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# The Effects of Structural Breaks on Cocoa Yield Response in Nigeria (1961 – 2007)

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## Abstract

*This study examines the effect of structural break- namely the Structural Adjustment Policy (SAP) change of 1986 – on the yield response of cocoa in Nigeria between 1961 and 2007. The yield of cocoa was specified as a function of factors such as exchange rate, cocoa producer price, producer price of substitute crops such as rice, maize and cassava. Quantitative estimates, based on Augmented-Dickey Fuller unit root test, cointegration and error correction specification, indicate that the real exchange rate, cocoa producer price, cassava price and trend significantly affected cocoa yield response in the long-run while the real exchange rate, cocoa producer price, cassava price and rice price significantly affected cocoa yield response in the short- run. In addition, from the results, the error correction mechanism (ECM) indicated a feedback of about 67.4% of the previous year's disequilibrium from long-run domestic cocoa yield. The Perron structural break test show that SAP has a positive and significant effect on cocoa yield, but a negative effect on the cocoa producer price. It is concluded that only a combination of price and other structural factors can bring about the much desired change in the Nigerian cocoa sector.*

**Key words:** Cocoa, Structural Adjustment Programme, Cointegration, Error Correction Modelling, Nigeria, Perron.

## Introduction

Agricultural export was the mainstay of the Nigerian economy prior to the discovery, exploitation and exportation of crude petroleum and the resulting total dependence on its revenue for economic sustenance. Agriculture has also been the most important single activity in the Nigeria economy with about 70% of the total working population engaged in it (Abolagba *et al*., 2010). Nigeria also ranked very high in the production and exportation of some major crops in the world in the 1940 and 1950s. Available statistics indicate that in 1960, agricultural export commodities contributed well over 75% of total annual merchandise exports (Ekpo and Egwaikhide, 1994).

The nation used to produce about 15% of world cocoa and was second largest producer of the crop in the world in the 60s (Utomakili and Abolagba, 1996).Government's involvement in its production was mainly supportive of the activities of farmers and are focused mainly in the areas of research, extension, export crop marketing and pricing activities (Manyong *et al*, 2005). However, by the middle to late sixties, the Nigerian Government like other developing

countries in realization of the relative importance of cocoa and other export crops to the economy brought the input supply and produce marketing systems under the state official monopoly. The commodity marketing boards among other things were set up by the government to (i) stabilize the prices received by the cocoa producers (ii) ensure public access and control over foreign exchange earnings (iii) strengthen the marketing mechanisms and (iv) create an ideological antipathy to private traders and impose constraints on multinational enterprises(Delloite *et al*.1990)

Idowu (1986) observed that in spite of the laudable objectives for which the marketing boards were set up, they served as great disincentives to cocoa farmers both in production and replanting. The domestic prices paid to export crop producers relative to the external prices received by the commodity boards were low, virtually amounting to implicit taxation or negatives protection of farmers (Abalu, 1975). The oil boom syndrome of the early 1970s and the overvaluation of the naira were other factors that negatively affected cocoa production in Nigeria.

Meanwhile, a major structural break occurred in the Nigerian economy in 1986. In order to correct for the distortions in the Nigerian agriculture which invariably affects the cocoa economy, Nigeria opted for structural adjustment programme (SAP) in September 1, 1986. SAP embraced exchange rate deregulation, liberalization of export trade, reduction in extra budgetary expenditures, withdrawal of subsidies and the privatization of public enterprises. Thus, deregulation placed much emphasis on the market forces in determining the prices of goods and services and allocating the resources within the economy (Idowu *et al*, 2007) .This policy measure led to the abolition of commodity boards and privatization of many agricultural enterprises that were formally under the control of the federal government. The agricultural market were liberalized, the foreign exchange was also liberalized while the naira was also devalued.

In deviation from other studies which have largely employed descriptive techniques and error correction modeling to examine the effect of structural breaks on the responses of agricultural crops to price, this study applies the Perron (1989) "Changing growth model" test for structural breaks to assess the effect of the 1986 structural break (SAP) on the Nigerian cocoa yield while the error correction modeling was used to examine the response of cocoa yield to price.

