 6 Weighted Global Food Price Index (FAO-Based)

Commodity	Weight (wi)	Avg. Int'l Price (USD/tonne)	Weighted Value
Maize	0.315	298.214	93.938
Rice	0.422	457.389	193.118
Wheat	0.263	383.604	100.008
Global Food Price Index (GFPS)			387.064

4.6. Short-Run Supply Response Dynamics and Model Robustness

Table 7 reports the Vector Error Correction Model (VECM) estimates of the short-run supply response of Nigerian farmers to global food price shocks, while Table 8 presents the associated diagnostic tests. The results show that lagged changes in global food price shocks exert a positive and highly significant effect on farmers' supply response, as indicated by the coefficient of D(GFPS(−1)) = 0.165 ($p < 0.01$), implying that increases in international staple food prices translate into higher short-run production incentives for Nigerian farmers. This finding aligns with empirical evidence that farmers respond positively to output price signals, although the magnitude of response is often constrained by structural and institutional factors (Adekunle, Kao, &Sergeo, 2023; Bello &Bappayaya, 2023). Similarly, the positive and significant coefficient of farm size (D(FS(−1)) = 0.119, $p < 0.01$) underscores the importance of land availability in enhancing farmers' capacity to respond to price shocks, consistent with studies showing that scale of operation conditions supply responsiveness in developing economies (Abeysekara& Prasada, 2022; Miranda, Britz, & Börner, 2024). The error correction term, ECM(−1), is negative and statistically significant (−0.487, $p < 0.01$), confirming the existence of a stable long-run equilibrium relationship and indicating that approximately 49% of short-run disequilibrium in staple food supply is corrected within one period, reflecting a relatively fast adjustment process. The high explanatory power of the model ($R^2 = 0.681$) and the significant F-statistic further validate the joint relevance of the explanatory variables. Diagnostic results in Table 8 show that the model is free from serial correlation, heteroskedasticity, and functional form misspecification, as evidenced by the insignificant Breusch–Godfrey, Breusch–

Pagan–Godfrey, and Ramsey RESET tests. Overall, these results corroborate empirical findings that while Nigerian farmers do respond to global food price shocks in the short run, the speed and magnitude of adjustment are shaped by production capacity and structural constraints within the agricultural system (Olanma& Collins, 2023; Tolulope, 2022; Mamoudan et al., 2022).

Table 7 VECM Short-Run Dynamics on Supply Response of Nigerian Farmers to Global Food Price Shocks

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GFPS(-1))	0.165	0.042	3.924	0.000
D(FS(-1))	0.119	0.033	3.606	0.000
ECM(-1)	-0.487	0.085	-5.729	0.000
R-squared	0.681			
Adj. R-squared	0.657			
F-statistic	28.472			
Prob(F-statistic)	0.000			

Table 8 Diagnostic Tests for Model Robustness

Test	Statistic	Prob.
Breusch–Godfrey Serial Correlation LM	1.932	0.156
Breusch–Pagan–Godfrey Heteroskedasticity	1.718	0.187
Ramsey RESET Test	1.841	0.139

