

*Full Length Research Paper*

# **The effects of petroleum dependency on agricultural trade in Nigeria: An error correlation modeling (ECM) approach**

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**Agricultural and petroleum sectors are both of great importance to the Nigerian economy in terms of their contribution to Gross Domestic Product (GDP) and value of their exports. Dependence of Nigeria on the oil sector has been found to adversely affect both the agricultural sector and the economy. This study covered the periods between 1970 and 2003. It sought to know the effects and extent of petroleum dependency (in terms of oil exploration, production and trade) on the agricultural sector using Co-integration and Error Correction Modeling (ECM) analysis. Time series data were obtained from Central Bank of Nigeria (CBN), Food and Agricultural Organization (FAO), Federal Office of Statistics (FOS), National Institute for Social and Economic Research (NISER) and Federal Ministry of Agriculture and Rural Development. The study revealed that the trend in production levels of major export crops increased in recent years. Results from the analysis showed the presence of at least one co-integrating vector for all the crops. The result of the ECM confirmed a long run equilibrium relationship between the cash crops and the exogenous variables; and also the presence of significant short-run dynamics or divergences. The Ordinary Least Squares (OLS) results showed that the value of oil exports and imports increased with agricultural production. However, the quantity of oil production had an inverse relationship with the output of agricultural export crops. Based on the results, workable recommendations were made for improving the agricultural sector and reducing the adverse effects of petroleum dependency on agricultural trade and the economy at large.**

**Key words:** Petroleum dependency, agricultural production, error correction model (ECM), Nigeria.

## **INTRODUCTION**

Agriculture is concerned basically with the husbandry of crops and animals for food and other purposes. It is the foundation upon which the development of stable human communities such as rural and urban communities has depended in many parts of the world.

In the pre-independence era, the contribution of the agricultural sector to the Gross Domestic product (GDP) surpassed every other sector in the economy. On attainment of political independence in 1960, the trend was still very much the same. During 1964-1965, agriculture accounted for 55% of GDP and employed 70% of the adult work force (Malton, 1981). In 1970, agricultural export crops like cocoa, groundnut, cotton, rubber, palm oil, palm kernel, etc, account for an average of between 65-75% of Nigeria's foreign exchange earnings and provide the most important source of revenue for the

federal as well as state governments through export product and sales taxes (Ekundare, 1973).

However, the 1967-70 Civil War in Nigeria coincided with the oil boom era, which resulted in extensive exploration and export of petroleum and its products. This led Nigeria to neglect its strong agriculture and light manufacturing bases in favor of an unhealthy dependence on oil for more than 97% of export earning and 80% federal revenue (United States Department of State, 2005). Oil dependency and the allure generated great wealth through government contracts, but the increased foreign exchange earnings of the country since 1970 has had some adverse effects on Nigeria's potential earning from non-oil export trade. It has discouraged the production of a number of export items, which are the traditional source of Nigeria's export earnings before the advent of oil.

The agricultural sector has suffered from years of poor management, inconsistent and poorly implanted government policy and lack of basic infrastructure. Presently, it accounts for 40.6% of GDP and 65% of employment in the country; Nigeria is no longer a major exporter of cocoa, groundnut, rubber and palm products. Cocoa production mostly from obsolete varieties and over-aged trees is stagnant at around 150,000 tonnes annually, 25 years ago cocoa production was 300,000 tonnes. There has been a similar decline in groundnut, palm oil and the other major export crops (United States Department of State, 2005). The share of agricultural products in total exports has plummeted from over 70% in 1960 to less than 2%. The decline was largely due to the phenomenal rise of oil shipments, but also reflected the fall in the output of products like cocoa, palm oil rubber and groundnuts, of which Nigeria was once a leading world producer.

