Aggregate Import Demand Analysis of Rice in Nigeria (1970-2012)

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Abstract: The objective of this study was to determine the aggregate import demand for rice in Nigeria. This study was based on time series secondary data obtained from various sources covering 1970 to 2012. The data were subjected to Augmented Dickey Fuller (ADF) and co-integration tests to measure stability of data for likely inclusion in the model. Import price, export earnings and import earnings had t-values at the trended first difference ADF test that were greater than critical values. The series are generally I (1) series except for price and export earnings I (>1). Trace test and Maximum Eigenvalue test reveal that the series in rice import demand model are co-integrated, with more than 1 co-integrating equation existing between them. The import demand function has both import price and income from export earnings being statistically significant at 1 percent level. Result shows that the Error Correction Model (ECM) term is associated with the desired negative coefficients which however are significant ($p < 0.10$). This result suggests stable long run relationships. However, the speed of adjustment is rather too slow but insignificant. The coefficient of the time trend was positive. This means that time was relevant in explaining variation in rice import. The findings and conclusion from this study led to the policy implications which if implemented will ensure the designing of consistent and welfare maximising import plan capable of stimulating the domestic growth of domestic rice production.
[Okeowo, T. A. **Aggregate Import Demand Analysis of Rice in Nigeria (1970-2012).** *World Rural Observ* 2016;8(3):12-18]. ISSN: 1944-6543 (Print); ISSN: 1944-6551 (Online). http://www.sciencepub.net/rural. 2. doi:10.7537/marswro080316.02.

Keywords: **A**ggregate, Co-integration, Import demand, Nigeria, Rice

1. Introduction

Agricultural sub-sector remains the mainstay of the Nigerian non-oil economy particularly in terms of national output and employment generation. The potentials of the sub-sector has, however, not been fully developed (Bello, 2004). Rice form a considerable proportion of food commodities produced and marketed in Nigeria by farmers. The output of rice was generally good in the early 60s, although there was decline in the production in recent years. Akande, (2001) reported that rice is cultivated in virtually all the agro-ecological zones in Nigeria. Despite this, the area cultivated to rice still appears small. Of about 25 million hectares of land cultivated to various food crops, only about 6.37% was cultivated to rice. During this period, the average national yield was 1.47 tons per hectare. Rice is the fourth largest crop produced in Nigeria after sorghum, millet and maize (Fashola et al., 2007). In the

last 30 years production has increased 6 folds with Nigeria producing 3.3 and 3.6 million tons of paddy rice in 2000 and 2005 respectively (FAOSTAT, 2007). Despite the increase in rice production in the country, it still remains a paradox that the production has consistently fallen below the national demand (Abba and Mohammed, 2000).

The demand for rice in Nigeria has been soaring. Rising demand was partly the result of increasing population growth, increased income levels, rapid urbanization and associated changes in family occupational structures. The average Nigerian now consumes 24.8 kg of rice per year, representing 9% of total caloric intake (Rice Web, 2001). The price elasticity of import demands for wheat and rice are 0.69 and 2.06 respectively, although the price elasticity for wheat is significantly negative (Hyunsoo *et al*., 2009).

Experts say some 4.9 million hectares of the country's 120 million hectares of arable land is suitable for rice cultivation. Only 1.8 million of that or 37 percent is currently being utilized for that purpose. Yet about 3.14 million hectares of land can also be irrigated for rice production. Specifically, the 11 River Basins project in the country have the capacity and high potential for enhancing the rice value chain. In fact, the under-utilized irrigation schemes located in 26 states boast of some 47, 300 hectares of land suitable for rice production (Eguwaikhide, 1993).

The problem militating against the positive import of food commodities have been identified to be exchange rate, local production, tariff, decline in economic and export performance. The country's imports of rice, wheat and maize are sensitive to real exchange rate and world price, implying that overvaluation of national currency resulted in increased imports and consumption of these

commodities to the disadvantage of cereals produced in Nigeria. A succession of good harvest produces price reductions in cereals imports and a resurgence of public and private investment in crop production resulted in a sharp recovery in production (FAO, 2001). In spite of the importance of basic food grains both in agricultural production and in food consumption, there is lack of knowledge as to how changes in prices and other factors affect their production and consumption. Lacking supply and demand function estimates, policy decisions are often taken exclusively on the basis of political pressures from interest groups.

