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Investigating the Effect of Fertilizer Subsidy on Agricultural Production and its Implication on Food Security in Nigeria (1981-2012)

[1]Binuomote, S. O and [2]K. A. Odeniyi

**[1]Department of Agricultural Economics,
Ladoke Akintola University of Technology, P. M. B. 4000,
Ogbomoso. Nigeria
sobinuomote@lautech.edu.ng; +2348033879828**

**[2]Department of Agricultural and Food Economics,
School of Agriculture, Policy and Development,
University of Reading, Berkshire**

Abstract

The study examines the impact of government funded fertilizer subsidies on agricultural production in Nigeria. The data for this study are primarily time series data at macro level spanning from 1981 to 2012. Data on agricultural gross domestic product, exchange rate, crude oil price, capital, agricultural land, foreign direct investment into the agricultural sector and data on fertilizer subsidy costs were sourced from the Food and Agricultural Organization (FAO) online Statistical data base of the United Nations, Penn world data of the University of Pennsylvania and Central Bank of Nigeria (CBN) statistical bulletin and the National Bureau of Statistics, Federal Ministry of Agriculture, International Fertilizer Development Centre (IFDC), Federal Fertilizer Department (FFD), Project Coordinating Unit (PCU) and Farm management survey and advisory services. The Johansen approach to cointegration and error correction modeling was used in analyzing the data. The results show that capital, foreign direct investment into the Nigeria agricultural sector and fertilizer subsidy cost all have positive and significant effects on agricultural production in Nigeria. The coefficient for the error correction mechanism (ECM) is -1.234 which indicates that the deviation of agricultural production, proxy as gross domestic product (LAGDP) from the long-run equilibrium level is corrected by about 123% in the current period. This shows that the speed of adjustment of the Nigerian agricultural production to the state of equilibrium is very high (all things being equal).

Keywords: Fertilizer, Subsidy, Cointegration, Nigeria, Agriculture.

1.0 Introduction

Fertilizer is one of the major farm inputs for achieving the green revolution objective in the world. According to Dada (2006), during the Africa Fertilizer Summit, it is generally believed that not less than 50% of incremental crop output in the past five decades is attributable to fertilizer use. Owing to fertilizer use, along with other inputs such as seeds and agro chemicals, many countries of the world with high population densities have been able to achieve, relatively, food self-sufficiency in the past decades (World Bank, 2004). Unfortunately, the benefits of green revolution did not accrue significantly to sub-Saharan

Africa to any perceptible extent due, among other reasons, to inadequate use of fertilizer (FGN, 2005).

Agriculture, forests, and fisheries together contribute about 32 percent of the gross domestic product (GDP) in Nigeria. Moreover, the sector employs about 60 percent of the working rural population (World Bank 2012). Additionally, the Nigerian agricultural sector contributed more than 50 percent of its GDP growth between 2000 and 2007 (Headey et al. 2010). This under-scores the key role of agriculture in Nigeria's efforts to transform the economy. However, agricultural GDP growth in Nigeria has largely been due to area expansion rather than to increased productivity. Indeed, agricultural yields in Nigeria have been stagnant or declining, raising concerns about the sector's sustainability and rural poverty reduction efforts in general. The large contribution of the agricultural sector and the large share of the working population employed in the sector underscore that agricultural development must be part of any poverty reduction strategy in Nigeria.

In Nigeria, Agricultural productivity estimates showed a decline in productivity growth from 1960s to the 1980s. The decline of agriculture production in the country began with the arrival of the petroleum boom in the early 1970. Although, the country has witnessed strong economic growth in the past few years, averaging 8.8 percent real annual GDP growth from 2000 to 2007 (Dayo et., al. 2009). However, the agriculture sector has lagged behind GDP growth, growing at 3.7 percent in 2007. The over dependency on crude oil discovery at the expense of agriculture that contribute large percentage to our nation GDP might be one of the reason agriculture production in Nigeria still suffer set back. Moreover, the country currently has 75 percent of its land suitable for agriculture that might have enhance agricultural production to a large and reasonable extent, but only 40% is cultivated (Omorogiuwa et., al. 2014). Sadly speaking, the repeated re cultivation of the 40% land suitable for agriculture couple with erosion and Flooding over the years also takes some millions of arable land out of production each year during the rainy season. The fragility and high susceptibility of the soils in Nigeria to degradation and loss of nutrients make augmentation through the use of fertilizers necessary to obtain reasonable yield (Alimi, Ajewole, Awosola and Idowu, 2006).

