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Drivers of *Cassava* and Rice Consumption in Nigeria: A Vector Error Correction Model Approach

Tohib Oyeyode Obalola[1], Tanko Likita[2], Kazeem Oriyomi Aboaba[3*] and Elega Julius Olabode[2]

[1]*Department of Agricultural Economics, Usmanu Danfodiyo University, P.M.B. 2346, Sokoto, Nigeria*
[2]*Department of Agricultural Economics and Extension Technology, Federal University of Technology, P.M.B. 65, Minna, Niger State, Nigeria*
[3]*Department of Agricultural Economics and Farm Management, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria*

*Corresponding author: aboabakazeem@gmail.com

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ABSTRACT

Considering the rate at which the country's population increases, bearing the population estimate in mind, the need arise to match the population increase with food production. Rice and *cassava* form the main meal of majority of the people of Nigeria, both the rich and the poor; therefore, providing both at affordable price is an important step towards achieving the food self-sufficiency objective of the nation. Bearing in mind past studies in Nigeria, more had been focused on price variation in the economy with very few of them addressing production, consumption or competitiveness in the economy. Filling this gap requires a study on the various factors that influence consumption of both rice and *cassava*. The study made use of secondary data which were tested for unit root using the Augmented Dickey-Fuller technique; Correlation analysis was used to evaluate the relationship between *cassava* and rice consumption and the Error Correction Model (ECM) to determine the long run relationship among variables. Findings revealed a positive relationship between *cassava* and rice consumption, with a low speed of adjustment for the variables in the short run. It was recommended that effort towards increasing household incomes in order to boost consumption should be adequately considered. There should be sustainability of the policies or programs towards increasing the production of these crops considering their importance in the food basket of the average populace.

Keywords: Time series, unit root, rice, *cassava*, consumption, Nigeria

The agricultural sector of Nigeria provides food for the growing population and income for millions of smallholders farmers. Agriculture feeds people, produces basic commodities for society and provides gainful employment for the majority (Ojemade, 2007). It provides employment for about 65 percent of the labour force for industrial development and also raw materials for industries (Akinpelu *et al*. 2011; Muhammed *et al*. 2013). However, the declining level

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of production in the Nigerian agricultural sector, rising food prices and increasing food import bills have become embarrassing considering the nature of agricultural resources available in the country (Onyemauwa, 2010).

Cassava and rice are major staple foods in Nigeria with the status of rice in the average Nigerian diet been transformed from being a luxury food item to that of a staple which is gradually taking part of the share formerly accounted for yam and other staples (Akande, and Akpokodge, 2003; Odushina, 2008). According to Akanji (1995) and Akpokodge *et al.* (2001), a combination of factors has triggered the structural increase in rice consumption which includes among many others: rapid urbanization and ease of preparation that fit easily to the lifestyle of urban workers.

Cassava is regarded as a food security crop in many developing countries, with a potential to provide off-season calories even on low-nutrient soils (Nweke *et al.* 2004). The crop is native to tropical regions of South America but is now a staple crop in many African countries (Allem, 2002). With the desire to sustainably increase production to improve food security, while also providing nonfood products from *cassava*, many countries have begun to explore innovative processes within their agricultural systems. It is expected that the demand for these crops (*cassava* and rice) will continue to increase (Akande, and Akpokodge, 2003; FAO, 2005) and thus will spur rural industrial development and contribute to the economic development of producing, processing and trading communities and well-being of numerous disadvantaged people in the world (IFAD, 2004).

Inadequate planning of Nigeria's agricultural sector to cope with the growing population has led to wide spread food shortage in the country (Akande, 2000). In spite of the leading position of Nigeria in the production of rice and *cassava*, the country depends greatly on importation of rice and still imports significant quantities of *cassava* products such as starch, flour, sweeteners that can be derived from *cassava*. This is because agriculture has not really played the role of supplying adequate raw materials to the industrial sector.

