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# Determinants of Palm Oil Production in Nigeria: (1971-2010)

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## ABSTRACT

This study examined the determinants of palm oil in Nigeria between 1971 and 2010. Palm oil productivity measured by palm oil gross output in tonnes was specified as a function of factors such as exchange rate, crude oil price, palm oil price and structural adjustment programme (SAP). Quantitative estimates, based on Augmented-Dickey Fuller unit root test, co-integration and error correction specification, indicate that the exchange rate, palm oil price and time trend are the major determinants of palm oil productivity in the long-run while the price of crude oil is the most important determinant of palm oil productivity in the short-run. The result further shows that the error correction mechanism (ECM) indicated a feedback of about 99.8% of the previous year's disequilibrium from long-run domestic palm oil production. It is concluded that the price of crude oil indeed has a negative effect on palm oil productivity in Nigeria. The result of this study show that good price and exchange rate policies and factors inherent in time such as infrastructural developments, expenditure on agricultural research and extension, applications of modern techniques, use of genetically modified seeds for oil palm cultivation which are all captured by time trend are needed to bring about the much needed change in the Nigeria palm oil sector.

### Keywords:

palm oil, production, crude oil

price, error correction mechanism

## 1.0 INTRODUCTION

Agricultural export was the main stay of the Nigerian economy prior to the discovery, exploitation and exportation of crude oil which led to total dependence of the country on it for generation of revenue for economic growth and sustenance, before the oil boom in the 1970s, agricultural products accounted and contributed majorly to the export sector and the products were mainly (Oil palm, Cocoa, Rubber, Cotton etc) it fell to 35% of the GDP from an average of 72% between 1955 and 1969. It has been said that agricultural products tend to have the characteristics of a low price elasticity of demand while mineral export commodities are known to have high price elasticity of demand as Nigeria has a comparative advantage in production of agricultural commodity (raw materials, primary growth) with its level of technology.

The overall success of any export promotion strategy is to increase and sustain growth in agricultural exports growth. According to Gbetnkrom and Khan (2002), there are two main schools of thoughts explaining the decline in agricultural exports, one stresses factors that are external to the individual country, the slow volume of growth, world primary commodity market and the deteriorating terms of trade. The other line of thought emphasizes factors that are internal to the country that is, domestic policies that have affected export supply adversely.

Palm oil is an important commodity in the Nigerian economy with reference to its role as a source of farm income and food requirement. In addition to providing direct and indirect employment for about 4 million people, palm oil and palm kernel oil together contribute around 70% of the country's national consumption requirement of vegetable oils (Olagunju, 2008; Nzeka, 2014). Over the past 40 years, however, the Nigerian palm oil industry has undergone dramatic changes, recording slow growth in domestic production and losing its export share in the world market. Additionally, there has been a growing competition from imports in the face of rising domestic demand. These factors have heightened concerns with regards to the survival of the palm oil industry in Nigeria. (Egwuma *et al*, 2016).

In 1960'S Nigeria's palm oil production accounted for the major foreign exchange commodities alongside cocoa and some other cash crops such as rubber, cashew etc. Nigeria's palm oil also accounted for over 43 percent of the world's total global production. With this Nigeria was the major producer of palm oil amongst the other west African countries. However Nigeria has lost Her foremost place as the major palm oil exporting country to the Congo – Kinshasha and regained it only temporarily in 1964 to 1965 and as at today the country has lost her place to Malaysia and it a well known fact that Malaysia got the palm oil seedling from Nigeria.

Currently, oil palm is cultivated in 26 out of 36 states of Nigeria over a land area a little over 3 million hectares<sup>1</sup>. However, the total land available and ideal for oil palm cultivation is 24 million hectares. Also, about 80% of production is attributed to scattered smallholdings spread over an estimated 1.6 million to 2.4 million hectares of land (Dada, 2007; Kajisa, Maredia & Boughton, 1997). In contrast, estate plantations occupy only about 169,000 to 360,000 hectares, most of it coming up over the last decade with private sector investment. In 2013, palm oil area harvested stood at about 3.2 million hectares while production was only 930 thousand metric tons (Figure 1). On the other hand, statistics show that total palm oil consumption has increased sharply to about 1.4 million metric tons in 2013 thus creating a gap between domestic supply and demand. To reconcile the supply-demand imbalance, Nigeria has increased its import of palm oil over the years. In 2013, imports stood within the vicinity of 518 thousand metric tons. Furthermore, Nigeria's exports of palm oil to the world market account for a minuscule and insignificant portion of world export of palm oil (Egwuma *et al*, 2016).