Meanwhile, developing a competitive commercial sector for supplying agricultural inputs like fertilizer is critical for sustainable agricultural sector growth. The role of fertilizer to positively increase and improve production can never be swept under the carpet and this is well established all over the world. Fertilizer use in average for the world, Africa and Nigeria is given as 91kg/ha; 19kg/ha; and 8kg/ha respectively (Idachaba, 2006). But Nigerians fertilizer usage is far less than the FAO recommended (200kg/ha) rate. Therefore, the need for Nigeria to intensify fertilizer use so as to improve agricultural productivity and raise rural income in the face of a rapidly growing population and worsening poverty incidence has become obvious (Idachaba, 2006). The governments stated reason for fertilizer subsidies in the country as a means of relief to farmers that cannot afford the high free market fertilizer price; the implication is that the crop product price to fertilizer price ratio is too low for farmers to invest in fertilizer (Nwagbo, 2005). Hence fertilizer subsidy policy reform over the years has been to boost productivity in the country.

Agricultural input subsidies, including those on fertilizer, have been one of the widely used policy instruments in developing countries to develop a vibrant private sector for the supply of such inputs, as well as for raising farmers' income and agricultural productivity. The effectiveness of such subsidy programs has attracted much discussion in the literature. Public input subsidies are rarely the best policy for developing the commercial input sector as it leads to Pareto inefficient resource allocation. This tends to induce overuse of inputs and creates uncompetitive private agro-dealers who cannot survive without a permanent subsidy. However, subsidies can be a second best policy if their use can address various market failures (Stiglitz 1987). Moreover, subsidies can be a second best policy for the development of the commercial input sector, if the use of subsidies on inputs can crowd-in the commercial sector by addressing key market failures. However a key condition of the use of subsidies for such purposes is that the subsidies help the sector to grow sustainably so there will be no need for subsidies in the longer term.

There has been a lot of fertilizer policy reform in Nigeria over the years. A key feature of Nigeria's old system of fertilizer subsidy was a very active role of the state in fertilizer delivery. The federal government was in fact the sole procurer of fertilizer. Since 1970s, fertilizer has heavily been subsidized, with the rate that has been high as 95 % . Between the late 1980s and mid-1990s, domestic fertilizer production as a percentage of the total supply varied from 46 to 60 percent. According to Nagy and Edun (2002); Fertilizer was subsidize at the minimum rate of 65% to maximum rate of 87% between 1990 and 1996. In 1997-1998 and 2000, fertilizer was not subsidized at all. However, a federal subsidy was reintroduced in 1999 at a level of 25% and continues at this rate today.

The issue of fertilizer subsidy in Nigeria has long been in existent with many literates' minds investigating into its policy reform /challenges/shortfall and its prospect taken into consideration some specific crops in an area, state or the country. But very few literate minds investigate fertilizer effects generally on agricultural production. Hence, this study seeks to add to the existing body of knowledge the effects of fertilizer subsidy on agricultural production in Nigeria.
Okolo (2004) described the fertilizer supply in Nigeria as still inadequate. This accounts to some extent for its low usage. One major impetus to fertilizer usage is an improvement of the fertilizer market. Federal government of Nigeria implemented an annual program of monopolized fertilizer procurement and distribution between 1977-1996 and it suffer consequences of enormous wastage and diversions. Olufokunbi and Titilola (1993) said a large percentage of demand for fertilizers has not at any time been met. Most of the actual prices paid are as much as, or even higher than what the landed cost actually are. They further agreed that unintended beneficiaries are the one that have been gaining from fertilizer marketing arrangement.

Issues around fertilizer procurement, distribution and subsidy policies in Nigeria have been discussed extensively by Nagy and Edun (2002), Ayinde et al (2009) and a host of others. For instance, it was pointed out that, in 1997-1998 and 2000, fertilizer was not subsidized at all and the business was turned to an unprepared private sector which was initially or unwilling to respond adequately (Nagy and Edun 2002). Consequently, fertilizer use fell from a peak of 1.2 million tons in 1992 to 56,708 tons in 1997. Even upon reintroduction of fertilizer subsidy to Nigerians in 1999, there were still low consumption of fertilizers as the purchase and distribution system is heavily politicized.

The subsidy policy was widely recognized as being associated with multiple problems, including wide-scale corruption and inefficiencies. Over 776 billion naira ($4.8 billion) was estimated to have been lost to corruption in total, averaging 26 billion naira ($162.5 million) of losses annually (Adesina 2014).

The pertinent question bothering one's mind as a Nigerian has always been, why has Nigeria not yet been food secured amidst of inputs subsidies introduced and reintroduced over the years? Amidst of huge money invested to subsidized fertilizer input to farmers in the country, Can we then say as a nation that fertilizer subsidies over the years has any effects on our production as a country? If so, which effects can we really say it has on our agricultural production and to what extent can we predict the effects of fertilizer subsidy on our country production or crop performance. Moreover, what are the likely short comings of the fertilizer subsidy policy reform in the country? What are helpful recommended input subsidy policy reforms that can make our nation great in its productions? Answer to most of these questions which are needed urgently is what this study intends to look into.