Current reality in Nigeria is that, the economy is indeed mono-cultural with dominance of oil to the detriment of other more tradable and productive sectors such as agriculture, which was largely abandoned when oil boom lasted (Faborode, 2016). While many useful genetic and agronomic characters of *cassava* have been identified through researches (IITA, 2001; Chukwuji *et al.* 2007), not much appear to be known on the determinants of *cassava* consumption in Nigeria, in which more than 84% of people consume *cassava* and *cassava*-based products at least every day (Onyemauwa, 2010). In the same vein, the rice self sufficiency goal is not new to Nigeria as there have been several initiatives in the past to this end. A policy choice that has been adopted each time is the introduction of import barriers. Unfortunately, the effects that followed did not lead to any significant supply response (Akaeze, 2010).

Rising consumer preference for rice has increased demand at a faster rate. As demand for rice has risen in Nigeria to about 6 million metric tons with the level of production of about 2.7 million metric tons and importation of about 3 million metric tons, it is clear that production has failed to keep pace while the gap has been bridge by growing imports (Wudl *et al.* 2015).

Although, studies in agricultural production have been carried out; (Kamal and Meenu, 2000; Thanh and Singh, 2006; Karmokar and Imon , 2008; Abdullahi *et al.* 2013; Nmadu *et al.* 2013 and Oyinbo *et al.* 2013), but those on the determinants of *cassava* and rice consumption in Nigeria are seldomly available. It was against this backdrop that this study sought to provide answers to the following research questions:

(i) What is the relationship between *cassava* and rice consumption in Nigeria?

(ii) What are the determinants of *cassava* and rice consumption in Nigeria?

MATERIALS AND METHODS

The study was conducted in Nigeria been one of the Sub-Saharan African countries in the Western part of Africa which shares land borders with the Republic of Benin to the West, Chad and Cameroon to the East, Niger Republic to the North and the Atlantic Ocean to the South with its coast lying on the Gulf of Guinea in the South and bordered by Lake Chad to the Northeast (The Federal Ministry of Environment of Nigeria (FMEN), 2001). It is the most populous country in Africa accounting for approximately one – sixth of Africa's population with an estimated population of about 182.2 million people (NBS, 2015), therefore representing about 2.35% of the world's total population, an indication that one person in every 43 people on the planet is a resident of Nigeria (Aregheore, 2009).

The rural population makes up over 50% of the Nigerian population (World Bank, 2017). In the rural areas, farming is the predominant occupation, with smallholder farming dominating. Cassava and rice are produced in almost all states of the federation. In Northern Nigeria, *cassava* is produced mainly in the Guinea savannah belt—Kogi, Kwara, Benue, Taraba, and Kaduna states—while all the states in the southern Nigeria produce *cassava* at various capacities. On the contrary, the major Northern rice producing states are Kebbi, Borno, Kano and Kaduna states while in the Southern region, we have Enugu, Ebonyi and Cross River with Taraba, Benue and Niger in the middle belt.

The longitudinal survey design was adopted for this study. Time series data were collected for the following variables and sourced from 1970 to 2016: Population (National Population Commission of Nigeria (NPC); Consumer price indices and quantities of domestic and imported rice as well as quantity of domestic *cassava* (National Bureau of Statistics (NBS); Gross Domestic Product (GDP) from Central Bank of Nigeria (CBN); Value of rice imports and price of domestic *cassava* and rice from Food and Agriculture Organization Statistics (FAOSTAT).

Other secondary data used for this study include rice per capita consumption (tonnes), *cassava* consumption (tonnes), interest rate (%), exchange rate (Naira/Dollar), consumer prices indices of rice and *cassava* (Naira), per capita income (Naira), rice production (tonnes), *cassava* production (tonnes), and rice importation (tonnes) between the period of 1970 – 2016.

