Demand Analysis of Rice in Nigeria

S.A. Makama, I.Y. Ilu, N.J. Suleiman, S. Isiaku and M.A. Isah
National Agricultural Extension Research and Liaison Services, A.B.U. Zaria, Nigeria

Nigerian Journal of Agricultural Extension, Vol. 18, Number 3, September 2017

Abstract

The study attempted to estimate demand for rice in Nigeria using Almost Ideal Demand System, (AIDS) model. The results revealed that expenditure elasticities for rice in Nigeria was income inelastic thus implying that it is a normal good, and a necessity in the diet of Nigerians. All the own- compensated price elasticities were negative and greater than their corresponding uncompensated price elasticities in the country, implying that substitution effect is stronger than the income effect. The compensated elasticity of rice in Nigeria (-0.554) indicates that, a price increase of 1 per cent will cause a reduction in the demand for rice by 0.55 per cent. Considering the fact that rice has inelastic responses to its own price and income changes, efforts in increasing its supply should be made so as to enhance the demand for rice. Also, since rice was found to be a necessity in the diet of Nigerians, it is therefore recommended that rice as a core crop should be given priority in the country's National Programme for Food Security (NPFS) and many other similar government programmes.

Keywords: Economic demand, rice production, Nigeria

Introduction

Rice, wheat and maize are three leading food crops in the world; together they directly supply more than 50 per cent of all calories consumed by the entire human population. Human consumption accounts for 85 per cent of total production for rice, compared with 72 per cent for wheat and 19 per cent for maize (IRRI, 2015). Rice consumption is driven by income, population, changes in price relative substitute crops and other demographics. It provides 21 per cent of global human per capita energy and 15 per cent of per capita protein. Although rice protein ranks high in nutritional quality among cereals, protein content is modest. It also provides minerals, vitamins, and fiber, although all constituents except carbohydrates are reduced by milling (IRRI, 2015). Thus, rice is being consumed by more than half of the world population. Available data indicated that, production of milled rice in the world totaled 409.2 million tonnes in 1999 which has now increased to 496.4 million tonnes in 2014.

Nigeria produced 4.82 million tonnes of rice in 2013 and is reported to have reached 6.73 million tonnes in 2014 (World Rice Statistics, 2016). Average yield of rice for both wet and dry season in the country has increased from 1650 kg/hectare in 2013 to 2180 kg/hectare in 2014 (World Rice Statistics, 2016). The rice market situation in Nigeria is complex. The country is a major consumer and importer with low level of domestic production. As the most populous country in Africa, Nigeria is the largest rice producer in the West African sub-region and has in recent times assumed the status of the largest importer of rice in the world where 2 million tonnes of rice was imported in 2015 (World Rice Statistics, 2016).

According to Idriss *et al,* 2012, Nigeria is among the six countries that accounts for approximately 46 per cent of world malnourished. However, rice is of special importance for the nutrition of large reaches of the population in Asia, parts of Latin America and the Caribbean and, increasingly so, in Africa. As a result, it plays a pivotal role for the food security of over half the world population. For those reasons, rice is considered as a "strategic" commodity in many countries, both developed and developing, and has

consequently remained subject to a wide range of government controls and interventions (FAO, 2012). Thus, information to be generated by the present study about the demand of rice in Nigeria will be very useful to potential rice producers, traders as well as researchers and students in the field of agricultural economics and related discipline. Therefore, the objective of this paper is to analyse the demand for rice in Nigeria

Methodology

Annual time series of consumption and price data for food grains sourced from FAO, World Bank, World rice statistics as well as other relevant internet sources for the period 1970 to 2014 have been used to estimate the Linear Approximate/ Almost Ideal Demand System (LA/AIDS).

