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Determinants of Rice Production and Import in Nigeria (1970 – 2016): An Application of Co-Integration and Error Correction Model

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Abstract
This article estimated the response of rice production and import to long run and short run changes in price and non-price factors in Nigeria between 1970 and 2016 covering pre-SAP, SAP and Post-SAP periods. It made use of time series data sourced from the International Rice Research Institute (IRRI); the United State Development Agency (USDA), Food and Agricultural Organization (FAO) and Central Bank (CBN) Statistical Bulletin. Dynamic regression model: co-integration and error correction model (ECM) were used to realize the objectives. The results showed that rice import, area harvested of rice, rice consumption, government capital investment in agriculture, value of rice imports, rice domestic price, labour force in agriculture and trend variable were the factors influencing rice production in Nigeria within the referenced period in the long-run at 5, 1, 1, 5, 1,1, 1 and 1 % significant levels respectively .Quantity of rice production, quantity consumed of rice, world rice price, nominal exchange rate, domestic rice price and population determined rice imports in Nigeria within the period in the long-run at 1, 5, 10, 1, 1 and 5 % significant levels respectively. The ECM indicated a feedback of about 88.2 % of the previous year's disequilibrium from long-run elasticity of the factors influencing rice production and about 85.4% of the previous year's disequilibrium from long-run elasticity of the factors affecting rice import. The study recommended that policies aimed at reducing rice imports in Nigeria should consider those significant price and non-price factors influencing rice imports in Nigeria in both short and long terms

Keywords: Co-integration, Error Correction, Mechanism, Rice imports, Rice production

1. Introduction

Food security goals are often pursued by most developing economies through imports, especially when growth in domestic food production is not adequate with the needs of the ever-growing population and consumer's preference at least in the short-term (Udoh, Idiong & Omonona, 2001). In so doing, countries usually embark upon trade mostly in those commodities that they enjoy a comparative disadvantage in production in other to attain global welfare. Rice is one of the widely grown and consumed cereal crops in Nigeria, with per capita consumption of between 3.5 kg and more than 14 kg per year per household (FAO, 2014). There has been accelerated growth in rice consumption in Nigeria over time, for instance, per capita consumption during the 1980 decade averaged 18 kg while it was estimated to have reached 22 kg between 1995 and 1999. Since the mid-1980s, rice

consumption has increased at an average annual rate of 11 %, of which only 3 % can be explained by population growth. The remainder represents a shift in diet towards rice at the expense of the coarse grains millet, sorghum and wheat, and other traditional staples such as garri and yams. An estimated 2.1 million tons of rice are consumed annually (FAO, 2016). The World Bank cited in FAO (FAO, 2012) reports that rice indeed is no longer a luxury food in Nigeria, and that it has become a major source of calories for the urban poor, adding that the poorest third of urban households obtained 33% of their cereal-based calories from rice, and rice purchases represent a major component of cash expenditures on cereals. Although, Nigeria has comparative resource advantage, in terms of favourable climatic, edaphic, and ecological conditions in the production of rice for self-sufficiency, the growth of rice import quantity and value as documented by the Central Bank of Nigeria (CBN) in 1977 remains a cause of concern. This is particularly so because imports are paid for in foreign currency, and given the precarious balance of payments position of the country, especially in the 1980s, rice imports have constituted huge drains to the country's foreign exchange earnings over time. For instance, Akpokodje, Lancon & Erenstein (2001) found out that whereas Nigeria spent only about $100,000 on rice importation in 1970, by 1999, the value of rice imports had risen to $259 million. They further averred that between 1961 and 1999, Nigeria spent $4 billion on rice importation alone, giving an annual average of $102 million, during the period. In 1999, the value of rice imports was US$259 and this increased to US$655 million in 2001 and US$756 in 2002. Between 1990 and 2002, Nigeria imported 5,132,616 tons of rice valued at US$1,883,553milion. In 2002 alone, the country imported US$1.882 million tons of rice (FAO, 2007).

Nigeria rice imports increased significantly in the last quarter of 2011 caused by Government of Nigeria's announcement of high levies to be imposed twice within the year 2012 and came after the production shortfall after the flooding. Nigeria imports broken rice, rice husked and milled rice. In 2001-2005, a total of over 55 million tons of rice was imported into the country (FAO, 2012). According to United Nations Commodity Trade (UNCOMTRADE), Nigeria spent $403,578,202 in the importation of semi-milled/wholly milled in 2010 which is about 677,016 tons while the figure stood at above $500,000,000 in 2016 (FAO, 2016).

Several reasons have been adduced for such huge spending on rice importation in spite of the country's capacity to be self sufficient in its production. Principal among these reasons is government macro and sectoral policies on rice during the pre ban period, which lowered domestic rice and fertilizer prices relative to world price levels. Specifically, the massive importation of rice between 1975 and 1985 resulting in low price of domestically produced rice; government involvement in distribution and marketing of imported rice with non-transfer of marketing costs to consumers; protection of urban consumers at the expense of farmers thus leading to depressed farm gate prices; protection of producers through input subsidies such that actual input costs were not translated into production decision making process, taken together were said to have encouraged rice imports (Nkang, Abang, Akpan & Ofem, 2006). Other reasons include an over-valued exchange rate policy which made imports cheaper than domestically produced goods, and fiscal policies which did not favour the agricultural sector from 1986 after government's divestment from agricultural business (Nkang *et al,* 2006). In other words, government policy on rice importation and production has been inconsistent (Okolo, 2004).

Some of these policies include a liberal import regime, oscillating import tariffs and a system of import restrictions. These erratic policies have reflected the dilemma of securing cheap rice for consumers and a fair price for the producers. From the foregoing, the key problem is how to reduce the import of rice into the country without exacerbating food security problems, probably by increasing domestic production to keep pace with demand in the face of high production capacity (Nkang *et al,* 2006. Thus, an informed understanding of the factors, which shape rice import demand in Nigeria, is indispensable in formulating a sound rice import policy package. For instance, where rice import demand responds positively to domestic production, efforts to increase domestic production would not reduce import demand, and thus would not conserve foreign exchange.