Analytical Technique

Unit root test

The Augumented Dickey-Fuller (ADF) (Dickey and Fuller, 1979) was used for this test. It is used to test for stationarity or non-stationarity of each time series data set in order to avoid spurious results. The test also enables the determination of integration of the series, which is the number of times a series has to be differenced for it to become stationary. A stationary series is one with a mean value which will not vary within the sampling period. A series is integrated in the order of zero, denoted as I (0), if no differencing is needed to make it stationary and it is integrated in the order of one, denoted as I (1), if only one differencing is needed to make it stationary. A non-stationary series will exhibit a time varying mean (Juselius, 2006) or time varying variance denoted as I (d).

According to Gujarati (2003), the ADF test entails running a regression of the form:

$$\Delta Zt = \beta_1 + \beta_2 t + \partial Z_{t-1} + \sum_{i=1}^{m} \alpha \Delta Z_{t-1} + \ell \qquad \ldots(1)$$

Where;

Δ = Changing operator, Z_t = variable series, Z_{t-1} = past values of variables, t = time variable and e = error term and β_1, β_1, ∂, α = coefficients to be estimated.

However, when a series is found to be non-stationary, it is first differenced, that is $\Delta Z_t = Z_t - Z_{t-1}$ is obtained and the ADF is repeated on the first differenced series. If the null hypothesis of the ADF is rejected for the first differenced, then it is concluded as $Z_t - I$ (1). The model of the ADF test with a constant and trend was specified as follows:

$$\Delta Y_t = \alpha_0 + \alpha_2 t + \beta_1 Y_{t-1} + \sum_{i=1}^{p} \beta_2 \Delta Y_{t-1} + e_t \qquad \ldots(2)$$

Where;

Y_t = current value of consumption of rice or *cassava*, t = time trend variable, Δ = change operator, P = optimal lag length, α_0 = constant, α_2, β_1, β_2 = coefficients to be estimated and e = error term.

Correlation analysis

Correlation analysis was used to evaluate the relationship between *cassava* and rice consumption. The correlation model is expressed as:

$$r_{XY} = \frac{SP_{XY}}{\sqrt{SS_X SS_Y}} \qquad \ldots(3)$$

Where;

X = Rice consumption, Y = Cassava consumption,

r_{XY} = Correlation coefficient of rice and *cassava* consumption, SP_{XY} = Sum of product of rice and *cassava* consumption, SS_X = Sum of square of rice consumption and SS_Y = Sum of square of *cassava* consumption.

The Johansen Co-integration and Error Correction Model (ECM)

The Johansen co-integration test is preferred relative to all approaches because it indicates the number of co-integration vectors which determine the presence of long run comparing the trace statistics and critical values or Eigen value at most times. The test for co-integration is based on the framework developed by Johansen (1991) and it determines the number of co-integrating equations. This number is called the co-integrating rank. According to Johansen (1995), the variables are not co-integrated if the rank is zero, but if the rank = r, then there exists possible independent linear combinations (co-integrating vector) in the data consisting of all vars with a vector β so that;

$\beta_1 X_{1t} + \ldots + \beta_k X_{kt} = \beta' X_t$ ...... trend-stationary (meaning that after subtracting a deterministic trend the process is I(0) ...(4)

β_j ‡ 0, j = 1,..., k Then the X's are co-integrated.

If the Johansen co-integration test shows that co-integration exist among the variables, the ECM will be used which was the case for this study as results indicated that there exist co-integration among variables, therefore, ECM was employed. The hypothesis of co-integration was accepted when the number of co-integrating relationships is greater than or equal to one.

The Error Correction Model (ECM) to determine the long run relationship among variables is specified as:

$$\beta_0 + \sum_{i=1}^{p} \beta_1 \Delta 1nPOP_{t-1} + \sum_{i=1}^{q} \beta_2 \Delta 1nPCI_{t-1} + \sum_{i=1}^{r} \beta_3 \Delta 1nPOC_{t-1} + \sum_{i=1}^{s} \beta_4 \Delta 1nTRP_{t-1} + \upsilon_t \quad \ldots(5)$$

Where:

ln = natural log, β_0 = constant, $\beta_1 - \beta_4$ = coefficients to be estimated, Δ = change operator, p = optimal lag length, C = quantity of *cassava* or rice consumed (tons), POP = population (number), PCI = per capita income (₦), POC = price of *cassava* or rice (₦/ton), TRP = total quantity of *cassava* or rice produced (tons) and υ = error term.