The threat of price increases and the subsequent complaint of consumers necessitate most times government motivation to intervene in the markets by importing food grains (Akande, 2000). Very often these decisions to import result in over supply, driving prices down to the detriment of producers, where if decisions were to be based on quantitative estimates, the magnitude of interventions could be calculated to only correct temporary anomalies. In particular, the price elasticities of demand are vital components of how much consumption are affected by price policy decisions (Akande, 2000).

Bello (2004) reported that the ban on rice importation in 1986 led to an increased rice production from 0.94 million tonnes in 1986 to 2.54 million tonnes in 1990. Of all cereal import, rice alone gulps ₦60 billion in 1990 of which Nigeria imported 224, 000 million tonnes of rice. As in many developing nations, basic food grains in Nigeria are of critical importance in rural economy and in the daily diets. Information of price elasticities of supply and demand can be crucial to better inform policy making (IRR, 1996). Thus, this study aims at determining the aggregate import demand for rice in Nigeria covering 1970 - 2012.

2. Modelling and data

Econometric estimation of import demand model include that the demand for imports is the function of domestic price and real income (Murry and Ginman, 1975; Deyak *et al*, 1988; Carone, 1996). These papers suggest that in modelling the import demand function, the log-log linear model is preferable to the linear model. Therefore, the log –log import demand function is specified as follows;

SLog (IM it) = a0 + a1Slog (GNIit) + a2 Log (DRPt) + et .....(Eq 1)

i =1 i =1

Where

IM_{it} = the import volume of rice in period t;

GNI_{it} = the gross national income (GNI) for importing country$_i$ in period t;

DRP = domestic rice price in period t; and

u_i = the random error term.

Coefficients a_1 and a_2 indicate the income and price elasticities of import demand, respectively. On the basis of the *apriori*, we can expect that $a_1>0$ and $a_2<0$.

3. Methodology

This study was based on time series secondary data to be obtained from various sources covering 1970 to 2012. They were obtained from various editions of the National Bureau of Statistics' review of external trade. National Bureau of Statistics' Trade Summary and Annual abstract of Statistics, Central Bank of Nigeria's Economic and Financial Review and the CBN Statistical Bulletin covering various years. Import quantities were extracted for the entire period (1970 – 2012) from FAOSTAT (2014) – an online database maintained by Food and Agriculture Organisation (FAO).

3.1 Statistical properties of the series

While estimation of the theoretical model specified below in Eq. 1 would appear straight forward, recent development in time series modelling points to the need to exercise some caution, by first examining the statistical properties of the series and incorporating these in the final model specification where necessary, as to guarantee non-spurious regression. The tests for statistical properties of the series will be done in three stages. The first stage of the analysis will involve the test for stationarity of the individual economic series, which is a precondition for application of least square techniques, and the failure of which Granger and Newbold (1974) observe results in spurious regression. This test will be conducted on each series using procedures for the two variants of augmented Dickey-Fuller (ADF) tests (Dickey and Fuller (1981), with one lagged term, in E-Views.

3.2 The economic model

The cereal demand model that was used in the analysis is stated in general form as:

Q_{dt} = f (Pt, Yt, Xt, T)…… (Eq 2)

Where

Q_{dt} = Quantity of commodity imported in period t.

P_t = Import price of commodity in period t.

Y_t = Nigeria's capacity to import, defined as total export earnings in period t.

X_t = Measure of Nigeria's import restriction defined as total earnings from import duties in period t

T = Time trend variable measured in year.