The Almost Ideal Demand System (AIDS)

Stone (1954) first estimated a system of demand equations where he specified a particular form of utility function and then used it to directly derive the demand equations of his linear expenditure system (LES). This method derives explicitly from the consumer theory (Deaton and Muellbauer, 1980) and implied all restrictions. However, the model negated the opportunity to test whether the data satisfied these restrictions, and suffers from the fact that the utility function is in additive and not general. In order to test the restrictions, Theil (1965) and Barten (1969) developed the Rotterdam model. This model abandoned the notion of specifying an explicit utility function, opting to rather formulate a collection of demand equations which are capable to satisfying the theoretical restrictions, using this specification the validity of the restrictions could then be explored. However, it is still unanswered, what are the true functional forms of the demand equations (Thomas, 1987 cited in Akhtarul, 2011).

The estimation of a demand system using the concept of duality was first used in Houthakker's (1960) Indirect Addilog model. Although this specification highlighted the opportunities of employing duality theory but it failed to significantly address the aforementioned disadvantages of the LES and Rotterdam model (Thomas, 1987 cited in Akhtarul, 2011). To overcome these disadvantages, a model was developed with specifications that approximate indirect utility and cost functions with flexible functional forms (Cooper and McLaren, 1992). Christensen *et al.*, (1975) developed the Translog model using a flexible functional form to approximate an indirect utility function. Though the model comes a long way in improved generality and ability to produce meaningful parameter estimates but they possess limited regularity (i.e. can still violate the restrictions of consumer theory) (Cooper and Mclaren, 1992) and are restricted to the consideration of convex consumer preference orderings (Thomas, 1987 cited in Akhtarul, 2011).

An alternative to using flexible functional forms for describing indirect utility functions, Deaton and Muellbauer (1980) developed a demand system called the Almost Ideal Demand System (AIDS), which based on the duality of consumer decision making and gives an arbitrary approximation to any demand system without violating any of the axioms of rational consumer choice (Akhtarul, 2011). Unlike other models, the demand equations of the AIDS model generates nonlinear Engel curves and allows for exact aggregation across consumers (Moschini, 1998). In addition, the described functional forms of AIDS model; lend themselves to being estimated using household budget data. The AIDS model provides yields of price and income elasticities that are consistent with consumer theory and are more flexible than those obtained from other commonly used demand systems (Nzuma and Sarker, 2010). Due to these properties, the AIDS model has been widely used in applied demand systems analysis.

The AIDS model by Deaton and Muellbauer (1980) is derived from a utility function specified as a second-order approximation of any utility function. Deaton and Muellbauer (1980) specified an expenditure function, which belongs to the preference price independent logarithmic (PIGLOG) class and defines the minimum expenditure to attain a specific utility level at given prices and satisfies the necessary

conditions for consistent aggregation across over consumers. These conditions ensure that the functional forms of the market demand equations are consistent with the behavior of a rational representative consumer (Deaton and Muellbauer, 1980 cited in Akhtarul, 2011). The AIDS model in budget share for food grain can be written as:

$$S_i = \alpha_i + \beta_i \ln\left(\frac{x}{p}\right) + \sum \gamma_{ij} \ln P_j + \varepsilon_i \ \ldots\ldots \quad (1)$$

Where
S_i = budget share associated with the ith good,
α_i = constant coefficient in the ith share equation
γ_{ij} = slope coefficient associated with the jth good in the i^{th} share equation;
p_j = price on the j^{th} good and
X = total expenditure on the system of goods

In the demand system, parameters are usually difficult to directly interpret like other regression function because of the complexity of empirically adequate specifications (Lewbel 1997). It is therefore, useful to interpret the price and income elasticity derived from the demand system. When all prices are normalized to unity, the elasticities derived from the LA-LAIDS and AIDS are identical at the point of normalization (Asche and Wessells, 1997, Nzuma and Sarker, 2010, cited in Akhtarul, 2011). Then, at normalization point, the Marshallian price and expenditure elasticities for the LA-LAIDS are obtained by the following Chalfant's (1987) formula as:

$$\varepsilon^{M}_{ij} = -\delta_{ij} + (\gamma_{ij} / S_i) - (\beta_i / S_i) S_j \quad (2)$$

$$\eta_i = 1 + (\beta_i / S_i) \quad (3)$$

Where
δ is the Kronecker delta (δ_{ij} = 1when i = j and δ_{ij} = 0 when i ≠ j).