The decision rule upon which to accept or not, that there exists a long run relationship among variables is based on the Likelihood Ratio (LR) and the critical value at a given level of significance. As such if the LR is less than the critical value at a given level of significance, it implies that there is no long run relationship among the variables; otherwise, there is a long run relationship among the variables.

RESULTS AND DISCUSSION

Summary Statistics of Variables

The summary statistics of the variables used in the empirical models for investigation in this study are presented on Table 1. The results showed that rice per capita consumption (RPCC), rice production (RPRO) and price of *cassava* (POC) were negatively skewed to the left tail while all other variables were positively skewed to the right. The probability of Jarque-Bera test of normality shows that consumer price index (CPI), gross domestic product (GDP) and value of rice imported (VRIMP) were statistically significant at 1% probability level (p< 0.01), price of rice (POR) and *cassava* per capita consumption (CPCC) at 5% (p<0.05) while total rice imported (TRIMP) was statistically significant at 10% (p<0.10) probability level. This is an indication that these variables are normally distributed. The implication of this result is that CPI, GDP, VRIMP, POR, PCI and TRIMP passed the normality test and therefore were all normally distributed. This result supports the findings of Oluyemisi and Angga (2013) in their study on econometric analysis of rice demand in Nigeria reported that price of rice, per capita income, gross domestic product and rice importation were all positively skewed to the right and statistically significant at the 1% probability level but contrary to the findings of Nathalie *et al.* (2013) who studied econometric analysis of the determinants of rice share in starchy staple calories and found that rice importation, price of rice and rice consumption were positively skewed to the right but were not statistically significant, thereby implying that these variables do not have the skewness and kurtosis matching that of a normal distribution.

Table 1: Summary statistics of the variables used for analysis

Variables	Minimum	Maximum	Mean	Std. dev.	Skewness	Kurtosis	Jarque-Bera
EXR	0.54	253.49	63.98	69.83	0.64	2.26	4.72
PCI	427.32	3221.68	1390.32	865.55	0.45	1.77	4.58
CPI	0.10	183.89	35.31	49.60	1.47	4.12	19.30***
GDP	23922.15	568498.80	163921.40	146054.40	1.33	3.67	14.67***
POP	55981.40	185990.00	108692.00	38134.53	0.41	2.02	3.20
RPCC	5.10	34.38	20.07	8.56	-0.33	1.91	3.21
POR	74.68	585.45	212.67	132.82	0.96	3.32	7.42**
RPRO	284000.00	2877000.00	1495809.0	877420.10	-0.06	1.60	3.85
RCON	285000.00	5600000.00	2470702.0	1667734	0.40	1.94	3.47
RIMP	1000.00	3200000.00	982042.60	883102.40	0.82	2.60	5.62*
VRIMP	71.00	1593455.00	311087.30	402861.30	2.04	6.37	54.75***
CPRO	917200.00	5764371.00	27041638	15414317	0.36	1.87	3.53
CPCC	0.02	0.07	0.04	0.01	0.11	1.26	6.02**
POC	30.02	98.85	69.96	21.23	-0.28	1.72	3.84

Source: Output from data analysis, 2018.

***, ** and * implies significant at 1%, 5% and 10% levels respectively.

EXR = Exchange rate; **PCI** = Per capita income; **CPI** = Consumer price index; **GDP** = Gross domestic product; **POP** = Population; **RPCC** = Rice per capita consumption; **POR** = Price of Rice; **RPRO** = Rice production; **RCON** = Rice consumption; **RIMP** = Rice importation; **VRIMP** = Value of rice imported; **CPRO** = Cassava production; **CCON** = Cassava consumption; **CPCC** = Cassava per capita consumption; **POC** = Price of *cassava*.

