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Assessment of the suitability of grafted model in forecasting rice consumption trend in nigeria.

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ABSTRACT

This paper was designed to examine the predictive power of grafted polynomial functional form in forecasting rice consumption in Nigeria with a linear model used as bench mark. Data on rice consumption trend in Nigeria from 1961 to 2011 elicited from the United States department of Agriculture foreign Agricultural services were utilized in this study. It was observed that rice consumption did not correlate linearly with trend over the entire sample period and this necessitated the grafting of a Linear – Quadratic – Linear model. The ex-post forecasts of the grafted model had lesser forecast error and were closer to the observed values than that of the linear model which had greater forecast error. Therefore, the predictive performance of the grafted model is more reliable in forecasting future trend of rice consumption in Nigeria for planning purposes.

Keywords: Forecasting; Grafted model; Rice; Consumption.

1. INTRODUCTION

Rice has assumed a strategic position in the food basket of rural and urban households in Nigeria. Nigeria's rice consumption is projected to reach 35 million tonnes by 2050 from five million tonnes currently, rising at the rate of 7 per cent yearly due to population growth[1]. During the 1960s, Nigeria had the lowest per capita annual consumption of rice in the sub-region at an annual average of 3kg. Since then, Nigerian per capita consumption levels have grown significantly at 7.3% per annum. Consequently, per capita consumption during the 1980s averaged 18kg and then 22kg in 1995–2000[2].

Nigeria is the largest consumer of rice in the West African region and its demand for rice has been soaring at a very fast rate over the years[3]. A combination of various factors seems to have triggered the structural increase in rice consumption over the years with consumption broadening across all socio-economic classes, including the poor. Rising consumption was partly the result of increasing population growth, increased income levels, rapid urbanization and associated changes in family occupational structures. [4] pointed that urbanization appears to be the most important cause of the shift in consumer preferences towards rice in Nigeria like elsewhere in West Africa.

The demand for rice has continued to outstrip production given the shift in consumption preference for rice especially by urban dwellers[5]. One way of addressing the demand – supply gap of rice in Nigeria is by understanding the rice consumption trend; this is because knowledge of the numerical of ex-post forecast of rice consumption is a veritable tool for policy making in planning for ways of exploring the domestic potential for rice production to meet the future rice consumption need of the teeming population of Nigeria. However ex-post forecast which provides useful information for planning is not readily available due to the inadequacy of functional forms for forecasting purpose. In view of this, there is the need to undertake a study that will examine the predictive power of grafted models in forecasting rice consumption in

Nigeria and also make an ex-post forecast of rice consumption in Nigeria extending from 2012 – 2016 for the purpose of providing relevant information for planning rice supply to meet the consumption needs of Nigerians.

2. METHODOLOGY

The study area is Nigeria. Nigeria has a total area of 923,800 sq km and occupies about 14 per cent of the land area in West Africa. It has a population of 166.6 million people[6]. The country lies between 4ºN and 14ºN, and between 3ºE and 15ºE. This study made use of secondary data which were principally elicited from the database of United States Department for Agriculture(USDA) foreign agricultural services[7] and also journal articles. The secondary data used for the analysis in this study were on rice consumption in Nigeria extending from 1961 to 2011(over a period of 50 years). The data were analysed using a grafted model(Linear – Quadratic – Linear function) and a linear model as the benchmark.

2.1 Analytical framework

A linear trend model for rice consumption in Nigeria is expressed as follows:

$$Y = \alpha_0 + \beta_1 t \quad \text{.......} (1)$$

Where:

Y = Level of rice consumption

α_0, β_1 = structural parameters

t = trend variable

However, the linear trend relationship expressed by equation (1) was not depicted by a rough representation of Y over the observed time series as shown in figure (1). This observed trend requires that equation (1) be modified for better forecasting strength by dividing the entire time series into segments with a view to using different functional forms for the segments.