Against the backdrop of declining production, the government of Nigeria initiated a number of programs and policies with the aim of reviving the palm oil industry. For example, the Presidential Initiative on tree Crops (PITC) was set up in 1999 to stimulate vegetable oil production through: the cultivation of one million hectares of oil palm capable of producing 2.25 tons of palm oil; the production of five million tons of groundnuts per annum; the production of one million tons of cottonseed per year; and the production of 0.68 million tons of soybean oil per annum (Dada, 2007). Also, in 2012, the government unveiled a number of initiatives under the Agricultural Transformation Agenda (ATA) including the launching of an oil palm value chain to recapitalize the oil palm plantation. The government also approved 4 million sprouted nuts of high-yielding oil palm seedlings to be distributed to farmers across the oil palm growing states in the country; about 1.3 million of these seedlings capable of establishing 9,300 hectares were distributed to 18 private estates at no cost to the farmers. In addition, a number of oil press machines were distributed to farmers to enhance the harvesting of fresh fruit bunches (FFB).

No doubt that the discovery of crude oil brought prosperity wealth and great development to the economy of the nation as a whole, but over reliance of the country on crude oil exportation has led to negligence of the agricultural sector where palm oil is a product and before the discovery of crude oil the government was a key developer of the agricultural sector because of the provision of agricultural materials such as fertilizer chemicals insecticides and other input materials to the sector but all this contributions declined after the oil boom (Egwuma *et al*, 2016)

While it is obvious that palm oil has an immense potential for enhancing and stabilizing the foreign exchange earnings, of recent there has been a steady decline in the role of palm oil as a foreign exchange earner. Although Nigeria is currently the third largest producer of palm oil in the world after Indonesia and Malaysia; however, it remains a net importer. Despite governments' attempt to revamp the palm oil industry, there is yet to be seen any significant improvement.

Against this background, it is therefore important to investigate the interdependence between the critical market variables in the Nigerian palm oil sector. This study therefore examined the determinants of palm oil production in Nigeria using the Augmented-Dickey Fuller unit root test, co-integration and error correction specification, in order channel a new course towards putting palm oil in the fore front as a foreign exchange earner for the country as it was in the past.

**2. 0 METHODOLOGY**

**2.1 Co-integration analysis:** This study applied co-integration error correction modeling to examine the determinants of palm oil production in Nigeria. As a first step, Error Correction Model (ECM) ascertains the stationarity or otherwise of the time series data. Co-integration and error correction modeling thereafter is used to examine the determinants of palm oil production in Nigeria.

**Stationarity test:** This study applied co-integration and error correction modeling to examine the effect of crude oil prices on palm oil 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 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 I(0) series while a series that becomes stationary after first differencing is said to be 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  $X_t \sim 1 (D_x)$ , 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:

$$\text{For DF test } \Delta X_t = \alpha_0 + \delta X_{t-1} + e_t \dots \dots \dots (1)$$

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

$H_0$  is rejected if the t-statistic on  $\delta$  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).

**Co-integration and Error Correction Analysis:** To test for co-integration, two main approaches have been developed: one involves the estimation of a static model where all variables enter in levels according to Engle and Granger, 1987, the other estimation of an error correction model is the Johansen procedure (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 identifying problems one may encounter with the Engle-Granger approach if there is more than one co-integrating vector. Second, the Dickey-Fuller test employed to test for co-integration 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  $n \times n$  matrix  $Y_t$  in the specification as given below.

$$\Delta Y_t = \mu_t + \pi Y_{t-k} + \sum_{i=1}^{k-1} \tau_i \Delta Y_{t-i} + \mu_t \dots \dots \dots (3)$$

Where  $Y_t$  is a column vector of the  $n$  variables,  $\pi$  and  $\Delta$  are coefficient matrices,  $\Delta$  is difference operator,  $K$  denotes the lag length and  $\mu$  is a constant. The  $\pi$  matrix conveys information about the long-run relationship between the  $Y_t$  variables, and the rank of  $\pi$  is the number of linearity independent and stationary linear combination of variables studied. Thus, testing for cointegration involves testing for the rank of  $\pi$  matrix  $r$  by examining whether the eigen values of  $\pi$  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 error correction model we applied the minimum AIC-criterion. To determine the number of cointegrating equations, the Johansen maximum likelihood method provides both trace and maximum eigen value 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).