Although Nigeria has substantial oil wealth it is one of world's poorest nations, with more than 70% of the population living in poverty. Nigeria's economy is heavily dependent on oil sector revenues, which account for nearly 80% of government revenues. The intensification of oil export since the early 1960s have led to deprivation, violence, socio-economic and socio-cultural neglect in all ramifications in the region as shown in this research. The effect of oil extraction on peasant agriculture, basis of sustenance of a significant number of the people in the country has as over bearing influence on the economy. In view of all these, it is imperative to know the major determinants of agricultural output of five major agricultural export commodities: cocoa, cotton, groundnut, palm-oil and palm kernel. Also to determine the trend and establish the relationship between output of agricultural export crops, agriculture contribution to GDP, value of agricultural imports, value of oil imports and exports and quantity of oil production.

**METHODOLOGY**

This study relies on secondary data obtained from the Central Bank of Nigeria, Annual Report and statement of Account (Various issues) and Statistical Bulletin (2002), and the Federal Office of Statistics' annual abstract of statistics. The study centres on time series data from 1970 to 2003 on outputs of oil and five major agricultural export commodities in Nigeria (cocoa, cotton, palm kernel, palm-oil and groundnut), crude petroleum (oil) exports, oil and agricultural imports, as well as the contribution of agriculture to Gross Domestic Product (GDP).

**Method of data**

**Descriptive statistics**

Arithmetic means were employed to describe the variables in the study.

**Error Correction Modeling (ECM)**

The estimation technique used is the Error Correction Model (ECM).

It was used to determine the characteristics of the time series variables. The use of the ECM is facilitated when variables are first-differenced stationary and co-integrated. Co-integration theory (Felix and Welch, 1998; Godwin and Schroeder, 1991) examines the time series characteristics of data with a view to overcoming the problems of spurious correlation often associated with non-stationery time series data and simultaneously generate long-run equilibrium relationships (Henry, 1986; Engle and Granger, 1987).

**Test for unit root**

First, a test of stationarity or order of integration of the data series was conducted using the augmented Dickey- Fuller (ADF). The statistical test is carried out by applying a regression such as:

$$\Delta X_t = \alpha + \delta X_{t-1} + \sum_{i=1}^k \beta_i \Delta X_{t-i} + \epsilon_t \dots \dots \dots (1) \quad (\text{Is run and the t-test is carried out}).$$

**Test for co-integration-Johansen's approach**

The second test involves determining the number of co-integrating vectors using the Johansen's test; this is based on maximum likelihood estimates of all the co-integrating vectors in a given set of variables and provides the likelihood ratio test for the number of co-integrating vectors. The general model is given as:

$$X_t = C_t + \lambda_1 X_{t-1} + \dots + \beta_k X_{t-k} + \epsilon_t \dots \dots \dots (2)$$

And the first difference form is given by:

$$\Delta X_t = C_t + \lambda_{k-1} X_{t-k-1} + \beta_1 X_{t-k} + \epsilon_t \dots \dots \dots (3)$$

Where:  $X_t$  is vector of n variables;  $\epsilon_t$  is the error term.

**Error Correction Model (ECM)**

The ECM (OLS) is then applied to investigate the relationship between the dependent and the independent variables. The relationship investigated using the ECM is implicitly expressed as follows:

$$\Delta Y_t = X_0 + X_1 \Delta X_{t-1} + X_2 \Delta X_{t-2} + X_3 \Delta X_{t-3} + X_4 \Delta X_{t-4} + X_5 \Delta X_{t-5} + ecm_{t-1} + \mu \dots \dots \dots (4)$$

Where Y = agricultural output of crops: cocoa, cotton, groundnut, palm kernel and palm oil ('000 tonnes),  $X_{1t}$  = contribution of agriculture to GDP at current factor cost (Naira Billion),  $X_{2t}$  = value of agricultural imports (Naira Billion),  $X_{3t}$  = value of crude petroleum (oil) production ('000 barrels),  $X_{4t}$  = value of crude petroleum (oil) exports (Naira Billion),  $X_{5t}$  = value of crude petroleum (oil) import (Naira Billion), and  $ecm_{t-1}$  = Regressor to capture the short-run dynamics.

