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ESTIMATING SUPPLY RESPONSES VIA PRODUCER PANEL APPROACH —A CASE STUDY OF WESTERN NIGERIAN COCOA FARMERS

I. PRELIMINARY CONSIDERATION

The importance of cocoa to the Nigerian economy can be gauged from the fact that for the past twenty years it has accounted for 21 per cent of the aggregate export earnings, 3.4 per cent of the G.N.P., and helped to purchase 23 per cent of the aggregate imports.[1] When considered against its sectional background, cocoa assumes an economic importance which far outweighs its relative contribution to the national wealth. Western State of Nigeria is the main cocoa producing area of the country and at present it supplies more than 95 per cent of the Nigerian cocoa exports. Besides the fact that cocoa has been the main source of income for over 300,000 peasant farmers, it has provided the main stream of revenue for the Western State government particularly through three forms of direct taxes—export duty, produce sales tax and Marketing Board surpluses. These taxes have averaged about £7.4 million per annum for the past decade.

In view of the prominent position occupied by cocoa in Western Nigerian economy, the growth and development of the State have become crucially linked with a policy to expand the production of this commodity. The pursuance of this policy calls for a thorough understanding of the determinants of cocoa supply and an analysis of the mechanism of response among the producers. This study attempts to estimate the acreage response among the Western Nigerian cocoa farmers. It is hoped that an understanding of the mechanism of response and the estimated elasticities will enhance our ability to forecast changes in cocoa supply from one period to another and at the same time improve our competence to prescribe concrete solutions to the problems related to the agricultural supply of this commodity.

1.S. A. Oni: An Econometric Analysis of the Provincial and Aggregate Supply Response Among Western Nigerian Cocoa Farmers, unpublished Ph. D. dissertation, University of Ibadan, 1971, p. 12.

Section two of the paper examines the methodology adapted for the study. The data sources and the estimating equations are also discussed in this section. The third section presents the empirical results on provincial basis whilst section four compares the results of producer panel approach with those obtained from macro time series data. The policy implications of the results and conclusion of the study are presented in section five.

II. METHODOLOGY

Considerable interest has been displayed in recent years in the synthetic estimation of aggregate commodity supply response from data obtained by the producer panel aoproach. However, only few empirical studies have actually experimented with this approach because it involves an enormous task of accumulating information and analysing them, both in money, time and manpower. Not only that, the issue of coverage in terms of "representative farms" *versus* the universe presents a challenge which only few researchers are willing to undertake. This study focuses our attention on estimating supply response of Western Nigerian cocoa farmers by utilizing the producer panel approach.

Sample Size

From a population of about 300,000 cocoa farmers a representative sample of 300 farmers were drawn up. The farmers were grouped by provinces. Table I shows the break down of the sample size on provincial basis.

TABLE I—DISTRIBUTION OF THE SAMPLED COCOA FARMERS

Province	Number of farmers selected
Ondo	80
Oyo	60
Ibadan	60
Ijebu	50
Abeokuta	50
All areas	300

Questionnaires were drawn up to accumulate background information about the cocoa farmers and their families, the size of cocoa farms, the existing age distribution of the cocoa trees — those too old to produce, those too young to produce, and those trees in production; existing acreages of food crops and other cash crops, existing virgin forest suitable for cocoa; and other pertinent information which can influence the farmers' supply response.

From the view point of supply analysis, an acreage response hypothesis was to be tested. The farmers were asked how many acres of cocoa they would plant at various alternative producer prices. (The producer prices were varied from £50 to £400.) The seemingly realistic hypothesis was that as producer prices go up, the farmers would increase their cocoa planting; and that as producer prices go down, the farmers would decrease their cocoa planting. Our hypothesis amounts to saying that there is a positive relationship between cocoa plantings and the producer prices of cocoa.

Data Sources and Limitations

The survey conducted in 1970 covered the following towns and villages : in Ibadan province, interviews were conducted for selected cocoa farmers at Iwo, Apomu, Egbeda, Moniya, Ode-Omu and Gbongan; for Ijebu province, selected cocoa farmers were interviewed at Ijebu-Ode, Ijebu-Igbo, Ago-Iwoye and Ishara. At Oyo province, interviews were conducted for selected cocoa farmers at Ife, Ilesha, Ifewara, Oshun and Ipetu Ijesha. In Ondo province, the cocoa farmers interviewed were drawn from Effon Alaye, Ikole-Ekiti, Ado-Ekiti, Owo, Akure, Owena, Idanre, Ile Oluji and Ondo. At Abeokuta province, the selected cocoa farmers were drawn from Abeokuta, Ilaro, Ibeshe, Iboro, Awba and Asha.