The graphical representation of the data reflects the following relationship between the level of rice consumption in Nigeria over the entire sample period and the time trend.

$$Y_t = \alpha_0 + \beta_1 \quad \text{for } t \leq k \quad \text{.......} (2)$$

$$Y_t = \alpha_1 + \beta_2 t + \gamma t^2 \quad \text{for } k_1 < t > k_2 \quad \text{.......} (3)$$

$$Y_t = \alpha_2 + \beta_3 t \quad \text{for } t > k_2 \quad \text{.......} (4)$$

The α's, β's and γ are the structural parameters while Y and t are as defined in equation (1).

Inorder to achieve the purpose of forecasting as opposed to approximation in grafted models, it is customary to assume a linear trend relationship in the terminal segment[8], [9], [10]. This is shown by equation (4). The purpose of the linear – quadratic – linear segmentation is to obtain a mean function which captures all the local trends observed in the time series and this requires that the time series must satisfy the followingassumptions:

1. The mean function must be continuous and linear in the structural coefficient.
2. The mean function must be differentiable at the joint points of the pairs of the trend of the function.

In order words, the following restrictions are expected to hold in the domain of the mean function:

$$\alpha_0 + \beta_1 k_1 = \alpha_1 + \beta_2 k_1 + \gamma t^2 \quad \text{.......} (5)$$

$$\alpha_1 + \beta_2 k_2 + \gamma k^2 = \alpha_2 + \beta_3 k_2 \quad \text{.......} (6)$$

Equations (5) and (6) are transformed by differentiating with respect to k_1 and k_2 respectively

$$\alpha_0 = \beta_1 + 2\beta_2 k \quad \text{.......} (7)$$

$$\beta_2 + 2\gamma k_2 = \beta_3 \quad \text{.......} (8)$$

The k's are the joint points of the segmented functions. In this study, k_1 and k_2 are 1975 and 1994 respectively. From the mean function, there are seven structural parameters and four restrictions which imply that only three parameters can be estimated. The goal of the mean function determines the parameters to be retained or dropped[11], [12]. According [8], it is important to retain the coefficients in the terminal trend (usually linear) function where the goal is to forecast. Therefore, α_2,

β_3, and γ will be retained for estimation while α_0, α_1, β_1 and β_2 will be dropped. The expressions for the dropped parameters are as follows:

$$B_2 = \beta_3 - 2\gamma k_2 \quad (9)$$

Equation (9) is used to eliminate β_2 from equation (6) and then solved to obtain an expression in terms of β_1.

$$\beta_1 = \beta_3 - 2\gamma(k_2 - k_1) \quad (10)$$

Equation (10) is used to eliminate α_0 in equation (6) and then solved to obtain an expression in terms of α_1.

$$\alpha_1 = \alpha_2 + \gamma k^2{}_2 \quad (11)$$

The expressions obtained for β_2, β_1, α_1 were substituted into equation (5) to get an expression in terms of α_0.

$$\alpha_0 = \alpha_2 + \gamma(k^2{}_2 - k^2{}_1) \quad (12)$$

The mean function was obtained by substituting for β_2, β_1, α_1 and α_0 into equations (2) to (4).

For equation (2), α_0 and β_1 were substituted for using equations (12) and (10) to obtain:

$$Y = \alpha_2 + \beta_3 t + \gamma[k^2{}_2 - k^2{}_1 - 2(\gamma(k2 - k1)t] \quad (13)$$

For equation (3), α_1 and β_2 were substituted for using equations (11) and (9) to obtain:

$$Y = \alpha_2 + \beta_3 t + \gamma(t - k_2)^2 \quad (14)$$

For equation (4), α_2 and β_3 were retained for forecasting purpose.

The resulting mean function estimated is

$$Y = \alpha_2 X_0 + \beta_3 X_1 + \gamma X_2 \quad (15)$$

Where:

$X_0 = 1 \quad \forall\, t$

$X_1 = t \quad \forall\, t$

$X_2 = [k^2{}_2 - k^2{}_1 - 2(\gamma(k_2 - k_1)t]$ for $t \le k$

$= (t - k_2)^2$ for $k_1 \le t \le k_2$

$= 0$ Otherwise

The mean function is now a continuous mean function given the set of restrictions in equations (5) to (8) and was estimated using ordinary least square regression. Equation (1) and (15) were estimated respectively on the data of rice consumption in Nigeria from 1961 to 2006 while 2007 to 2011 retained for the evaluation of the result.