The Marshallian elasticities is therefore confuted using equation (2) above while the Expenditure elasticities were confuted using equation (3). However, the Hicksian demand elasticities for good i with respect to j can be obtained from the following equation as:

$$E^{h}_{ij} = -\delta_{ij} + (\gamma_{ij} / S_i) + S_j \quad (4)$$

Results and Discussions

Demand functions for rice in Nigeria

Results of the estimated parameters and associated asymptotic errors of the AIDS model for Nigeria are shown in Table 1. The results revealed that, for every unit income and expenditure, Sorghum had taken the highest average share (1.197) followed by Rice (0.749), Maize (0.698) and Wheat (-0.945). This is contrary to the findings of Erhabour and Ojogho (2011) where they reported rice with highest average share (0.2125) followed by garri, yam, potatoes, beans and plantain. This variation may be due to the variation in the crops considered for the analysis and may also be as a result of the time of research.

Similarly, the vast majority of the gamma's (γ's) indicated some degree of sensitivity of budget share to prices. The values and signs of this γ's shows that most of the foodgrains are complement of rice. The expenditure coefficients (ß) which measure the changes in budget share as price changes indicate the nature of commodities, i.e whether a commodity is necessary or luxury commodity. Here, the estimated expenditure coefficient of rice is negative and significant at 5 per cent level of significance. This means that rice in Nigeria is not a luxury but necessary commodity. Thus, its importance in the diet of Nigerians will increase with increase in economic growth. This tallies with the findings of Oyinbo *et al*, (2013) where they reported rice as necessity in the food basket of Nigerians.

The own price effect of the commodities under considerations were 0.365, 0.237, 0.199, and 0.033 for Sorghum, Rice, Wheat and Maize respectively and were all significant at 1 per cent level with exception of Maize which was not significant at 5 per cent level. Also, Rice had the second largest budget share (0.237) after Sorghum (Table 1) when the real expenditure and price are equal to one. This means that a substantial decline in price with increase in production will no doubt benefit the majority of its consumers.

Estimated Marshallian and expenditure elasticities

The estimates of own price Marshallian and expenditure elasticities for Nigeria is however presented in Table 2. All the Marshallian own price elasticities were found to be negative. This negativity of the own price elasticities indicated that increase in price leads to decrease in the quantity of rice demanded and this follows the law of demand where the demand curve of the corresponding commodity will be downward sloping.

Based on the Marshallian own price elasticities the demand for rice (which is inelastic) is less than unity (-0.508). This means that rice is a necessity in the diet of Nigerians, implying the demand for rice by Nigerians is not changing much when its price increases as they must purchase for them to stay alive. This result clearly indicated that, there is an inverse relationship between the quantity of rice demanded and its price in Nigeria though inelastic. In absolute terms, the values of elasticities was found to be least in case of maize then followed by sorghum, rice and wheat. This means that rice and wheat are more sensitive to their own price changes than maize and sorghum. This result of own price elasticity of rice is in consistence with the prior expection and also close to the findings of Omojola *et al.*, (2006) where they reported a negetive price elasticity (-0.6) as the own price elasticity of rice in Nigeria. Also, Rahji and Adewumi, (2008) reported -0.841 as the own price elasticity of rice in Nigeria, Oyinbo et al, (2013) also reported a negative own price elasticity for rice in Nigeria (-0.8887).