Alemu et al (2003) defined structural break as "changes in economic systems" Therefore in this study, policies changes of stabilization and market liberalization of the structural adjustment programme(SAP) are referred to.

## Material and Methods

### Data Source:

The present study is based on time series data pertaining to cocoa production in Nigeria during the period 1961- 2007 . The data were sourced from the FAOSTAT database of the Food and Agricultural Organization of the United Nations. Data on exchange rate were taken from Penn World table of the

Penn World database of the University of Pennsylvania (2006)

**Analytical Techniques**

**(a) Perron's test for Structural Break.**

In order to examine the effect of the 1986 structural break on the supply of cocoa yield and price series in Nigeria; this study adopted the Perron (1989) crash and changing growth model. In Perron (1989), the main concern is to determine whether structural breaks in a "trend stationary" series may reverse a failure to reject the null hypothesis of a unit root. That is, random walks with possible non-zero drift. Traditional tests for unit roots (such as Dickey-Fuller, Augmented Dickey-Fuller and Phillips-Perron) have low power in the presence of structural break. Perron (1989) showed that in the presence of a structural break in time series, many perceived nonstationary series were in fact stationary. Perron (1989) re-examined Nelson and Plosser (1982) data and found that 11 of the 14 important US macroeconomic variables were stationary when known exogenous structural break is included. Perron (1989) allows for a one time structural change occurring at a time *TB* (1 < *TB* < T), where T is the number of observations. According to Perron (1989), the null hypothesis considered is that a given series $\{y_t\}_0^T$ (of which a sample of size T + 1 is available) is a realization of a time series process characterized by the presence of a unit root and possibly a nonzero drift. However, the approach is generalized to allow a one-time change in the structure occurring at a time $T_B(1<T_B<T)$. Three different models are considered under the null hypothesis: one that permits an exogenous change in the level of the series (a "crash"), one that permits an exogenous change in the rate of growth, and one that allows both changes. These hypotheses are parameterized as follows:

Null hypotheses:

Model (A)

$$y_t = \mu + dD(TB)_t + y_{t-1} + e_t,$$

……. (1)

Model (B)

$$y_t = \mu + y_{t-1}(\mu_2 - \mu_1)DU_t + e_t,$$

…….(2)

Model (C)

$$y_t = \mu + y_{t-1}dD(TB)_t + (\mu_2 - \mu_1)DU_t + e_t,$$

……(3)

where

$D(TB)_t = 1$ if $t = T_B + 1$, 0 other wise;

$DU_t = 1$ if $t > T_B$, 0 otherwise; and

A (L) et = B (L) $U_t$,

$u_t \approx I.I.D.(0,\sigma^2)$, With A (L) and B (L) pth and qth order polynomials, respectively, in the lag operator L.

The innovation series ($e_t$) was taken to be of the ARMA (p, q) type with the order p and q possibly unknown. This postulate allows the series ($y_t$) to represent quite general processes. More general conditions are possible and will be used in subsequent theoretical derivations.

Instead of considering the alternative hypothesis that $y_t$ is a stationary series around a deterministic linear trend with time invariant parameters, he analyzed the following three possible alternative models:

Alternative hypotheses:

Model (A)

$$y_t = \mu_t + \beta t + (\mu_2 - \mu_1)DU_t + e_t, \quad \ldots\ldots\ldots\ldots (4)$$

Model (B)

$$y_t = \mu + \beta_1 t + (\beta_2 - \beta_1)DT^*_t + e_t, \quad \ldots\ldots\ldots\ldots (5)$$

Model (C)

$$y_t = \mu + \beta_1 t + (\mu_2 - \mu_1)DU_t + (\beta_2 - \beta_1)DT_t + e_t, \quad \ldots\ldots.(6)$$

Where

$DT^*_t = t - T_B$, *and* $DT_t = t$, if t>$T_B$ and 0 otherwise.

