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**Ogheneruemu Obi–Egbedi[1], Olaide A Akin–Olagunju[1] and Isaac B Oluwatayo[2]**

[1]Dept. of Agricultural Economics, University of Ibadan, Nigeria

[2] Department of Agricultural Economics and Agribusiness, University of Venda, South Africa

[1] gheneobi@gmail.com, [2] isaac.oluwatayo@univen.ac.za

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**Ogheneruemu Obi-Egbedi[1], Olaide A Akin-Olagunju[1] and Isaac B Oluwatayo[2]**

[1] Dept. of Agricultural Economics, University of Ibadan, Nigeria
[2] Department of Agricultural Economics and Agribusiness, University of Venda, South Africa
[1] gheneobi@gmail.com, [2] isaac.oluwatayo@univen.ac.za

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**Abstract:** Low productivity, modest production and large-scale importation characterize Nigeria's rice subsector despite government intervention through trade policy measures since independence. Studies on Nigeria's trade policy and rice productivity are scanty in the literature. Therefore, this study investigated the effect of the country's rice trade policy on rice productivity from 1961-2017, employing the Vector Error Correction Modeling approach. The results show that protectionist trade policy reduced rice productivity in the short run but was not significant in the long run. Producer price and domestic consumption improved rice productivity in the short run although, the latter reduced productivity in the long run. Similarly, fertilizer consumption and exchange rate reduced productivity in the short run but exchange rate increased productivity in the long run. Thus, government should focus on exchange rate, liberalized trade policy and appropriate fertilizer policy to improve Nigeria's rice productivity.

***Keywords:*** *Trade policy; rice self-sufficiency; rice productivity; protectionist policy; liberalized policy.*

## 1. Introduction

Despite increases in land area cultivated to rice in Nigeria, domestic output is lagging demand. Currently, land area under rice cultivation is put at 2.9 million ha while output stands at 2.8 million tons (FAO, 2017). Although Nigeria is the largest rice producer in the West African sub region and has continued to record increases in domestic rice production since the 1970s, domestic rice demand has not been matched (Johnson *et al.*, 2013). Domestic demand currently stands at about 5.4 million tons of rice, giving a deficit of over 2 million tons (FAO, 2017). The huge domestic supply-demand gap has been largely attributed to low yield (Cochrane *et al.*, 2016). Rice output per hectare in Nigeria ranks far behind that of other major rice producing countries of the world. For instance, rice yield in Nigeria currently stands at 2.02 metric tons per hectare compared to Egypt (highest rice producer in Africa) which has a yield of 9.4 metric tons per hectare and China (highest rice producer in the world) with a yield of 6.9 metric tons per hectare (FAO, 2017). Nigeria's rice yield thus remains one of the poorest in the world with consequent modest production and massive rice importation (Dorosh and Malek, 2016). In 2017, Nigeria was the largest net importer of rice on the African continent and the second largest importer in the world, after China (FAO, 2017).

Attempts at boosting rice productivity and ensuring self-sufficiency in rice production have been at the heart of the Federal government agricultural policy, especially since the reinstatement of democracy in 1999. Government interventions have included development programs such as the Agricultural Transformation Agenda in 2011 and the Presidential Initiative on Rice in 2007. Government actions and interventions were motivated by the facts that Nigeria is naturally endowed with viable ecologies that are suitable for massive cultivation of different rice varieties and should therefore not rely on importation of rice to feed its population (Adesina, 2012). Moreover, potential land area for rice cultivation of between 4.6 and 4.9 million hectares exists but fewer than 3.2 million hectares is under rice cultivation (FAO, 2015). Hence, the use of various producer-oriented policies by past governments have emphasized increasing land cultivated to rice. The use of trade policies to bridge the rice supply-demand gap has been the most popular measure employed since the country's independence in 1960. Trade policies used included

various measures ranging from tariff imposition or removal/reduction, quantitative restriction on imports through the use of quotas to outright ban on imported rice. These measures could be broadly categorized under two main types of rice trade policy; protectionist and liberalized trade policies. Trade protectionist policy used included import quotas, outright bans and tariff increases on rice imports while trade liberalization policy used included tariff reductions and zero tariff (elimination of tariff) on rice imports. More importantly, the policy measures have been changed intermittently by successive governments although, such inconsistency could have adverse effects on domestic rice productivity. It therefore becomes pertinent to understand how trade policy has impacted on rice productivity in Nigeria.

Many studies have dwelt on trade policies in the rice sector. Tewelde Medhin and Schalkwyk (2010) examined the empirical relationship between trade liberalization and Total Factor Productivity (TFP) in the agricultural sector of South Africa and found that trade liberalization causes productivity gains. Similarly, Ravallion (2004) studied the impact of trade liberalization on some developing countries' agricultural sectors with the result suggesting that full liberalization reduces poverty and improves production efficiency and output of less developed countries. Dorosh (2004) also found that trade liberalization causes productivity improvements in Bangladesh input markets. In Nigeria, Obi-Egbedi *et al.* (2012 and 2013) focused on the effect of rice trade policy on household welfare and the Nigerian economy, respectively. They found that full liberalization hurts both rural and urban households, but the effect on productivity was not assessed. Thus, research works on rice productivity and trade policy are scanty, with particular reference to Nigeria. Understanding the trade policy catalysts/inhibitors for rice productivity in Nigeria is vital to actualizing the country's goal of attaining rice self-sufficiency. Moreover, trade policy effects on rice productivity, with respect to the various interventions that have been employed since 1970, have not been thoroughly researched.