**RESULTS AND DISCUSSION**

From Table 1, the trend in cocoa production has some mild fluctuations reducing from an average of 246,000 tonnes from 1970-1974 to 183,400 tonnes during 1985-1989. It has a peak of 286,600 tonnes from 1990-1994 and started to reduce up till 2003. Cotton seed production has similar fluctuations with an average of 291,000 tonnes produced from 1970-1974 to as low as 56,000

**Table 1.** Trend in Nigerian agricultural output of export crops.

<b>Years</b>	<b>Y1</b>	<b>Y2</b>	<b>Y3</b>	<b>Y4</b>	<b>Y5</b>
<b>1970 – 74</b>					
Total	3162.0	1455.0	7136.0	2363.0	1422.0
Mean	246.4	291.0	1427.2	472.6	286.6
<b>1975 – 75</b>					
Total	898.0	1212.0	2783.0	2733.0	1435.0
Mean	179.6	242.4	556.6	546.6	287.0
<b>1980 – 84</b>					
Total	763.0	283.0	2649.0	2730.0	1502.0
Mean	152.6	56.6	529.8	546.0	300.4
<b>1985 – 89</b>					
Total	917.0	790.0	4237.0	3364.0	3395.0
Mean	183.4	158.0	847.4	672.8	679.0
<b>1990 – 94</b>					
Total	1433.0	1341.0	6693.0	3944.0	4708.0
Mean	286.6	268.2	1338.6	788.8	941.6
<b>1995 – 99</b>					
Total	1361.0	1561.0	10292.0	3860.0	2813.0
Mean	272.2	312.2	2058.4	772.0	562.6
<b>2000 – 03</b>					
Total	686.2	1490.6	9605.1	3552.5	2566.1
Mean	171.6	372.7	2401.3	888.1	641.5

tonnes from 1980-1984. There was an increase in production of cotton between 1995 and 2003; the highest production was 372,700 tonnes. Groundnut production has a downward trend over the years. With a production of 1,427,200 tonnes from 1970-1974, it plummeted to as low as 847,400 tonnes from 1985-1989 and increased gradually to 2,401,300 tonnes between 2000 and 2003. Palm-oil production, however shows an increasing trend over the years; from an output of 472,600 tonnes from 1970-1974 to about 888,100 tonnes from 2000-2003.

Table 2 showed the trend in the major determinants of agricultural production. Agriculture Gross Domestic Product was N3.7 billion from 1975-1979 but increased over the years to N1,604 billion from 2000-2003. This showed that although the agricultural sector has been neglected for years, it still contributes strongly to Nigeria's GDP. The value of agricultural imports rose sharply from less than N1 billion from 1970-1974 to N232 billion during the oil boom years between 1975 and 1979. During the oil glut in the 1980s, it reduced to N1.72 billion and subsequently increased to N203.65 billion from 2000-2003. This could be as a result of overdependence on oil which led Nigeria, a one-time major exporter of agricultural goods, to become largely import dependent. The quantity of crude petroleum production has fluctuated over the years. In the oil boom years, there was extensive exploration and production of crude oil ranging from 632.48 million barrels during 1970-1974 to 745.20 million barrels between 1975 and 1979. The glut in the international oil market was responsible for the fall

in oil production between 1980 and 1989. It increased gradually from 689.88 million barrels to 986.05 million barrels from 1990 to 2003. This fluctuation was largely responsible for similar fluctuations in cocoa production during the period. The value of oil exports has an increasing trend over the years ranging from N1.98 billion from 1970-1974 to N2,085.65 billion between 2000 and 2003. Oil export has contributed greatly to the foreign exchange earnings of the country and has led to the neglect of the agricultural sector. The value of oil imports has faced similar increase over the years from less than N1 billion during 1970-1974 to over N253 billion between 2000 and 2003. It is ironic that Nigeria, a major producer of crude oil has to import oil from foreign nations. This could be a result of mismanagement of public funds, political instability, confusion and disagreement over the pricing of petroleum products and over dependence on one export commodity.