Here, $T_B$ refers to the time of break i.e., the period at which the change in the parameters of the trend function occurs. Model (A) describes what we shall refer to as the crash model. The null hypothesis of a unit root is characterized by a dummy variable which takes the value one at the time of break. Under the alternative hypothesis of a "trend-stationary" system, Model (A) allows for a one-time change in the intercept of the trend function. For the empirical cases, $T_B$ was the year 1929 and $\mu_2 > \mu_1$. Model (B) is referred to as the "changing growth" model. Under the alternative hypothesis, a change in the slope of the trend function without any sudden change in the level at the time of the break is allowed. Under the null hypothesis, the model specifies that the drift parameter $\mu$ change from $\mu_2$ *to* $\mu_1$ at time $T_B$. Model (C) allows for both effects to take place simultaneously, i.e. a sudden change in the level followed by a different growth path.

This study adopted Model C which allows for both effects to take place simultaneously, i.e. a sudden change in the level followed by a different growth path. Equation 7 below is the Perron's equation for unit-root test.

$$y = \mu + \beta t + \alpha y_{t-1} + \sum_{i=1}^{k} c\Delta y_{t-1} + \ell_t \quad \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

However, when a policy shift variable and a variable to examine possible change in intercept are included, the equation becomes,

$$y = \mu + \beta t + \theta DU_t + \gamma DT1 + \alpha y_{t-1} + \sum_{i=1}^{k} c\Delta y_{t-1} + \ell_t \quad \ldots\ldots\ldots (8)$$

Where $\alpha$ = the intercept term; $\gamma$ = coefficient for growth change variable DT, the dummy for structural break (SAP in this case). Model (C) above allows for both effects to take place simultaneously, i.e. a sudden change in the level followed by a different growth path. Where, TB is the date of implementation of SAP policy in Nigeria. The summation sign contains the relevant number of lagged difference terms (which will be determined for each of the series to be considered by using the Schwarz Information Criterion (SIC)).

The estimation and interpretation of this equation for each of the series, $LY_{t,}$ *and* $LPe_t$ will be a means of evaluating the effect of SAP Policy on cocoa series in Nigeria. The significance of α and γ terms are of particular importance. A significant γ coefficient indicate the presence of a structural break (which implies that SAP policy significantly affect the variable in question). A α significantly close to one indicates the presence of a unit

root. That is the series is the series is differenced- stationary rather than trend stationary. The hypothesis is that many series may have α close to one in a normal ADF test with an intercept and time trend, but that when a shift parameter is included and is significant, the α term may no longer be significantly close to one.

**(b). Error correction and co-integration model**:

This study adopts the Johansen (1988) procedure in co – integration. The concept of co-integration (Hendry, 1986), (Hall, 1986) and (Mills, 1990), creates the link between integrated process and the concept of steady state equilibrium. The first step in co-integration analysis is to test the order integration of the variables. This study adopts the test for stationarity as obtained in Ajetomobi *et al* (2006). The grim fact is that economist look for the presence of stationary co-integrated relationships since only these can be used to describe long-run stable equilibrium. The Granger representation theorem states that if set variables are co-integrated (1, 1): implying that the residual is co-integrated of 1(0), then there exists an Error Correction Model describing the relationship.

**Model Specification:**

The hypothesized structural relationship for cocoa yield response is specified as follows:

$$LY = \beta_0 + \beta_1 LEX_t + \beta_2 LP_{CO} + \beta_3 LEX_t + \beta_4 LP_M + \beta_5 LP_R + \beta_6 LP_c + T + \mu$$

Where:

$LY$ = Cocoa yield

$LP_{co}$ = Real World market Price for cocoa

$LEX_t$ = Real exchange rate

$LPc_t$ = Cassava Price (index of price)

$LP_R$ = Rice Price (index of price)

$LP_{mi}$ = Maize Price (index of price) and

$T$ = Time trend. The variable T, which represents technology was modeled with the series as represented by the time variable serving as a proxy for the impact of technology change on output, i.e. to capture technical progress, productivity, high-yielding varieties, etc $\mu$ = Other unobserved variables

The estimated linear function of the above specification was found to give the lead equation, on which the discussions were made.