Given the strategic position of rice in the diet of the Nigerian populace and the huge amount of foreign exchange expended on rice importation, it is pertinent to examine the trade policy effect on rice productivity in Nigeria. Therefore, the objective of this study is to investigate the effect of rice trade policy on rice productivity in Nigeria for the period 1961-2017. The rest of the paper is structured as follows: Section two addresses the various trade policies in the rice sector, Section three presents the theoretical framework for the study while Section four describes that data and focuses on the empirical model. Results are presented and discussed in Section five while the paper ends with conclusion in Section six.

## 2. Rice Sub-Sector Policies in Nigeria

Several agricultural policies existed in Nigeria since before independence, whereas; the first national policy on agriculture was adopted in 1988. The agricultural policy targeted production improvement of cereals, among other crops, especially rice. The policy aimed to improve producers' efficiency, raise local rice output and reverse rice importation. Following implementation difficulties and an extended period of neglect, the Presidential Initiative on Rice was launched in 2007 and the National Rice Development Strategy in 2009. The sustained national interest in rice led to yet another rice subsector policy under a new agricultural policy called the Agricultural Transformation Agenda (ATA) which was launched in 2011. The overall objectives of the ATA were similar to the 1988 policy which included: self-sufficiency in basic food supply and the attainment of food security, increased production of agricultural raw materials for industries, increased production, and processing of export crops and generating gainful employment. The ATA, however; focused much more on the value chain of agricultural commodities than the earlier policy (FMARD - Federal Ministry of Agriculture and Rural Development, 2011). Under the ATA, the new rice subsector policy had the following objectives: an appropriate increase in national output of rice, curbing the level of importation of rice, reducing amount of scarce foreign exchange devoted to rice importation, creating employment and enhancing rice farming households' incomes; and developing and diversifying the export base of the country. Various supporting policies to implement the rice subsector policy were used such as: rice commodity pricing policy, rice input subsidy policy (seed, fertilizer and chemicals), credit policy, extension services policy and public investment in rice production, in addition to trade policies (FMARD, 2011). The trade policy measures used to help achieve the set goals were mainly protectionist in nature ranging from imposition of high tariffs to outright ban on rice importation.

Nigeria's history of rice trade protectionist policy measures consists of tariff charges of varying degrees and increases on the tariffs in addition to import quotas and bans on rice importation. As documented by Daramola (2005), a stable but relatively high tariff of 66% was placed on rice imports since after the civil war in 1970 till 1973. A relatively more liberalized period ensued between 1974 and 1978, after which the government proceeded to ban rice imports into the country in October 1978 till September 1979. The ban was reversed to issuance of general import licenses without quantitative restrictions in 1980. By the end of the year, quotas were issued through the Presidential Task Force (PTF) on rice from December 1980 to 1984. The government further tightened its protectionist stance by placing an outright ban on rice imports from 1985-1994. Tariffs replaced the rice import ban in 1995 and prevailed at varying tariff levels till 2008. After a brief spell of full liberalization in 2008, tariffs went from zero to 30% in the same year. Following the launch of the National Rice Development Strategy in 2009

which aimed at doubling rice production in Nigeria and increasing land area under rice cultivation, a new tariff of 50% levy on imported rice was introduced in July 2012 and further reviewed up to 100% in December 2013. Thereafter, tariff regimes continued up to 120%. The trade policy on rice remains protectionist with an outright ban currently in place since late 2017. Howbeit, land and sea borders remain porous and smuggling activities continue to frustrate the actualization of a complete ban on rice imports.

Trade liberalization policy measures on rice in Nigeria have been mostly in the form of tariff reductions of varying degrees. Tariffs were reduced from 66% to 20% in 1974 and then to 10% in 1975. This was the period of oil boom when agricultural production largely suffered neglect while importation generally soared due to available huge foreign exchange earnings from crude oil. Liberalized policy generally gave way for protectionist up till 1996 when tariffs were lowered from 100% to 50%. The only period when a fully liberalized trade policy ensued was in 2008. This was the period of global grain crisis hence; tariffs were eliminated to allow unrestricted rice imports to meet domestic demand for six months (May to October 2008). After the brief period of zero tariff, a 30% tariff was enforced which marked a reduction from 109% before May 2008.

## 3. Theoretical framework

The trade policy effects on rice productivity can be explained using the theory of production as it describes the process of transforming inputs to outputs. A country's productivity is commonly defined as a ratio of a volume measure of output produced to a volume measure of input used. Consider the long run production function given as,

$$Q = f(L, k) \qquad \ldots(1)$$

where,
Q = production; L = labor; K = capital.