Table 2: Augmented Dickey Fuller (ADF) Unit Root Test of Variables

Variable	Level	1st Difference	Order of Integration	Critical Value (5%)
Exchange rate	-0.725 (0.972)	-4.486*** (0.005)	I(1)	-3.524
Gross Domestic Product	-2.032 (0.584)	-4.411*** (0.002)	I(1)	-3.524
Per capita income	-2.020 (0.591)	-4.513*** (0.001)	I(1)	-3.524
Per capita consumption (rice)	-3.815** (0.016)		I(0)	-3.524
Per capita consumption (*cassava*)	-2.263 (0.455)	-5.193*** (0.000)	I(1)	-3.524
Consumer price index	2.951 (1.000)	-9.246*** (0.000)	I(1)	-3.524
Population	-2.876 (0.170)	-12.047 (0.000)	I(1)	-3.524
Rice production	-2.387 (0.387)	-5.636*** (0.000)	I(1)	-3.524
Rice consumption	-3.089 (0.109)	-4.197*** (0.005)	I(1)	-3.524
Rice importation	-2.058 (0.569)	-5.228*** (0.000)	I(1)	-3.524
Price of rice	-1.137 (0.923)	-6.220*** (0.000)	I(1)	-3.524
Cassava consumption	-1.129 (0.924)	-5.883*** (0.000)	I(1)	-3.524
Cassava production	-2.519 (0.318)	-7.824*** (0.000)	I(1)	-3.524
Price of *cassava*	-1.456 (0.844)	-5.651*** (0.000)	I(1)	-3.524

Source: Output from data analysis, 2018.

*** and ** implies significant at 1% and 5% probability levels respectively.

Figures in parentheses are probability values.

Stationarity Test

The ADF test shows that only rice per capita consumption (RPCC) was stationary at level with order of integration 0, I (0) while other variables were non stationary at levels but became stationary after first differencing with order of integration 1, I (1). The results also show that rice per capita consumption was significant at the 5% probability level (p<0.05) while other variables were significant at the 1% probability level (p<0.01). This result corroborates the findings of Wudil *et al.* (2015) who studied econometric analysis of the effect of rice production and importation on domestic consumption in Nigeria (1999-2013) and indicated that the variables; total rice production, total rice importation and total rice consumption were all stationary at first difference and integrated of order I (1) leading to the rejection of the null hypothesis of non stationarity of variables.

Correlation analysis between *cassava* and rice consumption

There was a strong and positive association between *cassava* and rice consumption in Nigeria during the period under study with a correlation coefficient of 0.9781 (Table 3) and was statistically significant at the 1% probability level (p<0.01).

Table 3: Result of correlation analysis between *cassava* and rice consumption

Variable	CCON	RCON
CCON	1.0000	
RCON	0.9781***	1.0000

Source: Output from data analysis, 2018.

*** implies significant at the 1% probability level.

CON = Cassava consumption; RCON = Rice consumption.

This is an indication that *cassava* and rice consumption moves in the same direction, which implies that as *cassava* consumption increased, rice consumption also increased. The implication of this result is that *cassava* is not a substitute for rice in Nigeria as both products can be consumed independently. This finding contradicts that of Mushingwani (2009) who studied the factors affecting *cassava* and maize consumption in an urban population in Zambia and found a negative association between *cassava* and maize consumption.

Results of cointegration test

Short and long run effects of economic variables on *cassava* consumption

The results of Johansen co-integration test presented in Table 4 show a trace statistic of 150.1464 which is greater than the critical value of 69.8188 at 5% level of significance (p<0.05). The results show that there was one co-integration equation among the variables. Therefore, based on the decision rule, the null hypothesis of no co-integration among the variables, namely; *cassava* consumption, population, per capita income, price of *cassava* and *cassava* production was rejected. This implies that there is a long run relationship among *cassava* consumption, population, per capita income, price of *cassava* and *cassava* production in Nigeria during the 1970 – 2016 and the variables in the model are co-integrated.