**The Error Correction Model**

First, the variables, in equation (9) were tested for unit root using the ADF technique while Johansen (1988) reduced-rank test for co-integration was used to test for co integrations relationships between selected set of variables at crop level data. The error correction model (ECMs) estimated are shown in (10) below. ECM in (10) represents the short- run behaviour of cocoa yield response in (10) while equation (9) represents the long -run static equation. The parameter λ, which is negative, in general measures the speed of adjustment towards the long run equilibrium relationship between the variables in (10). The optimum lag lengths to be included in equations (10) were determined based on Akaike Information Criterion (AIC).

***Static long run model for cocoa yield response***

$$LY = \beta_0 + \beta_1 LEX_t + \beta_2 LP_{CO} + \beta_3 LP_M + \beta_4 LP_R + \beta_5 LP_c + \beta_6 T + \mu \quad \text{.....(9)}$$

Error correction model (ECM) for the wheat import model is also given as equation (10) .

$$\Delta LY_t = \gamma_0 + \sum_{i=1}^{p} \gamma_1 \Delta LEX_{t-p} + \sum_{i=1}^{J} \gamma_2 \Delta LP_{co(t-j)} + \sum_{i=1}^{k} \gamma_3 \Delta LP_{m(t-k)} + \sum_{i=1}^{m} \gamma_4 \Delta LP_{R(t-m)} + \gamma_5 LP_{C(t-x))} + \mu_t \text{ -ECM....} \quad (10)$$

Where $\Delta$ represents first differencing, $\lambda$ measures the extent of correction of errors by adjusting in independent variable, $\beta$ measures the long-run elasticities while $\gamma$ measures the short-run elasticities. General – to – specific modelling technique of Hendry and Erricson (1991) is followed in selecting the preferred ECM. This procedure first estimate the ECM with different lag lengths for the difference terms and, then, simplify the representation by eliminating the lags with insignificant parameters.

## Results and discussion

### Test for Stationarity:

The results of the unit root tests are shown in table 1. The null hypothesis of the presence of a unit root (non – stationarity) was tested against the alternative hypothesis of the absence of a unit root (stationarity). All the variables tested contain unit root processes, and all became stationary after first differencing, except for rainfall which was stationary at level. Hence the variables are integrated of order 1 that is I (1) but for rainfall which has a an order of integration indicated as I (0). This established the suitability of all the variables for use in co-integration analysis with the exception of rainfall which is dropped from the analysis.

**Table 1:** ADF Unit Root Test Results (Constant and Trend Included) Critical values: 5% 0 -3.514 1% = - 4.178

| **Variable** | **t-values ( level)** | **t- values ($1^{st}$ difference)** | **Order of Integration** |
|---|---|---|---|
| $LY_{co}$ | -3.298 | -9.749** | 1 |
| $LEX$ | -2.072 | -5.103** | 1 |
| $L\rho_{co}$ | -2.1101 | -5.476** | 1 |
| $L\rho_m$ | -1.7421 | -5.340** | 1 |
| $L\rho_R$ | -1.7641 | -6.237** | 1 |
| $L\rho_c$ | -1.8671 | -6.970** | 1 |
| $LR$ | -4.623** | -9.253** | 0 |

***Source:*** *Data Analysis, 2011*

.*** Indicates significant at 1%, ** Indicates significant at 5%, * Indicates significant at 10%

**Test for co-integration:**

The result of Johansen multivariate cointegration test between cocoa yield and selected variables is presented in table 2 below. The result shows the the existence of co-integration relationship among selected variables. On application of the test, the results of the maximum- Eigen value statistics and trace statistics from the table 2 show that, there is at least 1 co-integration relation. This indicates that there exists a long-run relationship between all the explanatory variables and cocoa yield in Nigeria. Since co-integration has been established, the regression results were analysed and diagnosed.

