



IMPACT OF ECONOMIC OPENNESS ON RICE PRODUCTION IN NIGERIA (1993 – 2023)

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ABSTRACT

The study examined the trend of economic openness and rice production in Nigeria from 1993 to 2023, and investigated the impact of economic openness on rice production using Johansen cointegration, long-run Fully Modified OLS (FMOLS) regression and Vector Error Correction Modelling (VECM). Annual secondary time-series data for 12 variables were sourced from the CBN, NBS, World Bank, FAO, and NIMET. Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests confirmed universal I(1) integration across all variables. The Degree of Economic Openness (DEO) was the most strongly cointegrated variable (Trace = 545.73; Max-Eigen = 246.89), confirming it as a fundamental structural determinant of rice production. The long-run regression ($R^2 = 0.799$; $F = 7,936.31$) revealed that DEO (0.017), rural population (0.333), imported rice price (0.395), domestic rice price (0.848), land area (0.264), labour freedom index (0.231), property rights index (0.614), FDI (0.013), exchange rate (0.091), tariff rate (0.615), rainfall (0.430) and GDP growth rate (0.492) all exert positive and statistically significant long-run effects on rice production. VECM confirmed 12% per-period equilibrium adjustment ($ECT = 0.120$; $t = 8.37$). The null hypothesis is rejected at 5% level of significance. The study concluded that economic openness is a fundamental structural determinant of Nigeria's rice production. Graduated trade liberalisation, scaling of the Anchor Borrowers' Programme, rural infrastructure investment and exchange rate stabilisation were recommended in order to promote rice production in Nigeria.

Keywords: Economic, Openness, Rice, Production, Johansen-cointegration, Nigeria

INTRODUCTION

Nigeria's rice subsector faces a persistent production-consumption gap, with milled rice output of 5.2 million metric tons falling short of annual domestic demand of 7 million tons (Doris, 2023). This shortfall, sustained over more than a decade, has translated into substantial foreign exchange outflows for rice imports, periodic price volatility for consumers, and recurring policy interventions aimed at closing the deficit through self-sufficiency drives. Rice occupies a unique position within Nigeria's food security architecture, it is both a staple consumed across nearly all socioeconomic strata and a politically sensitive commodity, making its production dynamics a recurring focus of national agricultural policy (Doris, 2023). Since 1986, agricultural liberalisation policies have stimulated producer responsiveness but also increased market uncertainty (NISER, 2022). The transition from the heavily regulated pre-Structural Adjustment Programme era to a more market-oriented agricultural policy regime exposed domestic rice producers to international price signals and import competition for the first time, with consequences that have been alternately stimulative and disruptive depending on the prevailing exchange rate and trade policy stance. The local rice market, valued at 684 billion Naira (PwC, 2023), faces challenges including inadequate infrastructure, macroeconomic misalignment and production inefficiencies caused by high energy costs. These supply-side constraints mean that domestic producers often cannot respond competitively to the price incentives that openness might otherwise transmit, raising the question of whether trade and financial integration help or hinder the subsector under prevailing structural conditions.

Economic openness is the degree to which a country's economy is interconnected with international markets, trade and investment (Osei *et al.*, 2019), shapes rice production through price transmission, technology diffusion and competitive pressures on domestic producers. Greater openness can lower the cost of imported agricultural inputs and machinery, but it can equally expose import-competing producers, such as Nigerian rice farmers, to price undercutting from heavily subsidised



foreign rice, particularly from Asian exporters. Most prior studies focused on the link between trade openness and aggregate economic growth, neglecting financial openness and sector-specific analysis. This aggregate-level orientation obscures the differentiated impact that openness can have across sectors: an economy may register growth-enhancing effects of openness overall while specific import-competing subsectors, such as rice, experience contraction or stagnation. Terwase *et al.* (2014) and Ekundayo (2023) all noted challenges in measuring openness and its relationship to agricultural performance, including the inconsistent use of trade ratios versus composite openness indices and the limited attention paid to financial account liberalisation alongside trade liberalisation. No prior study has thoroughly examined the long-run structural impact of economic openness on rice production in Nigeria across a three-decade horizon incorporating both ADF/PP unit root testing, Johansen cointegration and VECM within a single unified framework. This gap, combined with the persistent production deficit, motivated the present study covering 1993–2023, a period capturing structural adjustment, trade liberalisation, democratic transition, global commodity shocks and recent protectionist episodes, including land border closures and foreign exchange restrictions targeted specifically at rice imports.