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^k \ln(1 - \hat{\lambda}_i)$$

The maximum eigen value

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 obtained from the estimated  $\pi$  matrix and  $T$  is the number of observations. When the trace statistic ( $t$ ) and the maximum eigen value statistic ( $\lambda$ ) 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 defined as:

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

Where  $\delta$  is the maximum likelihood estimate (MLE) of  $\delta$ ,  $k$  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.

**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 behavior of cocoa yield response in (7) while equation (6) represents the long – run static equation. The parameter  $\lambda$ , 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 palm oil**

$$LQ = \beta_0 + \beta_1 LP_e + \beta_2 LEX_t + \beta_4 LP_0 + \beta_5 SAP_c + T + \mu \dots\dots\dots(6)$$

Error correction model (ECM) for the Palm oil production model is also given as equation (7)

$$\Delta LQ = y_0 + \sum_{i=1}^P y_1 \Delta LP_{e,t-p} + \sum_{i=1}^j y_2 \Delta LEX_{(t-j)} + \sum_{i=1}^K y_3 \Delta LP_{0(t-k)} + \sum_{i=1}^m y_4 \Delta SAP_{(t-m)} + \mu_t - \lambda ECM \dots\dots\dots(7)$$

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  $Y$  measures the short-run elasticities.

General – to – specific modeling technique of Henry 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.

**2. 2 Data**

The data used is secondary data which include time series micro level data spanning from 1971-2010. The data was sourced from Central Bank of Nigeria (CBN) statistical bulletin and the statistical database of the Food and Agricultural Organizations of the United Nations.

The features of the data include;

1. Palm oil price ( N)
2. Palm oil production(tonnes)
3. Crude oil price (N)
4. Exchange rate.
5. Structural adjustment programme (SAP)

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

$$LQ = \beta_0 + \beta_1 LP_{mo} + \beta_2 LEX_t + \beta_4 LP_0 + \beta_5 SAP_c + T + \mu$$

Where:

LQ = Palm oil output

$LP_{mo}$  = Real World market Price for palm oil  
 $LEX_t$  = Real exchange rate  
 $LP_o$  = Crude oil price  
 SAP = Structural Adjustment Programme.

SAP 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

$\mu$  = other unobserved variables

Theoretically, it is expected that  $LP_o \leq 0$ ,  $LEX_t \geq 0$ ,  $LP_{mo} \geq 0$ ,  $SAP_c \geq 0$

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

### 3.0 RESULTS AND DISCUSSION

#### 3.1 Unit Root Tests

The results of the unit root tests are shown in table 1 below. The null hypothesis of the presence of 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 I (1). This established the suitability of the variables with order I (1) for use in co-integration.

**Table 1: Unit Root Test Results for Palm oil (Constant and Trend Included) Critical t-values: 5% =3.539; 1% = -4.232**

Variables	t-statistic (level)	t-statistics (1 <sup>st</sup> difference)	Order of integration
LQM	-2.083	-3.936*	1
LEX	-1.625	-3.192*	1
LP <sub>o</sub>	-3.289	-7.831**	1
SAP	-1.586	-5.979**	1
LP <sub>mo</sub>	-1.252	-5.506**	1

Source: Data Analysis, 2015

\*\* Indicates significance at 5%, \* indicates significance at 10%

**Table 2: Results of the Johansen's maximum-Eigen value and Trace Statistics Co-integration test**

	Trace Statistical Test		Eigen-value Statistical test	
	Test statistics	Critical value	Test statistics	Critical values
$\rho = 0$	92.4*	87.3	42.41*	37.5
$\rho \leq 1$	50.0	63.0	24.13	31.5

Source: Data Analysis, 2015

\* Numbers of values significant at 5%

**Table 3: Static long-run and Short-run error correction model estimate for effect of crude oil price on palm oil production in Nigeria.**

