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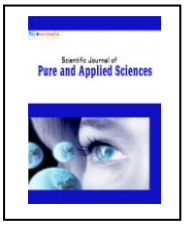

Original article

Logistic regression on consumption of rice (case study of Offa local government Offa, Kwara State, Nigeria)

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ABSTRACT

This research work is on logistic regression on consumption of locally and imported rice using Offa local government, Kwara state as case study, it aimed to establish a model that can use to predict Age, Income, Expenditure and frequency of locally and imported produced rice and determine the best model among the variables of the outcome. The statistical tools that were used for the analysis of the data is logistic regression, backward elimination method were also employ to check the best model. The variable with the lowest difference among the non significant variable (i.e. change in -2LL) shows the model that are significant, at the end of the analysis it can be concluded that the best model is the one with age since it is not dropped from the model.

1. Introduction

Rice is a major commodity in world trade. Rice has become the second most important cereal in the world after wheat in terms of production, due to a recent decline in maize production (Jones, 1995). It is widely cultivated throughout the tropics; and where flood controls are effective as in South-east Asia, production is high. Much of the foreign rice imported into West Africa is from South-east Asia. In Sub-Saharan Africa, West Africa is the leading producer and consumer of rice (WARDA, 1996). West Africa accounts for 64.2% and 61.9% of total rice

production and consumption in Sub-Saharan Africa respectively. Except for Burkina Faso and Niger, rice is a staple crop throughout West Africa, especially in Côte d'Ivoire, the Gambia, Guinea, Guinea Bissau, Liberia, Senegal and Sierra Leone. The River Niger drainage system is a major rice growing environment in the Region. Nigeria has a leading role in rice production in West Africa. Nigeria ranks highest as both the producer and consumer of rice in the Sub-region with figures slightly above 50% (WARDA, 1996). Rice is known to have been grown along the Niger for over 3000 years (Imolehin and Wada, 2000).

1.1. Rice production in Nigeria

Rice is important in Nigeria for several reasons. It is a major contributor to internal and sub-regional trade. Rice is also the staple for most of the peoples in the Niger-Benue trough which divides Nigeria into three parts, Sokoto-Rima Basin in the north-west, Chad Depression in the north-east, Hadejia-Jamaare trough in the extreme north, and Cross River trough in the south. Farmers find rice more adaptable than a high input staple like maize when there is declining soil fertility because of the huge array of varieties they can switch over to every few years. Since it is becoming a staple crop, farmers seem to be willing to grow it all the time no matter the constraints they are facing.

1.2. Aims and objectives

The aims and objectives of this research work are as follows:

To establish a model that can use to predict Age, Income, Expenditure and frequency of locally and imported produced rice

To determine best model among the variable of the outcome considered.

1.3. Literature review

Rice is the second largest produced cereal in the world after wheat. At the beginning of the 1990s annual production was around 350 million tons and by the end of the century it had reached 410 million tons (Oluwatomi, 2011). During the past three decades the crop has been in a steady increase in demand and its growing importance is evident given its important place in the strategic food security planning policies of many countries (Bzugu and Mustapha, 2010). Rice is the world's most important food commodity and an average Nigerian consumes about 24.8 kg of rice per year, representing 9% of total caloric intake (Ojehomon et al., 2012).

The challenges faced by countries as regards rice production however differs from one country to the other in terms of population, the preference attached to the commodity in the lists of household menu, natural endowment for expanded production and the productivity of the rice farm (WARDA 2003; Ajayi et al 2000 as cited by Bzugu et al,2010). According to FAO (2000) the global annual rice production needs to increase from 586 million metric tons in 2001 to 756 million metric tons by 2030.Sources of such increase are identified as including; increased acreage under high yielding varieties; developing hybrid rice and evolving a more appropriate and efficient crop, soil, water, nutrient management technologies and accelerate technology transfer. All these factors no doubt go a long way in defining the potentials of a country for expanded rice production (Bzugu et al, 2010).