2. 0 Methodology

2.1 Analytical technique

Error correction and co-integration model:

The study adopts the Johansen (1988) procedure in co-integration. The concept of co-integration (Hendry, 1986), (Hall, 1986) and (Mills, 1990), creates the link between integrated process and the concept of steady equilibrium. The first step in co-integration analysis is to test the order integration of the variables. Following Ajetomobi *et al* (2007), a series is said to be integrated if it accumulated some past effects, so that following any disturbance, the series will rarely return to any particular mean value, hence is non-stationary. Non-stationary of time series has always been regarded as a problem in econometric analysis. Philip (1986) shows that, in general, the statistical properties of regression analysis using non-time series are dubious notwithstanding promising diagnostic test statistics from such regression analysis. The order of integration is given by the number of times a series needs to be differenced so as to make it stationary. According to Charemza and Deadman (1992), a stochastic process is said to be stationary if the joint and conditional probability distributions of the processes are unchanged if displaced in time. If the series are co-integrated of the same order, a linear relationship between these variables can be estimated and examining the order of this linear relationship can test for co-integration. The grim fact is that economist look for the presence of stationary co-integrated relationships since only theses can be used to describe long-run stable equilibrium. The Granger representation theorem states that if set variables are co-integrated (1,1); implying that the residual is co-integrated of 1(0), then there exists an *Error correction model* describing the relationship.

Cointegration with Multiple Equations: The Johansen Approach

The Johansen's Full Information Maximum Likelihood (FIML) approach (Johansen, 1988; Johansen and Juselius, 1990) allows the estimation of all possible cointegrating relationships and develops a set of statistical tests to test hypotheses about how many cointegrating vectors is important as under-or over-estimation has potentially serious consequences for estimation and inference. Under-estimation implies the omission of empirically relevant error-correction terms and over-estimation implies that the distribution of statistics is non-standard.

The Johansen maximum likelihood approach for multivariate cointegration is based on the following vector autoregressive (VAR) model:

$$Z_t = A_t Z_{t-1} + ... + A_k Z_{t-k} + u_t \tag{1}$$

Where Z_t is an (nx1) vector of I (I) variables (containing both endogenous and exogenous variables), A_i is an (n x n) matrix of parameters, u_t is (n x 1) vector of white noise errors. Since Z_t is assumed to be non-stationary, it is convenient to rewrite (7) in its first-difference or error correction form (Cuthbertson et al., 1992) as:

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + ... + \Gamma_{k-1} \Delta Z_{t-k+1} + \pi Z_{t-k} + u_t \quad where \tag{2}$$

$$\Gamma_1 = -(I - A_1 - A_2 - ... - A_i), (i = I, ..., k-1), \; and \; \pi = -(1 - A_1 - A2 -, ..., -A_k)$$

This specification provides information about the short-run and long-run adjustments to the changes in Z_t through the estimates of Γ_I and π respectively. Equation (14) differs from the standard first-differenced form of the VAR model only through the inclusion of term π Z_{t-k}. This term provides information about the number of cointegrating relationship among the variables in Z_t is given by the rank of the matrix π. If the rank of the π matrix r, is $0 < r < n$, there are r linear combinations of the variables in Z_1 that are stationary. In this case, the π matrix can be decomposed into two matrices α and β such that $\pi = \alpha$,β, where α is the error correction term and measures the speed of adjustment in ΔZ_t and β contains r distinct cointegrating vectors i.e., the cointegrating relationships between the non-stationary variables.

Johansen (1988) used the reduced rank regression procedure to estimate the α and β matrices and identified tests to test the number of distinct cointegrating vectors that exist, as well as to test hypotheses about the matrices. He demonstrated that the maximum likelihood estimate of β can be estimated as the eigenvector and the related eigenvalues by solving the following equation:

$$I \; \lambda \; S_{kk} - S_{ko} \; S_{oo} \; -1 \, S_{ok} \quad I = 0 \tag{3}$$

Where S_{oo} is the residual matrix obtained by regressing ΔX_t on its lagged differences, i.e., $\Delta X_{t-1}, ..., \Delta X_{t-k+1}$. S_{kk} is the residual matrix obtained by regressing X_{t-k} on its lagged differences, i.e., ΔX_{t-k+1}, S_{ko} *and* S_{ok} are the cross-products of residual matrixes S_{kk} and S_{oo}. However if there are variables which are *I* (0) and are insignificant in the long-run cointegrating space but affect the short-run model, (15) can be rewritten as:

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \pi \, Z_{t-k} + \psi D_t + u_t \tag{4}$$

Where D_t represents the *I* (0) variables, which are often included to take account of short-run shocks to the system such as policy interventions. These variables typically enter as dummy variables.