Increasing Q will require K and L, and whether both K and L can be increased will depend on the time period considered for increasing production, that is, whether it is in the long run or short run. The introduction of a trade policy will affect production, productivity, consumption and trade. Consider the case of a small economy as depicted on Figure 1, the introduction of trade policy such as ban on rice importation or imposing of tariff on importation (protectionist policy) for a period of time allows domestic firms to grow in size, enabling them to exploit the economies of scale and become more efficient thereby increasing their productivity as seen in Figure 1. Liberalization of trade in the final market will decrease productivity of the local producers of rice. Thus, in an existing situation of a free trade economy where rice is domestically produced, the importation of rice into the country will reduce the demand for locally produced rice and consequently, the domestic production will decline. However, when tariff is imposed on the importation of rice, it tends to increase the price of the imported rice thereby increasing the demand for the local rice as shown in Figure 1 where QS is the domestic production while QC is the domestic consumption. Prior to the tariff introduction, the price of rice in the world market (and hence in domestic market) is Pworld. The tariff increases the domestic price to Ptariff. The higher domestic price causes domestic production to increase from QS1 to QS2 and causes domestic consumption to decline from QC1 to QC2. The productivity of labor in the production of rice will increase due to the incentives resulting from the increase in price from Pworld to Ptariff. The additional income gain by domestic rice producers will serve as capital which will be re-invested through purchase of vital inputs such as fertilizer, pesticides and others in order to increase productivity (yield).

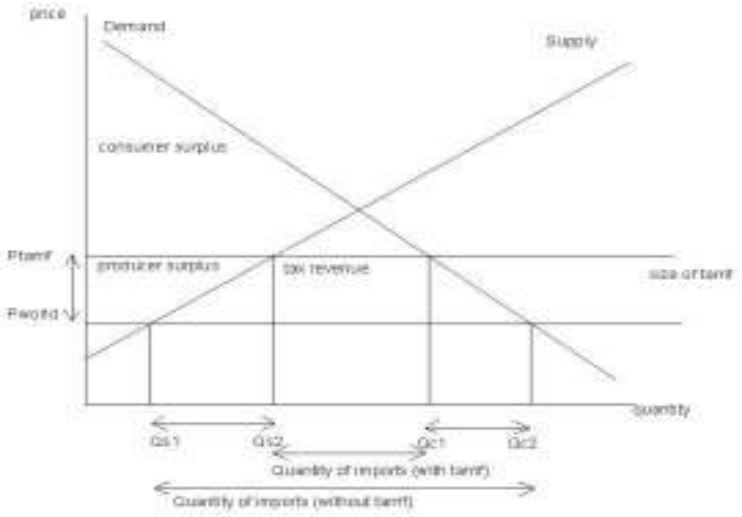


**Figure (1):** Effect of trade policy on domestic rice production

## 4. Empirical review

Ogunlesi et al (2018) examined the relationship among agricultural productivity, fiscal and trade policies in 37 countries of Sub- Saharan Africa (SSA), using a three-variable Panel Structural Vector Error Correction Model (PSVECM) in capturing the dynamic structure of the relationship. The authors found that fiscal policy (government expenditure) and trade policy (terms of trade) had a positive impact on agricultural productivity in the short and long run, although they advised further research in specific regions to substantiate the findings. Thus, a country and crop-specific study may produce more reliable results for the country than a group of countries and crops study. Moreover, Abdkadir and Tunggal (2015) estimated an Autoregressive-Distributed Lag (ARDL) model to examine the relationship between macroeconomic factors and agricultural productivity in Malaysia, using annual data from 1980 to 2014. The study found that inflation, export and public expenditure have a short-run impact on agricultural productivity, while only nominal exchange rate showed long-run influence on agricultural productivity. Other factors such as interest rate, inflation, money supply, export and public expenditure did not show any strong long-run influence on agricultural productivity, while trade policy was not considered. Cristea et al. (2014) conducted a 20-year period study in Romania using a regression analysis and discovered that exchange and interest rates both have indirect and direct effects on agriculture GDP, while inflation only impacted in the long run. Although, the statistical basis on which the macroeconomic effect on agriculture was analysed in Romania is unreliable since the study concluded that there is no bi-directional association between agriculture GDP and the macroeconomic factors considered. Fuglie and Rada (2013) employed a simultaneous equation model using data between 1977 and 2005 on 32 SSA countries. The study found that economy and trade policy transformations that increased prices and improved agricultural terms of trade, within the SSA region encouraged farmers to employ new innovative methods of enhancing agricultural productivity. Hence, to boost agricultural productivity in SSA annual expenditure on agricultural research should be doubled and macroeconomic policy structure that increase farmers' earnings should be put in place. However, dynamism was not considered in the study. Flemming (2013) analyzed the empirical relationship between trade and agricultural productivity in Chile using trade exposure index which captured import and export exposure of about 70,000 farms. He found that farms with higher trade exposure index had higher yields and less poverty, thus supporting that trade openness increases agricultural productivity, although, the dynamic aspect of policy effects was not considered in the study since policy effects can change overtime and differ from country to country. Country specific studies on Nigeria are also limited, hence, the effect of trade policy on agricultural productivity, especially rice productivity is not abundant in literature. Yu and Nin Pratt (2011) examined the trend in agricultural productivity growth for 37 SSA countries between 1961 and 2006, using the Malmquist index – a nonparametric tool. The study found significant growth in the agricultural sector from 1984 to 2006 due to production efficiency, optimum input use and a fiscal policy with positive influence, while huge tax burden and rapid population expansion remained as challenges, although, trade policy was not considered. Moreover, ABARE (2001) reported that trade policy has different implications for developed and developing countries. They analyzed the impact of agricultural trade liberalization across developed and developing countries using a computable general equilibrium model. Developed countries would capture most of the gains of increased global GDP from removal of trade restrictions, while developing countries stand to lose their gains in terms of enhanced productivity due to the inefficiencies in their marketing systems. Therefore, the effect of trade policy on agricultural productivity is no conclusive in the literature