A combination of various factors seem to have triggered the structural increase in rice consumption over the years with broadening across all socio economic classes, including the poor. Rising demand is as a result of increasing population growth and income level (GAIN, 2012). Rice has become a staple food in Nigeria such that every household; both the rich and the poor consume a great quantity (Godwin, 2012). In bid to achieve rice self sufficiency in line with the rice transformation plan, the Ministry of Agriculture and Rural Development have rolled out a special intervention programme a dry season paddy production plan 2013 (Fagbemi, 2012). The dry season paddy production take place across ten states of the federation namely; Kebbi, Zamfara, Kano, Jigawa, Sokoto, Kastina, Bauchi, Gombe and Kogi states.

Milled rice consumption has increased significantly over years from 240 metric tones in 1961 to 850 metric tones in 1981 and 2757 metric tones in 1991 to 4970 metric tones in 201. Local production has not been able to keep pace with the incresase in consumption over the years which have resulted into a demand supply gap for milled rice in Nigeria (USDA FAS, 2012). Over the years, Nigeria has relied upon importation of rice to meet its growing demand for rice but the increased demand in recent years reflect more of increase in the demand for imported rice brands to meet the shortfalls in domestic demand and to meet consumers demand in the urban areas. The importation of rice to bridge the demand supply gap is worth N365 billion (Ayanwale and Amusan,

2012). The cost of these rice import represent a significant amount of lost earning of the country in terms of job and income (Bamba et al., 2010).

The Nigeria rice sector has witnessed some remarkable developments, particularly in the last ten years. Both rice production and consumption in Nigeria have vastly increased during the aforementioned period (Ojehemon et al., 2009). However, the demand for rice has continue to outstrip production given the shift in consumption preference for rice especially by urban dwellers. The growing consumption preference for rice have led to several research outcome on rice in Nigeria but it is worth noting that exist little empirical information to the determinants of rice consumption preference between foreign and local rice at the micro (household) level. This constitute the gap in research that this study was designed to fill.

2. Materials and methods

2.1. Logistic regression

Logistic regression or logit regression is a type of probabilistic statistical classification model. It is used for predicting the outcome of a categorical dependent variable based on one or more predictor variable i.e. it is used in estimating empirical value of the parameter in a qualitative response model. Frequently, logistic regression is used to refer specifically to the problem in which dependent variable is binary.

Binary logistic regression is a type of regression application that the response variable has only two outcomes: an event did or did not occur. A regression model with this type of response can be interpreted as a model that estimates the effect of the independent variable on the log of the odd of the probability of event occurring.

Consider the model

$$p = \frac{1}{1+e^{-(\beta_0+\beta_1 x_1+....)}} \quad \text{.....(1)}$$

$$1-p = \frac{e^{-(\beta_0+\beta_1 x_1+....)}}{1+e^{-(\beta_0+\beta_1 x_1+....)}} \quad \text{..... (2)}$$

$$\frac{p}{1-p} = \frac{1}{1+e^{-(\beta_0+\beta_1 x_1+....)}} \quad \text{..... (3)}$$

$$\log\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_k x_k \quad \text{.....(4)}$$

2.2. Assumption

The dependent variable must be dichotomous (2 categories)

The independent variables need to be itnervla, normally distributed linearly related, of equal variance within each group

Error terms are independent

No multicollinearity

Logistic regression does not assume a linear relationship between the dependent and independent variable

2.3. Odds ratio

The most common way of interpreting a logit is to convert it to odd ratio using the exponential function. It is the ratio of two odds (the probability of success (response = 1) divided by the probability of failure) Odds ratio above 1 refer to positive odds that the dependent variable equals.

