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EFFECT OF CRUDE OIL PRICE ON COCOA PRODUCTION IN NIGERIA (1961-2008): A COINTEGRATION AND ERROR CORRECTION MODELLING APPROACH.

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ABSTRACT
This study examines the effect of crude oil price on cocoa production in Nigeria between 1961 and 2008. The output of cocoa was specified as a function of factors such as exchange rate, cocoa producer price, crude oil price and structural adjustment programme. Quantitative estimates, based on Augmented-Dickey Fuller unit root test, cointegration and error correction specification, indicate that the crude oil price, structural adjustment programme and trend are the major determinants of cocoa output in the long-run, while price of crude oil is the most important determinant of cocoa output in the short –run. The results further shows that the error correction mechanism (ECM) indicated a feedback of about 50.5% of the previous year's disequilibrium from long-run domestic cocoa production. It is concluded that the price of crude oil indeed has a negative effect on cocoa production in Nigeria. It also shows that only a combination of price and other structural factors can bring about the much desired change in the Nigerian cocoa sector.

KEYWORDS: Cocoa production, Quantitative estimates, structural adjustment programme, oil

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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. This was the situation prior to the oil boom of the early 1970's when the contribution of agricultural exports (cocoa, rubber, palm oil, palm kernel, cotton, etc.) fell to 35% of the GDP from an average of 72% between 1955 and 1969. Agriculture has 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).

Meanwhile, of all Nigeria's export crops, cocoa is about the most prominent. By the 1960s, Nigeria was rated the second largest world's producer (Adegbola and Abe, 1983). The commodity became the major foreign exchange earner until the discovery of oil in the 1950s. Subsequently, the production of cocoa fell off sharply during the oil boom years of the 1970s from 317,000 tons in 1970-1971 to 100,000 tons in 1986-87. Currently, Nigeria is the fourth largest producer after Cote d'Ivoire, Ghana and Indonesia contributing to 12% of total world production (FAO STAT, 2009). Despite the dwindling production of cocoa in Nigeria, the crop still contributes to the nation's economic development. In terms of foreign exchange earnings, no single agricultural export commodity has earned more than cocoa. With respect to employment, the cocoa sub-sector still offers quite a sizeable number of people employments both directly and indirectly (Nkang *et al*., 2009). In addition, cocoa is an important source of raw materials, as well as source of revenue to Governments of cocoa producing states (Nkang *et al*., 2009).

Meanwhile, a number of factors have affected cocoa production in Nigeria. The advent of the petroleum sector and its resultant effect in terms of massive movement of farm labour into the industrial, construction and service jobs created by the oil boom. Secondly, unattractive producer prices and deteriorating productivity due to aging trees, pests incidence, non-availability and high cost of cocoa production inputs, diminishing fertility of the soils and poor attention to cocoa plantations. Furthermore, the abolishment of the Nigerian Cocoa Board (NCB) impacted negatively on the quality of cocoa beans exported from Nigeria.

Nigeria's contemporary development has been sustained by extreme dependence on one single primary commodity that is oil and it accounts for greater than 95% of the export earnings in recent times. Crude oil also contributes greater 95% of government revenue in the recent years and greater than 25% of the real GDP. Extreme dependence of the Nigerian economy on crude oil has rendered it most vulnerable to the instability of market forces with grave implications to the nation's economic growth and development. Also, the adverse impact of volatility of the international oil market with the attendant volatility of government revenue gives credence to any argument for diversification of exports (Okoh, 2004).

This study therefore seeks to empirically examine the effect of crude oil price on cocoa production in Nigeria. The remainder of this paper is organized as follows. Section 2 describes the materials and methods, section 3 gives the result of the econometric analysis and offer explanation for them while section 4 presents the summary, conclusion and policy recommendation to the study.

MATERIALS AND METHODS

Stationarity test

This study applied cointegration and error correction modelling to examine the effect of crude oil prices on cocoa production in Nigeria. 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_o: 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, $$\Delta X_t = \alpha_0 + \delta X_{t-1} + e_t \quad \ldots \quad (1)$$

For ADF test, $$\Delta X_t = \alpha_0 + \delta X_{t-1} + \sum_{t=1}^{k} \Delta X_{t-1} + e_t \ldots \quad (2)$$

H_o 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).