## 5. Data and model specification

### 5.1. Data:

The data for this study were obtained from secondary sources; the Central Bank of Nigeria (CBN) and the Food and Agriculture Organization (FAO). Data on exchange rate and import tariffs were obtained from the CBN while data on yield of rice, rice consumption, rice producer price, fertilizer consumption and quantity of rice import were obtained from FAOSTAT. Data on temperature and rainfall were from the World Bank Climate Data Portal. The data covered a period of 57 years from 1961 to 2017. The 57-year period was categorized into trade protectionist and liberalization periods. The years in which import bans, import quotas and tariff increase occurred were categorized as trade protectionist policy periods while the years in which tariff reduction or removal occurred were categorized as trade liberalization policy periods. Productivity was proxied as yield, which is output of rice per unit hectare used in the production while trade policy was captured as a dummy (protectionist policy period=1; liberalized policy period=0).

Summary statistics of the data used are given in Table 1. The table shows a low average rice yield value for the period of study. Producer price, on the other hand, showed very high variations along with rice import, fertilizer consumption and exchange rate as reflected in the ranges and standard deviation values. The distribution of temperature and rainfall values were relatively satisfactory.

**Table (1):** Summary statistics of regression variables (1961-2017)

| Variable | Minimum | Maximum | Mean | Standard Deviation |
|---|---|---|---|---|
| Yield (tons/ha) | 0.89 | 2.39 | 1.68 | 0.33 |
| Producer price ($/ton) | 94.00 | 75138.00 | 20234.04 | 24763.08 |
| Rice consumption ('000 tons) | 90.00 | 6628.52 | 2213.36 | 1866.82 |
| Import quantity ('000 tons) | 0.26 | 2455.20 | 590.46 | 646.04 |
| Fertilizer consumption (kg/ha) | 42.00 | 281918.00 | 46032.54 | 72158.43 |
| Exchange rate (%) | 0.55 | 305.29 | 58.23 | 75.20 |
| Temperature ($^0$C) | 26.18 | 27.86 | 27.01 | 0.4233 |
| Rainfall (mm) | 72.07 | 112.25 | 94.78 | 8.15 |
| Policy tariff (dummy) | 0.00 | 1.00 | | |

### 5.2. Empirical model:

The Vector Error Correction Model (VECM) was used to analyze the effect of the rice trade policy on rice productivity in Nigeria. Following Anowor et al. (2013), the model is stated thus:

$$\boldsymbol{prod = f(fert_t + cons_t + prodp_t + poli_t + imp_t + \cdots + exc_t)} \quad (2)$$

The log linear model is;

$$\boldsymbol{ln\,prod = (ln\,fert_t + ln\,cons_t + ln\,prodp_t + poli_t + ln\,imp_t + \cdots + ln\,exc_t)} \quad (3)$$

This implies

$$\boldsymbol{ln\,prod = (\beta_0 + \beta_1\,ln\,fert_t + \beta_2\,ln\,cons_t + \beta_3\,ln\,prodp_t + \beta_4 poli_t + \beta_5\,ln\,imp_t + \beta_6\,ln\,exc_t + \cdots + ln\,prod_{t-1})} \quad (4)$$

The general error correction model adopted for this study to eliminate the problem of spurious estimates is of the form:

$$\boldsymbol{ln\,prod = (\beta_0 + \beta_1\,ln\,fert_t + \beta_2\,ln\,cons_t + \beta_3\,ln\,prodp_t + \beta_4 poli_t + \beta_5\,ln\,imp_t + \beta_6\,ln\,exc_t + \cdots + ln\,ECM_{t-1} + \mu_t)} \quad (5)$$

Where:

$\ln prod$ = natural logarithm of productivity (yield is used as proxy for productivity)

$\ln fert$ = natural logarithm of fertilizer used

$\ln cons$ = natural logarithm of consumption of rice

$\ln prodp$ = natural logarithm of producer price per ton.

$poli$ = trade policy (1 =protectionist and 0=liberalized)

$\ln imp$ = natural logarithm of quantity of rice imported.

$\ln exc$ = natural logarithm of exchange rate

$ln\,temp$ = natural logarithm of temperature level

$ln\,rainfall$ = natural logarithm of amount of rainfall

$\beta' s$ = unknown parameters to be estimated.

The protectionist trade represented by the dummy variable is expected to encourage domestic rice productivity proxied by rice yield. This is because when an economy protects its domestic rice producers through imposition of tariff on imported rice or outright ban, consumption of the locally produced rice is expected to increase, thus, providing the much-needed incentives for increased production. Bearing in mind that land area is not in unlimited supply to smallholder farmers, the land area currently under cultivation will be properly managed for more output per unit area. On the other hand, rice import is expected to have negative impact on domestic rice productivity since it discourages local production.

Before applying the model to the data, unit root test was conducted on the variables to ascertain their stationarity properties in order to avoid spurious regression result. Hence, all the series were tested for stationarity by using the Augmented Dickey Fuller (ADF) in line with Greene (2003). Result of the test, which is presented on Table A2 in the appendix, shows that all the variables were stationary at first difference. Having established the stationary property of the variables, cointegration test was carried out to ascertain whether the variables have long-run relationship. The result of the Johansen Co-integration test, presented on Table A3 in the appendix, showed eight (8) and six (6) co-integrating equations with Trace statistics and Maximum-Eigen values, respectively indicating presence of long-run relationship among the variables. Furthermore, long-run and short-run models were run to show the relationship between the independent variables (rice trade policy variable inclusive) and rice productivity. Thereafter, serial correlation, heteroscedasticity, normality and stability tests were run for the main (short-run) model to ascertain the absence of econometric problems that could invalidate the results of the analysis. The post-estimation results, which are presented in Appendix II, were in the affirmative.