The cross price elasticities were mostly negative and also showed some level of substitutability. In this case rice consumption showed a high substitute-bility response to price of maize (0.230) followed by wheat (-0.083) and then lastly sorghum (-0.694). A similar study by Omojola et al., (2006) reported a negative cross price elasticity (-0.169) for rice in Nigeria. The expenditure elasticity for rice was found to be 0.842 which is so high compared to the findings of Oyinbo et al, (2013) where they reported 0.69 as the expenditure elasticity of rice in Nigeria however; the expenditure elasticities of wheat, maize and sorghum were, 0.507, 0.548 and 0.138 respectively, implying that these commodities are normal goods. This result is in accordance with findings of Erhabor and Ojogho (2011) where they reported an expenditure elasticity of 0.883 for rice in Nigeria.

Hicksian compensated price elasticities

Hicksian elasticities which capture the substitution effect provides a better estimate for substitution effects among goods compared to Marshallian elasticities that only estimated income effect. Results showed that all the own price elasticities are negative and greater than their corresponding uncompensated price elasticities (Table 3). This means that substitution effect is stronger than the income effect. This is so considering the fact that people do substitutes their diet even without change in their income for a change in price, nutrition or utility purpose. The own price compensated elasticity of rice (-0.554), wheat (-0.607), maize (-0.888) and sorghum (-0.233) were inelastic. The elasticity of rice (-0.554) indicated that for a price increase of 1 per cent would cause a reduction in the demand for rice by 0.55 per cent. This is to say that, the change in the demand for rice when price change is somewhat negligible. This is because rice is considered as a normal and necessity good among consumers in Nigeria. This is contrary to the findings of Erhabor and Ojogho (2011) where they reported an elastic (-1.0659) own price compensated elasticity for rice in Nigeria but is however similar with the findings of Oyinbo et al, (2013) where they reported an inelastic (-0.7291) own price compensated elasticity of rice in the Nigerian households.

Conclusion and Recommendations

Based on the findings, the study concluded that the expenditure elasticities for rice in particular and all other commodities under consideration in Nigeria were income inelastic. The implication is that these commodities are normal goods and also necessities in the diet of Nigerians. Also, the own price elasticities of demand for all the commodities in Nigeria were inelastic. Consumption of wheat has the lowest own-

price elasticity of demand followed by Rice thus, suggesting the importance of wheat and rice in the diet of Nigerians.

All the own compensated price elasticities were negative and greater than their corresponding uncompensated price elasticities. This implies that substitution effect is stronger than the income effect. The compensated elasticity of rice in Nigeria (-0.554) indicates that, a price increase of 1 per cent will cause a reduction in the demand for rice by 0.55 per cent. Based on our findings, it can be therefore concluded that price and expenditure for rice demand in Nigeria were inelastic.

However, considering the fact that rice demand has inelastic responses to its own price and income changes, efforts in increasing its supply should be made so as to enhance the demand for rice. Also, since rice was found to be a necessity in the diet of Nigerians, it is recommended that rice as a core crop should be given priority in the country's National Programme for Food Security (NPFS) and many other government programmes of this nature.

References

Akhtarul, A.M. (2011). An analysis of consumption demand elasticity and supply response of major food grains in Bangladesh. MSc thesis, Department of Rural Development Ghent University, Belgium. Pp 81.

Asche, F. and Wessells, C. (1997). On price indices in the almost ideal demand system. *American Journal of Agricultural Economics*, 79(5): 1182-1185.

Barten, A.P. (1969). Maximum likelihood estimation of a complete system of demand equations. *European Economic Review,* 1:7-73.

Chalfant, J. (1987). A globally flexible, almost ideal demand system. *Journal of Business Economics Stat.* 5(2): 233-242.

Christensen, L.R., Jorgenson D.W. and Lau L.J. (1975). Transcendental logarithmic utility functions. *American Economic Review*, 65: 367-383.

Cooper, J.P. and McLaren, K.R. (1992). An empirical orientated demand system with improved regularity properties. *Canadian Journal of Economics*, 25: 652-667.

