Abstract

This study analyzes the determinants of hectarage allocation to oil palm production in Nigeria and estimates the hectarage response to a number of exogenous variables. Annual data covering the period 1970 to 2013 were used for the study. The analysis was carried out using the autoregressive distributed lag model. The results of the study reveal that palm oil producer price and government expenditure are the significant determinants of oil palm hectarage. The study recommends a review of the producer price of palm oil in order to incentivize farmers in the production of palm oil. In addition, government support should be intensified to develop the oil palm areas in order to reduce the cost of production and incentivize oil palm farmers and processors. Such government support could be in the form of advancing cost-reducing incentives schemes to palm oil producers such as offer of replanting schemes and new planting schemes to independent oil palm smallholders. The provision of credit, storage, processing and transportation facilities are also likely to stimulate production in the long-run. Support should also be provided for training, waste land development, and technology transfer through extension programs.

Keywords: Oil palm, Hectarage, Producer price, Econometric analysis, Cointegration,

Introduction

Agriculture plays a significant role in the growth and survival of the Nigerian economy and is the largest sector providing a livelihood for two-thirds of the population. Within the agricultural sector, the palm oil industry has contributed substantially to the Nigerian economy providing employment for an estimated 4 million people both in the upstream and downstream sectors (Gourichon, 2013; Olagunju, 2008). However, palm oil production in Nigeria is dominated by small-scale farmers who account for about 80% of output on scattered smallholdings that spread across 26 out of 36 states of Nigeria over a land area a little over 2.4 million hectares. A number of the plantations were set up by the Nigerian government in an effort to promote large-scale farming, most of which did not yield significant success.

Over the years, palm oil production has only been increasing sluggishly in Nigeria. For example, between 1970 and 2017 palm oil production marginally increased from 432,000 metric tons to 970,000 metric tonnes (United States Department of Agriculture (USDA), 2018). Whereas, palm oil production has fluctuated over the years, consumption has steadily increased from 412,000 metric tonnes in 1970 to 1,260,000 metric tonnes in 2017 (USDA, 2018), a situation which can be attributed to the rapid population growth. Thus, domestic supply has been lagging well below the aggregate demand requiring the demand deficit to be closed through import. Consequently, there has been a drain in scarce foreign exchange thereby exacerbating the balance of payments problem of the country. For example, in 2017 alone Nigeria spent an estimated N116.3 billion to import about 450,000 metric tonnes of palm oil (Punch Newspaper, March 25, 2018).

A variety of factors are responsible for the low palm oil production and the dismal performance of the industry. These factors include rapid increase in population which has contributed to soil degradation, unfavourable climate and bad weather, poor agronomic practices and inefficient farm management practices. Similarly, the erstwhile pricing policy of the defunct commodity boards for the major export crops as well as the poor infrastructural base of the agricultural sector are major contributing factors.

Given the declining state of the palm oil industry, the government has initiated a number of economic reforms over the years to revitalize the industry. The first National Development Plan (NDP) of 1962 to 1968 was aimed at the expansion of oil palm plantation and grove rehabilitation (Ugbah & Nwae, 2008). The civil war in the late 1960s disrupted activities in the palm oil industry, which caused the plantations to be abandoned and the attention to smallholder and oil palm groves declined (Dada, 2007). Consequently, in the second NDP (1970-1974) improved varieties were provided to replace low-yielding palms. The third NDP (1975-1980) focused on the expansion of area under cultivation with the replanting and setting up of plantations of 50,000 hectares as measures that were adopted. The establishment of the Nigerian Institute for Oil Palm Research (NIFOR) was another measure taken by the government to support domestic production. As a research institute, the mandate of NIFOR includes the production and provision of improved seeds to farmers.
and rendering extension services. However, low level of funding has limited the capacity of the institute to promote and deliver its products to farmers (Thomas et al., 2011). The Presidential Initiative on Tree Crops (PITC) was set up at the return of democracy 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. This goal was to be pursued over a five-year period beginning from 2003 (Dada, 2007). Hence, between 2001 and 2008, palm oil production expanded from 760,000 metric tons to 850,000 metric tons while recording a corresponding rise in local utilization. The government in 2012 again unveiled a number of initiatives under the Agricultural Transformation Agenda (ATA) with the aim of revamping the sector. This includes 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 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) (Osagie, 2014; Oyeleye, 2013).