Table 4: Co-integration Rank Test (Cassava Consumption)

Hypothesized No. of CE(s)	Eigen Value	Trace Statistics	Critical Value (5%)
None*	0.9136	150.1464	69.8189
At most 1	0.3896	42.3795	47.8561
At most 2	0.2972	20.6586	29.7971
At most 3	0.0860	5.1409	15.4947
At most 4	0.0266	1.1866	3.8415

Source: Output from data analysis, 2018.

* denotes rejection of null hypothesis at 5% significant level.

Short and long run effects of economic variables on rice consumption

The results of Johansen co-integration test presented in Table 5 show a trace statistic of 72.2477 which is greater than the critical value of 69.8188 at 5% level of significance (p< 0.05). This implies that there was one co-integration equation among the variables. The null hypothesis of no co-integration among the variables, namely; rice consumption, population, per capita income, price of rice and rice production was rejected. This shows that there is a long run relationship among rice consumption, population, per capita income, price of rice and rice production in Nigeria. The implication of this result is that since the test for number of co-integrating vector (s) based on trace statistic indicated "one" co-integrating equation at the 5% level. By this, it can be concluded that the variables in the model are co-integrated. With co-integration having been confirmed, a dynamic error correction model or vector equilibrium correction model, instead of a VAR becomes more appropriate since there exist a long run relationship between the macroeconomic variables and *cassava* and rice consumption in Nigeria during the period of study. The Error Correction Model (ECM) was therefore applied.

Table 5: Co-integration Rank Test (Rice Consumption)

Hypothesized No. of CE(s)	Eigen Value	Trace Statistics	Critical Value (5%)
None*	0.4990	72.2477	69.8189
At most 1	0.4052	41.1484	47.8561
At most 2	0.1687	17.7672	29.7970
At most 3	0.1535	9.4529	15.4947
At most 4	0.0425	1.9522	3.8415

Source: Output from data analysis, 2018.

* denotes rejection of null hypothesis at 5% significant level.

Vector Error Correction Model Estimates for *cassava* consumption

The ECM results shows a coefficient of determination (R^2) of 0.863, which implies that about 86% of the variation in *cassava* consumption was explained by population, per capita income, price of *cassava* and *cassava* production as specified in the ECM while the remaining 14% was accounted for by error in estimation and other variables not included in the model. The F-statistic was 100.890 and statistically significant at 1% ($p<0.01$) probability level. This shows that the entire ECM was significant and that the explanatory variables adequately explained the dependent variable. In the long run, the results of the Error Correction Model (ECM) for *cassava* consumption show that the ECM coefficient (-0.936) was negative and statistically significant at 1% probability level ($p<0.01$) which is an indication that there is a long run relationship between the explanatory variables used in the model and *cassava* consumption during the period under study.

The implication of the LR relationship between *cassava* consumption and the explanatory variables, namely; population, per capita income, price of *cassava* and *cassava* production is that these variables significantly influence *cassava* consumption and therefore determines the direction of growth of *cassava* consumption in the long run. The results also show that the coefficient of population (0.584) and *cassava* production (0.295) were found to be positively related to *cassava* consumption and statistically significant at 1% ($p<0.01$) and 5% ($p< 0.05$) probability levels respectively. This implies a direct relationship. This suggests that 1% increase in population will result to 0.58% increase in *cassava* consumption and vice versa while a 1% increase in *cassava* production will result to 0.30% increase in *cassava* consumption and vice versa. This result agrees with the findings of Tsegai and Kormawa (2002) that analyzed the determinants of urban household demand for *cassava* and *cassava* products in Kaduna State, Nigeria and observed that *cassava* consumption was influenced by the level of *cassava* production and population growth. Also, the coefficient of price of *cassava* (-2.488) was found to be negatively related to *cassava* consumption and statistically significant at 10% ($p< 0.10$) probability level. This is an inverse relationship, which implies that 1% increase in price of *cassava* will result in 2.49% decrease in *cassava* consumption and vice versa. This result is in line with the a priori expectation and in conformity with the law of demand which states that the higher the price of a commodity, the lower the quantity demanded and vice versa. This finding corroborates that of Adeniyi (2014) on the determinants of *cassava* consumption in Asa Local Government Area of Kwara State Nigeria, who also found that price of *cassava* was a significant factor to consider in *cassava* consumption.