## 6. Results and Discussion

The long run relationship results of the effect of trade policy on rice productivity are presented on Table 2. The significance of the F-statistics shows that the model fits the data, while the Durbin-Watson statistics show near to absence of the presence of autocorrelation. The results show that exchange rate has positive effect on yield hence, increasing exchange rate by 1% will lead to a 0.6% increase in rice productivity. This agrees with Cristea et al. (2014) which found a direct relationship between exchange and agricultural growth. An increase in the exchange rate will make imports more expensive and consumers will shift from imported to domestic rice. Consequently, rice farmers will be encouraged to increase their productivity due to the increased demand and limited availability of land. On the other hand, rice consumption has negative relationship with yield. If rice consumption continues to increase, imports are used to augment domestic production with trade protection of high tariff imposition. Consequently, the protected rice farmers may not have any motivation to increase their productivity. The trade policy variable was, however, not significant. This contradicts the findings of Ogumlesi et al. (2018) which found a positive relationship between trade policy and agricultural productivity in SSA. The finding is not surprising for Nigeria since the government has actively interfered with the rice economy over the last four decades. The country's trade policy on rice has oscillated between protectionist and liberalization, especially protectionist tariff regimes. Furthermore, the porous borders have given the opportunity for rice smugglers to thrive on the border control lapses of the government thus, rendering government's trade policy ineffective in the long-run.

**Table (2):** Parameter estimates of the relationship between trade policy and rice productivity in the long run

| Dependent Variable: D(Rice Yield) | Coefficients | t-value |
|---|---|---|
| Constant | 1.6972 | 0.5359 |
| | (3.1669) | |
| Tariff Policy | 0.0405 | 0.4331 |
| | (0.0936) | |
| Producer Price | 8.86e-06 | 1.6357 |
| | (5.42e-06) | |
| Rice Yield | 0.7901*** | 4.9370 |
| | (0.1600) | |
| Rice Consumption | -2.70e-04*** | -3.3715 |
| | (8.01e-05) | |
| Import Quantity | -3.51e-05 | -0.3546 |
| | (9.90e-05) | |
| Fertilizer Consumption | -1.33e-06 | -1.2946 |
| | (1.02e-06) | |
| Exchange Rate | 0.0060** | 2.5013 |
| | (0.0024) | |
| Temperature | -0.1162 | -0.9945 |
| | (0.1169) | |
| Rainfall | 0.0031 | 0.6911 |
| | (0.0044) | |
| D(Tariff Policy(-1)) | 0.0425 | 0.3792 |
| | (0.1119) | |
| D(Producer Price(-1)) | -4.52e-06 | -1.1601 |
| | (3.90e-06) | |
| D(Rice Consumption(-1)) | -3.01e-05 | -0.1458 |
| | (2.07e-04) | |
| D(Import Quantity(-1)) | 3.33e-05- | 0.1668 |
| | (2.00e-04) | |
| D(Fertilizer Consumption(-1)) | 1.83e-07 | -0.1354 |
| | (1.35e-06) | |
| D(Exchange Consumption(-1)) | -0.0100* | -1.9438 |
| | (0.0051) | |
| R-Squared = 0.4186 | | |
| Adjusted R-Squared = 0.1950 | | |
| Log likelihood = 15.7952 | | |
| F-statistic = 1.8719; Prob. (F-statistic) = 0.0585 | | |
| Durbin-Watson Statistic = 2.3347 | | |

**Notes:** ***, ** and * indicate levels of significance at 1%, 5% and 10%, respectively.
Standard errors are in parentheses.

The diagnostic test results for the short-run model presented on Table 3 showed the absence of serial correlation and heteroscedasticity, as revealed by acceptance of the null hypotheses for both tests. Similarly, non-significance of Jarque-Bera (JB) statistics indicates that the residual is normally distributed while the CUSUM test depicts stability for the period considered in the analysis. With respect to the model, the overall F-statistic of the model was also significant at 1% level, Durbin-Watson value of 2.29 showed absence of autocorrelation while 77.7% of the variation in rice productivity was jointly explained by the independent variables. These results show that the model is reliable.

Results from Table 3 revealed that eight (8) variables were significant out of fourteen (14) variables. Domestic consumption and producer price had positive effect on rice yield in the short-run while trade policy, fertilizer consumption and exchange rate showed negative relationship. The results indicate that 1% increase in quantity of rice consumed locally will increase yield by 0.053% while a dollar increase in producer price per ton will increase yield by 0.003%. This is expected as price incentive will encourage rice farmers to increase their efforts at getting

more output using the same level of resources. Moreover, the use of protectionist trade policy will reduce yield by 31.3% while 1% increase in exchange rate will reduce yield by 1.62%. The trade protection provides little or no competition for the domestic farmers hence, they may not increase efforts at improving their yields. Thus, a more liberalized stance will bring about yield development rather than protectionism. The negative effect of fertilizer consumption on yield may be an indication that only recommended levels result in yield development; merely increasing the quantity used does not improve and may even be inimical to yield. Furthermore, the problem fertilizer the distribution has been age-long in Nigeria hence, the aggregate quantity supplied may not reach many rice farmers on time for their production needs or even be diverted.