The objective of this study therefore is to estimate the response of rice production and import to long run and short run changes in price and non-price factors in Nigeria between 1970 and 2016 using a dynamic regression model: co-integration and error correction model (ECM). The study period of 47 years (1970 to 2016) was selected because of the availability of data for all the variables under study considering the long response of rice output and import to price and non-price variables

It is also pertinent to state here that this period (1970 to 2016) under study also covered part of pre-Structural Adjustment Programme (1970 – 1985), Structural Adjustment Programme (1986 – 1994) and post- Structural Adjustment Programme (1995 – 2016).

2. Methodology

The study was carried out in Nigeria using secondary data which were principally elicited from the database of Statistical Bulletins and Annual Reports of the United States Department of Agricultural (USDA), Food and Agricultural Organization (FAO) of the United Nations and also journal articles. All the relevant data in this regards were standardized by taking the natural logs of both the dependent variables (quantity of rice imported and quantity of rice produced) and the independent variables (price and non-price variables) within the referenced period in order to stabilize their variance thereby making them uniform. The time series data used for analysis were on rice output and import (measured in Metric Tons) alongside price and non-price variables that influenced quantity of rice import and quantity of rice production in Nigeria extending from 1970 to 2016. Some of these price and non-price variables included: time (Trend), Domestic price of rice (₦.'Million), Exchange rate (₦./$), Area harvested of rice (Ha), Average annual rainfall (mm), Value of government loan to farmers into rice production (₦./$), Nigeria's agriculture labour force (millions) and Real exchange rate (₦./$).

2.1 Meaning of Variables Used for the Study

Quantity of Rice Output (QR_t): This is one of our dependent variables measured in Metric Tons (MT). It is defined as the mean quantity of rice produced by all resident rice farmers during the period under study

Quantity of Rice Import ($IMPT_t$): It is also an independent variable measured in Metric Tons (MT). It is defined as the mean quantity of milled rice imported by Nigeria during the period under review

Area Harvested of Rice (AHRt) = Area harvested of rice is measured in Heactre and it is defined as land area available for rice production during the period under investigation.

Annual Rainfall ($RAIN_t$) = Average annual rainfall measured in millimeters. It is a climate element and so climate is proxied by rainfall in this study.

Value of Government Loan (AGI_t) . This implies loan to farmers into rice production within the period under stud. It is measured in ₦'Million.

Government Capital Investment in Agriculture ($GCIA_t$). This is measured in ₦'Million. In this study, it is proxy for government capital investment in rice production implying government budgetary allocation o rice subsector. It is also a capital incentive given to farmers by the government to boost rice production by sharing in the cost of producing rice with the farmers.

Nigeria's Labour Force In Agriculture (LFA_t)=. This is measured in Millions. Labour force in this regards is considered the economically active population that includes both the employed and the unemployed

Real Exchange Rate (RER_t). This is measured in ₦/$. In this study, it tells us how much the goods and services in Nigeria can be exchanged for the goods and services in a foreign country

2.2 Method of Data Analysis and Model Specification

In realizing the objectives, the data were first subjected to a stationarity test and thereafter, ordinary least square (OLS) multiple regression model was employed for the evaluation of the determinants of long and short run of rice production and import in the entire period. To capture the long run and short run of the response of rice production and imports to changes in price and non-price factors, the error correction model (ECM) using the Engle- Granger methodology was used. The models for these analyses are as follows:

2.2.1 Long-Run Model for Rice Output.

The long- run model that was used to estimate the response of rice production (output) to changes in price and non-price factors in Nigeria is implicitly and generally given as

$$QR_t \mathbf{t=f(}AHR_{t,}\ RAIN_{t,}\ PRIC_{t,}\ IMPT_{t,}\ AGI,\ QCR_{t,}\ GCIA_{t,}\ RER_{t,}\ LFA_{t,}\ SGP_{t,,}\ TREND_t \quad (1)$$

Where,
QR_t = Quantity of rice output (measured in metric tons) in period t;
AHR_t = Area harvested of rice (Heactre) in period t;
$RAIN_t$ = Average annual rainfall in millimeters in period t as climate element;
$PRIC_t$ = Domestic Price of Rice in year t (Naira/tons)
$IMPT_t$ = Volume of Rice Import (tons) in period t as a proxy for importation policy
AGI_t = Value of government loan to farmers into rice production (₦'Million) in period t,
QCR_t = Quantity of rice consumed (tonnes) in period t,

$GCIA_t$ = Government capital investment in agriculture (₦'Million) in period t (proxy for government capital investment in rice production),

RER_t= Real exchange rate (₦/$) in period t,

LFA_t = Nigeria's labour force in agriculture (Millions) in period t,

SGP_t= A dummy variable for stance of government policy on interest rate (SGP= 1 in years of fixed and concessionary interest rate policy, and SGP= 0 in years of floating interest rate policy), and

$TREND_t$= linear trend time (t = 1, 2...47), a proxy for technology, which measures productivity effect.

we estimated the following equation from our generalized model in equation (1), to empirically examine or capture the long run and short run of the response of rice production and imports to changes in price and non-price factors by taking the natural logs on both sides of the equation (1) ie using Cobb-Douglas functional form in order to rule-out the differences in the units of measurements for our variables. This leads us to:

$$\text{Log } QR_t = \beta_0 + \beta_1 \text{logAHR}_t + \beta_2 \text{logRAIN}_t + \beta_3 \text{logPRIC}_t + \beta_4 \text{logIMPT}_t + \beta_5 \text{logAGI}_t + \beta_6 \text{logOCR}_t + \beta_7 \text{logGCIA}_t + \beta_8 \text{logVRI}_{t-1} + \beta_9 \text{logRER}_t + \beta_{10} \text{logLFA}_t + \beta_{11} \text{logSGP}_t + \text{TREND}_t + \mu \quad (2)$$

where,
μ_t = Stochastic disturbance term.
$\beta_0 - \beta_{12}$ = parameter estimates.
On a priori ground, it is expected that the coefficient estimates for AHR_t , $RAIN_t$, $PRIC_t$, AGI_t, QCR_t, $GCIA_t$,, LFA_t , $TREND_t > 0$; and $IMPT_t$, RER_t, $SGP_t < 0$.