3. RESULTS AND DISCUSSION

The estimated structural parameters of equations (1) and (15) are presented in table 1. The results in table 1 indicate that all the structural coefficients of the linear and grafted functions were significant at 1 percent level of probability. The F-Statistic of the linear and grafted functions respectively implies that the models are of good fit for ex-post forecast of rice consumption in Nigeria.

Table 1: Estimates of Structural Parameters of Linear and Grafted Functions

Variables	Linear Function	Grafted Function
Intercept	-495.116 (-4.490)	-1978.87 (-9.731)
X_1	81.240* (19.884)	121.436* (20.936)
X_2		1.748* (7.798)
F – Statistics	395.377	496.818
Adjusted R^2	0.897	0.956

d.f	45	45

Note: * Implies significant at P < 0.01 and Figures in parentheses are the computed t values

The estimated coefficients of the linear and grafted functions were utilized to obtain the ex-post forecast of rice consumption in Nigeria over 2007 - 2011 sub periods which were retained for evaluating the predictive efficiency of the linear and grafted functions in forecasting rice consumption. Based on the ex-post forecast of the linear and grafted functions, the predictive performance of the grafted function in forecasting rice consumption in Nigeria is more reliable than the linear function. An ex-post forecast of rice consumption in Nigeria extending from 2012 – 2016 was carried out inorder to provide information to policy makers for the purpose of strategic planning of rice supply to meet the consumption needs of Nigerians.

Table 2: Ex-post Forecast of Rice Consumption in Nigeria

Year	Observed Value†	Linear Value‡	Grafted Value‡
2007	3925	3323.17	3980.33
2008	3910	340.40	4145.47
2009	4100	3484.17	4314.10
2010	4450	3566.88	4486.23
2011	4970	3648.12	4661.85
2012	-	3729.36	4840.97
2013	-	3810.60	5023.59
2014	-	3891.84	5209.70
2015	-	3973.08	5399.31
2016	-	4054.32	5592.41

Source: † USDA FAS, 2011. ‡ Researcher's Estimates.

4. CONCLUSION

The numerical ex-post forecast of rice consumption in Nigeria was estimated using the structural parameters of the linear and grafted models to determine their predictive performance with the liner model utilized as a benchmark. The result indicated that the estimate of the grafted model was closer to the observed rice consumption trend in comparison with the estimate of the linear model. Therefore, the predictive power of the grafted model is more reliable in forecasting rice consumption in Nigeria and this is attributed to the nature of the grafted polynomial functional form (linear-quadratic-linear polynomial function) of the rice consumption trend in Nigeria.

