Model for Assessment and Computational Analysis of Some Selected Staple Crops in Nigeria

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Abstract: Model has been derived for assessment and computational analysis of some selected staple crops (maize, rice, beans, yam, and cassava) in Nigeria. Data collected were regressed without data corrected for the mean so that all parameters including the intercept could be obtained from the matrix, so that the variance and co-variances could be easily deduced. The significance of the models and estimated parameters were also analysed using the t-test, Durbin Watson test, Farrar-Glanber test, and Spearman's Rank correlation coefficient. The results of the analysis shows that the general model:

$$\hat{Y} = -1.655 \times 10^3 + 3.231M + 0.644R + 12.328B + 1.366Y + 0.356C$$

is found to predict the total output of the selected crops. The model gave rise to a coefficient of determination of 0.986. The results also show that autocorrelation and multicollinearity exists among the explanatory variables, however the variance of the disturbance error term for each of the explanatory variable have no heteroscedasticity.

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Introduction

Modeling is the process of producing a model; a model is a representation of the construction and working of some system of interest. A model is similar to but simpler than the system it represents. One purpose of a model is to enable the analyst to predict the effect of changes to the system. On one hand, a model should be a close approximation to the real system and incorporate most of its salient features. On the other hand, it should not be so complex that it will be impossible to understand and experiment with it. A good model is a judicious trade off between realism and simplicity (Maria, 1997). Agriculture is the economic mainstay of the majority of households in Nigeria (Udoh, 2000) and is a significant sector in Nigeria's economy (Amaza, 2000). The important benefits of the agricultural sector to Nigeria's economy include: the provision of food, contribution to the gross domestic product (GDP), provision of employment, provision of raw materials for agro-allied industries, and generation of foreign earnings labour (until the early 1970s; agricultural exports were the main source of foreign exchange earnings).

Although increases in agricultural productivity are urgently needed, such increases need to be sustainable. Liebhardt, (1987) posits that agricultural sustainability involves minimizing the use of external input and maximizing the use of internal inputs which already exists in the farm. The slow growth in staple food production in Nigeria and other Sub-Saharan Africa is attracting attention in the scientific community as well as in the political sphere (Onyegbula, 1999).

Staple crops are the most commonly consumed foods in the diet of people in a specific region. Maize, rice, beans, yams and cassava are some of the staple crops in Nigeria hence, our choice for them. Regression analysis deals with an approach to modelling the relationship between two or more variables related in a non-deterministic fashion. The main objective of Regression analysis is to exploit the relationship between two or more variables so that we can gain information about one of them through knowing the values of the other(s) (Aliu, 2006). Since variation (increase or decrease) in total output of staple crops affects a country's GDP, the objective of this work is to critically examine the strength of the relationship between the total output of some staple crops and each of the staple crops i.e. maize, rice, beans, yams and cassava in Nigeria for a period of 30 years. The extent to which each staple crop affects the

variation in total output over a span of 30years (1975-2004) is also discussed. We tested for the dependence of the explanatory variables (staple crops) on one another (Multicollinearity).

Materials and Methods

(a) Hypothesis

The following hypotheses were formulated for testing:

Output of the selected staple crops (maize, rice, beans, yam, and cassava) have no effect on the variation of total output of staple crops.

1. There is no dependence of the selected staple crops on one another i.e no multicollinearity.
2. There is no autocorrelation.
3. There is no heteroscedasticity.

(b) Collection of data

The data collected covered a period of 30 years i.e from 1975-2004.

Consequently, the output('000 tonnes) of maize, rice, beans, yam, and cassava were collated from Nigeria by central Bank of Nigeria in their statistical bulletine.

(c) Population and Sample

The sample consist of staple crops like maize, rice, beans, yam, and cassava. The yearly output of each staple crops were used and their total output was also used.