Result in Table 3 shows the unit root test. Six variables were non-stationary at levels: four of these variables-output of cotton (XCOTON), groundnut (XGNUT), palm kernel (XPKERN) and palm oil (XPOIL) each became stationary after first differencing at 1% levels of significance while two variables- contribution of agriculture to GDP (AGGDP) and values of agricultural imports (AGIMP) each became stationary after second differencing at 1% levels of significance. However, four variables were stationary at levels: values of oil imports (OILIMP) and quantity of oil production (OILQTTY) each becoming significant at 1% level while values of oil

**Table 2.** Trend in major determinants of agricultural production in Nigeria.

Years	X1	X2	X3	X4	X5
<b>1970 – 74</b>					
Total	-	0.56	3162.38	9.90	0.24
Mean	-	0.11	632.48	1.98	0.05
<b>1975 – 79</b>					
Total	18.49	11.64.20	3726.10	33.52	0.66
Mean	3.70	232.80	745.20	6.70	0.13
<b>1980 – 84</b>					
Total	76.42	8.91	2714.50	48.36	1.03
Mean	15.28	1.78	542.50	9.67	0.21
<b>1985 – 89</b>					
Total	221.35	8.60	2721.80	131.25	12.61
Mean	44.27	1.72	544.36	26.25	2.52
<b>1990 – 94</b>					
Total	908.11	57.40	3449.40	839.36	116.72
Mean	181.62	11.48	689.88	167.87	38.91
<b>1995 – 99</b>					
Total	4600.09	539.53	3770.20	5315.73	872.93
Mean	920.02	107.91	754.04	1063.15	174.59
<b>2000 – 03</b>					
Total	6418.26	814.59	3344.20	8342.59	1015.44
Mean	1604.57	203.65	986.05	2085.65	253.86

**Table 3.** Results of the unit root test.

Variables	ADFT-statistics	Critical value*	Significance level	Nooflags
D(AGGDP)	-4.581	-3.770	1%	2
D(AGIMP)	-12.694	-3.662	1%	2
OILEXP	-2.659	-2.663	10%	-
OILIMP	-8.024	-3.738	1%	-
OILQTTY	-4.074	-3.646	1%	-
XCOCOA	-2.724	-2.616	10%	-
D(XCOTON)	-6.861	-3.654	1%	1
D(XGNUT)	-9.554	-3.654	1%	1
D(XPKERN)	-5.988	-3.654	1%	1
D(XPOIL)	-7.319	-3.654	1%	1

exports (OILEXP) and output of cocoa (XCOCOA) each became significant at 10% levels.

The result of Johansen's test of co-integration carried out is presented in Table 4. The result indicates that co-integration exists, and the likelihood ratio test gives 3 co-integrating equations at 5% significance levels for output of cocoa (XCOCOA), output of cotton (XCOTON), groundnut (XGNUT) and palm kernel (XPKERN) while the test indicates 4 co-integrating equations for palm oil (XPOIL). The co-integration tests reveal that there is a long-run relationship between the dependent variables and their determinants. To this effect, the null hypothesis

of no co-integration was rejected for all the dependent variables.

Table 5 shows the results of the Error Correction Model. For the determinants of cocoa, it is shown that the determinants of cocoa production are quantity of oil (crude petroleum) production D (OILQTTY), value of oil imports D (OILIMP), value of oil exports D (OILEXP) and value of agricultural imports (DAGIMP). However, the value of oil exports D (OILEXP) is only significant in the long-run. Based on the signs of the coefficient, quantity of oil production D (OILQTTY) and value of oil exports D (OILEXP) lagged by 2 years have an inverse relationship

**Table 4.** Results of the unit root test.

Cocoa	Cotton seed	groundnut	Likelihood ratios			Critical value 5%	Critical value 1%	Hypothesis
			Palm-oil	Palm-kernel				
277.860	276.098	264.702	280.031	324.214	94.15	103.18	None	
149.413	144.276	136.207	155.190	181.200	68.52	76.07	At most 1	
75.120	73.282	60.114	66.368	73.295	47.21	54.46	At most 2	
<b>22.381</b>	28.861	<b>23.520</b>	<b>32.250</b>	<b>29.025</b>	29.68	35.65	At most 3	
8.923	<b>9.985</b>	11.790	11.938	7.896	15.41	20.04	At most 4	
0.346	1.041	0.745	0.414	0.251	3.76	6.65	At most 5	