Two likelihood ratio (LR) tests are conducted for detecting the presence of a single cointegrating vector. The first test is the trace test statistic:

$$\lambda_{trace} = -2 \; InQ = -T_i^p \sum_{r+1} In(1 - \lambda_i) \tag{5}$$

which tests the null hypothesis of at most r cointegrating vectors against the alternative that it is greater than r. The second is the maximal-eigenvalue test:

$$\lambda_{ma}x, = -2\ In(Q{:}r\ I\ r+1 = -T\ \ In\ 1-\lambda_{r+1}) \quad (6)$$

Which tests the null hypothesis of r cointegrating vectors against the alternative, that is ,r+1. The critical values of these tests have been derived by Monte Carlo Simulations and tabulated by Johansen (1988) and Osterwald- Lenum (1992). Harris (1995, p. 89) noted that '….between these two LR tests for contegration, the trace test shows more robustness to both skewness and excess kurtosis in (the residuals) than the maximal eigenvalue test.

A characteristic feature of the error-correction formulation of (2) is that it includes both the differences and the levels of the series in the same model; thus there is no loss of information about the long-run equilibrium relationship between the variables. A number of issues need to be addressed before using this methodology. First, the endogenous variables included in VAR are all *I* (I). Second, the additional exogenous variables included in the VAR which explain the short-run behavior need to be *I* (0). Third, the choice of lag length k (i.e. order) in the vector autoregressive (VAR) is important and the Akaike Information Criterion (AIC) or Schwarz Information Criterion (SBC) is often used. However, the information criteria may not be adequate when errors contain moving average terms.

Hall (1991) argued that the Johansen maximum likelihood estimation procedure for cointegrating vectors may be sensitive to the selection of the order of VAR. When the order of VAR is too short, serial correlation among the residuals may result and test statistic becomes unreliable. Conversely, if the order of VAR is too high, there is an upward bias in the test statistics, again causing doubts on their reliability. Therefore, in the light of this sensitivity to the VAR length, Hall suggested that when applying the Johansen procedure the effect of varying the VAR specification should be examined. He suggested that in choosing k, one should first select an arbitrary high order for the VAR and then work through the likelihood ratio test statistics to determine the validity of restrictions imposed by successive reductions in its value. The correction order of the VAR is where a restriction on the lag length is rejected.

In this study we use the adjusted likelihood ratio (LR) statistics (Sims, 1980) to test the null hypothesis that the order or the VAR is k against the alternative that it is k+1. We substantiate this with the AIC and SBC criteria. The fourth issue in Johansen's procedure in testing for cointegration is the inclusion of deterministic components, i.e., constant and/or trend in the long-run relationship arises. In general, the specification of the model depends upon the characteristics of the data. We expand (6) to take into account the options needed for the appropriate model to be used.

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \alpha[\beta u_1\ \ \delta_2]\ \breve{Z}_{t-k} + \alpha_1 u_2 + \alpha_1 \delta_2 t + u_t \quad (7)$$

Where $\breve{Z}_{t-k} = (Z^1{}_{t-k}, 1, t)$, t is the time trend. We examine three models, labeled as Models 2-4 (Harris, 1995 p. 96):

Model 2: If the data exhibits no linear trends in its level form, then the constant is restricted to the cointegrating space (i.e., long-run model), thus $\delta_1 = \delta_2 = u_2 = 0$. The critical values for this model can be found in Table 1* in Osterwald-Lenum (1992).

Model 3: If the data shows linear trends in level form, then the constant is restricted in both the cointegrating space and the short-run model (although the constant in the cointegrating space is assumed to be cancelled by the constant in the short-run, leaving only a constant in the short-run model). So, $\delta_1 = \delta_2 = 0$. The critical values for this model can be found in Table 1 in Osterwald-Lenum (1992).

Model 4: If the data indicate no quadratic trends in level form, the trend is not allowed in the short-run model: but if there is some long-run linear growth in the data e.g., technological progress), then the trend is restricted in the cointegrating space, so $\delta_2 = 0$. The critical values for this model can be found in Table 2* in Osterwald-Lenum (1992). In practice, the structure of the data provides little information as to which of these three models is appropriate. Johansen (1992), based on the so called Pantula principle, suggested that the joint hypothesis of both the rank order and the deterministic components (constant and/or trend) is tested in determining the appropriate model. Thus, all three models are estimated and the results from the most restrictive one (i.e., r = 1, Model 2) through to the least restrictive one (i.e., r = n – 1, Model 4) are presented. The testing procedure is then to move through the most restrictive model at each stage comparing the $\lambda_{\max} - or\, \lambda_{trace}$ - test statistic to its critical value and only stopping when the null hypothesis is accepted (Harris, 1995, p. 97).