The coefficient of the Error Correction Term (ECT) ($p<0.01$) followed a priori and revealed a small speed of adjustment of the short run to the long run at 9.55% rate. The results meant that there is long-run causality from the independent variables to the dependent variable but indicating that the variables have minimal influence on rice productivity in the long-run. Furthermore, Wald test was conducted to ascertain short-run causality in the model (Appendix II). Significance of F-statistics and chi-square statistics for lags of yield (-1, -2), rice consumption, producer price and exchange rate indicate short run causality from these variables to rice yield.

**Table (3):** Parameter estimates of the relationship between trade policy and rice productivity in the short-run

| Dependent Variable: D (Rice Yield,2) | Coefficients | t-statistics |
|---|---|---|
| ECT (-1) | -0.0955* | -1.9415 |
| | (0.0492) | |
| D (Rice Yield (-1),2) | -1.1607*** | -7.4877 |
| | (0.1550) | |
| D (Import Quantity (-1),2) | -1.63e-04 | -0.9422 |
| | (1.73e-04) | |
| D (Domestic Consumption (-1),2) | 5.35e-04** | 2.4945 |
| | (2.15e-04) | |
| D (Producer Price (-1),2) | 2.53e-05* | 1.8432 |
| | (1.37e-05) | |
| D (Tariff Policy (-1),2) | -0.3128** | -2.0698 |
| | (0.1511) | |
| D (Fertilizer Consumption (-1),2) | -2.45e-06* | -1.9421 |
| | (1.26e-06) | |
| D (Exchange Rate (-1),2) | -0.0021 | -0.3136 |
| | (0.0067) | |
| D (Temperature (-1),2) | 0.1227 | 1.0829 |
| | (0.1133) | |
| D (Rainfall (-1),2) | -5.91e-04 | -0.1626 |
| | (0.0036) | |
| D (Rice Yield (-2),2) | -0.6290*** | -4.1048 |
| | (0.1532) | |
| D (Import Quantity (-2),2) | 2.07e-06 | -0.0114 |
| | (1.81e-04) | |
| D (Domestic Consumption (-2),2) | 4.07e-04* | 1.9911 |
| | (2.05e-04) | |
| D (Producer Price (-2),2) | 5.04e-06 | 0.7670 |
| | (6.57e-06) | |
| D (Tariff Policy (-2),2) | -0.1069 | -0.8002 |
| | (0.1336) | |
| D (Fertilizer Consumption (-2),2) | -3.47e-07 | -0.2718 |
| | (1.28e-06) | |
| D (Exchange Rate (-2),2) | -0.0162** | -2.2685 |
| | (0.0072) | |
| D (Temperature (-2),2) | 0.0800 | 0.8923 |
| | (0.0897) | |
| D (Rainfall (-2),2) | -0.0021 | -0.5661 |
| | (0.0037) | |
| Constant | 0.0029 | 0.0803 |
| | (0.0357) | |
| R-Squared = 0.7767 | | |
| Adjusted R-Squared = 0.6482 | | |
| Log likelihood = 11.3797 | | |
| F-statistic = 6.0428 Prob. (F-statistic) = 0.000 | | |
| Durbin-Watson Statistic = 2.2911 | | |

**Notes:** ***, ** and * indicate levels of significance at 1%, 5% and 10%, respectively.
Standard errors are in parentheses.

## 7. Conclusion

This study set out to investigate the effect of rice trade policy on rice productivity in Nigeria. It is established that rice protectionist trade policy has negative effects on rice productivity in the short run but is not significant in the long run. Furthermore, increased producer prices and domestic consumption improve yield while higher exchange rate and fertilizer consumption have side effects on yield in the short-run. However, in the long-run, rice yield is encouraged by exchange rate but affected negatively by domestic consumption. Given that yield development is possible over time for Nigeria's rice, the study recommends that the government should focus more attention on its monetary policies of exchange rate which produces long-term gains and less on its protectionist stance on rice trade. Trade policy should tilt towards a more liberalized stance. In the meantime, policies that

improve prices for the rice farmers while encouraging domestic consumption should be put in place by the government. It is worthy of note that measures to curtail consumption problems that could possibly arise from population pressure also need to be put in place by the government. Finally, the problem between rice yield and fertilizer consumption might be in the distribution rather than the aggregate quantity being consumed and this should be addressed.

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## Appendix I: Pre-estimation tests results

