

Economic Deregulation and Supply Response of Cocoa Farmers in Nigeria

O. O. Olubanjo¹, S. O. Akinleye² and T.T. Ayanda¹

1. *Department of Agricultural Economics, Olabisi Onabanjo University, Ogun State, Nigeria*

2. *Department of Economics, University of Lagos, Nigeria*

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ABSTRACT The effect of deregulation on the supply response of cocoa farmers in Nigeria was analyzed using the ECM approach. Time series data (i.e. 1970-2000) were compiled and a functional relationship was established using OLS technique. The data were tested for their time series characteristics using the DF/ADF tests. Preliminary analysis suggested that estimations based on their levels might be spurious. Results indicated that almost all the variables in the model were not stationary at their levels. Further results revealed that higher prices received by producers affected cocoa output. Moreover, statistical significance of the error correction term confirmed the existence of an equilibrium relationship among the variables. More importantly, the deregulation period's policy instruments instituted in Nigeria, favored cocoa production. Consequently, policies encouraging domestic price alignment with world prices are recommended.

INTRODUCTION

Prior to the introduction of economic reforms in 1985, export commodities in Nigeria were traded through the marketing boards. The boards were vested with the monopoly power to export crops such as cocoa, palm oil, rubber, kola-nut, among others. However, as agricultural production strategies changed over time, so did agricultural marketing strategies. Thus, between the colonial era and now, the Nigerian agricultural system has undergone profound changes, culminating in the present liberalized marketing arrangement for major export commodities in Nigeria. Consequently, the prices at which cocoa and other cash crops farmers in Nigeria are able to sell their produce to a large extent now depend on how they respond to both local and global demand in the cocoa industry.

With the scrapping of the Cocoa Marketing Board in 1986, the cocoa marketing channel now has more operators and links; resulting into many people becoming gainfully employed. Moreover, cocoa farmers in Nigeria are now able to monitor and sell their produce at rates close to world market prices. They are also saved the agonies of long delays in payment for purchases. These two

favorable developments, inter alia, thus serve as incentives to local farmers to produce more for the market. Official statistics from the Central Bank of Nigeria indicate that an average of about 252,000 tonnes of cocoa beans were produced per annum between 1986 and 1995 (i.e. the first decade of economic deregulation) as against an average 160,000 tonnes of cocoa beans produced in the 1977 to 1985 period. The other fact that is obvious from Table 1 is the increase in the value of the exchange rate after 1986. Also, farmers have received higher prices for their produce in the world market. Furthermore, changes in the average annual rainfall were not enough to affect output negatively in the periods of economic deregulation in Nigeria. Finally, increased hectares of cocoa plantations were harvested in the deregulation period, obviously in response to improved price incentives, as compared to the pre-deregulation period.

Given the importance of the agricultural sector as a vital component in the economies of developing countries as Nigeria's and the relative importance of cocoa as a major cash crop in Nigeria, there is the need to ensure its improved performance. A means of achieving this would be through the analysis of the cocoa economy, before and since the onset of economic deregulation in Nigeria. Similarly, the emphasis in Nigeria on the adoption of a realistic exchange rate policy coupled with the liberalization of external trade and payments system, and the growing reliance on market forces especially in

Corresponding author:

Akinleye S. Oludiran
Department of Economics, University of Lagos,
Akoka, Lagos, Nigeria
E-mail: akinleye@gmail.com
Telephone: +234 803 3483 326, 805 8871 652

Table 1: Summary of selected macroeconomic variables in Nigeria, 1970-2000

<i>Period</i>	<i>Output of Cocoa (‘000 tonnes)</i>	<i>Producer prices (₦ per ton)</i>	<i>Average rainfall (inches)</i>	<i>Indices of av. world prices</i>	<i>Exchange rate (₦/US Dollar)</i>	<i>Area Harvested (‘000 ha)</i>
1970 – 1975	241.33	286.67	1467.54	32.83	0.66	700.00
1976 – 1981	168.17	1086.67	1640.40	84.83	0.61	700.00
1982 – 1986	148.80	1860.00	3320.56	98.60	1.02	700.00
1987 – 1993	242.57	12183.00	1487.20	544.00	10.47	716.29
1994 – 2000	264.86	80421.00	1439.53	10579.04	66.04	781.43
1970 – 2000	213.15	19167.47	1871.05	2267.86	15.76	719.54

Source: Computed from CBN Statistical Bulletin (Various Issues)

the determination of prices necessitate an econometric analysis of the effects of economic deregulation on the supply response of cocoa farmers.