The issue of the estimated coefficients being the long-run elasticities in the cointegrating vector is not clear. This is true when there are only two variables in the cointegrating vector, but when there are more than two variables, the dynamics of the VAR raise some doubts about this interpretation (Lutkepohl, 1993, pp. 379-380). Nevertheless, some authors (for example Hallam and Zanoli, 1993; Townsend and Thirtle, 1994) interpret the estimated coefficients as the long-run elasticities. Since cointegration implies that a stationary long-run relationship exists among the series in the cointegrated system and as these series are linked by common stochastic trends, movements among the variables are not independent and there are systematic co-movements among them. Moreover, any deviation from the long-run equilibrium influences the time paths of the cointegrated series. Impulse response or dynamitic multiplier analysis can be used to investigate these interrelationships among the variables in dynamic models and to assess adjustments to long-run equilibrium.

Model Specification

We specified the hypothesized structural relationship for agricultural gross domestic product which is will be specified as follows:

$$LAGDP = \beta_1 + \beta_2 LER + \beta_3 LPco + \beta_4 LK + \beta_5 LLb + \beta_6 LLd + \beta_7 LF + T + \mu \quad \ldots\ldots\ldots \quad (8)$$

Where *LAGDP* is the agricultural gross domestic product; *LEX* is the exchange rate; LP_o is the price of crude oil; *LK* is the invested capital; *LLb* is the quantity of labour, *LLd* is the size of agricultural land in hectares; *LF* is the amount invested on fertilizer subsidy. The estimated linearized 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 (1) 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 relationship between selected set of variables at crop level data. The error correction model (ECMs) estimated are shown in (2) below. ECM in (2) represents the short run behaviour of agricultural gross domestic product in (2) while equation (1) represents the long run static equations. The parameter λ, which is negative, in general measures the speed of adjustment towards the long run equilibrium relationship between the variables in (2). The optimum lag lengths to be included in equations (2) were determined based on Akaike Information Criterion (AIC).

Static long run model for agricultural gross domestic product

$$LAGDP = \beta_1 + \beta_2 LEX + \beta_3 LP_o + \beta_4 LK + \beta_5 LLb + \beta_6 LLd + \beta_7 LF + T + \mu \qquad (8)$$

Error correction model (ECM) for the agricultural gross domestic product model is also given as equation (2)

$$\Delta LAGDP = \gamma_0 + \sum_{i=1}^{p} \gamma_1 \Delta LEX_{t-p} + \sum_{i=1}^{j} \gamma_2 \Delta LPo_{t-j} + \sum_{i=1}^{k} \gamma_3 \Delta LK_{t-k} + \sum_{i=1}^{m} \gamma_4 \Delta LLb_{t-m} + \sum_{i=1}^{y} \gamma_5 \Delta LLd_{t-y} + \sum_{i=1}^{z} \gamma_6 \Delta LF_{t-z} + \mu_t \, ECM \qquad (2)$$

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.

Data and data source

The data for this study are time series data at macro level spanning from 1981 to 2012. All the data were largely sourced from Food and Agricultural Organization (FAO) online Statistical data base of the United Nations, Penn world data of the University of Pennsylvania and Central Bank of Nigeria (CBN) statistical bulletin and the National Bureau of Statistics. Other sources of data include the Ministry of Agriculture, Agricultural Development Projects (ADPs), International Fertilizer Development Centre (IFDC), Federal Fertilizer Department (FFD), Project Coordinating Unit (PCU) and Farm management survey and advisory services. The data include agricultural gross domestic product, exchange rate, crude oil price, capital, agricultural land, foreign direct investment into the agricultural sector and data on fertilizer subsidy.

3.0 Results and Discussion

3.1 Test for stationary

The results of the unit root tests are shown in table 1. The null hypothesis of the presence of a unit root (non-stationary) was tested against the alternative hypothesis of the absence of a unit root (stationary). All the variables tested contain unit root processes, and all became stationary after first difference. Hence, the variables are integrated of order 1. This established the suitability of the variables with order I (1) for use in co-integration and error correction study..

Table 1: **ADF Unit Root Test Results for Selected Variables (Constant and Trend Included)**

Variables	t–values (level)	t–values (1^{st} difference)	Order of Integration
LAGDP	-0.6308	-8.0553***	1
LER	-0.8997	-5.3352***	1
LPo	-1.8525	-5.9235***	1
LKa	-1.0987	-5.3440***	1
LAlbr	-1.7146	-5.5437***	1
LLd	-1.2236	-4.8671***	1
LFs	-2.6053	-5.9178***	1
LFDI	-0.3254	-11.463***	1

Source: Data Analysis, 2015 *** Indicates significant at 1%

3.2 Test for Co-integration

Tables 2 and 3 show the results of Johansen test for evidence 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 tables 2 and 3 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 the explained variable. Since co-integration has been established, the regression results were analyzed and also diagnosed..