By applying a rigorous time-series methodology to this extended period, the study aims to isolate the long-run equilibrium relationship between economic openness and rice production from short-run fluctuations driven by policy shocks and commodity cycles, thereby providing an evidence base for policies seeking to reconcile Nigeria's broader trade liberalisation commitments with the goal of rice self-sufficiency. The study therefore was carried out to describe the trend of economic openness and rice production in Nigeria from 1993 to 2023, and examine the impact of economic openness on rice production in Nigeria. The hypothesis tested was that economic openness has no significant impact on rice production in Nigeria.

MATERIALS AND METHODS

The Study Area

The study is conducted in Nigeria, Africa's largest rice producer and one of the continent's largest importers, over the period 1993–2023. It is located between latitudes 4° and 14°N and longitudes 3° and 14°E, along the Gulf of Guinea. Nigeria covers a geographical area of 923,768 square kilometers with a projected population of about 227,872,000 people as of 2026 and population density of 205 persons per square kilometer. The population figures used in this study were projected from the 2006 National Population Census conducted by the National Population Commission (NPC). The projection was carried out using the exponential growth model and an annual population growth rate of 2.44%, which has been widely adopted by the NPC and the National Bureau of Statistics (NBS) for intercensal population estimates. NPC, 2023 and World Bank, 2024).