2.2.2 Short-Run Model for Rice Output

In a bid to estimate the short-run rice output model, following the error correction model approach, co-integration test was performed using the ADF test procedure. This tends to confirm that the residuals of the non-stationary series that were integrated at order one are actually integrated of at order zero. Co- integration test for the presence of unit roots was performed on the residual series generated from the long- run estimation of the response of rice output to changes in price and non-price factors in Nigeria using the Augumented Dickey-Fuller (ADF) test procedure. The short- run model that was used to estimate the response of rice output to changes in price and non-price factors in Nigeria is given as:

$$\text{Log } QR_t = \beta_0 + \beta_1 \text{logAHR}_{t-1} + \beta_2 \text{logRAIN}_{t-1} + \beta_3 \text{logPRIC}_{t-1} + \beta_4 \text{logIMPT}_{t-1} + \beta_5 \text{logAGI}_{t-1} + \beta_6 \text{logOCR}_{t-1} + \beta_7 \text{logGCIA}_{t-1} + \beta_8 \text{logVRI}_{t-2} + \beta_9 \text{logRER}_{t-1} + \beta_{10} \text{logLFA}_{t-1} + \beta_{11} \text{logQR}_{t-1} + \text{ECM}_{t-1} + \mu_t \quad (3)$$

where,
QR_t = Quantity of rice output (measured in metric tons) in period t;
AHR_{t-1} = Area harvested of rice (Heactre) in period t-1;
$RAIN_{t-1}$ = Average annual rainfall (in millimeters) in period t-1, as climate element;

$PRIC_{t-1}$ = Domestic Price of Rice in year t-1 (Naira/tons)
$IMPT_{t-1}$ = Volume of Rice Import (tons) in period t-1, as a proxy for importation policy
AGI_{t-1} = Value of government loan to farmers into rice production (₦'Million) in period t-1,
QCR_{t-1} = Quantity of rice consumed (tons) in period t-1,

$GCIA_{t-1}$ = Government capital investment in agriculture (₦'Million) in period t-1 (proxy for government capital investment in rice production),

VRI_{t-2} = Value of rice imports (₦' Million) in period t-2,

RER_{t-1} = Real exchange rate (₦/$) in period t-1,

LFA_{t-1} = Nigeria's labour force in agriculture (Millions) in period t-1,

QR_{t-1} = Quantity of rice output (measured in metric tons) in period t-1;
ECM_{t-1} = Error correction mechanism in period t-1.
μ_t = Stochastic disturbance term.
$\beta_0 - \beta_{12}$ = parameter estimates.

On a priori ground, it is expected that the coefficient estimates for AHR_{t-1} ,$RAIN_{t-1}$, $PRIC_{t-1}$, AGI_{t-1}, QCR_{t-1}, $GCIA_{t-1}$, VR_{t-2}, LFA_{t-1} , $QR_{t-1} > 0$; and $IMPT_{t-1}$,RER_{t-1}, $ECM_{t-1} < 0$.

2.2.3 Long-Run Model for Rice Imports.

The long- run model that was used to estimate the response of rice imports to changes in price and non-factors in Nigeria is given as:

$$LogIMPT_t = \beta_0 + \beta_1 logAHR_t + \beta_2 logQR_t + \beta_3 logWPRIC_t + \beta_4 logNER_t + \beta_5 logDPR_t + \beta_6 logOCR_t + \beta_7 logGCIA_t + \beta_8 logPO + \beta_9 logERES_t + \mu_t \quad (4)$$

where,
$IMPT_t$ = Volume of Rice Import (tons) in period t;
QR_t = Quantity of rice output (measured in metric tons) in period t;
AHR_t = Area harvested of rice (Hectare) in period t;
$WPRIC_t$ = World Price of Rice in year t (Naira/tons)
QCR_t = Quantity of rice consumed (tonnes) in period t,

$GCIA_t$ = Government capital investment in agriculture (₦'Million) in period t (proxy for government capital investment in rice production),

NER_t = Nominal exchange rate (₦/$) in period t

DPR_t= domestic price of rice output (₦' Million) in period t,

POP_t = Population estimates (million) in period t;

$ERES_t$= External reserves (₦' Million) in period t,

μ_t = Stochastic disturbance term.
$\beta_0 - \beta_9$ = parameter estimates.
On a priori ground, it will be expected that the coefficient estimates for, $ERES_t$,POP_t, QCR_t, $GCIA_t$, $DPR_t > 0$; andAHR_t , QR_t, ER_t, $WPRIC_t < 0$.

2.2.4 Short-Run Model for Rice Imports

In a bid to estimate the short-run rice import model, following the error correction model approach, co-integration test will be performed using the ADF test procedure. This tends to confirm that the residuals of the non-stationary series that were integrated at order one are actually integrated of at order zero. Co- integration test for the presence of unit roots will be

performed on the residual series generated from the long- run estimation of the response of rice imports to changes in price and non-price factors using the Augmented Dickey-Fuller (ADF) test procedure. The short- run model that was used to estimate the response of rice imports to changes in price and non-price factors in Nigeria is given as:

$$\text{Log IMPT}_t = \beta_0 + \beta_1 \text{logAHR}_{t-1} + \beta_2 \text{logQR}_{t-1} + \beta_3 \text{logWPRIC}_{t-1} + \beta_4 \text{logNER}_{t-1} + \beta_5 \text{logDPR}_{t-1} + \beta_6 \text{logOCR}_{t-1} + \beta_7 \text{logGCIA}_{t-1} + \beta_8 \text{logPOP}_{t-1} + \beta_9 \text{logERES}_{t-1} + \beta_{10} \text{logIMPT}_{t-1} + \text{ECM}_{t-1} + \mu_t \quad (5)$$

where,
$IMPT_t$ = Volume of Rice Import (tons) in period t;
QR_{t-1} = Quantity of rice output (measured in metric tons) in period t-1;
AHR_{t-1} = Area harvested of rice (Hectare) in period t-1;
$WPRIC_{t-1}$ = World Price of Rice (Naira/tons) in year t-1
QCR_{t-1} = Quantity of rice consumed (tons) in period t-1,