As laudable as these efforts are, they have failed to significantly improve the performance of the palm oil industry. The marginal increase in production has been argued to be a result of expansion of the hectarage devoted to oil palm cultivation relative to other crops. According to Potter (2015), Nigeria has approximately 24 million hectares of land that can be used for oil palm plantation. However, current land utilized for oil palm plantation is about 3 million hectares suggesting the existence of a huge potential for increasing oil palm production by increasing the area under cultivation and improve yield per unit area. Although annual data on oil palm area under cultivation is not available, data on area harvested indicates an unimpressive trend. Total area harvested only grew modestly from about 2.15 million hectares in 1970 to 3.05 million hectares in 2016, increasing less than two-fold and growing at an average rate of 1.1% annually. Assuming area harvested is equal to the total area under oil palm cultivation, this implies that of a total of 24 million hectares available for oil palm cultivation in Nigeria only about 13.5% is currently under cultivation. This presents a huge opportunity for oil palm expansion in Nigeria.

The present study, therefore, is an attempt to establish the factors that determine oil palm hectarage in Nigeria. To the best of our knowledge, no empirical study on the determinants of oil palm hectarage in Nigeria is available. An understanding of how various exogenous factors affect the supply response of oil palm will help to inform appropriate policies that will enhance the performance of the Nigerian palm oil industry and achieve the desired hectarage in oil palm.

The remainder of the paper is organized as follows: Section two deals with the method adopted in this study as well as presents the data. Section three presents the results from the analysis and discusses the implications of the results. Finally, the conclusion and policy recommendations are provided in section four.

Method and Data

The commodity market model proposed by Labys (1973) is adopted for this study. The model is based on the neoclassical production function to investigate commodity supply, demand and price adjustment. In the basic Labys (1973) model, the supply equation is given as:

\[ Q_t = q(Q_{t-1}, P_{t-1}, N_t, Z_t) \]  

Where: \( Q_t \) = supply of commodity, \( P_{t-1} \) = price with lag \( i \) (i = 1,2,3,...), \( N_t \) = natural factors, and \( Z_t \) = policy variables influencing supply. Several extensions and modifications of this basic model have emerged including that of Shamsudin et al. (1994), Arshad et al. (2012), and Wong et al. (2014). The present study also adopts the classic model of Labys (1973) with some modifications in order to investigate the determinants of oil palm hectarage in Nigeria.

The farmer's decision to plant is illustrated by the oil palm area harvested equation. As a perennial tree crop, oil palm has a long gestation period between planting and harvesting and as such any formalization of the farmer's planting decision must account for the production lag. The area harvested for Nigerian oil palm depends on the cost of production and expected returns on investment. Thus, the planted acreage is influenced by the bank lending rate as the major component of the cost of production. Expected returns on investment depend on the expected price of palm oil and the price of cocoa. Cocoa competes with oil palm for land acreage and as such resources are shifted between these two crops based on the expected returns on investment in each of the crops. The expected price of palm oil is unobservable and, therefore, we use lagged prices of palm oil as a proxy for the expected price in the area harvested equation. The lagged area harvested is included in the area harvested equation to reflect the dynamics associated with farmer's planting.

Due to the unavailability of data on area planted, this study uses the area harvested as a proxy for area planted. The use of area harvested as a proxy for area planted, however, has some setbacks as the total area planted may not be harvested due to crop failure, damage, disease, etc.
decisions. In addition, government expenditure on agricultural development is expected to stimulate farmers to increase oil palm area harvested. Equation (2) represents the oil palm area harvested response function:

$$AH_t = f(AH_{t-1}, PPO_{t-1}, PPC_{t-1}, IR_{t-1}, GOVE X_{t-1})$$

All the variables are expressed in their logarithmic form, and therefore, the estimated coefficients represent elasticities. The estimated equation can be written as:

$$LAH_t = \beta_0 + \beta_1 LAH_{t-1} + \beta_2 LPP O_{t-1} + \beta_3 LPP C_{t-1} + \beta_4 LIR_{t-1} + \beta_5 LGOVE X_{t-1} + \varepsilon_t$$

where,

- $AH_t$ = Oil Palm Area Harvested in Hectares
- $PPO_t$ = Producer Price of Crude Palm Oil in Naira/ton
- $PPC_t$ = Producer Price of Cocoa in Naira/ton
- $IR_t$ = Nigerian Average Lending Rate in whole number
- $GOVE X_t$ = Nigerian Government Expenditure on Agricultural Development in Naira
- $t$ = Time Period
- $i$ = Time Lag
- $\varepsilon_t$ = Error term

Equation (2) postulates that oil palm area harvested is a function of lagged area harvested, lagged palm oil price, lagged cocoa price, lagged lending rate and lagged government expenditure. The signs on the coefficients of the price of palm oil and government expenditure are expected to be positive while the price of cocoa and lending rate are expected to be negatively related to area harvested. The partial adjustment hypothesis imposes a restriction on the adjustment coefficient to lie between zero and one. Consequently, lagged area harvested is expected to have a positive effect on the current area harvested.