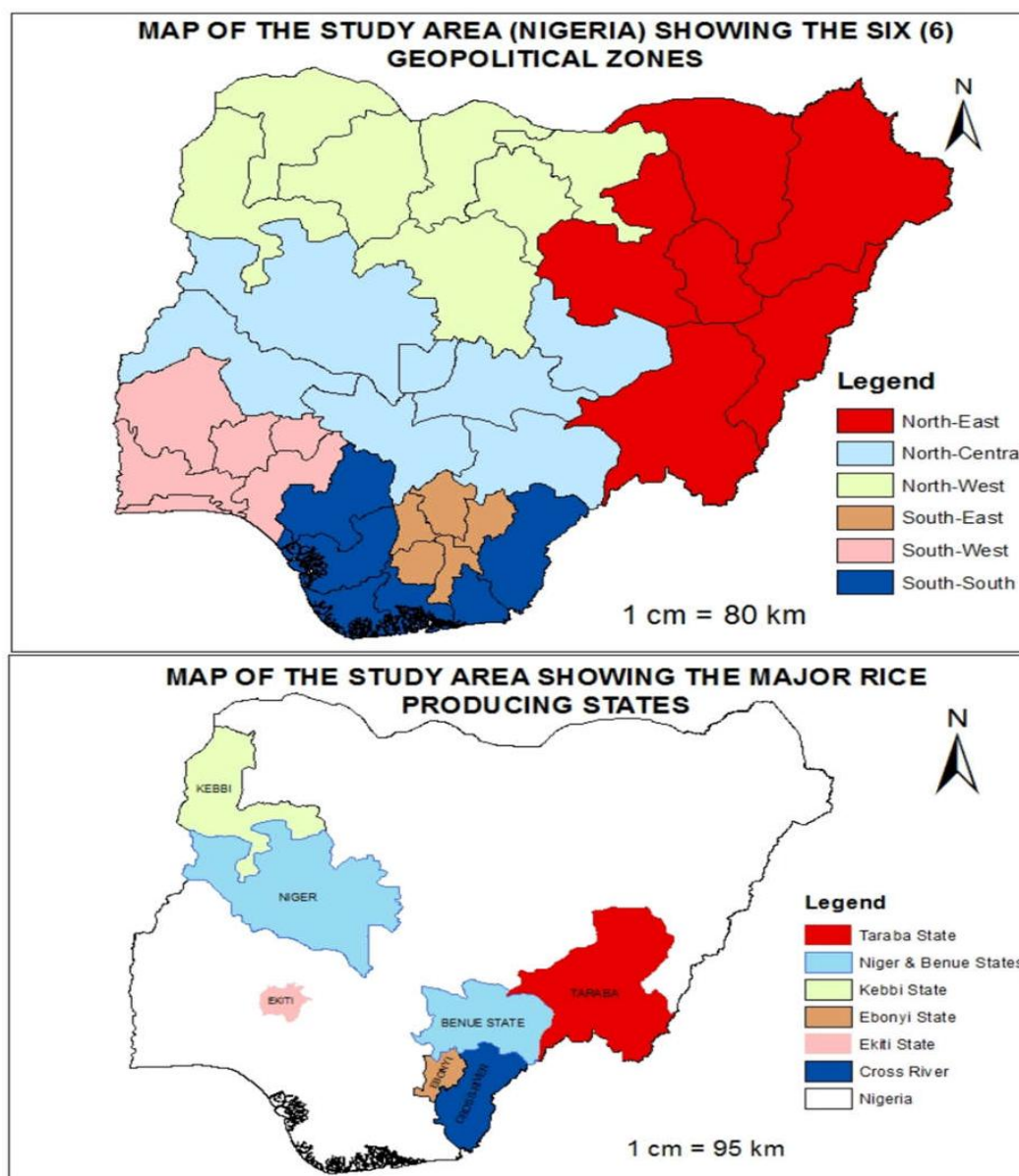


Figure 1: The study area with the most rice producing States in the six geo-political regions.

Sampling Technique

The study purposively focuses on Nigeria and the period from 1993 to 2023 due to several key factors. As Africa's largest rice producer and economy, Nigeria offers a critical case study for understanding the interplay between economic openness and agricultural subsector performance. The country's significant policy transitions, including structural adjustment programs and trade liberalization, provide a rich context for analysis. This period allows for a comprehensive examination of how economic openness has influenced the rice subsector through various political, economic, and environmental changes.

Methods of Data Analysis

Stationarity was assessed using the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979) and the Phillips-Perron (PP) test (Phillips and Perron, 1988), both at the 5% significance level (critical value: -3.6329). Johansen cointegration was applied to identify long-run equilibrium relationships among $I(1)$ variables using both Trace and Maximum Eigenvalue statistics (Johansen, 1995). FMOLS Fully Modified Ordinary Least Squares estimated the long-run cointegrating equation,

correcting for endogeneity and serial correlation in small samples. VECM captured short-run dynamics and the speed of adjustment toward long-run equilibrium (Engle and Granger, 1987). This sequential procedure follows the standard cointegration-based time-series methodology widely used in agricultural economics (Liverpool-Tasie *et al.*, 2023). The rice production function, based on Olomola and Nwafor (2018) and Ogunniyi *et al.* (2022) with modifications, is specified as:

$$\text{ARP (VO)} = f(\text{DEO, RPS, PIR, PDR, ALR, LFI, PRI, FDI, EXR, ATR, AAR, GDP})$$

Where;

ARP = Annual Rice Production (Metric tonnes)

DEO = Degree of Economic Openness (% of imports and Exports on GDP)

RPS = Rural Population Size (Number of persons)

PIR = Price of Imported Rice (Naira)

PDR = Price of Domestic Rice (Naira)

ALR = Area under Rice Cultivation (Hectare)

LFI = Labour Freedom Index (%)

PRI = Property Rights Index (%)

FDI = Foreign Direct Investment (US Dollars)

EXR = Exchange Rate (Naira per Dollar)

ATR = Average Tariff Rate on rice imports (Naira)

AAR = Annual Amount of Rainfall (mm per annum)

GDP = GDP Growth Rate (%)

Natural logarithms were applied to all variables to linearise and stabilise variance. Estimation was performed using EViews 12.0 via Maximum Likelihood.

RESULTS AND DISCUSSION

Trend of Economic Openness and Rice Production in Nigeria (1993–2023)

The results in Figure 2 showed the trend of the Degree of Economic Openness (DEO) in Nigeria from 1993 to 2023. The result revealed a highly volatile and broadly upward trajectory, shaped predominantly by global oil price movements, trade policy oscillations and macroeconomic cycles. The 1990s recorded conspicuously low openness under military governance combined with protectionist trade policies that restricted international economic engagement. The democratic transition of 1999 marked a pivotal turning point, with openness accelerating through the 2000s and peaking during the oil boom. The precipitous collapse in international oil prices from 2014 triggered severe contraction of openness indicators, while the 2016 economic recession and subsequent foreign exchange restrictions compounded these challenges. Although moderate recovery occurred from 2017, COVID-19 in 2020 further disrupted international trade and investment flows. This conforms with Igberi *et al.* (2022) who documented Nigeria's fluctuating but generally increasing trade openness from 1981 to 2019.