**Table 5.** ECM result for the determinants of agricultural trade by OLS- cocoa (1970 – 2003).

Independent variables	Coefficient	Standard error	T-statistics
C	203.7934***	4.8332	42.1652
D(OILQTTY(-1))	0.0002***	4.35E-05	3.6307
D(OILQTTY(-1),2)	-5.82E-05*	3.22E-05	-1.8048
D(OILIMP(-1))	0.0040***	0.0009	4.6747
D(OILEXP(-1),2)	-0.0001*	6.75E-05	-1.8673
D(AGIMP(-1))	-0.0039**	0.0016	-2.3695
D(AGIMP(-1)2)	0.0019***	0.0006	3.1796
ECM	0.8902***	0.0815	10.9240

**Table 6.** ECM result for the determinants of agricultural trade by OLS-cotton seeds (1970 – 2003).

Independent variables	Coefficient	Standard error	T-statistics
C	196.3938***	4.2381	46.3394
D(OILQTTY(-1) )	0.0002***	4.56E-05	4.0047
D(OILQTTY(-1), 2)	-9.54E-05***	3.35E-05	-2.8482
D(OILIMP(-1) )	-0.0054***	0.0006	-8.7569
D(OILIMP(-1), 2)	0.0031***	0.0004	7.4632
D(OILEXP(-1), 2)	0.0002***	2.30E-05	7.5800
D(AGIMP(-1), 2)	-0.0012***	0.0003	-4.0751
D(AGGDP(-1) )	1.6860***	0.1129	14.9395
D(AGGDP(-1), 2)	-0.08868***	0.0945	-9.3892
ECM	1.0092***	0.0390	25.8564

to cocoa production. The implication of this is that sustained increase in the quantity and prices of crude petroleum (oil) produced and exported will lead to a reduction of farmers production of cocoa. Also, there is an inverse relationship between value of agricultural imports D (AGIMP) and cocoa production. This means that farmers produce less cocoa the more we import agricultural products. Naturally, people spend more money to buy imported goods at the detriment of locally produced goods. As a result the government shifts its priority from funding the farmers to importing agricultural goods and the farmers receive less income and lack

incentives to produce more.

From Table 6, all the variables strongly determine or influence the production of cotton and are all significant at 1%. However, in the long-run quantity of oil production (OILQTTY), values of agriculture to GDP (AGGDP) have an inverse relationship to production of cotton. This invariably means that sustained increase in the production of oil (crude petroleum), prices of agricultural imports and contribution of agriculture to GDP will result in lesser quantity of cotton produced. Whereas, in the short-run, the value of oil imports (OILIMP) has an inverse relationship with the production of cotton. The significance of this

**Table 7.** ECM results for the determinants of agricultural trade by OLS-palm kernel (1970-2003).

Independent variables	Coefficient	Standard error	T-statistics
C	47.0642***	12.4660	38.2692
D(OILQTTY(-1) )	0.0003***	6.93E-05	3.6061
D(OILIMP(-1) )	-0.0040***	0.0017	-2.3523
D(OILIMP(-1), 2)	0.0107***	0.0027	4.0317
D(OILEXP(-1) )	0.0009***	0.0003	3.8205
D(OILEXP(-1), 2)	-0.0006***	0.0001	-3.2246
D(AGIMP(-1) )	-0.0141***	0.0037	-3.7733
D(AGGDP(-1) )	2.0594***	0.4638	4.4407
D(AGGDP(-1), 2)	-0.9991***	0.2731	-3.6584
ECM	1.0008***	0.0358	27.9401

**Table 8.** ECM Results for the determinants of agricultural trade by OLS-groundnut (1970 – 2003).

Independent variables	Coefficient	Standard error	T-statistics
C	838.6250***	39.7619	21.0912
D(OILQTTY(-1) )	0.00019***	0.0004	4.9003
D(OILQTTY(-1), 2)	-0.0007***	0.0003	-2.2733
D(OILIMP(-1) )	-0.0262***	0.0050	-5.2950
D(OILIMP(-1), 2)	0.0237***	0.0033	7.2503
D(OILIMP(-1), 2)	0.0006***	0.0002	3.1787
D(AGIMP(-1) )	-0.0228***	0.0050	-4.5914
D(AGGDP(-1) )	15.11474***	1.2077	12.5180
D(AGGDP(-1), 2)	-6.8299***	0.8566	-7.9737
ECM	0.8384***	0.111	7.5444

is that more cotton can only be produced with sustained increase in the prices of oil imports.