This study uses published secondary data from various sources including Central Bank of Nigeria (CBN, 2018), Nigeria Bureau of Statistics (NBS, 2018), United State Department of Agriculture (USDA, 2018), and Food and Agriculture Organization of the United Nations Statistical database (FAOSTAT, 2018). Annual data covering 1970 to 2013 are used for the analysis. The selection of this time frame is based on data availability and the fact that beginning from the early 1970’s palm oil experienced a phenomenal rise in the world oils and fats market in terms of volume of exports.

Results and Discussion

Generally, when a model is specified such that there is a feedback of endogenous variables from one equation to another, the system is confronted with the problem of serial correlation (that is, there is a correlation between the error and the endogenous variables). Consequently, the use of ordinary least squares (OLS) as an estimation approach will produce estimators that are both biased and inefficient. This means that OLS is no longer the best linear unbiased estimator (BLUE) in the presence of serial correlation because OLS variances and standard errors are biased and, hence, the usual inference procedures are not valid (Gujarati, 2009; Wooldridge, 2013). In addition, in simultaneous equation models where lagged endogenous variables are included, the problem of serial correlation may further be compounded which would further exacerbate the estimation of the equations. Several estimation procedures commonly used to solve the system of equations in such a way as to eliminate simultaneous bias include maximum likelihood estimation techniques (MLE), Seemingly Unrelated Regression (SUR), Two-stage Least Squares (2SLS), Three-stage Least Squares (3SLS), and autoregressive distributed lag (ARDL) approach.

The ARDL approach developed by Pesaran et al. (1996), Pesaran and Shin (1998), and Pesaran et al. (2001), was used to estimate the hypothesized model in equation (3). This approach is a cointegration technique employed in time series analysis and as such we first proceed with unit root and cointegration tests. The results of the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests in level and first difference are captured in Table1. The results of the unit root tests indicate that all the variables are integrated of order one i.e. I(1), which indicates that the variables are non-stationary in level but become stationary after being transformed to first differences². This result is robust regardless of the choice of test applied.

2A requirement in the ARDL technique is that variables be I(0) or I(1) but not I(2)
Table 1: ADF and PP Unit Root Tests

<table>
<thead>
<tr>
<th>Variable</th>
<th>ADF</th>
<th>PP</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level</td>
<td>First Difference</td>
<td>Level</td>
</tr>
<tr>
<td>Area Harvested</td>
<td>-0.654</td>
<td>-7.540***</td>
<td>-0.397</td>
</tr>
<tr>
<td>Palm Oil Price</td>
<td>-0.938</td>
<td>-5.806***</td>
<td>-0.914</td>
</tr>
<tr>
<td>Cocoa Price</td>
<td>-1.064</td>
<td>-4.702***</td>
<td>-0.899</td>
</tr>
<tr>
<td>Interest Rate</td>
<td>-1.965</td>
<td>-6.851***</td>
<td>-2.191</td>
</tr>
<tr>
<td>Government Expenditure</td>
<td>-1.876</td>
<td>-7.796***</td>
<td>-1.791</td>
</tr>
</tbody>
</table>

Note: *** denotes significant at 1% significance level

Table 2 summarizes the ARDL Bounds test of cointegration for the equation used in this study. This test uses the F-statistic and is conducted against the null hypothesis of no cointegration. Because the set of critical F values provided by Pesaran et al. (2001) are for large samples, we use the critical values of Narayan (2005) which is more appropriate for sample size ranging from 30 to 80 (Alinsato, 2009). Thus, a rejection of the null hypothesis will imply the existence of a long-run relationship between the variables. As reflected in Table 2, the null hypothesis of no cointegration is rejected, lending evidence to the existence of a long-run cointegration relationship among the variables.

Table 2: ARDL Bounds Test of Cointegration

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Area Harvested</td>
<td>4</td>
<td>3</td>
<td>2.516[0.284]</td>
<td>4.294*</td>
<td>3.838</td>
</tr>
</tbody>
</table>

Note: * denote significant at 10% level. Figures in brackets [...] are p-values and critical values are from Narayan (2005). BG-LM is Breusch-Godfrey LM test statistic for testing autocorrelation.