In the short run, the ECM coefficient for *cassava* consumption as presented in Table 6 was -0.001, which indicates a low speed of adjustment of population, per capita income, price of *cassava* and *cassava* production towards equilibrium. This implies that the speed of adjustment at which the variables used in the model will be in equilibrium with *cassava* consumption is at the rate of 0.001%.

Table 6: Estimates of the Vector Error Correction Model for Cassava consumption

Variable	Coefficient	Standard Error	t-statistics
Long Run			
ECM (-1)	-0.936***	0.339	2.760
POP (-1)	0.584***	0.144	4.060
PCI (-1)	1141.441	1486.808	0.770
POC (-1)	-2.488***	0.283	8.810
CPRO (-1)	0.295*	0.171	1.730
Constant	609298.800	542621.300	1.120
Short Run			
ECM (-1)	-0.001	0.007	0.190
POP (-1)	2.053	7.782	0.260
POP (-2)	0.716*	0.387	1.850
PCI (-1)	0.000	0.003	0.230
PCI (-2)	209.897	814.792	0.250
POC (-1)	2.38e-12***	8.14e-12	2.930
POC (-2)	0.501	0.488	1.030
CPRO (-1)	9.02e-09	5.33e-07	0.020
CPRO (-2)	542.374***	256.926	2.110
Constant	-0.377	1.172	0.320
R-squared	0.863		
Adj. R-squared	0.743		
F-statistics	100.890***		
AIC	29.831		
HQIC	30.735		
SC	32.066		

Source: Output from data analysis, 2018.
***, ** and * implies significant at 1%, 5% and 10% probability level respectively.
CCON = Cassava consumption; POP = Population; PCI = Per Capita Income; POC = Price of Cassava; CPRO = Cassava production; AIC = Akaike information criterion; HQIC = Hannan Quinn Criterion; SC = Schwarz criterion.

Vector Error Correction Model for Rice Consumption

This study also investigated the LR between rice consumption and some selected macroeconomic variables and the results are presented in Table 7. The ECM coefficient (-0.888) was negative and statistically significant at 1% probability level ($p< 0.01$) which is an indication that there is a long run relationship between the macroeconomic variables included in the model and rice consumption. These results are in line with the findings of Bamidele and Abayomi (2007) who found out that there exist a LR relationship between price of rice, per capita consumption, income, population and rice consumption. The significance of the ECM supports the presence of co-integration and therefore suggests the existence of a LR relationship between the quantity of rice consumed and other macroeconomic variables.

Table 7: Estimates of the Vector Error Correction Model for Rice consumption

Variable	Coefficient	Standard Error	t-statistics
Long Run			
ECM (-1)	-0.888***	0.284	3.130
POP (-1)	0.313*	0.185	1.690
PCI (-1)	-0.003	0.003	1.030
POR (-1)	-0.077***	0.025	3.020
RPRO (-1)	2.531***	0.926	2.730
Constant	-4.58e-06	4.49e-06	1.020
Short Run			
ECM (-1)	0.236***	0.106	2.230
POP (-1)	-11139.610	9680.488	1.150
POP (-2)	7.10e-08***	3.0e-08	2.390
PCI (-1)	89.810	198.132	0.450
PCI (-2)	-150.167	148.808	1.010
POR (-1)	-106.457	1325.417	0.080
POR (-2)	282.670***	116.067	2.440
RPRO (-1)	0.053	0.234	0.220
RPRO (-2)	447.770*	255.525	1.870
Constant	33.153	42.137	0.780
R-squared	0.662		
Adj. R-squared	0.552		
F-statistics	181.110***		
AIC	26.842		
HQIC	37.613		
SC	39.931		