Table 7 shows the ECM result for the determinants of palm kernel. All the variables were significant at 1% level except one-year-lagged variable of value of oil imports (OILIMP-1) which was significant at 5% level. This shows that all the variables are major determinants of palm kernel production. Based on the signs of the coefficient, the negative sign indicates an inverse relationship between values of oil imports (OILIMP) and agricultural imports (AGIMP) in the short-run; indicating that farmers produce less palm kernel the more we import crude petroleum and agricultural products. However, as indicated by the two-year-lagged variables of value of oil imports (OILIMP-2), sustained increase in importation of crude petroleum will result in high production of palm kernel. On the other hand, sustained increase in exportation of crude petroleum will lead to a decrease in the production of palm kernel.

The ECM result for groundnut are as shown in Table 8. All the variables were also significant at 1% except for two-year-lagged of quantity of oil production (OILQTTY-2) which was significant at 5%, an indication that they are all major determinants of groundnut production. The

negative signs of the coefficient of (OILQTTY-2), (OILIMP) and (AGGDP-2) indicate that they are inversely related to groundnut production. The two-year-lagged variables of quantity of oil production and contribution of agriculture to GDP, however, shows the long-run inverse relationship existing between them and groundnut production. Hence, farmers can only produce more groundnuts if these variables do not continue to increase over time. Conversely, sustained increase in importation of oil and agricultural imports will lead to a resultant decrease in quantity of groundnut being produced.

Table 9 shows that all variables are determinants of palm oil except the contribution of agriculture to GDP (AGGDP) and quantity of oil exports (OILEXP). On the basis of the signs of the coefficient, two-year-lagged variable of quantity of oil production (OILQTTY-2) and agricultural imports (AGIMP) each has an inverse relationship with production of oil palm. This is an indication that the more we produce oil, the less we produce palm oil.

The Error Correction Variable (ECM) was rightly signed and highly significant for all the crops under consideration. This is an indication of the existence of long-run equilibrium relationship between the output of each crop and

**Table 9.** ECM results for the determinants of agricultural trade by OLS-palm Oil (1970 - 2003).

Independent variables	Coefficient	Standard error	T-statistics
C	590.6387***	7.6979	76.7269
D(AGIMP(-1) )	0.0019***	0.0002	9.4620
D(AGIMP(-1), 2)	-0.0020**	0.0007	-2.6688
D(OILIMP(-1) )	0.0023**	0.0009	2.4730
D(OILQTTY(-1) )	0.0003***	6.73E-05	4.4747
D(OILQTTY(-1), 2)	-0.0002***	4.55E-05	-3.3217
ECM	1.0973***	0.0763	14.3772

the variables. Also the goodness of fit of the model is further confirmed by the F-statistics in all the crops, which is significant at one percent.

### Conclusion

The co-integration and Error Correction Modeling of the agricultural outputs of 5 major export commodities for a vivid exposition of determinants revealed the importance of all the variables considered. In view of the findings from this study, the following are antidotes for Nigeria's dependency on petroleum that policy makers and Nigeria leaders can work on to revitalize agricultural trade.

1. Since the main manifestation of the Dutch Disease is the crowding out or depression of the non-oil export sector, it follows that the disease can be cured by effective implementation of prices aimed at promoting and devitalizing the non-oil export section. These policies should address not only the agricultural exports but also exports of other (non-oil) minerals, manufactured goods and services where Nigeria has comparative advantage.

2. Given the vagaries of the oil market, it stands to reason that the federal, state and local governments should adopt a conservative fiscal stance and a more cautious and transparent budgeting process.

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