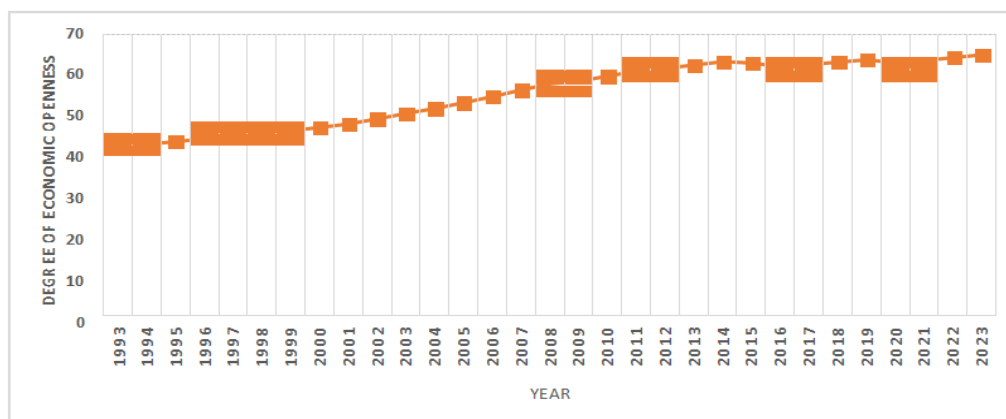


FIGURE 2: THE TREND OF ECONOMIC OPENNESS IN NIGERIA FROM 1993 TO 2023

Source: Author's computation, 2025



Furthermore, Figure 3 presents annual rice production trends from 1993 to 2023, revealing a predominantly upward trajectory from modest early-1990s output levels to substantially higher production volumes by 2023. The initial period of the 1990s was characterised by stagnant or sluggish growth, as the agricultural sector grappled with inadequate infrastructure, limited access to improved inputs and minimal government support. A noticeable acceleration became evident from the early 2000s onward, coinciding with renewed policy emphasis on food self-sufficiency. The most dramatic surge occurred from approximately 2015 onward, driven by the Anchor Borrowers' Programme, import restrictions and the exclusion of rice importers from official foreign exchange, which collectively incentivised domestic production expansion. By 2023, Nigeria had achieved remarkable progress in closing the production-consumption gap. This conforms with Obi-Egbedi *et al.* (2023) and Otekunrin *et al.* (2023), who documented an overall upward production trend with marked acceleration post-2011.