**Table 2:** Results of the Johansen's maximum eigen-value and Trace statistic co-integration test

| $H_0 : = \rho$ | *Maximum Eigenvalue* | *Trace Statistics* |
|---|---|---|
| $\rho$ = = 0 | 99.75** | 381.9** |
| $\rho$ < = 1 | | |
| $\rho$ < = 2 | | |

***Source:*** *Data Analysis, 2011.*
*** Indicates significant at 1%,
** Indicates significant at 5%,
* Indicates significant at 10%

**Short –run dynamic error correction (ECM) modeling of export crops**

General- to- specific modeling procedure of Hendry and Ericsson, (1991) was followed in the modeling and selection of the preferred dynamic short-run error correction model (ECM). This procedure first estimates the ECM with different lag lengths for the difference terms and, then, simplifies the representation by eliminating the lags with insignificant parameters. However, only the simplified version of the short-run dynamic ECM was reported in this study.

**Cocoa Yield Response in Nigeria**

The solved static long- run equation for cocoa yield response in Nigeria as well as its short – run equation is given in table 3 above. The $R^2$ value of 0.708 for the ECM in table 3 shows that the overall goodness of fit of the ECM is satisfactory. However, a number of other diagnostic were also carried out in order to test the validity of the estimates and their suitability for policy discussion. The Autoregressive conditional Hetoroscedasticity (ARCH) test for testing heterscedasticity in the error process in the model has an F-statistic of 0.281 which is statistically insignificant. This attests to the absence of heteroscedasticity in the model. The Breusch – Godfrey Serial correlation Langrange Multiplier (LM) test for higher order - serial correlation with a calculated F – statistic of 0.781 could not reject the null of absence of serial correlation in the residuals. The Jacque- Bera $\chi^2$ - statistic of 2.406 for the normality in the

distribution in the error process shows that the error process is normally distributed.

From the battery of diagnostic tests presented and discussed above, this study concludes that the model is well estimated and that the observed data fits the model specification adequately, thus the residuals are expected to be distributed as white noise and the coefficient valid for policy discussions.

It could be observed from the results in table 3 that the coefficient of error correction term ECM carries the expected negative sign and it is significant at 1%. The significance of the ECM supports cointegration and suggests the existence of long – run steady state equilibrium between cocoa yield and other determining factors in the specified model. The coefficient of -0.674 indicates that the deviation of cocoa supply from the long-run equilibrium level is corrected by about 67.4% in the current period.

The short-run coefficient of cocoa yield in the immediate past period is -0. 143 but is insignificant at 5%. Although this is contrary to a- priori expectation, it could be due to discouraging producer price

However, real exchange rate and cocoa price has elasticity values of 0.200 and 0.257 respectively in the short- run and elasticity values of 0.371 and 0.288 respectively in the long run. Both variables are significant at 5% in the long and short run. The elasticities of the two variables move in the same direction in the long and short run. As Ajetomobi (2006) also observes, an increase in both price and exchange rate is not sufficient enough to stimulate increase in cocoa yield, which is already declining due to old age and neglect of rehabilitation of existing trees. The elasticity value for real exchange rate in the long- run is 0.371 and 0.257 in the short run and both are significant at 5%. The result shows that devaluation negatively influenced cocoa yield in Nigeria. The response obtained in this study for Nigeria is the same obtained by Olayide (1972) - 0.2- but higher than the estimates obtained by previous research work on Nigerian cocoa supply response – 0.006 (Ajetomobi, 2006), 1.29 (Stern, 1965), but is much lower than the 0.45 elasticity value obtained by Behrman (1968). Although the sign of the coefficient for cocoa price is negative which is contrary to expectation, it could be because of declining prices of cocoa even in the face of increased output because of fall in cocoa quality. The marketing boards (until their removal) have been responsible for the grading and the quality control of exported cocoa seeds. However, this function was completely out of place after the scrapping of the marketing boards in Nigeria.