Table 2
Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.787235	135.0420	95.75366	0.0000
At most 1 *	0.728440	87.06745	69.81889	0.0012
At most 2	0.497670	46.65670	47.85613	0.0645
At most 3	0.363665	25.31328	29.79707	0.1505
At most 4	0.295452	11.30037	15.49471	0.1937
At most 5	0.014227	0.444206	3.841466	0.5051

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Source: Data analysis 2015

Table 3
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.787235	47.97458	40.07757	0.0053
At most 1 *	0.728440	40.41075	33.87687	0.0072
At most 2	0.497670	21.34342	27.58434	0.2560
At most 3	0.363665	14.01291	21.13162	0.3640
At most 4	0.295452	10.85616	14.26460	0.1615
At most 5	0.014227	0.444206	3.841466	0.5051

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Source: Data analysis, 2015

3.3 Short-run error correction results and diagnostics

The solved static long- run equation for agricultural productivity in Nigeria as well as its short – run equation is given in table 3 below. The R^2 value of 0.726 for the ECM in table 4 shows that the overall goodness of fit of the ECM is satisfactory. This means that only about 73% of the variation in agricultural gross domestic product is explained by the explanatory variables, the remaining 27% 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 Hetoroscedasticity (ARCH) test for testing heteroscedasticity in the error process in the model has an F-statistic of 0.0249 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 an insignificant calculated F – statistic of 0.918 confirms the absence of serial correlation in the residuals. The Jacque- Bera χ^2 - statistic of 2.28 for the normality in the distribution in the error process shows that the error process is normally distributed.

The estimated model passes a battery of diagnostic tests and the graphical evidence (CUSUM and CUSUMQ graphs) indicate that the model is fairly stable during the sample period. The analysis of the stability of the long-run coefficients together with the short-run dynamics, the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUM) point to the in-samples stability of the model (see CUSUM and CUSUMQ in Figures 1 to 4).

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

It could be observed from the results in table 4 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 agricultural gross domestic product in Nigeria and other determining factors in the specified model. The coefficient of -1.234 indicates that the deviation of agricultural gross domestic product (AGDP) from the long-run equilibrium level is corrected by about 123% in the current period. This shows that the speed of adjustment of the Nigerian agricultural production to the state of equilibrium is very high.

The exchange rate has a positive coefficient of 0.089 and 0.006 in the short and long-run respectively. While the coefficient in the short-run is statistically significant at 1%, it is not significant in the long-run. The elasticity values of exchange rate in both the short and long-run suggests that devaluation has a great tendency to decrease import of agricultural material if other components of exchange rate devaluation are well managed, thereby encouraging local production which will subsequently increase agricultural productivity.

In the short-run, crude oil price has a negative and significant coefficient of -0.026. However, in long-run, it has a negative but insignificant coefficient of -0.033. The elasticity value obtained for crude oil price in the short-run is in line with theoretical expectation since we expect that as the world price of crude oil increase, the focus on agricultural productivity will further shift towards oil export as it has always been the case in Nigeria

The coefficient of capital is significant both in the long-run and the short-run. The coefficient is 1.70 in the long-run with a significance level of 1% while the coefficient in the short-run is 1.598 and it is significant at 10%. These results suggest that a unit increase in agricultural capital will drive agricultural productivity to increase by almost 2 units increase in the long run and short-run.

In the long-run, agricultural land has a negative coefficient of -0.180 which is statistically insignificant. In the short-run however, it has a negative significant coefficient of 1.210. This result suggests that a unit increase in the hectarage of land employed in agricultural production in Nigeria will result in a corresponding reduction of the nations agricultural GDP by 1.210 units. Although this is contrary to theoretical expectation, it could be a result of overuse of the same portions of land over the years. It will be of necessity for the farmers to allow the land fallow and open new frontiers of agricultural lands for better production in the country.

Foreign direct investment into the Nigerian agricultural sector has a coefficient of 0.051 in the long-run and coefficient of 0.036 in the short run and both are significant 5% level. These results suggest in the long- run, a unit increase in the *LFDI* inflow into the Nigerian agricultural sector will significantly increases agricultural production by 0.051 unit while in the short-run, a unit increase in *LFDI* inflow into the nation's agricultural sector will increase agricultural production by 0.035 unit. From these results, it is apparent that *LFDI* is playing a positive and significant role in the agricultural sector of the Nigerian economy. It is therefore important that the government of Nigeria encourages more foreign investment into the Nigerian agricultural sector and also creates a conducive investment climate for the foreign investors.

The coefficient for fertilizer subsidy in the long-run in Nigeria is 0.051 and it is significant at 5%. This result suggests that if government can effectively monitor the subsidy programme and distribution of fertilizer in Nigeria, it will go a long in improving agricultural production in Nigeria.