Cointegration and Error correction analysis

To test for cointegration, two main approaches have been developed: one involves the estimation of a static model where all variables enter in levels (Engle and Granger, 1987), the other the estimation of an error correction model (Johansen, 1988). The Johansen procedure is to be preferred over the Engle-Granger approach for two major reasons. First, in the multivariate case considered here, it avoids the identification problems one may encounter with the Engle-Granger approach if there is more than one cointegrating vector. Second, the Dickey-Fuller test employed to test for cointegration in Engle-Granger regressions too often rejects the existence of equilibrium relationships (Kremers et al., 1992). Johansen (1988) considers a simple case where Y_t is integrated of order 1, such that the first difference of Y_t is stationary. The procedure developed by Johansen (1988) which includes the identification of rank of the $n \; x \; n$ n matrix Y_t in the specification as given below $\Delta Y_t = \mu_t + \pi Y_{t-k} + \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-1} + \mu_t$ ……(3)

where Y_t is a column vector of the n variables, π and are coefficient matrices, Δ is difference operator, K denotes the lag length and μ is a constant. The π matrix conveys information about the long-run relationship between the Y_t variables, and the rank of π is the number of linearity independent and stationary linear combination of variables studied. Thus, testing for cointegration involves testing for the rank of π matrix r by examining whether the eigenvalues of π are significantly different from zero. The maximum likelihood approach enables testing the hypothesis of r cointegrating relations among the elements of Y_t. Hence the null hypothesis of no cointegrating relations $(r = 0)$ implies $\pi = 0$.

In order to obtain the optimal VEC model we applied the minimum AIC-criterion, suggesting. To determine the number of cointegrating equations, the Johansen maximum likelihood method provides both trace and maximum eigenvalue statistics. One important regarding these two tests is that both tests have no standard distributions under the null hypothesis. The order of r is determined by using the likelihood ratio (LR) trace test statistic suggested by Johansen (1988). $\lambda_{trace}(r) = -T \sum_{i=r+1}^{k} \ln(1 - \hat{\lambda})$ The maximum eigenvalue LR test statistic as suggested by Johansen is $\lambda_{\max}(r, r+1) = -T(1 - \hat{\lambda})$ where r is the number of cointegrating vector, $\hat{\lambda}$ is the estimate values of the characteristics roots obtain from the estimated π matrix and T is the number of observations. When the trace statistic (t) and the maximum eigenvalue statistic (λ) are greater than Osterwald-lenum (1992) critical values, the null hypothesis of r cointegrating vectors against the alternative of $r + 1$ vectors is rejected.

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: $S_c = \ln \delta^2 + k \ln t$ … (4)

Where δ is the maximum likelihood estimate (MLE) of δ, k is the lag length and 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.

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Model Specification:

The hypothesized structural relationship for the study is specified as follows:

$$LQ = \beta_0 + \beta_1 LP_e + \beta_2 LEX_t + \beta_4 LP_o + \beta_5 SAP_c + T + \mu \quad \ldots\ldots\ldots\ldots. (5)$$

Where:

LQ = Per capita output of cocoa

LP_e = Real World market Price for cocoa

LEX_t = Real exchange rate

LP_o = Crude oil price

SAP = Structural Adjustment Programme. This is a dummy variable which takes on 0 for period before adoption of SAP and 1 for period after the adoption of SAP in Nigeria

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

μ = 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 (5) 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. The error correction model (ECMs) estimated are shown in (7) below. ECM in (7) represents the short-run behaviour of cocoa yield response in (7) while equation (6) 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 (7). The optimum lag lengths to be included in equations (7) were determined based on Akaike Information Criterion (AIC).

Static long run model for cocoa yield response

$$LQ = \beta_0 + \beta_1 LP_e + \beta_2 LEX_t + \beta_4 LP_o + \beta_5 SAP_c + T + \mu \quad \ldots\ldots\ldots\ldots. (6)$$

Error correction model (ECM) for the cocoa production model is also given as equation (7) .

$$\Delta LQ_t = \gamma_0 + \sum_{i=1}^{p} \gamma_1 \Delta LPe_{t-p} + \sum_{i=1}^{J} \gamma_2 \Delta LEX_{(t-j)} + \sum_{i=1}^{k} \gamma_3 \Delta LP_{O(t-k)} + \sum_{i=1}^{m} \gamma_4 \Delta SAP_{(t-m)} + \mu_t - \lambda \text{ECM} \quad \ldots\ldots (7)$$

Where Δ represents first differencing, λ measures the extent of correction of errors by adjusting in independent variable, β measures the long-run elasticities while γ 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

Unit Root Tests

The results of the unit root tests are shown in table 1 below. 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. Hence the variables are integrated of order 1 that is are I (1). This established the suitability of the variables for use in co-integration.