In the short – run cassava price (lagged one year) has a positive and significant coefficient of 0.280. The coefficient for cassava is 0.227 in the long run and it is also significant at 5%. Although the coefficients for maize and rice are also positive in the long run, they are not significant. The price of rice in the immediate past period ( with coefficient of 0.295 and significant at 1%), price of maize (with coefficient of 0.022) and cassava price are moving in the same direction, which suggests that, cassava, maize and rice were grown as

complementary crops by the farmers and are substitute crops to cocoa in Nigeria.

Time trend, which represents technology, was modeled with the series as represented by the time variable serving as a proxy for the impact of technology change on output, i.e. to capture technical progress, productivity, and high-yielding varieties appears to be the most important determinant of cocoa yield in the long run. It has a coefficient of 0.052 and it is significant at 1%. This results further justifies the position that price factors are not sufficient to increase the supply of export crops in Nigeria, - the most important of which is cocoa- it takes a good combination of price and structural factors, one of which is technology.

**Table 3:** Static long –run and Short-run error correction model estimate for Cocoa yield in Nigeria.

| **Static Long – run equation** | | **Parsimonious Short – run equation** | |
|---|---|---|---|
| **Constant** | 6.268(5.951)*** | Constant | 0.056(2.333)*** |
| $LEX$ | -0.371(-2.258)** | $\Delta LY(-1)$ | -0.143(-1.124) |
| $L\rho_{co}$ | -0.288(-2.308)** | $\Delta LY(-2)$ | 0.082(1.023) |
| $L\rho_{m}$ | 0.340(1.552) | $\Delta LP_{co}$ | -0.2000(2.55)** |
| $L\rho_{R}$ | 0.110(0.530) | $\Delta L\rho_{o}(-1)$ | 0.111(1.151) |
| $L\rho_{c}$ | 0.227(2.748)** | $\Delta LEX$ | -0.257(-2.560)** |
| Trend | 0.052(3.900)*** | $\Delta LEX(-2)$ | -0.020(-026) |
| | | $\Delta L\rho_{c}(-1)$ | 0.280(3.210)*** |
| | | $\Delta L\rho_{m}$ | 0.022(0.037) |
| | | $\Delta L\rho_{R}(-1)$ | 0.295(3.031)*** |
| | | $ECM(-1)$ | -0.674(-5.786)*** |
| | | | |
| | | | |
| | | $R^2$ = 0.708 | |
| | | AR LM F = 0.761(0.476) | |
| | | ARCH F = 0.281(0.599) | |
| | | Normality $X^2$ 2.406(0303) | |

***Source:*** *Data Analysis, 2011*

*** Indicates significant at 1%,

** Indicates significant at 5%,

* Indicates significant at 10%

**Perron Structural Break Test Results with `Growth Change and intercept shift` dummy Variables Included.**

The results of the estimation of equation (8) assuming a one-time `crash` and then a slope change for cocoa yield and producer price are presented in tables 4 to 5. Under the hypothesis of a unit root process $\mu \neq 0$ (in general), $\beta=0$, $\gamma=0$, $\alpha=1$ ands the alternative hypothesis of stationary fluctuations around a deterministic breaking trend: $\mu \neq 0$, $\theta \neq 0$, $\beta \neq 0$, $\gamma \neq 0$ and $\alpha<1$. It is important to note that although the various break dummies and intercepts` t-statistics are distributed normally, the critical test statistic that is produced in Perron (1989) must be used for $\alpha$.

**Perron structural break test results for Nigeria**

Tables 4 and 5 show the Perron's structural break test for cocoa yield and producer price series in Nigeria. Table 4 is the Perron's unit root test for the cocoa series while table 5 is the model estimates for the Perron unit root test but with broken trend and intercept included. From table 4, the cocoa producer price could not reject the null hypothesis of unit root while cocoa yield ($LY_{co}$) rejected it. Cocoa producer price has significant $\alpha$ value that is close to which shows that cocoa producer price is trend stationary rather that differenced stationary. However, after the introduction of SAP (which is the growth change variable with time of break at 1986) and trend shift variables, some remarkable differences were observed in the table and are as explained below.