Earlier studies carried out on Nigeria such as Oni (1969) showed that farmers responded positively to increase in producer prices by planting more acres of land in the succeeding years. More recent studies by Yusuf and Falusi (2000) and Salami (2001) which employed the error correction mechanism (ECM) suggested that deregulation improved price incentives, and increased cocoa output and trade in Nigeria. Dercon (1993), however, in his analysis of cotton production in Tanzania noted otherwise, as no aggregate supply response existed for cotton.

To this end, this study will employ an ECM approach that corrects for spurious regression results in analyzing the effects of deregulation on the supply response of cocoa farmers in Nigeria. Consequently, the main objective of this study is the analysis of the effect of economic deregulation on the supply response of cocoa farmers in Nigeria between 1970 and 2000. The specific objectives are to:

- Estimate the supply response function for cocoa during pre-deregulation and deregulation era in Nigeria, and
- Assess the determinants of the supply response of cocoa.

METHODOLOGY

Study Data: The study used data from secondary sources. These sources include the Central Bank of Nigeria (CBN), the Department of Meteorological Services, the Federal Ministry of Aviation, the Federal Office of Statistics (FOS), the Food and Agriculture Organization of the United Nations (FAO/UN) and the Quarterly Bulletin of Cocoa Statistics (various issues).

The time series data covers a period of thirty-one years (1970-2000). The choice of the time period was based on the completeness of the available data and the need to adequately capture the pre-deregulation and deregulation periods in Nigeria. Data collected include those on output and producer prices of cocoa, average annual rainfall in different geographical locations; indices of world average price of cocoa; the dollar-naira exchange rate, cocoa area harvested and world cocoa prices.

Analytical Procedure: Past researches, in trying to estimate the supply response of farmers using the ordinary least squares (OLS) regression analysis approach, have consistently generated spurious results due to the non-stationary nature of time series data. Consequently, this study used the error correction model (ECM), which has been developed to address the problem associated with the non-stationary nature of time series data.

As a first step, ECM ascertains the stationarity or otherwise of the time series data. A non-stationary series requires differencing to become stationary. As such, there is the need to assess the order of integration of both the dependent and independent variables in the model under analysis. The order of integration ascertains the number of times a variable will be differentiated to arrive at stationarity. A stationary series is an $I(0)$ series while non-stationary series are $I(1)$. But it is also possible for non-stationary series to be of order 2, that is $I(2)$, or even of a higher order. X_t is integrated of order D_x or $X_t \sim I(D_x)$, if it is differentiated D_x times to achieve stationarity (Dickey and Fuller 1981).

Engle and Granger (1987) provided appropriate tests for stationarity of individual series. Specifically the test procedure includes the estimation of the Dickey-Fuller (DF) and the Augmented Dickey-Fuller (ADF) statistics. The DF and ADF are tests for the null hypothesis that

the variable of interest is non-stationary. Thus,

H_0 : The variables are not stationary at their levels, i.e. $I(1)$

H_a : The variables are stationary at their levels, i.e. $I(0)$.

The test procedure is usually indicated in the following type of equation:

For DF test,

$$\Delta X_t = \alpha_0 + \delta X_{t-1} \quad \dots(1)$$

For ADF test,

$$\Delta X_t = a_0 + \delta X_{t-1} + \sum_{i=1}^k \Delta X_{t-i} + e_t \quad \dots(2)$$

H_0 is rejected if the t-statistic on δ is negative and statistically significant when compared to appropriate critical values established for stationarity tests. In order to generate an error correction model, there is the need to examine the existence of any meaningful long-run relationship between variables (i.e. co-integration). A test of co-integration was thus carried out using the Engle-Granger method (Engle and Granger 1987).

If a set of time series on economic variables $X_t \dots Y_t$ are integrated in the order Dx , as long as their stationarity properties have been established, then they can be tested for co-integration. If these series are all integrated of the same order $I(p)$, then they form a co-integrating set. The DF and ADF frameworks are utilized in the test procedure. Co-integration is accepted when the residuals from the linear combination of non-stationary $I(1)$ series are themselves stationary. Co-integration is accepted if the critical value of the DF/ADF, which is negative, is greater than the DF/ADF t-statistic value of the individual variables.