Table 4: Long-run result of Effect of Fertilizer Subsidy on Agricultural Production in Nigeria

Included observations: 33 after adjustments
Dependent Variable: LAGDP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-13.86796	8.666452	-1.600189	0.1216
LEX	0.005999	0.014182	0.423001	0.6758
LPO	-0.033695	0.027845	-1.210077	0.2371
LK	1.702578	0.146657	11.60925	0.0000
LLD	-0.183668	0.390810	-0.469967	0.6423
LFDI	0.051500	0.020190	2.550814	0.0170
LFS	0.007642	0.002805	2.724115	0.0114

Source: Data Analysis 2015

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**Table 5: Parsimonious Short- run Error Modeli
Effect of Fertilizer Subsidy on Agricultural
Production in Nigeria**

Dependent Variable: D(LAGDP)
Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.009063	0.021910	-0.413644	0.6828
D(LEX)	0.089071	0.025650	3.472568	0.0020
D(LPO)	-0.026933	0.014719	-1.829844	0.0797
D(LK)	1.593750	0.848183	1.879017	0.0724
D(LLD)	-1.210196	0.489919	-2.470196	0.0210
D(LFDI)	0.035284	0.012658	2.787608	0.0102
D(LFS)	-0.001811	0.002802	-0.646370	0.5242
ECM(-1)	-1.234096	0.164127	-7.519170	0.0000

R-squared	0.788369	Mean dependent var	0.046594
Adjusted R-squared	0.726643	S.D. dependent var	0.068122
S.E. of regression	0.035617	Akaike info criterion	-3.619686
Sum squared resid	0.030445	Schwarz criterion	-3.253252
Log likelihood	65.91497	F-statistic	12.77211
Durbin-Watson stat	1.686368	Prob(F-statistic)	0.000001

Source: Data Analysis 2015

ARCH Test for Heteroscedasticity:

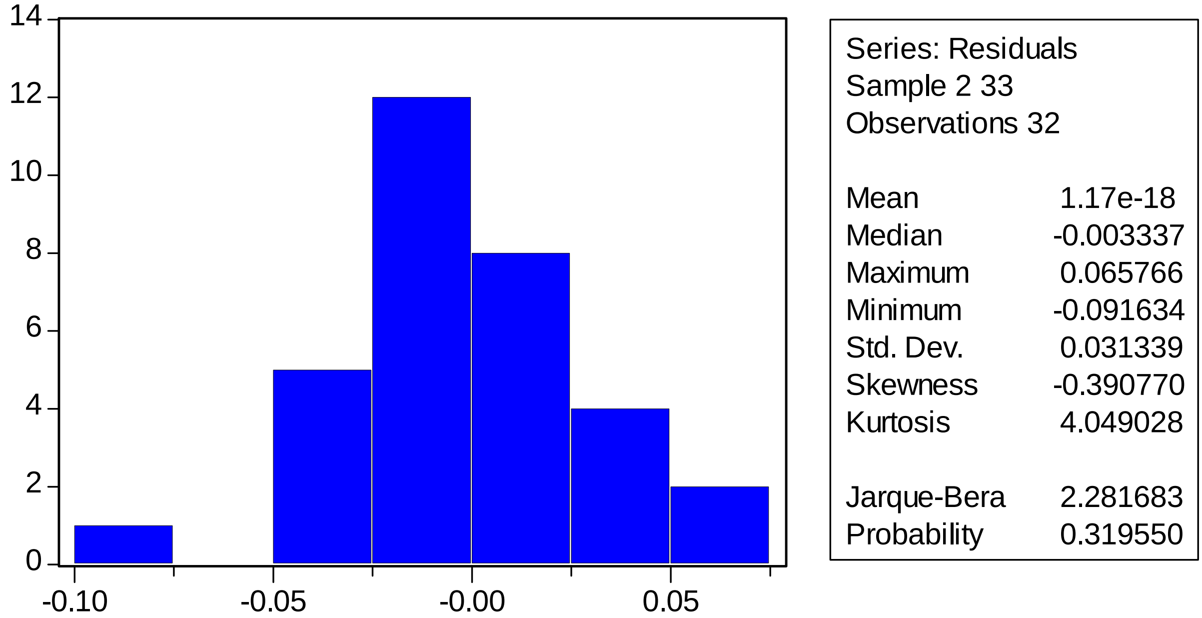
F-statistic	0.024961	Probability	0.875559
Obs*R-squared	0.026659	Probability	0.870300

Source: Data Analysis 2015

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.917699	Probability	0.414193
Obs*R-squared	2.464097	Probability	0.291694

Source: Data Analysis 2015


14
12
10
8
6
4
2
0
-0.10
-0.05
-0.00
0.05
Series: Residuals
Sample 2 33
Observations 32
Mean 1.17e-18
Median -0.003337
Maximum 0.065766
Minimum -0.091634
Std. Dev. 0.031339
Skewness -0.390770
Kurtosis 4.049028
Jarque-Bera 2.281683
Probability 0.319550