In each village or town covered, the farmers interviewed were randomly selected from the group of cocoa farmers. Since cocoa is a very important crop, almost in every instance, we had over 40 farmers in each village out of which about eight were randomly selected for our interview, in other words, one out of every five farmers that turned out in each village undertook the interview. In order to remove bias in response, each selected farmer was interviewed privately and occasionally checks were made on his farm to assess the farmer's degree of reliability. Where some doubts existed the farmer was dropped from the list. At the end of the survey, about 262 farmers were assumed to have given reliable information and our present analysis is therefore based on these 262 selected farmers. Although the selection limited the size of our sample it removed apparent bias and errors in our analysis.

Estimating Procedures

The responses of the farmers were aggregated on provincial basis since the pertinent characteristics of the cocoa farmers varied from one region to another. The model to be tested was an acreage response model whose mathematical representation may be written as follows :

$$A = f(P_c \quad U_t) \quad .. \quad .. \quad .. \quad .. \quad (1)$$

where A = acres of cocoa planting,

P_c = producer price of cocoa,

and U_t = error term.

In estimating the parameters of the acreage response model the following functional equations were tried :

$$A = a_o + a_1 P_e \longrightarrow \text{Linear} \quad .. \quad .. \quad (2)$$

$$\text{Log } A = a_o + a_1 \text{ Log } P_c \longrightarrow \text{Power} \quad .. \quad .. \quad (3)$$

$$\text{Log } A = a_o + a_1 P_c \longrightarrow \text{Exponential} \quad .. \quad .. \quad (4)$$

From the cross sectional data obtained from the survey, the parameters of the acreage response model were estimated for the five provinces as well as for the entire state by utilizing ordinary least square regression techniques. The empirical results are presented in section III.

III. EMPIRICAL RESULTS

In presenting the empirical results we must reiterate that these acreage response models actually represent what the farmers said they would do; not what the farmers had actually carried out. The derived response should therefore be recognized for what it represents — a normative supply response.

The normative supply parameters are presented in Table II. The table indicates the performance of the various functional relationships for the five provinces as well as for the entire Western State of Nigeria. In the table, R^2 is the coefficient of multiple determination, S_{At} is the standard error of estimate, D^t is the Durbin-Watson test statistic,[2] the figures in parentheses are the t-ratios, and P_c and A are as defined earlier.

In all instances the price coefficients (P_c) had the expected positive signs and were significant at 1 per cent level of probability. Another interesting feature of the estimated parameters is that the power functions provided the "lead" equations in all the regions on account of their high explanatory power (R^2 value) and their lowest standard error of estimates (S_{At}).

The best performance of our model was in Ondo province where the lead equation (6) was able to account for about 48 per cent of the variability in cocoa planting. It is significant to note that the low level of R^2 for all the regions indicated that besides producer prices other considerations which have been left out in the model are also important determinants of cocoa planting in Western Nigeria.

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2. Because of the possibility of "measurement error" in the 'explained variable' there is a real possibility of an auto-correlated disturbance term which may result in unduly large sampling variances. This necessitated the use of Durbin-Watson statistic to test the presence of auto-correlated errors.

TABLE II—EMPIRICAL RESULTS OF COCOA NORMATIVE SUPPLY RESPONSE

Region	Equation number	Dependent variable	Constant term	Regression coefficient (P_c)	S_{At}	D_t	R^2
Ondo province	5	A	0.0778	0.0239* (7.2984)	7.4614	1.3374	0.1579
	6	Log A**	—24.2833	4.3723* (16.3230)	3.6224	1.8475	0.4840
	7	Log A	—7.0944	0.0237* (13.8942)	3.8911	1.8627	0.4047
Oyo province	8	A	1.4578	0.0094* (5.1240)	3.5209	1.6929	0.1066
	9	Log A**	15.9823	2.9459* (8.8001)	3.7327	1.5887	0.2603
	10	Log A	—3.8085	0.0135* (6.4752)	3.9778	1.6192	0.1601
Ibadan province	11	A	—2.4853	0.0509 (4.1839)	23.5311	1.6759	0.0790
	12	Log A**	—15.7242	3.0856* (12.3162)	2.8745	1.8052	0.4264
	13	Log A	—3.5450	0.0165* (10.4229)	3.0660	1.8688	0.3474
Abeokuta province	14	A	0.5898	0.0163* (5.6051)	6.0139	1.3783	0.1192
	15	Log A**	—15.4546	2.9072* (11.1849)	3.1789	2.0192	0.3503
	16	Log A	—4.0504	0.0159* (9.9017)	3.3066	2.0122	0.2970
Ijebu province	17	A	1.8136	0.0114* (8.1430)	2.9764	1.2819	0.2109
	18	Log A**	—12.0672	2.3756* (8.5919)	2.8235	1.9068	0.3159
	19	Log A	—2.6339	0.0124* (7.1976)	2.9667	1.9188	0.2445
Western State Aggregate	20	A	0.1566	0.0233* (8.8827)	11.6340	2.0678	0.0669
	21	Log A**	17.3208	3.2341* (24.6166)	3.4495	2.6933	0.3573
	22	Log A	—4.4988	(20.9721) (20.9721)	3.6384	2.5503	0.2856