Deaton, A. and Muellbauer, J. (1980). An almost ideal demand system. *American Economic Review,* 70: 312 – 326.

Erhabor, P.O.I. and Ojogho, O. (2011). Demand analysis for rice in Nigeria. *Journal of Food Technology*, 9(2):66 – 74.

FAO (2015). Food and Agriculture Organization statistical database. Rome; FAO.

Houthakker, H. (1960). Additive preference. *Econometrica*, 28: 244-257.

Idriss, A., Lupien J., Sheet I. and Romanos H. (2012). *Food Security: The moving borders of poverty, free markets and political interventions*. MENA Food Safety Associates (MEFOSA), Lebanon, University of Massachusetts, United States and Food and Nutrition Division of the FAO, Rome.

IRRI (2015). Rice production course manual. From www.knowledgebank.irri.org.

Lewbel, A. (1997). Consumer demand systems and household equivalence scales. In: H.M. Pesaran and P. Schmidt (eds), *Handbook of Applied Econometrics II: Microeconomics*. Blackwell Publishers, Oxford. 167-201.

Moschini, G. (1998). The semi-flexible almost ideal demand system. *European Economic Review*, 42(2): 349-364.

Nzuma, M.J. and Sarker, R. (2010). An error corrected almost ideal demand system for major cereals in Kenya. *Agricultural Economics*, 41: 43–50.

Omojola, J.T., Effiong J.A.L. and Pepple I.D. (2006). Analysis of the demand for locally processed rice in Niger State, Nigeria. *Journal of Agriculture and Social Research,* 6(1): 22-26.

Oyinbo, O., Omolehin R.A. and Abdulsalam Z. (2013). Analysis of the demand for rice in Kaduna State, Nigeria. *Agris* 5(3):45 – 52.

Thiel, H. (1965). The information approach to demand analysis, *Econometrica,* 33: 67-87.

Table 1: Estimate of an AIDS model for rice in Nigeria (1970 – 2014)

Parameters	*Rice*	*Wheat*	*Maize*	*Sorghum*
α_i	0.749* (2.014)	-0.945** (4.203)	0.698** (3.393)	1.197** (2.999)
γ_{i1}	0.237** (3.778)	-0. 053 (0.857)	0. 060 (1.490)	-0.244** (6.121)
γ_{i2}	-0. 053 (0.857)	0.199** (3.091)	-0.060 (1.171)	-0.087 (1.237)
γ_{i3}	0. 060 (1.490)	-0.060 (1.171)	0.033 (0.387)	-0.033 (0.428)
γ_{i4}	-0.244** (6.121)	-0.087 (0.223)	-0.033 (0.671)	0.365** (4.105)
β_i	-0.005* (2.156)	-0.159** (3.551)	0.084** (2.782)	.079 (1.679)

Values in parentheses are t-values, * = Significant @ 5%, ** = Significant @ 1%, where γ_{ij} = price effect of other food items on rice, α_i =average share of expenditure, β_i= expenditure effect on budget

Table 2: Marshallian uncompensated price elasticities and expenditure for Nigeria

Commodities	*Own price and cross price elasticities for the commodities*				*Expenditure elasticities*
	Rice	*Wheat*	*Maize*	*Sorghum*	
Rice	-0.508	-0 .212	0. 239	-0. 903	0.842
Wheat	-0.083	-0.526	0.295	0.308	0.507
Maize	0.230	0.055	-0.148	-0.613	0.548
Sorghum	-0.694	-0.052	-0.237	-0.227	0.138

Table3: Hicksian compensated price elasticities for Nigeria

Commodities	*Own price and cross price elasticities for the commodities*			
	Rice	*Wheat*	*Maize*	*Sorghum*
Rice	-0.554	-0.036	0.412	-0.529
Wheat	-0.054	-0.607	0.313	0.348
Maize	0.623	0.318	-0.888	-0.053
Sorghum	-0.372	0.163	-0.024	-0.233