Static long-run result		Short-run result	
Constant	15.038(190.120)	Constant	0.004 (0.310)
LEX	0.032(1.720)*	$\Delta$ LQM (-1)	0.243 (1.313)
LPo	0.072(14.33)**	$\Delta$ LEX	0.015 (0.619)
SAP	-0.01(-0.263)	$\Delta$ LPm <sub>o</sub>	0.053 (1.910)*
LPm <sub>o</sub>	-0.026(-2.314)**	$\Delta$ LPm <sub>o</sub> (-1)	-0.03 (-0.906)
T	0.3201(1.993)*	$\Delta$ LPe	0.008 (0.043)
		$\Delta$ LPe (-1)	0.006 (0.353)
		ECM (-1)	0.998 (-4.263)***
		R <sup>2</sup> = 0.503	
		AR F (2, 25)	= 2.303 (0.121)
		ARCH (1, 25)	= 2.926 (0.2990)
		Normality $\chi^2$	= 6.681 (0.1354)

Source: Data Analysis, 2015

### 3.2 Result of tests for Co-integration

The result of Johansen multivariate co-integration test between palm oil output and selected variables is presented in table 2 below. The result shows 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 shows that there is at least 1 co-integration relation. This indicates that there exists a long-run relationship between the explanatory variables and palm oil production in Nigeria. Since co-integration has been established, the regression results were analyzed and diagnosed.

### 3.3 Short-run Dynamic Error Correction Modeling (ECM) of Palm oil 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 mode (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.

The solved static long-run equation for palm oil production in Nigeria as well as its short-run equation is given in table 3 below. The R<sup>2</sup> value of 0.503 for the ECM in table 3 shows that the overall goodness of fit of the ECM is satisfactory. This means that only 50% of the variation in palm oil gross domestic product is explained by the explanatory variables, the remaining 50% is inherent in error term or white noise. 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 Heteroscedasticity (ARCH) test for testing heteroscedasticity in the error process in the model has an F-statistic of 2.926 which is statistically insignificant. This attests to the absence of heteroscedasticity in the model. The Jacque- Bera  $\chi^2$  - statistic of 6.681 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 discussion.

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 co-integration and suggests the existence of long-run steady equilibrium between palm oil gross domestic product and other determining factors in the specified model. The coefficient of -0.998 indicates that the deviation of palm oil production from the long-run equilibrium level is corrected by 99.8% in the current period.

The exchange rate has a positive coefficient of 0.032 and 0.015 in the long and short-run respectively which are both significant at 5%. The elasticity values of exchange rate in both the short and long-run suggests that devaluation will decrease import of palm oil products, thereby encouraging local production which will subsequently increase palm oil production.

The producer price of palm oil ( $LP_{mo}$ ) has a negative and significant value of -0.026 in the long run. The elasticity value of palm oil price in long-run suggests that the producer price of palm oil is not encouraging production. Although this is contrary to theoretical expectation, it could be understood if we consider the fact that the petroleum sector negatively affected agricultural export in Nigeria. The coefficient of the producer price of palm oil in the short run is however positive and significant.

In the short-run, crude oil price ( $LP_o$ ) in the immediate past period has a positive coefficient of 0.006 and 0.008 in the short-run but a negative and significant value of -0.026 in the long-run. The elasticity value obtained for crude oil price in the short-run is in line with theoretical expectation since it is expected that as the world price of crude oil increase, the focus on agricultural production in developing country like Nigeria will further shift away. Therefore, it can be said that the price of crude oil determines the attitude or focus of government towards agricultural production in the country.

The coefficient of Structural Adjustment Programme (SAP) in the long-run is negative but insignificant with a value of -0.01. This means that SAP does not affect palm oil production. Therefore, SAP could be said not to be a major determining factor of palm oil production.

Time trend has a positive and significant effect on palm oil production in Nigeria. This rightly suggests that Factors inherent in time such as infrastructural developments, expenditure on agricultural research and extension, applications of modern techniques, use of genetically modified seeds for oil palm cultivation which are all captured by time trend positively affects palm oil production in Nigeria.

#### 4.0 CONCLUSION AND POLICY RECOMMENDATION

The study shows that in the long run, exchange rate (LEX) and palm oil price ( $LP_{mo}$ ) determine the level of palm oil production. Factors inherent in time such as infrastructural developments, expenditure on agricultural research and extension, applications of modern techniques, use of genetically modified seeds for oil

palm cultivation which are all captured by time trend are needed to bring about the much needed change in the Nigeria palm oil sector. Nigerian government must pay special attention to ensure that this factor especially is implemented as it has the capacity to turn around the fortune of our palm oil production in Nigeria. Exchange rate policies which encourage palm oil production should also be adopted by the Nigerian government. If these factors are put in place, it will go a long way in bringing agricultural export in Nigeria to its former place of pride as one of the major drivers of our economy as in the past.

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