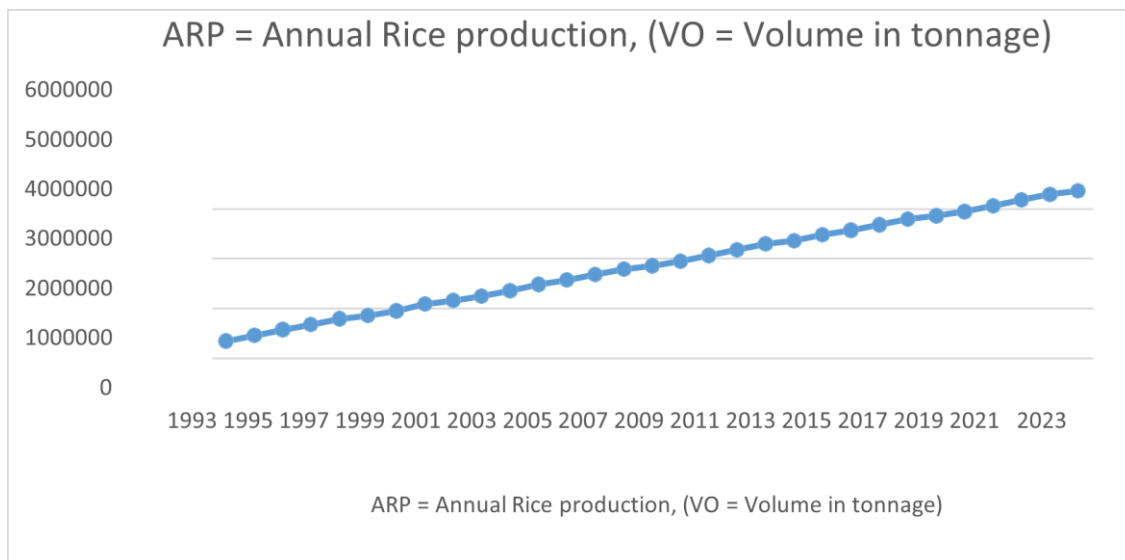


Figure 3: The Trend of Rice Production in Nigeria from 1993 to 2023

Source: Author's computation, 2025

Unit Root Analysis

The results in Table 1 revealed stationarity tests conducted on 12 economic variables using two complementary methods: the ADF test and the PP test. A striking and consistent pattern emerges: none of the series are stationary at their original levels. Both test statistics fail to exceed the critical threshold of -3.6329 (5%) in absolute value for every variable. After taking first differences, all 12 variables become stationary, confirming universal integration of order one, $I(1)$. This uniformity is essential, as it establishes the prerequisite for Johansen cointegration analysis and eliminates the risk of spurious regressions (Engle and Granger, 1987). The strong concordance between ADF and PP results enhances confidence in the findings.



Table 1: Unit Root Test Results for Rice Production Variables

Variable	ADF Level	ADF 1st Diff.	PP Level	PP 1st Diff.	Order
ALR	3.1379	-3.4718**	2.4357	-3.3884**	I(1)
ARP	-0.5642	-5.1818**	-1.9510	-12.0238**	I(1)
ATR	-3.0536	-4.3203**	-2.3655	-5.0067**	I(1)
DEO	-1.6985	-3.8897**	-1.3331	-11.3662**	I(1)
EXR	-3.5103	-3.8631**	-3.5185	-3.7841**	I(1)
FDI	-1.6237	-6.7019**	-1.6992	-6.5433**	I(1)
GDP	-1.8108	-7.4226**	-1.8108	-8.3573**	I(1)
LFI	-0.5361	-4.6505**	-0.3843	-4.6973**	I(1)
PDR	-2.4034	-4.4619**	-2.1784	-5.2319**	I(1)
PIR	0.7291	-5.2319**	8.6901	-6.1138**	I(1)
PRI	-0.9470	-4.8675**	-1.0506	-4.8683**	I(1)
RPS	81.6175	-7.7164**	47.0279	-8.2350**	I(1)

Source: Authors Computation (2025). ** = $p < 0.05$; Critical value = -3.6329 . All variables are I(1).

Johansen Cointegration Analysis

The result in Table 2 presents Johansen cointegration results investigating the long-run equilibrium relationships between economic openness and rice production in Nigeria. DEO emerged as the most strongly cointegrated variable, with the Trace statistic of 545.73 exceeding its critical value of 197.4 by nearly three times, while the Max-Eigen statistic of 246.89 surpasses its threshold of 58.43 by more than four times. Both tests produce p-values approaching zero, providing unequivocal evidence that economic openness is not merely correlated with rice production but constitutes a fundamental component of the long-run equilibrium structure governing Nigeria's rice sector. This supports the growing consensus that trade integration exerts long-term structural effects on domestic agricultural production through price transmission, technology diffusion and market integration (World Bank, 2024; FAO, 2023; Liverpool-Tasie *et al.*, 2023).

Rural Population Size (RPS; Trace = 298.84) and price variables both PIR (Trace = 191.22) and PDR (Trace = 128.44) exhibit similarly strong cointegration, confirming that demographic dynamics and market price signals are core structural drivers alongside trade openness. At the periphery, GDP recorded the weakest test statistics (Trace = 6.71; NS), explainable by Nigeria's economic structure where aggregate GDP is dominated by oil, services and telecommunications rather than rice agriculture, and consequently general economic growth may not translate directly into agricultural output expansion.