$GCIA_{t-1}$= Government capital investment in agriculture (₦'Million) in period t-1 (proxy for government capital investment in rice production),

ER_{t-1} = Exchange rate (₦/$) in period t-1

DPR_{t-1} = domestic price of rice output (₦' Million) in period t-1,

POP_{t-1} = Population estimates (million) in period t-1;

$ERES_{t-1}$ = External reserves (₦' Million) in period t-1,

$IMPT_{t-1}$ = Quantity of rice imports (measured in metric tons) in period t-1;
ECM_{t-1} = Error correction mechanism in period t-1.
μ_t = Stochastic disturbance term.
$\beta_0 - \beta_{11}$ = parameter estimates.
On a priori ground, it will expected that the coefficient estimates for, $ERES_{t-1}$, $POP_{t-1,}$ QCR_{t-1}, $GCIA_{t-1}$, $DPR_{t-1,}$ $IMPT_{t-1}$,> 0; and AHR_{t-1} , QR_{t-1}, ER_{t-1}, $WPRIC_{t-1,}$ ECM_{t-1}< 0.

2.3 Diagnostic Tests:

The study adopted Engle and Granger (1987) two-step procedure in co-integration. Step one involves a preliminary analysis to find the order of integration of the data series, and after that, ordinary least squares regression was carried out to estimate the equations for those economic aggregates where co-integration can be found (Granger & Newbold, 1974). These are the stationarity test (unit root test) and co-integration test respectively. In the second stage, the residuals obtained in the long-run co integration regression were used as explanatory variable to specify a dynamic error correction model, which is estimated via OLS regression. This approach is necessary because it has been found that a large number of time-series used in econometric analysis are non-stationary which means that they have persistence to increase or decrease over time. The consequence of this behaviour is that such data when used in regression, yield spurious results (Udoh, *et al*, 2001)

2.3.1 Tests for Stationarity (Unit Root Tests): To carry out the unit root test for stationarity, the Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) tests were used to examine each of the variables for the presence of a unit root (an indication of non-stationarity). The DF test

assumes that the data generating process is a first order {AR (1)} process, and so if this is not so the autocorrelation in the error term will bias the test. The ADF is used to avoid such bias in the test since it includes the first difference in lags in such a way that the error term is distributed as white noise. The test formula for the DF and ADF are shown in equations (5) and (6) respectively

$$\Delta Yt=\alpha+\rho Yt\text{-}1 + ut \quad (6)$$

$$\Delta Yt=\alpha+\rho Yt\text{-}1 + \Sigma\gamma\Delta Yt\text{-}j + ut \quad (7)$$

Here the significance of ρ was tested against the null that ρ = 0. Thus if the null hypothesis of non-stationarity cannot be rejected, the variables are differenced until they become stationary, that is until the existence of a unit root is rejected. We then proceeded to test for co-integration.

2.3.2 Test for co-integration: Co-integration is said to exist between non-stationary variables if their linear combination, namely, the residuals of the co-integrating regression are stationary (Granger, 1986). Thus, spuriousness can only be avoided if a stationary co-integrating relationship is established between the variables. In testing for co-integration, we use the DF and ADF and apply them to the residuals of the co-integrating regression rather than the levels of the series. If the residuals of the bivariate co-integrating regressions are found to be stationary, implying co-integration, we were guided towards specifying an error correction mechanism, which is the second step of the Engle-Granger two-step method. Following (Engle & Granger, 1986) the co-integration regression can be specified as

$$Y_t = \alpha_0 + \alpha_1 Z_t + u_t \quad (8)$$

The residuals of the equation, $u_t = (Y_t - \alpha_0 - \alpha_1 Z_t)$ are simply a linear difference of the non-stationary series (i.e. Yt - Zt). Consequently, a number of bivariate co-integrating regressions were run between the regressand and each of the explanatory variables, except the dummy. Finally, in stage two, the residuals of the valid co-integrating regressions were included in the model as explanatory variable, before estimating the model via OLS. From the example in equation 1 the error correction model can be specified thus:

$$\Delta Yt = a + a_1\Delta Z_t - a_2(Y - Z_t)_{t\text{-}1} + u_t \quad (9)$$

where: Z_t = the vector of explanatory variables, Y and Z_t = the co- integrating variables; a_2 = the error correction mechanism (ECM).

3. Results and Discussion

3.1 Test for Stationarity (Unit Root Test)

Unit root test was essential in determining the order of integration of the variables prior to the empirical model estimations. This is because estimation of the empirical model without prior knowledge on the order of integration of the variables would lead into spurious regression problem. All the variables were not stationary at their levels thus the need for differencing them to make them stationary. On application of the ADF tests on their first differences, all of them became stationary as indicated by their t-values of the ADF which are all negative and

larger (in absolute terms) than the standard critical values, thus leading to the rejection of the null hypothesis.. The completed results for stationarity / unit root tests with a deterministic trend in the variables are presented in Table 1. These tests were performed by including a constant and a deterministic trend in the regressions