Based on theory, quantity demanded (Q_{dt}) is determined principally by the price of the commodity and income relative to other determinants or variables. Thus, following the usual approaches in literatures, the long-run equilibrium demand function to be adopted in this study is specified in double logarithmic form as follows:

$InQ_{dt} = \beta_0 + \beta_1 lnP_t\ \beta_2 lnY_t + \beta_3 ln\ X_t + \beta_4 lnT + u_t$…… (Eq 3)

Where:

lnQ^i_t = the natural logarithm of aggregate quantity of commodity imported in period t.

lnP^i_t = the natural logarithm of aggregate quantity of import price of commodity in period t.

lnY^i_t = the natural logarithm of Nigeria's capacity to import, defined as total export earnings in period t.

lnX^i_t = the natural logarithm of the average world price measure of Nigeria's import restriction defined as total earnings from import duties in period t

lnT^i_t = the natural logarithm of the time trend variable measure in year.

The coefficients β_1, β_2, β_3, and β_4 can be interpreted, in a similar version to Arize *et al* (2000), as the elasticity of demand for rice with respect to the determinants. *Apriori*, the expectations are as follows:

$\beta_1 < 0$; $\beta_2 > 0$; $\beta_3 < 0$ and β_4 could either be > 0 or < 0

3.3 Trend Analysis

Trend analysis was undertaken by making quantity demanded a function of time. The modeling was as follows:

$Q_{rt} = \beta_0 + \beta_1 T + \mu_i$……(Eq 6)

Where:

Q_{rt} = Annual quantity demanded of rice (Tonnes)

T = Time Variation i.e. T = 1, 2, ……40 years (1970-2012)

μ_i = Disturbance term

Having ascertained that the series in the economic model are non-stationary in their level, but stationary in their first difference, it became obvious that least square technique would not be appropriate for the estimation of the economic model. Thus, bearing in mind the need to accommodate the interdependence of relationships between most economic variables, the economic model will be re-conceptualised as a vector autoregressive system, allowing for the possibility of co-integration among the endogenous variables.

$\Delta y_1 = Bx_t + \Sigma \Gamma_i\ \Delta y_{t-1} + \prod y_{t-1} + e_t\ i = 1$ …….(Eq.7)

Where:

x = is vector of deterministic variables, constant (C) and/or trend;

y = is vector of I (1) endogenous variables – lnQ^i, lnP^i, lnY^i, lnX^i and lnT^i.

β, Γ and $\prod$ are matrices of coefficients to be estimated, while

e = is vector of stochastic residuals.

Term in β gives the influence of the associated deterministic variables, while Γ represents short-term elasticities of response. And, where evidence of $r < 5$ co-integrating relations exists, by Granger causality theorem, $\prod = \beta\ \alpha$; in which β is the co-integrating vector (containing the long-run elasticities), while elements of α are the adjustment parameters in the vector error correction model. The next stage in the modelling technique was to test for co-integration among the endogenous variables in the VAR system. This was implemented in E-Views (1998) using procedures for Johansen (1992, 1995b) system based techniques. The test utilized a Trace Statistic based likelihood-ratio (LR) test for the number of co-integrating vectors in the system.

4. Results and discussion

4.1 Descriptive statistics of the series

Against the background that test for stationarity of economic series must precede their inclusion in regression models as to avoid estimating spurious regression, this study conducted the ADF unit root tests on the levels and first difference of the economic series in the study. The results are summarized in Table 1. As shown in Table 1, rice import demand function shows a unit root test that reveals the association of t-values that are greater than the critical values at the series level both at the trended and non-trended models. All variables exhibited I (1) series except for producer price (p >1). However, non-trended model at the first difference shows output supply, hectarage, world price, import quantity and rainfall as being greater in absolute values than critical value thus providing basis for the rejection of the unit root. Producer price however exhibited non-stationarity throughout. Rice output, hectarage and rainfall had t-values at the trended first difference ADF test that were greater than critical values. Thus, we reject the null hypothesis.

4.2 Tests for co-integration

For any meaningful long-run relationship to exist between non-stationary series, it is important that some linear combinations of the series must be co-integrated; such that even though the individual I(1) series may drift apart in the short run, they follow a common trend which permits stable long-run relations between them (Shittu *et al.*,2007). In an attempt to empirically investigate the co-integration test, the approach recommended by Johansen (1992, 1995a) for the linear combination of the series in the import demand model for rice was adopted. Table 3 present results of Johansen (1992; 1995a) test of co-integration between rice import demand and its determinants using both the Trace test and the Maximum Eigenvalue test. Both tests provide evidence of co-integration. The results of the Trace test reveals that the hypothesis of no co-integration (Ho: r = 0) is rejected at $p < 0.05$; given that the calculated trace test statistic (57.21) is higher than the critical value (47.85) at $p < 0.05$. . Thus, Trace test and Maximum Eigenvalue test reveal that the series in rice import demand model are co-integrated, with more than 1 co-integrating equation existing between them.