* = Highly significant regression coefficients.
** = Log form of the regression coefficients.
Note: The figures in parentheses are the t-ratios.

Elasticities of Acreage Response

Absolute changes in the dependent variable often do not fully explain the nature of the relationships between the independent variable and dependent variable.[3] Percentage increases or decreases associated with percentage changes in the independent variable measured about an established point, may reveal more information concerning these relationships. The elasticities of acreage response with respect to producer prices, indicate these percentage changes. These elasticities were calculated for the "lead" equations in each of the provinces and the estimated values are presented in Table III.[4]

TABLE III—CALCULATED ELASTICITIES FOR COCOA PLANTING

Region	Lead equations	Elasticities
Ondo province	6	4.3723
Oyo province	9	2.9453
Ibadan province	12	3.0856
Abeokuta province	15	2.9072
Ijebu province	18	2.3756
State Aggregate	21	3.2341

Table III indicates that the magnitude of the elasticity coefficients was greater than unity in every instance thus indicating an elastic normative supply relation. However, a cursory look at the table will reveal that certain regions have more elastic relations than others. For instance, the cocoa farmers in Ondo province who still have large areas of virgin forest suitable for cocoa have elasticity coefficient of 4.3723—almost double those of Ijebu cocoa farmers who have very limited areas suitable for further cocoa plantings. In a sense, the magnitude of the elasticity coefficients is thus a reflection of the farmers expansion capacity and these elasticity coefficients represent the upper limit of what the farmers can do with respect to cocoa planting in the various areas.

IV. COMPARISON OF THE EMPIRICAL RESULTS WITH THE TIME SERIES ANALYSIS

As indicated earlier, the response obtained from the producer panel approach is a normative supply response which indicates what the farmers would do under specified price conditions. This response is quite different from what the farmers have done historically. In this section, a comparison is made between these two types of responses.

3. C. O. McCorkle and Yair Mundlak, "Statistical Analysis of Supply Response in Late Spring Potatoes in California," *Hilgardia*, Vol. 24, No. 16, 1956.

4. For the selected power functions, the regression coefficients are the direct elasticity coefficients.

Utilizing time series data for the 1937 to 1958 period, the following acreage response model was tried :

$$A_t = F(P_c, T, e_t), \quad .. \quad .. \quad .. \quad .. \quad .. \quad (23)$$

where

A_t = acreages planted in year t,

P_c = producer price for cocoa in year t (Grade I price),

T = time trend variable representing changes in technology and production structure.

and e_t = the error term.

Trial techniques were adopted by fitting linear, power and exponential functions for this model and the selected "lead equations" for each region are presented in Table IV.

TABLE IV—SELECTED RESULTS OF TIME SERIES ANALYSIS (1937-1958)

Region	Equation number	Dependent variable	Constant term	Regression coefficients		S_{At}	D_t^1	R^2
				P_c	T			
Ondo province	24	A_t	25.0922	0.0922 (0.2219)	—1.4634* (3.7118)	5.6232	0.7138	0.7248
Oyo province	25	A_t	3.1855	0.0181 (0.2395)	—0.1663* (2.3017)	1.0308	1.4579	0.4829
Ibadan province	26	A_t	3.4687	0.0165 (2.6622)	—0.3416* (5.8308)	0.8356	1.3951	0.8356
Abeokuta province	27	A_t	2.6725	0.0207* (2.9785)	—0.2948* (4.4810)	0.9383	1.0415	0.5438
Ijebu province	28	A_t	0.6459	0.0043* (2.3583)	0.0644* (3.6955)	0.2488	0.7631	0.4581
Western State aggregate	29	A_t	36.9271	0.0652 (1.1706)	—2.5017* (4.7588)	7.4980	1.5115	0.7522

* Significant regression coefficients.

Table IV indicates that all the regression coefficients for the trend variable (T) were highly significant but the producer price coefficients were significant only for Ibadan, Abeokuta and Ijebu provinces. However, the price coefficients had the expected positive signs in all instances whilst the trend variable turned out with negative coefficients, thus suggesting a declining influence of technology over the period studied.