Table 1: Result of Unit Root Test for Variables Used in Regression Analysis

Variables	Level	First difference	Order of Integration
Import Qty of Rice$_t$	-3.304	-4.798*	I(1)
Area Harvested of Rice$_t$	-4.596**	-	I(0)
Qty. Consumed of Rice$_t$	-2.461	-8.410**	I(1)
Rainfall$_t$	-2.504	-7.883**	I(1)
Govt. Capital Invest.on Rice production$_t$	-2.745	-6.151**	I(1)
Value of rice Imports$_t$	0.545	-5.238**	I(1)
Domestic price of rice$_t$	0.154	-3.637*	I(1)
Value of Govt. loan$_t$	-5.639**	-	I(0)
Real exchange rate$_t$	-4.715**	-	I(0)
Labour force in Agric.$_t$	-3.034	-7.302**	I(1)
Import Qty of Rice$_{t-1}$	-2.265	-5.208**	I(1)
Area Harvested of Rice$_{t-1}$	-6.379**	-	I(0)
Qty. Consumed of Rice$_{t-1}$	-1.953	-5.186**	I(1)
Rainfall$_{t-1}$	-0.953	-5.684**	I(1)
Govt. Capital Invest. on Rice production$_{t-1}$	-1.432	-6.340**	I(1)
Value of rice Imports$_{t-2}$	-2.516	-4.246*	I(1)
Domestic price of rice$_{t-1}$	-1.874	-6.032**	I(1)
Value of Govt. loan$_{t-1}$	-9.341**	-	I(0)
Real exchange rate$_{t-1}$	-2.496	-6.307**	I(1)
Labour force in Agric$_{t-1}$	-0.757	-5.553**	I(1)
Quantity of rice output$_{t-1}$	-2.847	-8.517**	I(1)
Output Qty of rice$_t$	-1.148	-6.136**	I(1)
World price of rice$_t$	-3.767**	-	I(0)
Nominal exchange rate$_t$	-2.007	-6.136**	I(1)
Population$_t$	-3.772	-	I(0)
External reserves$_t$	-0.631	-6.147**	I(1)
Output Qty of Rice$_{t-1}$	-1.837	-4.642*	I(1)
World price of rice$_{t-1}$	-1.107	-5.774**	I(1)
Nominal exchange rate$_{t-1}$	-0.251	-5.208**	I(1)
Domestic price of rice$_{t-1}$	-6.379**	-	I(0)
Population$_{t-1}$	-5.186**	-	I(0)
External reserves$_{t-1}$	0.385	-5.381**	I(1)

Note: At level, critical value at 1% = - 4.212 and 5% = -3.529; at first difference, critical value at 1% = - 4.219 and 5% = -3.533 and at 10% =-3.198. Asterisks * and ** and *** represents 5% and 1% significance levels, respectively.

The result in Table 1 shows that only area harvested of rice in period 't', value of government loan to agriculture in period t, real exchange rate in period t, area harvested of rice in one year lagged period, value of government loan to agriculture in one year lag period, world

price of rice in period t, Nigerian population in period t, domestic price of rice in one year lag period and Nigerian population in one year lag period were stationary at level. All the other variables were found to be stationary at order one, I(1). Therefore all the lagged variables used for the study were integrated of order one, I(1) except for the area harvested of rice in period t, value of government loan to agriculture in period t, real exchange rate in period t, area harvested of rice in one year lag period, value of government loan to agriculture in one year lag period, world price of rice in period t, Nigerian population in period t, domestic price of rice in one year lag period and Nigerian population in one year lag period which were used at level, I(0). From the table 1, it is evident that the variables are integrated of order 1that is are I(1). We then proceed to discuss the results of co integration between the explained and each of the explanatory variables. The difference- stationary values for the variables found to be stationary at order one, I(1) were used for analysis.

3.2 Co – integration test (The Engle-Granger Test) and Specification of the Error Correction Model (ECM) for Rice Production and Import Model

The study conducted a co integration analysis to establish existence of either a long run or short run relationship between the rice production and the explanatory variables. Having established the stationarity, we generated the residuals and the first differences of the residuals. The first differences, lagged values and lagged values of the first differences are included in another successive regression as model regressors. The null hypothesis of no long run relationship between rice production and the explanatory variables is tested against the alternative hypothesis of presence of long run relationship

This tends to confirm that the residuals of the non-stationary series that were integrated of order one, I(1) are actually integrated of order zero, I(0). Prior to the co – integration test, the residual series from the ordinary least square estimation model used to analyze the response of rice production to changes in price and non-price factors in the long run as presented in table 4. Co-integration test for the presence of unit roots was then performed to the generated residual series using the Augmented Dickey Fuller (ADF) test procedure. The result of the co integration test is presented in table 2

The result of the co integration which is a precondition for the specification of an error correction model indicates the presence of co – integration in the residual of the static regression for rice production and import in Nigeria within the period under study and therefore data used to estimate the response of rice production and import to changes in price and non-price factors in Nigeria acted as the error correction factor. From the results in Table 2, the p-value of 0.0002 under rice production is less than 1, 5 and 10 % significant levels implying that there is co-integration. Also, the p-value of 0.000 under rice import is less than 1, 5 and 10 % significant levels also implying that there is co-integration. This means that there is a long run relationship between rice production and rice import and their respective independent variables. It implies that the variables under study move together in the same direction in the long run.

Table 2: Residual Based Co-Integration Test (The Engle-Granger Test) For Rice Production and Import at Level.

	Augumented Dicky Fuller	
Parameter	**Rice Production**	**Rice Import**
Test statistic	-6.0512***	-7.722*
Prob (Test statistic)	0.0002	0.000
R Squared	0.7018	0.674
Adj. R – Squared	0.6877	0.651
F – Statistic	26.1285***	22.113***
Prob. (F – Statistic)	0.0000	0.000
Durbin – Watson Stat	1.9225	2.0213
Test critical values at: level:		
1% level	-3.6999	-3.6999
5% level	-2.9763	-2.9763
10% level	-2.6274	-2.6274

Own computation based on analyzed data. (***), represents 1% level of significance.