Having established the extent and form of co-integrating relationships between the variables of the model, an ECM can then be estimated. First, an over-parameterized ECM was estimated and this specification established lag lengths on all variables. This was specified in order not to lose information of the variables by lagging all the variables once. At this stage, the over-parameterized model was found to be difficult to interpret in any meaningful way but could still be explained to some extent based on the probability values. This then led to the simplification of the model into a more interpretable characterization of the data. That is, a parsimonious ECM was estimated.

Parsimony helped to ensure data admissibility

and proper clarification on whether the model was consistent with theory, and with the estimation, non-significant variables were dropped from the model. The overall validity of the reduction sequence sought to minimize the goodness of fit of the model with minimum number of variables. The decision rule for choosing which of the two models had the best fit (i.e. whether over-parameterized or parsimonious model) is indicated in the Schwarz criterion. The Schwarz information criterion provides a guide to parsimonious reductions and is defined as:

$$S_c = \ln \delta^2 + k \ln t \quad \dots(3)$$

Where δ is the maximum likelihood estimate (MLE) of δ

k is the lag length

t is the sample size/number of observations.

Thus, a fall in Schwarz criterion is an indication of model parsimony; that is, the model is significant with theory. The final estimated equation of the ECM could be represented thus:

$$\begin{aligned} \Delta \ln Q_t = & a_0 + a_1 \Delta \ln P_t + a_2 \Delta \ln RAN_t + \\ & a_3 \Delta \ln IND_t + a_4 \Delta \ln EXC_t \\ & + a_5 \Delta \ln HA_t + a_6 DUM_t - a_7 ecm_{t-1} + U_t \dots(4) \end{aligned}$$

Where Q_t = Output of cocoa in year t (tonnes)

P_t = Price of cocoa in year t (naira)

RAN_t = Average annual rainfall in year t for five locations (inches)

IND_t = Index of average world price (1985=100) in year t .

EXC_t = Exchange rate in year t (\$ to ₦).

HA_t = Area harvested to cocoa in year t (hectares)

DUM_t = Dummy variable (1=deregulation period; 0 otherwise)

ecm_{t-1} = error correction factor.

U_t = Stochastic error term.

The *a priori* expectation of the error correction factor is negative and should be statistically significant to support the existence of co-integration.

RESULTS AND DISCUSSION

Results of Stationarity Tests

The analysis begins with a consideration of the time series characteristics of the data employed. This was achieved by considering the order of integration of each series using the

Table 2: Tests for the order of integration of macroeconomic variables, 1970-2000

<i>Variables</i>	<i>DF Test statistics</i>	<i>ADF Test statistics</i>	<i>No. of lags</i>	<i>Order of integration</i>	<i>Remarks</i>
Output	-6.9083	-4.3679	1	1(1)	Non stationary
Producer Price	-3.2741	-3.5798	1	1(1)	Non stationary
Rainfall	3.8572	-3.9973	1	1(0)	Stationary
Indices of World Price	-5.9415	-5.2058	1	1(1)	Non stationary
Exchange Rate	-5.0471	-3.4203	1	1(1)	Non Stationary
Land Area Harvested	-6.5784	-7.0998	1	1(3)	Non stationary

Source: Computed from result of Stationarity test.

Note: Critical value of ADF = -3.13

Dickey-Fuller (DF) and the Augmented Dickey Fuller (ADF) classes of unit root tests. The results are displayed in Table 2.

The decision rule was based strictly on an ADF test with critical value of 3.13. The ADF tests strongly support the hypothesis that almost all the included right-hand-side variables are I(1) or non-stationary. The results confirmed similar findings by Olopoenia (1992), Yusuf and Falusi (2000), Salami (2001). This suggests the need to differentiate the variables once to obtain stationary or 1(0) series. Cases of a higher order integration I(3) also exist for the variable representing the land area harvested. By implication, the variables should be differentiated thrice in order to attain stationarity in the series.

One immediate conclusion from this analysis is that any dynamic specification of the model in levels of the series is likely to be inappropriate and may be plagued by problems of spurious regression (Adams 1992). It is also argued that econometric results of the model in the levels of the series may not be ideal for policy making. These considerations thus lend credence to the earlier doubts cast over the efficacy of results for past studies and their usefulness in making policy decisions.

RESULTS OF THE CO-INTEGRATION ANALYSIS

In using the co-integration model, co-integration among macroeconomic variables that were themselves non-stationary are looked for. This was done as a condition for accepting the error-correction mechanism (ECM) model. The ADF/DF test was also used to test for co-integration. Co-integration would be confirmed if the residuals of the series that were I(1) are in fact I(0). The tests try to establish whether there was long run relationship between the dependent variables and their fundamentals. Table 3 shows the result of the co-integration tests conducted.