APPENDIX

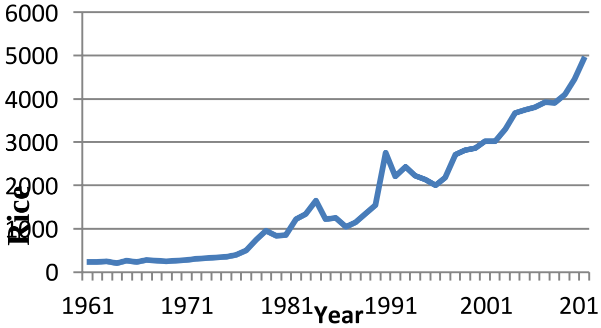
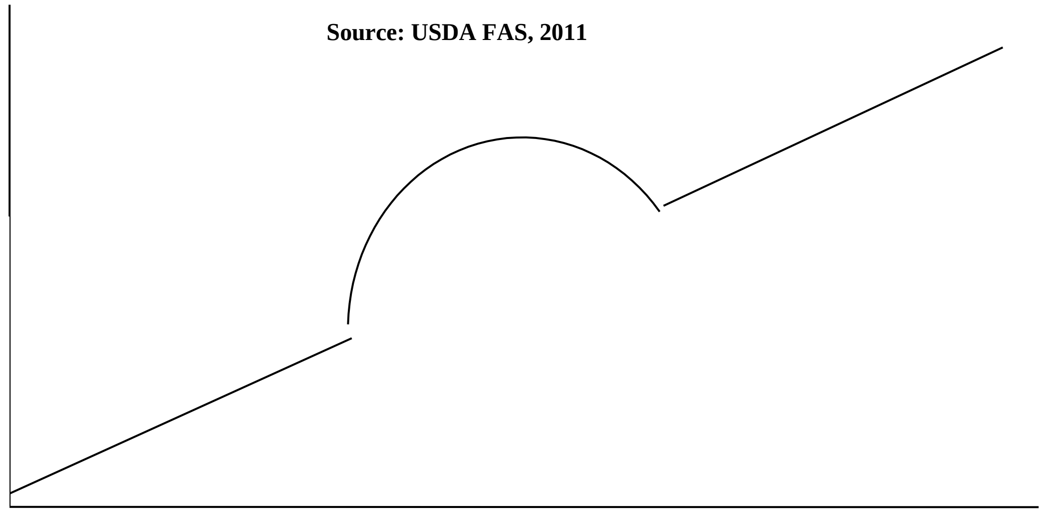


Fig 1: Rice Consumption Trend in Nigeria (1961 – 2011)

Source: USDA FAS, 2011



K1 K2

Yea

Fig 2: Linear – Quadratic – Linear Grafted Function for Rice Consumption in Nigeria

REFERENCES

[1] Ayanwale, A.B and Amusan, C.A. 2012. Gender Analysis of Rice Production Efficiency in Osun State: Implication for the Agricultural Transformation Agenda. Paper presented at the 13th National Conference of the Nigerian Association of Agricultural Economists, ObafemiOwolowo University, Ile – Ife, Nigeria, September 25th – 27th,

[2] Okoruwa, A. and Ogundele, O. 2006.Technical Efficiency Differentials in Rice Production Technologies in Nigeria, African Economic Research Consortium.

[3] Ezedinma, C.I. 2005. Impact of Trade on Domestic Rice Production and the challenge of Self-sufficiency in Nigeria, Paper presented at the `Workshop on Rice Policy & Food Security in Sub-Saharan Africa‘ organized by WARDA, Cotonou, Republic of Benin.

[4] Akande, T. 2002. An Overview of the Nigerian Rice Economy.The Nigerian Institute of Social and Economic Research (NISER), Ibadan, Nigeria.

[5] Ojehomon, V.E.T., Adebayo, S.B.,Ogundele, O.O., Okoruwa, V.O., Ajayi, O.,Diagne, A. and Ogunlana, O. 2009. Rice Data Systems in Nigeria: National Rice Survey.

[6] United Nations Department of Economic and Social Affairs(UNDESA), 2001. World Population Prospects: The 2010 Revision. New York: United Nations Department of Economic and Social Affairs, Population Division.

[7] USDA FAS, 2011. Database of Production, Supply and Distribution.[Online]Available at < http://www.fas.usda.gov/psdonline/psdQuery.aspx > [Accessed 15 December 2011].

[8] Fuller, W.A. 1969. Grafted Polynomials as Approximating Functions.*AustralianJournal of Agricultural Econonomics***,** 35 – 46.

[9] D. O. A. Philip, 1990. Grafted Polynomials as Forecasting Functions: Application to Cotton Production in Nigeria. *Savanna Journal,* 11: 103 – 108.

[10] Balogun, O.S.,Adeyemi, K.A., Simoyan, J.B. 2005.Forecasting Acha Production in Nigeria: A Comparison of Grafted Polynomial and Linear Models.*Journal of Agriculture, Forestry and Social Sciences*,3(2) :42 – 50.