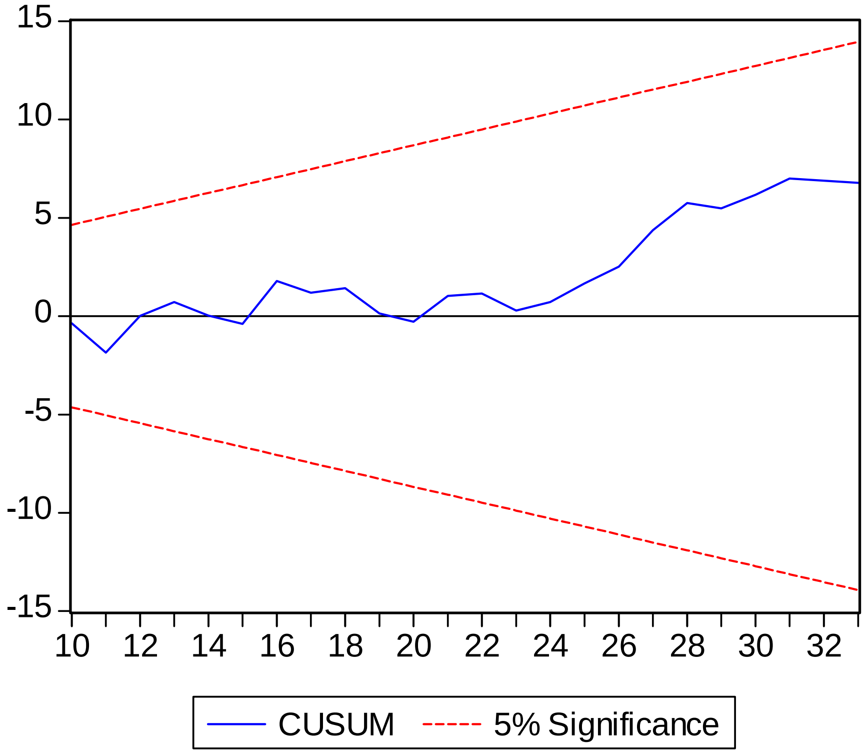

15
10
5
0
-5
-10
-15
10 12 14 16 18 20 22 24 26 28 30 32
CUSUM
5% Significance

Figure 3

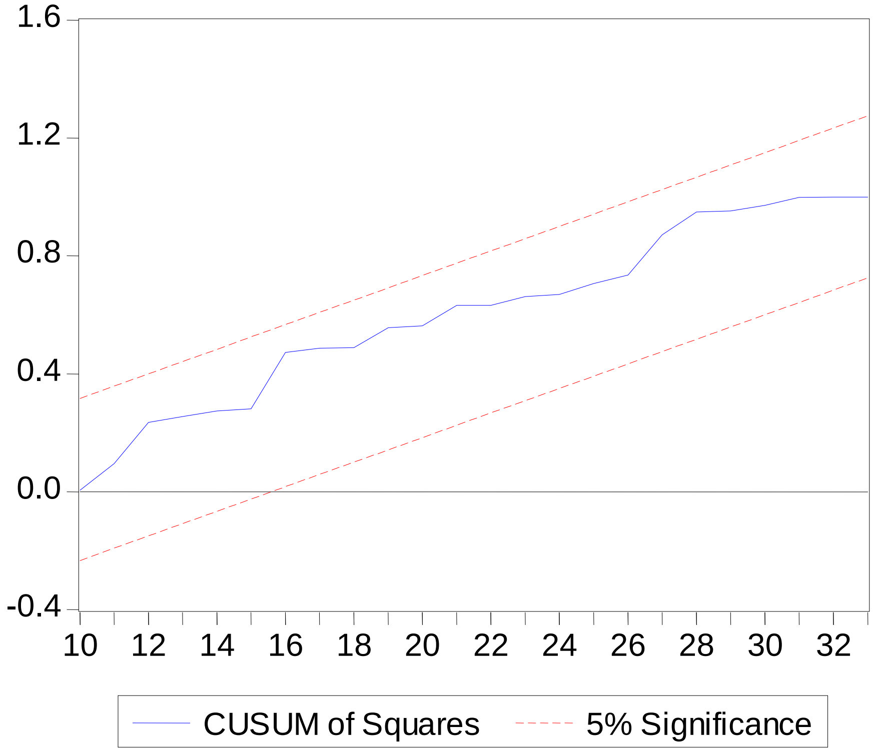


Figure 4

4.0 Conclusion and Policy Recommendations

It can be concluded that fertilizer subsidy which is one of the major policy thrust of the government of Nigeria to improve agricultural production has the capacity to improve agricultural productivity in Nigeria. However, the success of any fertilizer subsidy scheme in Nigeria partly depends on an effective reduction of the crowding out effects of the subsidy on the commercial fertilizer sector. This is possible only through both improved targeting of beneficiaries and effectively complementary policies that raise the financial return to fertilizer use among intended beneficiaries.

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