3.3 Response of Rice Production and Imports to Long-run Changes in Price and Non-Price Factors in Nigeria.

The multiple regression results of the response of rice production and imports to long-run changes in price and non-price factors in Nigeria within the period under review are presented in table 3

The results showed that the coefficient of multiple determinations (R^2) for rice output was 0.902. This indicates that the independent variables included in the model explained about 90.2% of the variations in rice output in the long – run while the remaining 9.8% was due to error of estimation and other factors affecting rice production. The F – statistics was significant at 1%, while Durbin-Watson (DW) of statistic 2.135 indicated absence of serial correlation in the error terms. Import quantity of rice, area harvested of rice, quantity of rice consumed, government capital investment in agriculture, value of rice imports, domestic price of rice, labour force in agriculture and trend variable were the significant variables that determined the quantity of rice production in Nigeria within the reference period. The coefficient of quantity of rice imports ((-1.602) is negatively signed and is statistically significant at 5%. This result implies that increasing domestic rice production by 10% would only reduce quantity of imported rice by 16.02%. This is an indication that a policy geared towards reducing imports of rice by increasing domestic production may achieve its objective the long-run and vice versa. The quantity of rice imported would naturally decrease as domestic production of rice increased especially when the domestic production of rice is in surplus to domestic utilization of rice as increase in the domestic production of rice will lead to a marked decreased in quantity of rice imports. This result is consistent will the findings of Onyebinama, Chidebelu & Nwagbo (2005).

Table 3: Response Of Rice Production To Changes In Price And Non-Price Factors In The Long – Run In Nigeria (1970 – 2016).

Rice Production			Rice Import		
Variables	Coefficients	t-Statistic	Variables	Coefficients	t-Statistic
Constant	6.624	5.911***	Constant	25.853	2.015*
	(1.121)			(12.834)	
Import Qty of $Rice_t$	-1.602	-3.694**	Output Qty of $rice_t$	-0.009	-4.323***
	(0.163)			(0.002)	
Area Harvested of $Rice_t$	0.556	5.478***	Area Harvested of $rice_t$	0.416	1.598
	(0.102)			(0.260)	
Qty. Consumed of $Rice_t$	0.009	4.323***	Qty. Consumed of $rice_t$	0.006	2.587**
	(0.002)			(0.002)	
$Rainfall_t$	2.744	1.418	World price of $rice_t$	-4.954	-1.992*
	(1.935)			(2.486)	
Govt. Capital Invest.on Rice $production_t$	0.348	2.531**	Govt. Capital Invest.on rice $production_t$	-0.353	- 1.336
	(0.137)			(0.264)	
Value of rice $Imports_t$	-1.086	-6.029***	Nominal exchange $rate_t$	0.978	-9.918***
	(0.180)			(0.068)	
Domestic price of $rice_t$	0.674	9.918***	Domestic price of $rice_t$	0.556	5.478***
	(0.068)			(0.102)	
Value of Govt. $loan_t$	0.006	1.587	$Population_t$	0.602	3.694**
	(0.004)			(0.163)	
Real exchange $rate_t$	0.171	0.399	External $reserves_t$	1.123	0.424
	(0.429)			(2.651)	
Labour force in $Agric._t$	-0.789	-7.592***	R^2	0.919	
	(0.103)				
Govt. Policy on Interest $Rate_t$	-0.005	-1.292	Adjusted R^2	0.895	
	(0.004)				
$Trend_t$	0.509	4.399***	F- statistic	80.935***	
	(0.002)				
R^2	0.902		Durbin-Watson statistic	2.045	
Adjusted R^2	0.886				
F- statistic	106.401***				
Durbin-Watson statistic	2.135				

Computed from time-series data, 1970-2016 Note: * and * represents 1% and 10%**

The area harvested of rice was positively related to rice production, an indication that rice production increases as the area harvested of rice increases and vice versa. The quantity of rice planted by a farm firm depends on the quantity of land available to it. According to Onyebinama (2004), limited access to land limits the size and scale of the farm business. Crop planted is likely to increase as the area of land increases. The coefficient of quantity of rice consumed was positively signed and statistically significant at 1 %. This implies that quantity of rice consumed and quantity of rice produced in Nigeria within the reference period were positively related. This is an indication that rice production increases as the quantity of rice consumed increases and vice versa. The increase in the quantity of rice consumed is brought about by the increase in demand pressure for the available rice commodity. Increase demand for rice at low rice import due to restricted rice import policy will induce more individuals to go into rice production in other to take advantage of the increased price of rice due to demand- supply gap. This will increase the production of rice the more in the country.

The coefficient of Government capital investment on rice production (proxy to government capital investment on agricultural production) is less than unity (0.348) and is positively signed. This means that a 10 % rise in Government capital investment on rice production, evokes a less than proportionate about 3.5 % increase in the quantity of rice production in the country.

The value of rice imports in the previous year was negatively related to rice production and was significant at 1% risk level. This implies that a reduction in rice imports lead to an increase in rice production. Food import supplements domestic production and a reduction in food importation will trigger a multiplier dependency on domestic production for food security and will force more financial, technical and managerial commitment of both government and agriculture operators towards increasing domestic production in an attempt to keep up with the domestic food needs of the populace. This result is consistent with that of Nkang *et al* (2006).The elasticity of response of quantity of rice production relative to the import value of rice was lower than unity (ER = -1.086). It suggests that a 10% increase in the value of rice imports will probably lead to about 10.7% decreases in the quantity of domestic rice production.

Domestic price of rice was positively related to quantity of rice production at 1 percent significance level. This implies that quantity of rice production increases as domestic price of rice increases. Producer's price is the profit accruable to producers and the income and profit of farmers depend on the prices they received for their products. Therefore, farmers will increase production of crops like rice in order to take advantage of higher product prices. As a result, rice production increases as producer's price of rice increased.

The coefficient of labour force in agriculture (-0.789) was negatively related to rice production. This is an indication that rice production decreased as labour force in agriculture increased and vice versa. This relationship which is contrary to a priori expectation is probably an indication of the prevalence of redundant workers in rice production subsector of agriculture. Labour is the most easily quantified factor of production and given the low technological base of Nigeria economy, the quest for improved managerial capability and effectiveness in agriculture is human strength dependent (Nnamerenwa, 2012). Given the subsistent nature of production in the sector in this country, the tendency of diminishing marginal labour productivity seems operative when more population of the economy are employed in the agricultural sector (Nnamerenwa, 2012). Thus, increased rice production may not require additional employment of labour but rather an optimal utilization of the existing under-utilized labour resources. The trend variable (technology) was directly related to rice production in the period under review. This indicated that rice production increased as new technologies in rice production were adopted by rice farmers. Rice production is dependent on technology. A change in current level of technology (total factor productivity) is brought about by such factors as increased knowledge about production methods, education, etc. In the presence of improved technologies, a farm firm will innovate to increase subsistence production. This suggests that an increase in the rate of adoption of improved systems of farming will likely lead to an increase in rice production and vice versa.