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 (1st difference)	Order of Integration
LQ	-3.1344	-9.0027**	1
LEX	-2.0910	-4.4995**	1
LPe	-3.2760	-4.9889**	1
LPo	-3.3521	-7.6110**	1
SAP	-1.7074	-5.7758**	1

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. 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*
ρ = = 0	52.08*	175.2**
ρ < = 1	41.67	123.1*

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

Short –run dynamic error correction (ECM) modeling of cocoa production.

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.

Effect of Crude oil Price on Cocoa Output in Nigeria

The solved static long- run equation for cocoa production in Nigeria as well as its short – run equation is given in Table 3. The R^2 value of 0.552 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 0.101 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 0.216 could not reject the null of absence of serial correlation in the residuals. The Jacque- Bera χ^2 - statistic of 1.056 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 output and other determining factors in the specified model. The coefficient of -0.505 indicates that the deviation of cocoa output from the long-run equilibrium level is corrected by about 50.5% in the current period.

The short-run coefficient of cocoa production in the immediate past period is -0. 126 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 0.128 and -0.016 respectively in the short- run and elasticity values of 0.222 and 0.134 respectively in the long run. Both variables are not significant at all in the long and short run. The elasticities of cocoa price move in the positive direction in both the long and short- run, the elasticities of real exchange rate was positive in the long-run while it is negative in the short –run. As Ajetomobi (2009) also observes, an increase in both price and exchange rate is not sufficient enough to stimulate increase in cocoa output, 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 suggests that devaluation will increase cocoa output in Nigeria, although not significantly. The response obtained in this study for Nigeria is higher than the estimates obtained by previous research work on Nigerian cocoa supply response – 0.006 (Ajetomobi, 2009), 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 long – run, crude oil price has a negative and significant coefficient of 0.245. In the short-run also, the coefficient is 0.219 and it is also significant at 5%. The elasticity values obtained for crude oil price in both the short and long-run is in line with theoretical expectation since will expect that as the world price of crude oil increase , the focus on agricultural export crops will further shifts away. At one time, Cocoa export is one of the major movers of the Nigerian economy. With the discovery of crude oil however, agricultural export sector has been on the neglect since. The results are in perfect agreement with the belief that, the advent of crude oil has affected the Nigerian cocoa sector negatively and significantly.

Structural adjustment programme also has a negative and significant effect on cocoa production in Nigeria. The coefficient for structural adjustment programme in the short –run is -0.383 although it is not significant. The adoption of SAP in Nigeria led to the abolition of cocoa marketing boards which until then has been responsible for quality for cocoa beans to be exported from Nigeria. Presently, cocoa beans for exportation in Nigeria, no longer through quality control and it are consequently been undervalued at the international market.

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 output in the long run. It has a coefficient of 0.050 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 effect of crude oil price on cocoa output in Nigeria.

Static Long – run equation		Parsimonious Short – run equation	
Constant	10.538(7.393)	Constant	0.054(1.828)
LEX	0.222(1.396)	$\Delta LQ(-1)$	-0.126(-0.816)
$L\rho_o$	-0.245(-2.544)**	ΔLEX	-0.0164(-0.114)
$L\rho_e$	0.134(1.046)	$\Delta LEX(-1)$	0.022(0.186)
SAP	-0.423(-2.050)**	ΔLP_O	-0.219(-2.032)**
Trend	0.050(5.703)***	ΔLP_e	0.028(0.263)
		ΔSAP	-0.383(-1.032)
		$\Delta ECM(-1)$	-0.505(-2.724)**
		R^2	= 0.552
		AR LM F	= 0.216(0.807)
		ARCH F	= 0.101(0.753)
		Normality X^2	= 1.025(0.806)

Source: Data Analysis, 2011

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