From Table 3, it is seen that the absolute value of the DF test statistic was greater than its corresponding critical value, so co-integration was not rejected based on the DF test while the absolute value of the ADF test statistic was less than its critical value, so co-integration was rejected by the ADF test, thus signifying no co-integration. Although the ADF test suggested that there was no co-integration, the DF test showed that there was a long-term equilibrium relationship between output and all its independent variables.

Table 3: Results of the co-integration tests of the residuals of the time series

<i>Variable name</i>	<i>Estimated coefficient</i>	<i>Standard Error</i>	<i>t-ratio</i>
Constant	14.114000	6.665100	2.11750
Trend	-0.35143	0.022257	-1.57900
Producer Price	-0.022622	0.149830	0.15098
Rainfall	0.317460	0.265120	1.19740
Indices of World Average Price	-0.171630	0.088680	-1.93530
Exchange Rate	0.408480	0.099016	4.12530
Land Area Harvested	-1.559300	0.959600	-1.62490
<i>Test statistics</i>		<i>Critical value</i>	
DF	-5.9932	-4.70	
ADF	-4.5830	-4.70	

Source: Computer printout of co- integration test

The rejection of the existence of co-integration by the ADF test suggested that the additional dynamics left out by the DF test indicates that the error terms were not randomly and independently distributed (Bogunjoko 1997). Long-run relationships is the relationship that occurs between variables when they are trending upward in a stochastic fashion; that is, when they are trending together and this can only take place over time. A test for long-run relationship can thus be thought of as a pre-test to avoid a spurious regression situation.

Error Correction Model for Cocoa

The existence of co-integration among the dependent variables and their determinants necessitated the specification of ECM for cocoa as well as its estimation in this study. An over-parameterized model was thus specified in order not to lose information on the variables. In this regard, all the variables were lagged once.

In Table 4, the test statistic revealed that exchange rate, land area harvested and dummy variable for economic deregulation were significant at the 10 percent level in the over-parameterized model. However, producer prices, rainfall, indices of world average prices and all the lagged variables were non-significant at the chosen test level. The co-efficients of exchange rate and land area harvested were negative. This implies that they have a negative effect on output or cause decrease in output as their magnitudes

increase. Unsurprisingly, increased exchange rate signifies Naira appreciation, and hence represents price disincentive for local (cocoa) production. Also, the unfavorable age structure of existing cocoa trees, the attendant, albeit declining output, and the poor processing may depress (or show in form of reduced) output even with larger cropped area harvested. Moreover, the economic deregulation with the attendant, favorable policy regime enhanced cocoa output. Hence, the positive coefficient on the dummy variable representing deregulation period.

The ECM produced the expected negative sign and the estimate was statistically significant (Table 4). Thus, it reinforced the finding of the DF test that there is a long-run structural relationship between output and its regressors. The coefficient in particular showed that the speed of adjustment of output to disequilibria from the long-term values of the independent variables was 99.01 percent.

Moreover, the R^2 values indicated that 76.20 percent of the variations caused in the output of cocoa was explained by the included independent variables. With respect to the parsimonious model, the coefficient of the land area harvested was significant at the 10 percent level, though its significance might not necessarily lead to increased output. This is because most cocoa farms are old or near their production limit and given the sizeable cost and time it would take to establish new farms, the old farms are only rehabilitated. Another reason for this is because cocoa production is unlike arable crops, which

Table 4: Results of the Estimation of the ECM Model for Cocoa

Variable	Over-parameterized ECM (DF=15)		Parsimonious ECM (DF=21)	
	Coefficient	t-statistics	Coefficient	t-statistics
Constant	0.0000(0.0583)	0.0348	0.0000(0.0539)	-0.1051
In P_t	0.0242(0.1673)	0.1393	0.0033(0.1330)	0.0235
In P_{t-1}	0.3053(0.1817)	0.6220	-	-
In RAN_t	-0.0473(0.2966)	-0.2222	0.0738(0.1956)	0.5256
In RAN_{t-1}	0.0146(0.2524)	0.0809	-	-
In IND_t	-0.0106(0.1104)	-0.0618	0.0167(0.0965)	0.1113
In IND_{t-1}	-0.1274(0.1447)	-0.5784	-	-
In ER_t	-0.3919(0.1932)	-1.8170*	-0.1858(0.1519)	-1.0850
In ER_{t-1}	-0.5036(0.3221)	-1.3880	-	-
In HA_t	-0.5349(1.046)	-2.8100**	-0.2814(0.7694)	-2.0090 *
In HA_{t-1}	-0.2343(3.106)	1.2980	-	-
DUM $_t$	0.3999(0.1176)	1.8940*	0.1287(0.0787)	0.8958
ECM $_{t-1}$	-0.9901(0.3072)	-4.1420*	-0.7534(0.1769)	-5.4750 *