Table 2: Johansen Cointegration Test of the Determinants of Impact of Economic Openness on Rice Production in Nigeria

Variables	Trace Statistics (k=9, r=9)	Critical Values (5%)	Prob.	Max- Statistics	Eigen Values (5%)	Critical Values (5%)	Prob.
DEO	545.7276***	197.4	0.0001	246.8857*	58.43354***	0.0000	0.0000
RPS	298.8420***	159.5	0.0000	107.6217*	52.36261***	0.0000	0.0000
PIR	191.2203***	125.6	0.0000	62.78103*	46.23142***	0.0004	0.0004
PDR	128.4392***	95.8	0.0001	42.56080*	40.07757**	0.0257	0.0257
ALR	85.87845**	69.8	0.0015	30.62622	33.87687 ^{NS}	0.1164	0.1164
LFI	55.25223**	47.9	0.0087	20.89417	27.58434 ^{NS}	0.2827	0.2827
PRI	54.3442**	44.5	0.0098	20.12317	26.7643 ^{NS}	0.2232	0.2232
FDI	51.7653*	42.4	0.0104	19.4355	23.76565 ^{NS}	0.2232	0.2232
EXR	26.8674*	24.9	0.0113	18.3564	20.3421 ^{NS}	0.18627	0.18627
ATR	17.35806*	16.8	0.0639	17.67051	21.13162 ^{NS}	0.1427	0.1427
AAR	16.68755*	15.5	0.0929	9.980012	14.26460 ^{NS}	0.2132	0.2132
GDP	6.707536 ^{NS}	3.8	0.1996	6.707536	3.841466 ^{NS}	0.296	0.296

DEO, RPS.....GDP (as earlier defined)

Source: Author's Computation, 2025, *** = P<0.01, ** = P<0.05, * = P<0.10 NS = Not Significant

Long-Run Cointegration Regression (FMOLS)

The result in Table 3 presents the estimated long-run FMOLS cointegrating equation. The model demonstrates strong explanatory power ($R^2 = 0.799$), indicating that approximately 80% of rice production variation is explained by the 12 determinants. DEO exhibits a positive and statistically significant coefficient of 0.017 ($t = 2.89$; $p = 0.018$), confirming that greater economic integration with international markets enhances rice production in the long run. Although the coefficient appears modest, long-run cumulative effects are substantial: each percentage point increase in economic openness increases rice production by 0.017%, *ceteris paribus*. This result supports contemporary agricultural trade literature which suggests that trade integration improves agricultural productivity through technology diffusion, input accessibility and efficiency-enhancing competition (World Bank, 2024; FAO, 2023; Arouna *et al.*, 2021).

The domestic rice price ($PDR = 0.848$; $t = 4.17$) recorded the largest coefficient, indicating high responsiveness of smallholder farmers to local price signals consistent with Liverpool-Tasie *et al.* (2023) who confirm that domestic price signals are more reliable than global market signals for smallholder farmers due to transaction costs and market segmentation. The imported rice price ($PIR = 0.395$; $t = 7.08$) reflects competitive supply theory: higher import prices reduce competitive pressure and encourage domestic supply expansion. Tariff protection ($ATR = 0.615$; $t = 3.91$) represents one of the largest policy effects in the model, confirming the role of trade barriers in stimulating domestic production. Rural population size ($RPS = 0.333$; $t = 6.33$) reflects the centrality of labour availability and local market demand, while rainfall ($AAR = 0.430$; $t = 2.09$) confirms continued dependence on rain-fed systems.



Table 3: Long Run Co-integration Regression of Impact of Economic Openness on Rice Production in Nigeria

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DEO	0.01700**	0.00588	2.89123	0.01840
RPS	0.33320***	0.05265	6.32856	0.00000
PIR	0.39537***	0.05584	7.08051	0.00000
PDR	0.84800***	0.20320	4.17313	0.00050
ALR	0.26396**	0.09443	2.79533	0.01150
LFI	0.23140**	0.08502	2.72156	0.01794
PRI	0.61430**	0.30730	1.99905	0.04320
FDI	0.01280**	0.00507	2.52383	0.02065
EXR	0.09076**	.040560	2.24000	0.02510
ATR	0.61479***	.015740	3.91010	0.0000
AAR	0.43029**	0.20628	2.08599	0.03240
GDP	0.49160**	0.16257	3.02395	0.00870
Constant	2.64530***	0.41631	6.35420	0.00000
R-squared	0.799768			
Adjusted R-squared	0.799645			
S.E. of regression	0.89774			
Long-run variance	0.03242			
Mean dependent var.	0.13927			
S.D. dependent var.	0.65423			
Sum squared resid.	0.34533			

DEO, RPS, GDP (as earlier defined)

Source: Author's Computation, 2025, *** = P<0.01, ** = P<0.05

Vector Error Correction Model (VECM)