The results obtained from the estimation of equation (3) are shown in Table 3. The estimated elasticities are normalized on the lagged dependent variable. The results reveal that the long-run coefficients for all variables in the equation have the expected signs from a theoretical perspective. Palm oil producer price has a positive and statistically significant effect on oil palm area harvested in the long-run with a fairly low own price elasticity of 0.085. This indicates that a 1% increase in palm oil price will lead to an increase in the current oil palm area harvested by about 0.085%, holding other factors constant. This small value of the own price elasticity means that Nigerian oil palm producers are predominantly unresponsive to price changes i.e. area harvested is price inelastic. This finding suggests that a review of the producer price of palm oil would incentivize farmers in the production of palm oil. The results further suggest that the price of cocoa, although having a reasonable sign, is statistically insignificant to influence oil palm area harvested. Thus, cocoa is a competitive crop; an increase in the price of cocoa will induce farmers to shift resources such as land toward cocoa production and away from oil palm cultivation. This finding reveals that farmers in Nigeria are sensitive to changes in the price of crops grown and would respond by efficiently allocating their resources based on price movements in the output market.
The coefficient of the interest rate carries a negative sign as expected and implies that the desire of agents to invest in oil palm cultivation declines with an increase in interest rate. In other words, the incentive for firms to invest reduces as the cost of borrowing increases. This is because interest rate represents the cost of investment and a rational investor will withhold investment in the face of rising interest rate. Thus, lower interest rates have a positive impact on investment. However, the interest rate was found to be statistically insignificant, suggesting that the interest rate is not important in influencing investors’ decision on oil palm area harvested in Nigeria.

In addition, the results show that the estimated coefficient of government expenditure on agriculture is positive and has a statistically significant effect on oil palm area harvested, underscoring the importance of government support to the agricultural sector. Thus, an increase in government support (such as the provision of infrastructure, replanting grant and extension support services) will crowd in private investment in the oil palm sector. This is, however, inconsistent with the neoclassical argument that increased government expenditure tends to crowd out private investment.

Unfortunately, no estimates of elasticities of area planted were found in the literature which could have allowed comparison with the results obtained here to draw inferences on the exact size of the estimates. In a dated study on short-run and long-run supply responses of palm produce in Nigerian, Oni (1969) found that palm oil output is price inelastic, with short-run and long-run price elasticities of 0.23 and 0.28, respectively. Oni (1969), however, used current price instead of lagged price and quantity of palm oil supplied instead of acreage planted as the dependent variable. The estimated results in the present study, however, appear to be in line with results obtained for the palm oil industry in other countries with respect to the effect of own price on acreage. In the case of Malaysia, for example, Talib and Darawi (2002) found the short-run and long-run elasticities of area planted with respect to the current price of palm oil to be 0.055 and 0.292, respectively. Similarly, Wong (2014) using the ratio of palm oil to rubber prices, reported elasticities of area planted with respect to lagged price of 0.029, 0.066 and 0.054, respectively for aggregate, Sabah and Sarawak oil palm estates in Malaysia. For the case of Indonesian oil palm planted acreage, Ernawati (2004) found the elasticity of acreage to lagged own-price to be 0.07. With respect to cross-price elasticity, Talib and Darawi (2002) reported a value of -0.032 for Malaysian oil palm area planted.

The existence of cointegration necessitates the use of the error correction model (ECM) which provides the short-run coefficients that explain the dynamic behavior of the exogenous variables in relation to a change in area harvested. The results of the ECM are reported in Table 4. The results reveal that the coefficient of the error correction term (ECT) lagged one period, indicating the speed of adjustment to long-run steady states, has the expected negative sign and is statistically significant at the 1% significance level. The empirical results suggest a moderate speed of convergence towards long-run equilibrium. Specifically, oil palm area harvested adjusts at the speed of 45% every year or, equivalently, it takes approximately 2.2 years to eliminate the disequilibrium and drive the variables back to their long-run equilibrium levels.

Table 3: ARDL Results for Area Harvested

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimated coefficient</th>
<th>T-statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>6.673***</td>
<td>2.635</td>
<td>0.013</td>
</tr>
<tr>
<td>Lagged Area Harvested</td>
<td>0.450***</td>
<td>2.761</td>
<td>0.009</td>
</tr>
<tr>
<td>Palm Oil Price</td>
<td>0.047**</td>
<td>2.036</td>
<td>0.049</td>
</tr>
<tr>
<td>Cocoa Price</td>
<td>-0.016</td>
<td>-0.644</td>
<td>0.524</td>
</tr>
<tr>
<td>Interest Rate</td>
<td>-0.097</td>
<td>-0.538</td>
<td>0.594</td>
</tr>
<tr>
<td>Government Expenditure</td>
<td>0.059*</td>
<td>2.031</td>
<td>0.050</td>
</tr>
</tbody>
</table>