2.4. Significance tests

2.4.1. Likelihood ration test (LRT)

It is based on the likelihood ratio (-2 log likelihood). The likelihood is the probability that the observed value of the dependent variable may be predicted from the observed value of the independent variables. Log likelihood is its log and is calculated through iteration using maximum likelihood estimation. Likelihood ratio test is

a test of significance of the difference between the 2-LL for the researcher's model minus -2LL for the reduced model.

$$LRT=-2\log(l0/l1)$$

$$=-2(\log l0-\log l1)$$

l0=Simpler model's likelihood function

l1=full model's likelihood function

2.4.2. Hosmer and lemeshow's goodness of fit test

This is another name for a chi-square goodness of fit test. The test divides subjects into deciles based on predicted probabilities, and then computes a chi square from observed and expected frequencies. Then a probability (p) value is computed from the chi-square distribution with 8 degrees of freedom to test the fit of the logistic model. If the H-L goodness of fit test statistic is greater than 0.05, as we want for well-fitting models, we fail to reject the null hypothesis that there is no difference between the observe and the model-predicted values, implying that the model estimate fit the data at an acceptable level. This test is particularly useful when some of the variables are continuous.

2.4.3. Wald test

The Wald test is an alternative test which is commonly used to test the significance of individual logistic regression coefficient for each independent variable (that is, to test the null hypothesis in LR that particular logit (effect) coefficient to its standard error.

However, there is a flaw in the Wald statistic such that very large effects may lead to large standard errors and small wald values. Therefore, for model with large coefficients or when dummy variables are involved, it is better to test the difference suing the likelihood ratio test of the difference of models with and without the parameter.

Table 1
Data presentation.

Respondents	Preference for rice	Age	Income	Expenditure	Frequency
1	1	1	2	2	2
2	1	1	1	1	4
3	0	1	1	1	3
4	0	2	1	1	4
5	0	2	2	1	4
6	0	2	1	1	2
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
297	0	1	1	1	4

Note: coding method used
For locally rice=0
For imported rice=1

2.5. Analysis

The data analysis for this research work was first subjected to descriptive statistics to know the frequency distribution of the respondent on each variable considered

Table 2
Descriptive statistics.

	N	Minimum	Maximum	Mean	Std. Deviation
Age	297	1.00	26.00	1.8956	1.81004
Preference Rice	297	0.00	1.00	0.5320	0.49982
Income	297	1.00	6.00	1.7172	1.00714
Expenditure	297	1.00	4.00	1.2290	0.50145
Frequency	297	1.00	8.00	3.5623	1.20682
Valid N (listwise)	297				

2.5.1. Logistic regression analysis

In this section a logistic regression model is fitted with preference (imported and locally produced rice) as response and Age, Income, Expenditure and frequency. These variable are then screened to obtain a parsimonious model. The model are specified as follows:

$$\ln\left(\frac{p}{1-p}\right) = Z$$

Where

$$\ln(odds) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_k x_k$$

$$\log\left(\frac{p}{1-p}\right) = odds$$

Dependent (Response) Variable: Preference (Imported and Locally produced Rice)
Independent (Explanatory) variable:
X1= Age (In years)
X2=Income (In thousands)
X3=Expenditure (In thousands)
X4=Frequency

Table 3
Variables in the equation.

		B	S.E.	Wald	Df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	Age	0.005	0.067	0.006	1	0.938	1.005	0.881	1.147
	Income	-0.128	0.172	0.555	1	0.456	0.880	0.628	1.232
	Expenditure	0.382	0.338	1.284	1	0.257	1.466	0.756	2.841
	Frequency	0.071	0.094	0.571	1	0.450	1.073	0.893	1.290
	Constant	-0.390	0.464	0.704	1	0.401	0.677		

a. Variable(s) entered on step 1: Age, Income, Expenditure, Frequency.
Hosmer and Lomesshow's Goodness of fit test
Ho: There is no difference between observed and model predicted values
H1: There is difference between observed and model predicted value

Model summary.