On the other hand, the results in table 3 showed that the coefficient of multiple determinations (R^2) for rice imports was 0.919. This indicates that the price and non-price factors included in the model explained about 91.9 % of the variations in rice imports in the long – run. The F –

statistics was significant, confirming the significance of the entire model. The Durbin-Watson (DW) value of 2.045 indicates that auto-correlation was not a problem in the models.
Quantity of rice production, quantity consumed of rice, world price of rice, nominal exchange rate, domestic price of rice and population were the significant variables that determined rice imports in Nigeria within the period of investigation.

The elasticity of domestic rice production is inelastic (-0.009). This result implies that increasing domestic rice production by 10 % would only reduce quantity of imported rice by 0.1 %. This implies that increase in the quantity of rice production decreases the quantity of rice imports in Nigeria and vice versa. Quantity of rice imports will naturally decrease as quantity of rice production increases because of reduction in producers price that usually accompany increase in supply of any given commodity. Quantity of rice consumed was positively signed and statistically significant at 10 % significant level. This is an indication that rice imports increases as the quantity of rice consumed increases and vice versa. The increase in the quantity of rice consumed is brought about by the increase in demand pressure for the available rice commodity. Increased demand for rice at high producer's price for domestically produced rice due to scarcity of rice occasioned by geometric population rise will induce the adoption of rice importation policy as an alternative strategy to solve rice scarcity problems. There was an indirect relationship between the quantity of rice imports and world price of rice an indication that rice imports increases as world price of rice decreases. World price is the price a given product is offered for in the international market. Therefore, a country with domestic food insecurity will increase their use of importation to supplement their food demand. Where the price of importing rice is far cheaper than the cost of investment in rice production, the tendency for rice imports will increase the more. As a result, quantity of rice imports increases at reduced world price of rice (Daramola, 2005)
There was a direct relationship between the quantity of rice imports and nominal exchange rate an indication that rice imports increases as nominal exchange rate increased. The nominal exchange rate captures not only changes in the inflation rate (Onyebinama, Chidebelu & Nwagbo, 2007) an increase in nominal exchange rate implies real devaluation that is in domestic prices as a result of devaluation translates into high rates of inflation. As a result, domestic output of rice will be more expensive in the domestic market and cheaper in international market. As a result, imports of rice will increase. This finding conforms to that of Nkang *et al,* (2006) who observed that changes in nominal exchange rate makes domestic price of rice expensive and that of rice imports less expensive domestically.

There was a direct relationship between the quantity of rice imports and producer's price of rice an indication that rice imports increases as producer's price of rice increases. Producer's price is the amount consumers pay for every unit of rice the purchased. At higher producers price of domestically produced rice, consumers pays more and would prefer to purchase foreign imported rice that is at a lower price than patronize domestic rice marketers and producers alike. This will force the demand for foreign rice to increase as producer's price of rice increases. This finding is consistent with that of Nkang *et al,* (2006) There was a direct relationship between the quantity of rice imports and population an indication that rice imports increases as population increases. An increase in population will lead to an increase in food demand. This will lead to rise in rice imports when the utilization of more available labour force necessitated by the increase in population to meet the demand for food does not translate into increase rice output.

3.4 Response Of Rice Production And Imports To Short-Run Changes In Price And Non-Price Factors In Nigeria.

The multiple regression results of the response of rice production and imports to Short-run changes in price and non-price factors in Nigeria within the period under review are presented in table 4

Table 4: Regression Result Of The Response Of Rice Production And Import To Changes In Price And Non-Price Factors In The Short – Run In Nigeria (1970 – 2016).

Rice Production			Rice Import		
Variables	Coefficients	t-Statistic	Variables	Coefficients	t-Statistic
Constant	12.045 (2.256)	5.340***	Constant	16.080 (2.777)	5.790***
Import Qty of Rice$_{t-1}$	-0.878 (0.958)	-4.484***	Output Qty of Rice$_{t-1}$	-0.008 (0.002)	-5.017**
Area Harvested of Rice$_{t-1}$	0.067 (0.043)	1.5659	Area Harvested of Rice$_{t-1}$	-1.026 (0.130)	-7.870***
Qty. Consumed of Rice$_{t-1}$	0.021 (0.225)	0.094	Qty. Consumed of Rice$_{t-1}$	4.9537 (2.486)	1.993*
Rainfall$_{t-1}$	1.786 (1.789)	6.029***	World price of rice$_{t-1}$	-0.004 (0.001)	-5.907
Govt. Capital Invest. on Rice production$_{t-1}$	0.686 (0.209)	3.286***	Govt. Capital Invest. on Rice production$_{t-1}$	-0.244 (0.040)	-6.164***
Value of rice Imports$_{t-2}$	-0.001 (0.097)	-0.008	Nominal exchange rate$_{t-1}$	0.002 (0.001)	2.241
Domestic price of rice$_{t-1}$	4.319 (2.431)	1.777*	Domestic price of rice$_{t-1}$	0.957 (0.320)	2.992*
Value of Govt. loan$_{t-1}$	0.649 (0.216)	3.005***	Population$_{t-1}$	1.319 (0.198)	6.674***
Real exchange rate$_{t-1}$	0.386 (0.117)	3.293***	External reserves$_{t-1}$	0.595 (0.154)	3.871***
Labour force in Agric$_{t-1}$	0.348 (0.137)	2.531**	Import Qty of rice$_{t-1}$	0.152 (0.024)	6.212***
Quantity of rice output$_{t-1}$	1.895 (0.207)	.9.140*	ECM$_{t-1}$	-0.854 (2.777)	-3.470***
ECM$_{t-1}$	-0.882 (0.163)	-5.408***	R^2	0.942	
			Adjusted R^2	0.925	
R^2	0.892		F- statistic	76.533***	
Adjusted R^2	0.877		Durbin-Watson statistic	2.232	
F- statistic	106.401***				
Durbin-Watson statistic	2.135				