Table 1: Results of ADF Unit root tests

	Test statistic at levels		**Test statistic first difference**		**Comment**
	Non trended model	Trended model	Non trended model	Trended model	
Rice series					
LnQ	-2.4398	-9.2103	-1.40	-135	I(1)
LnY	-1.01	-2.2	-3.79*	-3.79*	I(1)
LnP	-3.2109	-6.8684	-1.64	-1.42	I(>1)
LnX	-2.39	-2.36	-2.84*	-2.92	I(1)
LnT	-1.89	-2.61	-2.78*	-2.67	I(1)
Critical value	**-2.57**	**-3.13**	**-2.57**	**-3.13**	

NB: To reject H_o, ADF t-value must be negative, and greater in absolute value than the critical ADF statistic (i.e. $t_{cal} < t_{tab}$)

Source: Data Analysis, 2014.

Table 2: Johansen Co-integration tests for rice

Hypothesized		**Trace**	**0.05**	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
Trace Test				
None *	0.556416	57.21147	47.85613	0.0052
At most 1	0.387313	27.94823	29.79707	0.0805
At most 2	0.243890	10.31181	15.49471	0.2575
At most 3	0.006847	0.247351	3.841466	0.6189
Maximum Eigenvalue				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.556416	29.26324	27.58434	0.0302
At most 1	0.387313	17.63643	21.13162	0.1441
At most 2	0.243890	10.06446	14.26460	0.2077
At most 3	0.006847	0.247351	3.841466	0.6189

Source: Data analysis, 2014

Table 3: Estimated import demand function for rice

Variable	**Coefficient**	**t-value**	**R^2**
Constant	-1066.646	-1.113	0.963
LnPt	0.955	27.765***	
LnYt	1.100	-3.598***	
LnXt	0.361	1.045	
LnT	141.549	1.045	

*=significant at 1%. ** == significant at 5%. *** =significant at 10%.

Aggregate Import Demand Functions

This study estimated the import demand equation for rice. Table 3 shows the import demand functions with their corresponding coefficient of multiple determinations (R^2) for the crop under investigation.

Table 3 has an R^2 of 0.963 showing that 96.3% of tested independent variables affect the importation demand for rice and are thus included. The model further revealed a positively related import price of rice in period t (P_t) which contradicts the economic expectations whereas Nigeria's capacity to import, defined as total export earnings in period t (Y_t) is inversely related to import demand for rice which also contradicts the *apriori*. Rice import demand function has both import price and income from export earnings being statistically significant at 1 percent level.

4.3 Estimation of the short run elasticities (VECM)

The short run elasticity of the relationship between rice import demand response to their determinants and the speed of adjustment to any shock to the long run equilibrium is captured within the short run error correcting model (ECM) equation. Result in Tables 4 shows that the ECM terms are associated with the desired negative coefficients which however are significant for rice ($p < 0.10$). It is important to

note that the error correcting model term measures the direction and speed of adjustment of the long run model to any shock to its equilibrium. A negative sign suggests that any shock to the long run equilibrium is corrected with the import demand response occurring in the opposite direction to that of the impact of the exogenous variable e.g war or other natural disaster that destabilises the equilibrium. The speed of adjustment is measured by the coefficient which shows the fraction of the shift away from the equilibrium that is corrected within the next one year. The fact that the ECM term in the short run model is negative suggests stable long run relationships, however, the speed of adjustment is rather too slow but insignificant. This is evident in the result as 1.7% proportion of disequilibrium in one period is corrected in the next period. Olayemi (1998) opined that where the adjustment coefficient is less than 0.5, the speed of adjustment to production is said to be small or sluggish.