**1. Cocoa Yield**

The $\alpha$ coefficient for cocoa yield ($LY_{co}$) in the Perron unit root test for cocoa yield in Nigeria is 0.311. However, after the introduction of the broken trend and intercept variables in the Perron unit root equation, a positive and significant coefficient was observed for the SAP variable ($\gamma$). The coefficient of 0.032 which is significant at 1% shows that there is a significant increase in the yield of cocoa in Nigeria after the introduction of SAP in that country. Market liberalization which is one of the major features of SAP, significantly encouraged increased cocoa production through intensification of inputs and not necessarily as a result of increased acreage cultivated.

**2. Cocoa Producer price**

Cocoa producer price has a unit root as shown in table 4. However, after the introduction of the broken trend and intercept shift variables, the coefficient of $\alpha$ significantly dropped from 0.794 to 0.600. Hence cocoa producer price as the Perron unit root test shows is differenced stationary. The coefficient for the SAP (trend shift variable $\gamma$,) is -0.022 but it not significant. At the introduction of SAP in Nigeria, production increased and producer price increased also. Presently, the international price received by farmers for cocoa is not that favourable as the quality of cocoa produced as fallen due to the removal of the marketing boards that has been responsible for quality control. This result further supports the fact that SAP although brought about increased cocoa production in Nigeria, the long-run effect on the producer price was negative.

**Table 4 :** Perron's Structural Break test for Cocoa yield and Producer price in Nigeria

**(Broken intercept and trend not included)**

$$Y_t = \mu + \beta t + \alpha Y_{t-1} + \sum_{t=1}^{k} C\Delta Y_{t-1}$$

| Variables | μ | β | α | K |
|---|---|---|---|---|
| $LY$ | 5.486 | 0.004 | 0.311 | 0 |
| | (6.726) | (1.434) | (2.973) | |
| $L\rho_{eo}$ | 1.045 | -0.007 | 0.794 | 1 |
| | (2.507) | (-1.988)* | (9.615)*** | |

**Source:** Data analysis, 2011; NB :t-values in parenthesis critical;

**Critical t – Values for α taken from Perron's (1989) table. Critical t-values: 1% = 4.24; 5% = 3.95; λ = 0.48**

**Table 5:** Perron's Structural Break test for Cocoa yield and Producer price in Nigeria

**(Broken intercept and trend included)**

$$Y_t = \mu + \beta t + QDU1 + \delta DT1 + \alpha Y_{t-1} + \sum_{t=1}^{k} c\Delta Y_{t-1}$$

| Variables | μ | β | θ | δ | α | k |
|---|---|---|---|---|---|---|
| $LY$ | 6.566 | -0.020 | 0.214 | 0.032 | 0.208 | 0 |
| | (9.326) | (-3.626)*** | (2.328)** | (4.012)*** | (2.361) | |
| $L\rho_{co}$ | 1.751 | 0.01 | -0.324 | -0.022 | 0.600 | 1 |
| | (3.328) | (1.167) | (-2.053)** | (-1.521) | (4.855)** | |

**Source:** Data analysis, 2011; t-values in parenthesis.

**Critical t – values for α taken Perron (1989) table. Critical t-values: 5% = 4.24; 1% = 4.90; λ = 0.48**

## Conclusion and recommendation

This study shows that pricing reforms alone is not sufficient to move supply of cocoa forward in Nigeria. It is therefore important that the provision of non-price incentives must play a key role in reviving the Nigerian cocoa sector. The cocoa yield response can only be stimulated through technical progress and mechanization of agriculture rather than by just pricing reforms. Given the significance of the time trend variable in the static long-run model, other policies such as infrastructural developments, expenditure on agricultural research and extension, applications of modern

techniques, use of genetically modified seeds for cultivation are also likely to have a direct effect on cocoa supply. There is also the need to establish a better alternative to the scrapped cocoa marketing board in Nigeria, but under the close supervision of the government. This will ensure only cocoa beans of high quality are being exported and consequently compete favourably in the international market. A package of changes may bring out better response from farmers than a price change alone. It will also help the cocoa farmers to absorb price shocks as it is presently obtained with the Ghanaian cocobod.

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