**Table (A1):** Correlation matrix analysis result

| Variable | Yield | Producer Price | Rice Consumption | Import Quantity | Fertilizer Consumption | Exchange Rate | Policy Tariff | | |
|---|---|---|---|---|---|---|---|---|---|
| Yield | 1.0000 | | | | | | | | |
| Producer Price | 0.0469 (0.7289) | 1.0000 | | | | | | | |
| Rice Consumption | 0.3364 (0.0105) | 0.8906 (0.0000) | 1.0000 | | | | | | |
| Import Quantity | 0.1146 (0.3961) | 0.7318 (0.0000) | 0.7073 (0.0000) | 1.0000 | | | | | |
| Fertilizer Consumption | 0.1112 (0.4101) | 0.8535 (0.0000) | 0.7871 (0.0000) | 0.5233 (0.0000) | 1.0000 | | | | |
| Exchange Rate | 0.1042 (0.4405) | 0.9098 (0.0000) | 0.9329 (0.0000) | 0.6093 (0.0000) | 0.8167 (0.0000) | 1.0000 | | | |
| Policy Tariff | -0.0136 (0.9200) | 0.0348 (0.7971) | 0.0166 (0.9024) | -0.0154 (0.9096) | 0.1524 (0.2577) | -0.0306 (0.8215) | 1.0000 | | |
| Temperature | 0.2878 (0.0299) | 0.7078 (0.0000) | 0.7618 (0.0000) | 0.5745 (0.0000) | 0.6376 (0.0000) | 0.7216 (0.0000) | 0.1088 (0.4204) | 1.0000 | |
| Rainfall | -0.3675 (0.0049) | -0.0017 (0.9902) | -0.1173 (0.3849) | -0.1195 (0.3760) | -0.0299 (0.8254) | 0.0096 (0.9435) | -0.1723 (0.2001) | -0.1100 (0.4155) | 1.0000 |

The figures in parentheses stand for significance values (probabilities).

**Table (A2):** Unit root test result (Augmented Dickey-Fuller statistic)

| Variable | Level | First Difference | Decision |
|---|---|---|---|
| Yield | 0.7041 | -8.1817*** | I (1) |
| Producer Price | 1.3170 | -12.2380*** | I (1) |
| Rice Consumption | 4.8051 | -2.9459*** | I (1) |
| Import Quantity | 0.5244 | -5.5538*** | I (1) |
| Fertilizer Consumption | -0.2089 | -7.3694*** | I (1) |
| Policy Tariff | -1.3933 | -7.3485*** | I (1) |
| Exchange Rate | 2.4107 | -1.7137* | I (1) |
| Temperature | 0.9162 | -11.7263*** | I (1) |
| Rainfall | -0.3898 | -14.0094*** | I (1) |

**Note:** ***, ** and * signifies 1%, 5% and 10% level of significance, respectively.
MacKinnon critical values for the rejection of null hypothesis of unit root are: -2.6085, -1.9470 and -1.6129 at 1%, 5% and 10%, respectively.

**Table (A3):** Cointegration test results

| Trace Test | | | | Maximum Eigen values Test | | | |
|---|---|---|---|---|---|---|---|
| Ho | $H_A$ | (λ trace) | Critical values (5%) | Ho | $H_A$ | (λ Max) | Critical values (5%) |
| r ≤ 0 | r > 0 | 394.3093*** | 179.5098 | r ≤ 0 | r > 0 | 103.5926*** | 54.9658 |
| r ≤ 1 | r > 1 | 290.7167*** | 143.6691 | r ≤ 1 | r > 1 | 91.6263*** | 48.8772 |
| r ≤ 2 | r > 2 | 199.0903*** | 111.7805 | r ≤ 2 | r > 2 | 53.7989*** | 42.7722 |
| r ≤ 3 | r > 3 | 145.2915*** | 83.9371 | r ≤ 3 | r > 3 | 47.8574*** | 36.6302 |
| r ≤ 4 | r > 4 | 97.4341*** | 60.0614 | r ≤ 4 | r > 4 | 40.1085*** | 30.4396 |
| r ≤ 5 | r > 5 | 57.3256*** | 40.1749 | r ≤ 5 | r > 5 | 27.3634** | 24.1592 |
| r ≤ 6 | r > 6 | 29.9621*** | 24.2760 | r ≤ 6 | r > 6 | 16.9682* | 17.7973 |
| r ≤ 7 | r > 7 | 12.9939** | 12.3209 | r ≤ 7 | r > 7 | 9.4384 | 11.2248 |
| r ≤ 8 | r > 8 | 3.5556* | 4.1299 | r ≤ 8 | r > 8 | 3.5556* | 4.1299 |

**Note:** ***, ** and * represent 1%, 5% and 10% levels of significance respectively. r represents number of cointegrating vectors.
The results show eight (8) cointegrating equations at 5% level for Trace test and six (6) cointegrating equations for Max. Eigen values test.

## Appendix II: Post-estimation test results

**Table (A4):** Results of diagnostic tests

| Tests | F-statistics | df | Probability |
|---|---|---|---|
| Breusch-Godfrey Serial Correlation LM Test | 1.1423 | (2,31) | 0.3321 |
| Breusch-Pagan-Godfrey Heteroscedasticity Test | 0.6597 | (36,16) | 0.8524 |

**Table (A5):** Wald test results

| Variable | F-statistic | Probability | Chi² stat. | Probability | Decision |
|---|---|---|---|---|---|
| Rice Yield (-1, -2) | 28.8168 | 0.0000 | 57.6336 | 0.0000 | S |
| Import Quantity | 0.5311 | 0.5929 | 1.0622 | 0.5879 | NS |
| Rice Consumption | 4.1560 | 0.0246 | 8.3120 | 0.0157 | S |
| Producer Price | 3.3809 | 0.0462 | 6.7617 | 0.0340 | S |
| Tariff Policy | 2.1715 | 0.1300 | 4.3431 | 0.1140 | NS |
| Fertilizer Consumption | 2.1522 | 0.1323 | 4.3044 | 0.1162 | NS |
| Exchange Rate | 2.5934 | 0.0899 | 5.1869 | 0.0748 | S |
| Temperature | 0.6514 | 0.5279 | 1.3029 | 0.5213 | NS |
| Rainfall | 0.2062 | 0.8147 | 0.4124 | 0.8137 | NS |