The results in Table 4 showed VECM estimates capturing both short-run dynamics and long-run equilibrium adjustment. The Error Correction Term (ECT = 0.120; t = 8.37) was positive and highly significant, confirming that deviations from long-run equilibrium in rice production are corrected at a rate of approximately 12% per period. This moderate adjustment speed reflects the gradual nature of agricultural supply responses constrained by seasonal production cycles, credit access limitations and institutional factors consistent with FAO (2023) and Bene *et al.* (2023). DEO (−1) = 0.661 (t = 2.40; p = 0.028) confirms that trade integration generates delayed but substantial production expansion in subsequent periods, with trade openness influencing production through technology diffusion, input market integration and structural transformation processes that require time to materialise.

Among input-level variables, ATR(−1) = 0.163 (t = 13.22) carries the most precisely estimated short-run tariff effect, while EXR(−1) = 0.021 (t = 6.03) and PDR(−1) = 0.111 (t = 9.87) demonstrate that exchange rate and domestic price signals transmit rapidly into short-run production decisions. The large F-statistic (7,936.31) confirms the joint significance of all variables. The model achieves R² = 0.798, explaining approximately 80% of short-run production variation.

Table 4: Vector Error Correction Estimates of Impact of Economic Openness on Rice Production in Nigeria

Variable	Coefficient	Std err	t-stat	Prob.
CointEq1	0.120343***	0.01437	8.37459	0.0000
DEO(-1)	0.660563**	0.27537	2.39886	0.0279
RPS(-1)	0.111949***	0.03450	3.24468	0.0047
PIR(-1)	0.148376***	0.04014	3.69569	0.0018
PDR(-1)	0.11119***	0.01127	9.86575	0.0000
ALR(-1)	0.360589**	0.162640	2.217099	0.0405
LFI(-1)	0.05717***	0.01921	2.97595	0.0083
PRI(-1)	0.067973**	0.032750	2.075511	0.0530
FDI(-1)	0.007591**	0.00352	2.15693	0.0452
EXR(-1)	0.021231***	0.00352	6.03153	0.0000
ATR(-1)	0.1633491***	0.012352	13.22455	0.0000
AAR(-1)	0.044488**	0.016200	2.746173	0.0137
GDP(-1)	0.110595***	0.024890	4.443351	0.0004
C	0.673399**	0.34254	1.96589	0.0658
R-squared	0.797966			
Adj. R-squared	0.787840			
F-statistic	7936.314			
Log likelihood	-287.6058			

DEO, RPS, GDP (as earlier defined), CointEq1 = Coefficient of Error Correction Term (ECT)

Source: Author's Computation, 2025, *** = $P < 0.01$, ** = $P < 0.05$

CONCLUSION AND RECOMMENDATIONS

Economic openness is a fundamental structural determinant of Nigeria's rice production. DEO was the most strongly cointegrated variable (Trace = 545.73; Max-Eigen = 246.89), and the long-run FMOLS regression ($R^2 = 0.799$; $F = 7,936.31$) confirmed positive and statistically significant effects from all 12 determinants included in the model. The VECM confirmed 12% per-period equilibrium adjustment ($ECT = 0.120$; $t = 8.37$) with delayed but substantial production expansion from lagged trade openness ($DEO(-1) = 0.661$). The null hypothesis which stated that economic openness has no significant impact on rice production in Nigeria is rejected at the 5% significance level.

Based on the findings, the following recommendations were made:

- Adopt graduated trade liberalisation through AfCFTA and ECOWAS protocols, aligned with the competitiveness of the local rice industry, to preserve long-run production gains while deepening market integration.
- Scale the Anchor Borrowers' Programme and expand access to affordable agricultural credit, improved inputs and mechanisation services to sustain the post-2015 production trajectory.
- Implement land tenure reforms and invest in rural infrastructure roads, storage facilities, electricity and digital connectivity to reduce post-harvest losses and lower transaction costs.
- Stabilise the exchange rate through disciplined monetary policy to moderate import cost pass-through and reduce uncertainty for domestic producers who rely on imported inputs such as fertilisers and agrochemicals.
- Expand irrigation infrastructure to reduce dependence on rainfall and sustain the production expansion documented from 2015 onward, particularly in the face of increasing climate variability.



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