Step	-2 Log likelihood	Cox&Snell R Square	Nagelkerke R Square
1	408.523[a]	0.007	0.009

2LL of the model is 408.931

Table 4

Contingency table of hosmer and lemeshow test.

Hosmer and Lemeshow Test			
Step	**Chi-square**	**Df**	**Sig.**
1	6.528	8	0.588

P value is greater than α=0.05 i.e. (P value=0.588).

Decision: We do not reject Ho.

Conclusion: there is no significant different between the observed and model predicted value at α=0.05 which implies that the model fit the data and can be used to predict the probability of locally and imported produced rice.

2.5.2. Test for individual parameter

Test for the significance of the individual variables in the model, the -2LL for the full model is compare with a model each of the variables. If the difference is greater than χ^2_α, we do not reject Ho

$$\chi^2 = \text{Change in -2LL}$$

$$= [\text{-2LL(reduce model)-2LL(full model)}]$$

$$= \text{-2logL0-408.523}$$

Table 5

Test for Individual parameter (Age)

Variables in the Equation									
		B	**S.E.**	**Wald**	**Df**	**Sig.**	**Exp(B)**	**95% C.I.for EXP(B)**	
								Lower	**Upper**
Step 1a	Age	-0.002	0.064	0.001	1	0.974	0.998	0.880	1.132
	Constant	0.132	0.168	0.615	1	0.433	1.141		

a. Variable(s) entered on step 1: Age.

Table 6

Summary for likelihood ratio test for individual coefficient.

Variable dropped	-2LL	Df	Sig	Change in -2LL
Age	410.512	1	0.997	1.989
Income	410.507	1	0.937	1.984
Expenditure	409.717	1	0.376	1.194
Frequency	409.832	1	0.410	1.309

Based on the likelihood ratio test (LRT) and in order to achieve parsimonious model Age, Income, Expenditure and Frequency is drop from model. To check if the model containing the best model is screened using backward Backward Elimination Method

This method uses the difference between the -2LL for the full model and a reduce model without each of the variable to determine which variable to drop from the model. The variable with the lowest different among the non significant variable is dropped first. This continue until the variable left in the model are significant.

Table 7
Change in -2LL with respect to the model without expenditure, frequency and income

Variable dropped	-2LL	Df	Sig	Change in -2LL
Age	410.512	1	0.997	1.989

Conclusion: Since Age is a significant variable. the best model is therefore the one with only age as the independent variable since it is not dropped from the model.

3. Results and discussion

Rice is the world most important staple food crop consumed by more than half of the world population as represented by 4.8 billion people in 176 countries with over 2.89billion people in Asia, over 150.3 million in America and over 40 million peoples in African (IRRI, 2004). Nigeria currently double as the largest imported of rice in the world. This anomaly is attributed to the inability of its local production to meet up with its demand which has been soaring at a very fast rate over the years. As noted by MARKET (2009), Nigeria's fertile land and rich agro climatic condition could easily produce rice to feed the entire country and generate surplus. However, Nigeria has continued to depend on importation from countries like China and Thailand to meet the increasing demand for rice by households.

The data used for this research work were primary data distributed within Offa local government area, Offa Kwara state using three hundred (300) questionnaires where three (3) was not returned by the respondent. This research work was carried out to establish a model than can use to predict Age, Income, Expenditure and frequency of locally and imported produced rice. Logistic regression model were fitted to data and independent variable were removed from the model using backward elimination method to know the variable that contribute significantly to the prediction of the outcome, only age is found to be significant and income, expenditure and frequency were drop from the model.

4. Conclusions

Based on the logistic regression analysis from this research work and finding made the following conclusion were made; only age contribute significantly to the prediction of the probability and shows the best model as the independent variable since it is not dropped from the model with the lowest difference among the non significant variable (i.e. Change in -2LL).

The odd of the locally and imported produced rice for age is 0.998, Income is 0.937, expenditure is 1.233 and frequency is 1.080 respectively. It can be concluded that Age contributes significantly to the prediction model

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