S-Significant; NS-Not Significant

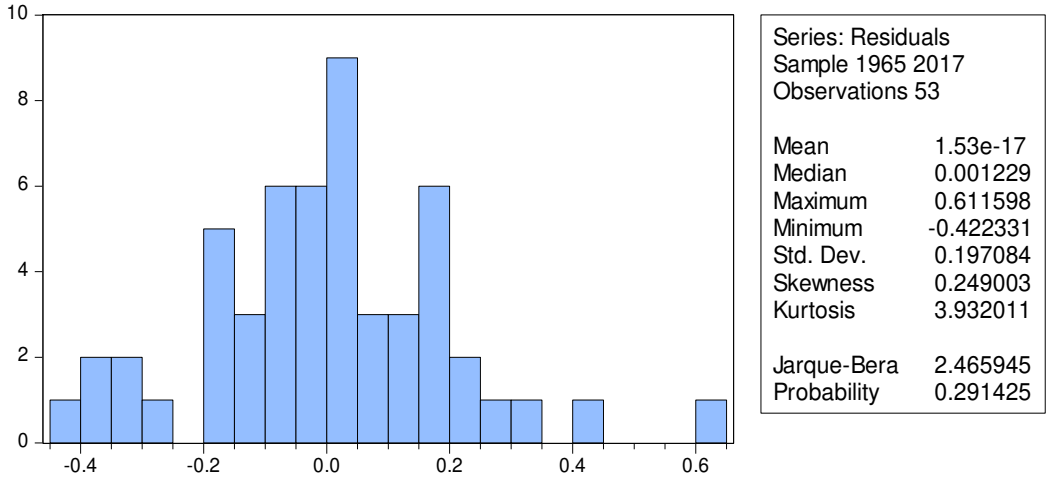


**Figure (A1):** Pictorial representation of normality test results

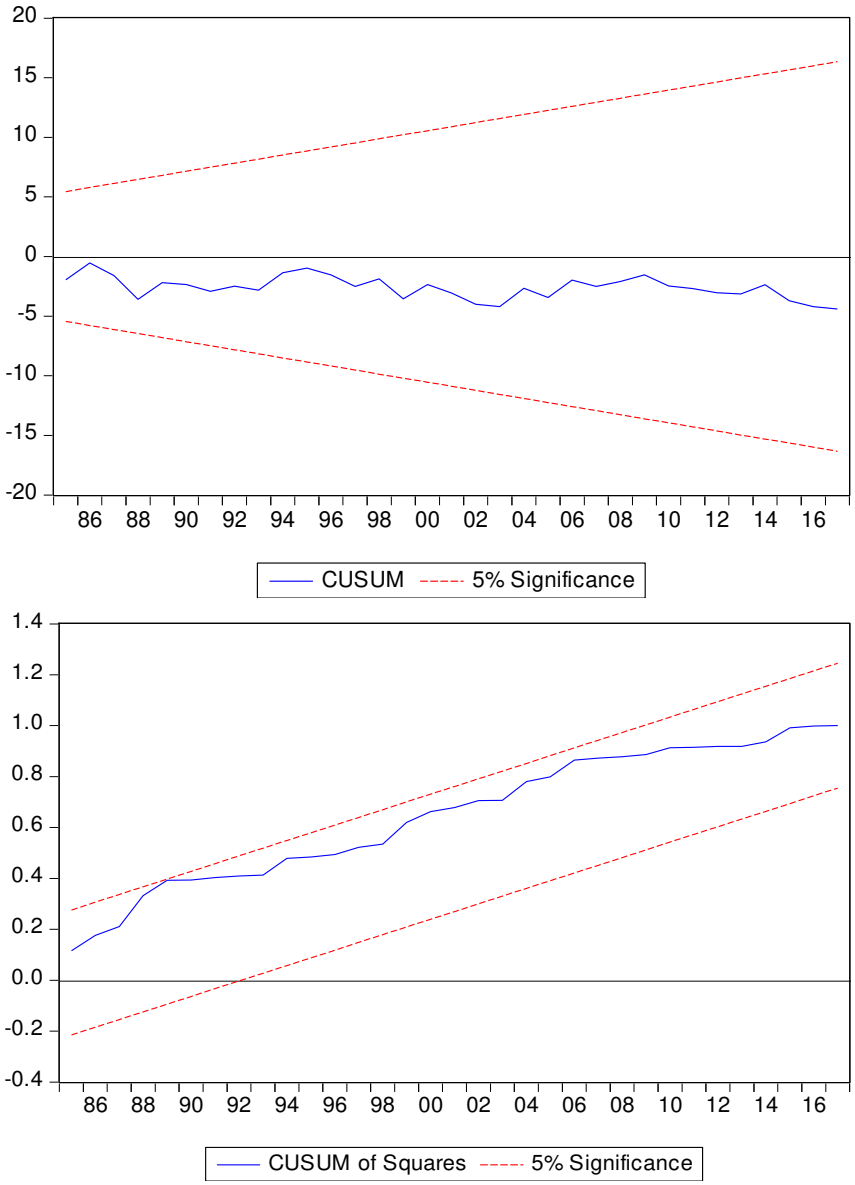


**Figure (A2):** Diagrams showing stability test results