Source: Output from data analysis, 2018.
***, ** and * implies significant at 1%, 5% and 10% probability level respectively.
RCON = Rice consumption; POP = Population; PCI = Per Capita Income; POR = Price of Rice; RPRO = Rice production; AIC = Akaike information criterion; HQIC = Hannan Quinn Criterion; SC = Schwarz criterion.

The results also show that the coefficient of population (0.313) and rice production (2.531) were positively signed and related to rice consumption; and statistically significant at 10% ($p<0.10$) and 1% ($p<0.01$) probability levels respectively. This is a direct relationship which implies that 1% increase in population will result to 0.31% increase in rice consumption and vice versa while 1% increase in rice production will result to 2.53% increase in rice consumption and vice versa. This finding suggests that increase in population and increase in rice production has the propensity to increase rice consumption because as population increases, there tends to be increased demand for the commodity while as rice production increases, this increases the availability of the commodity and as such increase in rice consumption. This result is in line with the findings of Akande (2002) who studied the overview of Nigerian rice economy and concluded that combinations of factors have triggered the increase in rice consumption, one of which was as a result of increasing population growth. Also, Onu *et al.* (2015) studied the empirical assessment of the trends in rice production and imports in Nigeria (1980 – 2013) and found that population growth and urbanization were the principal factors driving increased rice demand in Nigeria.

Also, the coefficient of price of rice (-0.077) was found to be negatively related to rice consumption and statistically significant at 1% ($p<0.01$) probability level. This is an inverse relationship, which implies that 1% increase in price of rice will result to 0.08% decrease in rice consumption and vice versa. This result is in line with the a priori expectation and could be attributed to the fact that consumers tend to buy less of a commodity as the price of such commodity increases. This result also conforms to the findings of Bamba *et al.* (2010) who found that price of rice represents a significant factor of rice consumption as it is one of the major determinants of rice consumption in Nigeria. Also, Oyinbo (2014) studied household demand structure for rice consumption in Kaduna State, Nigeria and concluded that price of rice among other variables significantly influenced household preference for rice consumption.

The coefficient of determination (R^2) was 0.662 which implies that about 66% of the variation in rice consumption was explained by population, per capita income, price of rice and rice production while the remaining 34% was accounted for by errors in estimation and other variables not included in the model. The F-statistic was 181.11 and statistically significant at 1% ($p<0.01$) probability level. This shows that the entire ECM was significant.

In the short run, the ECM coefficient for rice consumption as presented in Table 7 was 0.236 and significant at the 1% probability level, which indicates a low speed of adjustment of population, per capita income, price of rice and rice production towards equilibrium. This implies that the speed of adjustment at which the variables used in the model will be in equilibrium with rice consumption is at the rate of 23.58%.

CONCLUSION

The findings of this research indicate a strong positive relationship between *cassava* and rice consumption and can be said to be mutually exclusive. A long run relationship was observed between consumption of the two crops, population, per capita income, prices of the crops alongside their respective production. In the short run, low speed of adjustment was observed for population, per capita income, price of *cassava* and *cassava* production towards equilibrium for *cassava* consumption during the study period. In the case of rice, a low speed of adjustment towards equilibrium was also observed for population, per capita income, price of rice and rice production during the study period. These were however based on their respective ECM coefficients. The study therefore recommends effort towards increasing household incomes in order to boost consumption as more need to be done with the crops been a major staple consumed by majority of the Nigerian populace in one form or another, thus, priority is desired to increase the level of production of the crops. The sustainability of the policies or programmes towards increasing rice production should be worked on.

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