Notes: Figures in parentheses are standard errors

$R^2 = 76.20\%$; Schwarz criterion = -2.991 (Over-parameterised ECM)

$R^2 = 65.64\%$; Schwarz criterion = -3.098 (Parsimonious ECM)

**Coefficient significant at the 5 % level

*Coefficient significant at the 10 % level

allows for increased cultivation of land area in response to favorable short run situations.

The dummy variable (deregulation) with its positive coefficient indicates the better effect of deregulation on cocoa output. In other words, there was actually a significant improvement in cocoa output in Nigeria during deregulation. This thus indicates that farmers' incomes were actually increased after economic deregulation. ECM variable produced the expected negative sign and thus was statistically significant at the 1 percent level. The coefficient showed that the speed of adjustment of output to disequilibrium from the long-term values of the independent variables was 75.34 percent.

The R^2 value was 65.64 percent, which implied that the output of cocoa were well accounted for by variations in producer prices, world average prices, land area harvested, rainfall and exchange rate. Evidence contained in Table 4 indicated that the Schwarz criterion improved from -2.991 in the over-parameterized model to -3.098 in the parsimonious model, thus implying that the parsimonious model carried more information. In other words, the restricted model performed better than the full model.

CONCLUSION

The study examined the effects of deregulation on the supply response of cocoa farmers. The techniques used are the multiple regression and error correction mechanism. The study revealed that deregulation affected the supply response of cocoa farmers positively due to higher price incentives in the deregulated regime. The performance analysis of all the variables indicated that the deregulated period experienced increased production and higher prices. Also, producer prices and world average prices showed an increasing trend. In the error correction model, producer prices, rainfall and indices of world average prices all had a positive effect on output. This means that as the price received by the farmers is increased, the farmers were encouraged to improve production. This may indicate that the prices paid to farmers have increased substantially due to the abolition of the marketing board for cocoa produce in Nigeria.

Due to these better prices received at the world market, farmers were motivated to increase production, and hence supply. The favorable world price for cocoa could serve as an incentive

to the farmers if the high prices could be effectively transmitted to them. The R^2 for cocoa was 65.64 percent. This implies that the output of cocoa is well accounted for by variations in producer prices, exchange rate, rainfall, indices of world average prices and land area harvested. The deregulation period (as embodied in the dummy variable) was found to have a positive effect on the output of cocoa. This shows that the scrapping of the cocoa marketing boards (that is, deregulation), actually favored the farmers by increasing cocoa output in response to improving domestic (producer) and world prices.

Arising from the preceding analysis, certain inferences can be drawn from this study. Earlier specifications and estimations of the supply response models without any prior examination of the time series nature of the data will most probably yield spurious results. This is because our result showed that the data series were not stationary at their level and thus suggested a need for differencing to attain stationarity. The study findings thus underscored the application of the ECM model. Statistical significance of the error-correction terms for cocoa validated the existence of an equilibrium relationship among the variables. It is interesting to note that the coefficients of the ECM captured the short-run impact, which is tied to the long-run relationship between co-integrating variables through the feedback mechanism. The network of feedback mechanisms made the adopted model more powerful than any other behavioral specification. This study in essence has demonstrated the importance of examining the time series characteristics of the available data.

From the findings of the study, the following recommendations are pertinent:

- Economic deregulation comes with exposure to vagaries of the world market for primary produce. Efforts should be made to increase the level of protection of the farmers against likely price shocks.
- Farmers should be encouraged to re-plant tree crops after they have passed their peak of production. This is so because there has been a drastic decline in cocoa production from 1999.
- The government must pursue a realistic exchange rate since it affects the prices of agricultural inputs and outputs.
- There is need for the alignment of producer prices with world prices, which will serve as

incentives for farmers to produce more so that there will be excess for export purpose. The favorable price regime also, will encourage young people, who have left the cocoa-growing communities initially, to come back into cocoa production.

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