Computed from time-series data, 1970-2016 Note *, ** and * - represents 1%, 5% and 10% levels of significance.**

The coefficient of multiple determinations (R^2) of (0.892) showed that the independent variables included in the model; explained about 89.2% of the variations in rice production in

the short – run. In the short run, rice production responded negatively to the one year lag of quantity of rice import implying that the increase in the previous year's quantity of rice import led to a decrease in rice production and vice versa. Also in the short-run rice production responded positively to the one year lag of area harvested of rice, rainfall, government capital investment on rice production, domestic price of rice, value of government loan to farmers, real exchange rate, labour force in agriculture and quantity of rice output implying that the increase in the previous year's area harvested of rice, rainfall, government capital investment on rice production, domestic price of rice, value of government loan to farmers, real exchange rate, labour force in agriculture and quantity of rice output led to increase in rice production and vice versa. The coefficient of the error correction mechanism (ECM) which measures the speed of adjustment of the independent variable towards a long – run equilibrium carried the surmised negatively sign and is statistically significant at 1 %. This shows that a long – run equilibrium exist among the independent variables that estimated rice output in Nigeria in within 1970–2016. The error correction model of -0.882 suggested that a feedback of 88.2 % of the previous year's disequilibrium from the long run values of the independent price and non-price factors was evident. Thus there was a fast adjustment to long – run equilibrium among the independent variables included in the model which estimated the response of rice production to changes in the price and non-price factors within the period investigated and a feed back of 88.2 % of the adjustment towards long – run equilibrium for rice production was completed in one year.

On the other hand, the coefficient of multiple determinations (R^2) of 0.942 showed that the independent variables included in the model explained about 94.2 % of the variations in rice imports in the short – run. In the short run, the elasticity of domestic rice production is inelastic (-0.008). This result implies that increasing domestic rice production by 10% would only reduce quantity of imported rice by 0.01 %. This is an indication that a policy geared towards reducing imports of rice by increasing domestic production may not achieve its objective in the short-run. Also area harvested of rice, world price of rice and government capital investment on rice production were all negatively signed and statistically significant at 1 %, implying that increase in the previous year's area harvested of rice, world price of rice and government capital investment on rice production led to a decrease in rice imports and vice versa.

Also, rice imports responded positively to the one year lag of quantity consumed of rice, nominal exchange rate, domestic price of rice, population and imported quantity of rice. This implies that the increase in the previous year's amount of quantity consumed of rice, nominal exchange rate, domestic price of rice, population and imported quantity of rice led to an increase in rice imports in Nigeria and vice versa. The short-run elasticity of external foreign exchange reserves (0.595) is less than unity and is appropriately signed. This means that a 10 % rise in the level of external reserves, evokes a greater than proportionate (about 6%) increase in the quantity of imported rice into the country. The implication here is that since keeping huge external reserves is desirable both in terms of exchange rate stabilization and in the purchase of general imports, thus, a policy of import reduction cannot therefore suggest a reduction in external reserves as indicated in the positive relationship it has with the explained variable which is also very much significant This follows that the economics of this variable may not be interpreted in isolation.

The coefficient of the error correction mechanism (ECM) which measures the speed of adjustment of the independent variable towards a long – run equilibrium carried the surmised negatively sign and is statistically significant at 1 %. This shows that a long – run equilibrium exist among the independent variables that estimated rice imports in Nigeria in the period under study. The error correction model of --0.854 suggested that a feedback of 85.4 % of the previous year's disequilibrium from the long run values of the independent price and non-price variables was evident. Thus there was a fast adjustment to long – run equilibrium among the independent variables included in the model which estimated the response of rice imports to changes in the price and non price variables within the period investigated and a feed back of 85.4 % of the adjustment towards long – run equilibrium for rice imports was completed in one year.

4. Conclusions and Policy Recommendations

This study examined rice production, and imports by particularly analysing the determinants of rice import demand and production from 1970 to 2016. The model specification was based on the OLS multiple regression, while the estimation procedure made use of co-integration and error correction model. Empirical evidence shows that Import quantity of rice, area harvested of rice, quantity of rice consumed, government capital investment in agriculture, value of rice imports, labour force in agriculture and trend variable determined the quantity of rice production in Nigeria within the reference period in the long-run. In the short run, rice production was determined by one year lag of quantity of rice import, area harvested of rice, rainfall, government capital investment on rice production, domestic price of rice, value of government loan to farmers, real exchange rate, labour force in agriculture and quantity of rice output. The rate of adjustment towards long – run equilibrium for rice production was fast.

Quantity of rice production, quantity consumed of rice, world price of rice, nominal exchange rate, domestic price of rice and population determined rice imports in Nigeria within the period of investigation in the long-run. In the short run, rice imports responded to the one year lag of quantity of rice output, area harvested of rice, world price of rice, government capital investment on rice production, quantity consumed of rice, nominal exchange rate, domestic price of rice, population, external reserves and imported quantity of rice. The rate of adjustment towards long – run equilibrium for rice imports was fast. The study recommended that policies aimed at reducing rice imports in Nigeria should consider those significant price and non-price factors that determined rice imports in Nigeria in both short and long terms. Also policies aimed at increasing rice production in Nigeria should consider those significant price and non-price factors that determined rice production in Nigeria in both short and long terms the study recommends that policies aimed at reducing rice imports in Nigeria should consider those significant price and non-price factors that determined rice imports in Nigeria in both short and long terms. Also policies aimed at increasing rice production in Nigeria should consider those significant price and non-price factors that determined rice production in Nigeria in both short and long terms. Finally, policy actions to significantly reduce rice imports in the short-run should not only rely on reducing total imports, but should explore alternative measures such as trade agreements and perhaps restriction of rice imports to a level which will not lead to food insecurity, considering that rice is a food security crop in Nigeria.

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