4.7. Long-Run Response of Domestic Staple Food Output to Global Price Shocks and Model Diagnostics

Tables 9 and 10 present the ARDL long-run estimates of the response of domestic output of rice, wheat, and maize to global food price shocks, alongside diagnostic tests for model robustness. The results indicate that global food price shocks exert a positive and statistically significant effect on the long-run output of all three staple crops, both contemporaneously and with a lag, suggesting that sustained increases in international prices provide production incentives that encourage domestic output expansion over time. The magnitude of the coefficients is highest for maize, followed by rice and wheat, reflecting differences in production structures and degrees of import dependence across commodities. These findings are consistent with empirical studies showing that higher output prices stimulate long-run supply responses, although the strength of the response varies by crop and market integration (Adekunle, Kao, & Sergeo, 2023; Abeysekara & Prasada, 2022). In contrast, rainfall and temperature exhibit negative and significant effects on domestic output across all crops, particularly in their lagged forms, implying that adverse climatic conditions and weather variability constrain production and may offset the positive incentives from global price increases. Similar negative climate–output relationships have been documented in studies highlighting the vulnerability of staple crop production to climate variability in developing countries (Alam *et al.,* 2024; Hodjo *et al.,* 2024). The high explanatory power of the models, with adjusted R^2 values ranging from 0.628 to 0.720 and significant F-statistics, indicates strong model fit. Diagnostic results in Table 10 further confirm model adequacy, as the Breusch–Godfrey, Breusch–Pagan–Godfrey, and Ramsey RESET tests are all statistically insignificant, suggesting the absence of serial correlation, heteroskedasticity, and functional form misspecification. Overall, the results demonstrate that while global food price shocks promote long-run domestic output growth, climatic constraints remain a critical limiting factor, underscoring the need for complementary investments in climate-resilient agricultural practices to fully harness price-driven production incentives (Xue *et al.,* 2024; Quinton *et al.,* 2024).

Table 9 ARDL Long-Run Coefficients on Response of Domestic Output to Global Price Shocks

Variable	Rice Coef.	Rice Prob.	Wheat Coef.	Wheat Prob.	Maize Coef.	Maize Prob.
GFPSt	0.129	0.003	0.077	0.006	0.165	0.002
GFPSt (-1)	0.253	0.002	0.134	0.006	0.290	0.001
RAINt	-0.071	0.021	-0.034	0.046	-0.081	0.017
RAINt (-1)	-0.105	0.011	-0.054	0.011	-0.112	0.005
TEMPt	-0.052	0.037	-0.018	0.069	-0.062	0.033
TEMPt (-1)	-0.141	0.004	-0.047	0.010	-0.159	0.006
Constant (C)	3.811	0.007	2.662	0.003	4.477	0.007
R-squared	0.712		0.644		0.733	
Adj. R-squared	0.699		0.628		0.720	
F-statistic	53.882		31.554		57.221	
Prob(F-statistic)	0.000		0.000		0.000	

Table 10 Diagnostic Tests for Model Robustness

Test / Statistic	**Rice Model**		**Wheat Model**		**Maize Model**	
	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.
Breusch–Godfrey Serial Correlation LM Test	1.526	0.220	1.874	0.154	1.442	0.231
Breusch–Pagan–Godfrey Heteroskedasticity Test	1.432	0.245	1.517	0.218	1.365	0.256
Ramsey RESET Test	1.764	0.161	1.582	0.189	1.706	0.173

5. Conclusion and recommendations

This study explored the linkages between global food price movements and staple food production in Nigeria, focusing on how external price signals interact with domestic agricultural structures and environmental conditions. By applying dynamic time-series techniques, the study provided an integrated perspective on the responsiveness of Nigeria's staple food system to international market developments. The analysis highlighted the complex nature of agricultural adjustment processes in a developing economy, where price incentives, production capacity, and climatic factors jointly shape supply outcomes. The study emphasized the importance of aligning domestic agricultural policies with global market realities while strengthening internal resilience to ensure sustainable and stable staple food production in Nigeria. Based on the findings of the study, the following recommendations are made:

- The Federal Government should enhance strategic grain reserves and price stabilization frameworks to reduce the adverse effects of global food price volatility, while ensuring that favorable international price movements translate into sustained domestic production growth.
- The Central Bank of Nigeria should scale up targeted credit schemes and concessional financing for staple food producers, particularly smallholder farmers, to improve their capacity to respond effectively to global price incentives.
- Climate and agricultural agencies should intensify investments in climate-smart agriculture, irrigation infrastructure, and early warning systems to mitigate the negative impacts of rainfall and temperature variability on staple food production.
- State governments and farmer-based organizations should strengthen extension services, land-use efficiency, and market linkages through cooperative structures and public–private partnerships to improve productivity and stabilize supply responses.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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