Note: ***, **, and * denote significant at 1%, 5% and 10% levels, respectively. Figures in parenthesis (…) are p-values. The general to specific approach is used to select the lag length.
Table 4: Estimated Short-run Coefficient

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>T-statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-0.016</td>
<td>-1.590</td>
<td>0.122</td>
</tr>
<tr>
<td>ΔLagged Area Harvested</td>
<td>-0.101</td>
<td>-0.684</td>
<td>0.499</td>
</tr>
<tr>
<td>ΔPalm Oil Price</td>
<td>0.019</td>
<td>0.754</td>
<td>0.462</td>
</tr>
<tr>
<td>ΔCocoa Price</td>
<td>0.015</td>
<td>0.536</td>
<td>0.596</td>
</tr>
<tr>
<td>ΔInterest Rate</td>
<td>-0.172</td>
<td>-0.787</td>
<td>0.437</td>
</tr>
<tr>
<td>ΔGovernment Expenditure</td>
<td>0.012</td>
<td>0.321</td>
<td>0.750</td>
</tr>
<tr>
<td>$ECT_{t-1}$</td>
<td>-0.445***</td>
<td>-3.645</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Diagnostic Tests

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</thead>
<tbody>
<tr>
<td>Adjusted-R²</td>
<td>0.943</td>
<td>RESET</td>
<td>0.315(0.578)</td>
</tr>
<tr>
<td>BG-LM</td>
<td>5.331*(0.070)</td>
<td>WHITE</td>
<td>11.442(0.934)</td>
</tr>
<tr>
<td>JB</td>
<td>1.652(0.438)</td>
<td>F-statistic</td>
<td>126.958***(0.000)</td>
</tr>
</tbody>
</table>

Note: *** denotes significant at 1% levels. Figures in parenthesis (…) are p-values. BG-LM = Breusch-Godfrey LM test of autocorrelation, JB = Jarque Bera (JB) test of normality of residuals, RESET = Ramsey test of model specification, WHITE = White test of heteroscedasticity.

The regression results indicate an adjusted-R² of 0.943 implying that about 94% of the variation in oil palm hectarage under cultivation is explained by the variables included in the model. The findings also indicate that all the estimated equations satisfy the diagnostic tests at the 5% level of significance, suggesting that the statistical properties of the estimated equations are reasonable. Furthermore, the stability tests using plots of cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares of recursive residuals (CUSUMSQ) stability testing technique show that both lines are within the 5% error band, indicating that the model is structurally stable over the estimation period (Figures 1 and 2).

Figure 1: Plot of Cumulative Sum of Recursive Residuals
Conclusion and Policy Recommendation
The performance of the Nigerian palm oil industry over the last four decades has not been impressive. Rising demand in the face of sluggish growth in yields and output of oil palm has created a large demand-supply gap. This has created the need to rely on imported palm oil to meet domestic consumption. Although palm oil domestic supply has fallen short of demand, there has been a marginal increase in production which is attributable to hectarage expansion. This study analyzes the factors that determine oil palm hectarage in Nigeria and demonstrates that oil palm area harvested was significantly determined by the producer price and government expenditure. The coefficient of lagged area harvested was found to be significant which lends support to Nerlovian partial adjustment and also indicated that the model captured the adjustment process quite well.

The findings and discussion in this study suggest that two policy implications could be uncovered that may be of great importance to the government and policy makers and that could improve the performance of the Nigerian palm oil industry. First, it is clear from the analysis that palm oil producers are sensitive to price changes and thus a review of the producer price of palm oil would incentivize farmers in the production of palm oil. Secondly, the results show that government expenditure is important in explaining acreage expansion, and hence, the output response of palm oil producers. This underscores the need for government support in stimulating palm oil production. Therefore, this study recommends that government expenditure should be intensified to develop the oil palm areas in order to reduce the cost of production and incentivize oil palm farmers and processors. Such government support could be in the form of advancing cost-reducing incentives schemes to palm oil producers. For example, the Nigerian government could offer replanting schemes and new planting schemes to independent oil palm smallholders. This will, in addition to increasing cultivated acreage, help to replace old and unproductive trees and hence improve productivity. Other incentives such as credit, storage, processing and transportation facilities are also likely to stimulate production in the long-run. Support should also be provided for training, waste land development, and technology transfer through extension programs.

References