(d) The Data

Output of some Selected Major Agricultural Staple Crops ('000 Tonnes)

YEAR	MAIZE	RICE	BEANS	YAMS	CASSAVA	TOTAL
1975	1332	504	858	8620	2324	21993
1975	1068	218	727	6470	1786	18862
1975	650	410	408	6376	1656	17828
1975	658	280	498	5866	1620	15977
1975	488	160	624	5256	1446	15121
1980	612	105	510	5248	942	15421
1981	720	158	560.5	5212	620	15704
1982	766	212	616	5385	592	16445
1983	594	145	583	4047	513	14240
1984	2058	157	477	4600	11800	39552
1985	1190	196	611	4738	13500	31601
1986	1336	283	732	5209	12388	32512
1987	4612	808	688	4886	13876	37106
1988	5268	2081	887	9132	15540	47015
1989	5008	3303	1232	9609	17404	52772
1990	5768	2500	1354	13624	19043	55964
1991	5810	3226	1352	16956	26004	67581
1992	5840	3260	1411	19781	29148	75085
1993	6290	3065	1576	21633	30128	78691
1994	6902	2427	1545	23153	31005	81802
1995	6931	3203	1751	22818	31404	84286
1996	6217	3122	1847	23928	32950	88080
1997	6285	3230	1957	24713	33510	90817
1998	6435	3486	2054	25102	34092	93401
1999	6515	3522	2100	26007	35950	96769
2000	6491	3841	2261	26421	36750	102646
2001	6592	3989	2409	27589	37949	104043
2002	6698	4085	2612	28979	39410	108269
2003	7185	4364.8	2712.9	30573.3	41814.7	114702.3
2004	7908.8	4605.4	2793.9	325749.5	44693.4	121936.7

(e) Statistical analysis of data

The outputs ('000 tonnes) of the staple crops were summed up and taken as the total output. A general model for the total output of the selected staple crops was formulated

$$T = \beta_0 + \beta_1 M + \beta_2 R + \beta_3 B + \beta_4 Y + \beta_5 C + U_i$$

T = Total Output of Staple Crops
M = Maize
R = Rice
B = Beans
Y = Yams
C = Cassava
β_0 = Regression Constants (intercepts)
β_i = Regression Coefficients
U_i = Error term
i = 1, 2, 3, 4, 5.

A regression model to predict the total output of the selected staple crops was formulated;

$$\hat{Y} = \hat{\beta}_0 + \hat{\beta}_1 M + \hat{\beta}_2 R + \hat{\beta}_3 B + \hat{\beta}_4 Y + \hat{\beta}_5 C + e_i$$

We solved for the constants using matrix method and obtained the estimated model;

$$\hat{Y} = -1.655 \times 10^3 + 3.231M + 0.644R + 12.328B + 1.366Y + 0.356C$$

The significance of the constants were tested using t-test to show how each of the independent variable affects the variation in the total output and F-statistics was used to test for the overall significance of the regression. We tested for the dependence of the independent variables on one another using Farrar-Glauber test, used

Results

Durbin-Watson test to test for autocorrelation and spearman rank correlation test to test for heteroscedasticity.

The Goodness of fit (R^2) is determined using;

$R^2 = \frac{\sum \hat{Y}_i^2}{\sum T_i^2}$;

$\sum \hat{Y}_i^2$ = The sum square regression

$\sum T_i^2$ = The sum square total

The adjusted $\hat{R}$ is defined as;

$$\hat{R}^2 = 1 - [(1 - R^2)/(n - k)]$$

k = number of explanatory variables including the regression constant

n = number of observation

From statistical tables 0.05 or 5% critical level of significance is used. The degree of freedom is also determined at this level.

Variable	t-value	f-calculated	f-from table	R	R	Remark
Maize	2.2222					The higher
Rice	0.23					the t-values
Beans	11.905					the greater
Yams	2.865	339.555	2.62	0.986	0.983	theeffecton
cassava	1.215					the variation
						of thetotal
						output

Findings and Discussion

The high value of R^2 indicates a good fit of the regression. The explanatory variables explain most (98.6%) of the variation in the dependent variable (Total output) while the remaining 1.4% explain other factors which are not included in the analysis. The individual t-test shows that maize and yams contribute mostly to the variation in total

output respectively. There is dependence of the independent variables on one another to a certain extent, autocorrelation of the disturbance (error) term exists and the variance of disturbance error term for each of the explanatory variables are said to have no heteroscedasticity. The dependence of the output of each staple crops on one another is actually a problem that should be look into. Land tenure system, over use of land, inadequate know-how on mixed cropping/farming system e.t.c are some of the factors that needs attention.

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