Table 4: Vector Error Correction Model of Aggregate Import Demand for Rice

Error Correction:	**D(LNRICMQ)**	**D(LNRICMP)**	**D(LNYT)**	**D(LNXT)**
CointEq1	-0.075905	0.014154	-0.056292	0.067085
	[-1.74225]*	[1.24560]	[-1.81186]	[2.35437]
D(LNRICMQ(-1))	-0.168451	0.007059	-0.067576	0.053417
	[-1.29360]	[0.20784]	[-0.72771]	[0.62721]
D(LNRICMP(-1))	1.956022	0.112065	-0.024716	0.437294
	[3.99898]	[0.87841]	[-0.07086]	[1.36695]
D(LNXT(-1))	-0.167242	0.094526	-0.275085	-0.180064
C	0.185660	-0.046538	0.258144	0.335052
	[0.13249)	(0.03456)	(0.09448)	(0.08665)
R-squared	0.478615	0.261451	0.125970	0.401855
F-statistic	5.507802	2.124043	0.864750	4.031020
Log likelihood	-33.02204	15.35863	-20.85029	-17.73619

4.4 Long run elasticities

As shown in table 5, coefficients associated with income from export earnings and import earnings are significant at $p < 0.01$, import price was however not significant. The study supports the findings of Murray and Ginman (1975) who argued that imports depend upon price of imports specified in domestic currency as well as the price of domestically produced substitutes.

4.5 Trend Analysis of Aggregate Import Demand for rice (1970-2012)

The estimated trend equation is presented in Table 5. The coefficients of the time trends were positive. This means that time was relevant in explaining variation in the importation of rice. The coefficient is statistically significant ($p < 0.01$) signifying general output increases over the period. The regression equation also has good fit with R^2 of 0.83 and F-value of 169.13 respectively. Since positive slope coefficient was observed for the output supply series, it is concluded that significant growth or increases was recorded in output supply of the selected cereal during the period under consideration.

Table 5: Long run estimation for rice

Parameter	**Coefficient**
LNRICMQ(-1)	1.000000
LNRICMP(-1)	-1.707707
	[-1.10745]
LNYT(-1)	7.272765
	[5.79858]
LNXT(-1)	-8.295879
	[-5.97639]
C	5.075133

Table 6: Trend in Import Demand of rice

Crop	β_o	β_1	R^2	F Value	Sig.
Rice	-0.007 (=4.1)	20742.816 (4.1)***	0.31	16.84	0.000

Source: Data Analysis, 2014

5. Conclusion and recommendations

The study investigated the aggregate import demand for rice in Nigeria from 1970 to 2012. The data were subjected to ADF Tests and cointegration tests to measure stability of data for likely inclusion in the models. Rice import price, export earnings and import earnings had t-values at the trended first difference ADF test that were greater than critical values. The series are generally I (1) series except for price and export earnings I (>1). Trace test and Maximum Eigenvalue test reveal that the series in rice import demand model are co-integrated, with more than 1 co-integrating equation existing between them. Rice import demand function has both import price and income from export earnings being statistically significant at 1 percent level. Result shows that the ECM terms are associated with the desired negative coefficients which however are significant for rice ($p < 0.10$). The fact that all the ECM terms in the short run model are negative suggest stable long run relationships, however, the speed of adjustment is rather too slow for rice but insignificant. Only the income from export and import earnings was significant at $p < 0.01$ whereas import price was not significant. The coefficients of the time trends were positive. This means that time was relevant in explaining variation in rice import.

The general implications the findings of this study is that for the country to be food secured, the need for concerted efforts by all tier of government to promote local production of rice should be given more attention. It also shows that the relying on rainfed agriculture to produce rice would not sustain the increased demand by Nigerians whose taste for imported rice has risen over time. Therefore, there is a need for nationwide policy to improve food production and stable policy framework on sustainable rice production in Nigeria. The result of this will be an efficiently functioning network of markets that delivers food to consumers at an affordable cost with elimination of exploitative tendencies by any group of market intermediaries. In order to better understand and evaluate the consequences of these changes on consumer and producers welfare, it is essential to obtain reliable estimates of import demand elasticities of rice. From a policy viewpoint, the inelastic demand for rice allows industry to raise prices and profits in the short run.

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7/6/2016