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# Do Agricultural Support Policies Work in Nigeria? Evidence from an ARDL Model

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## ABSTRACT

This study analyzes agricultural output in Nigeria between 1987 and 2015 by modeling the existence of a long run relationship between agricultural output, bank credit allocation to the agricultural sector, government spending on agriculture, and interest rates. We employ an error correction model within an autoregressive distributed lag (ARDL) framework as suggested by Pesaran *et al*. (2001). Results from the bounds testing confirm the existence of a long run relationship among the variables. The short run parameters show that commercial bank loans, agricultural credit guarantee funds, and interest rates are all positively related with agricultural output. Interestingly, we find that government expenditure is negatively related to agricultural output, suggesting an important finding that in the short run farmers' production responds more favorably through credit channels than conventional government spending. The long run results confirm that commercial bank loans, government expenditure, and the credit guarantee fund have a positive and significant relationship with agricultural output. Based on our empirical findings, the study recommends that agricultural support policies be considered to attract more credit allocation for the agricultural sector.



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**ملخص**

تحلل هذه الدراسة الإنتاج الزراعي في نيجيريا خلال الفترة الممتدة بين عامي 1987 و 2015 من خلال عرض مدى وجود علاقة طويلة الأمد بين الإنتاج الزراعي ومخصصات القروض البنكية لقطاع الزراعة والإنفاق الحكومي على الزراعة ومعدلات الفائدة. فقد وظفنا نموذجا لتصحيح الخطأ في إطار نموذج الانحدار الذاتي للابطاء الموزع (ARDL) كما يقترح بيزاران وآخرون (Pesaran et al., 2001). وتؤكد النتائج الخاصة باختبار الحدود وجود علاقة طويلة الأمد بين مختلف المتغيرات. وتشير المعايير القصيرة الأمد إلى أن القروض التجارية للبنوك وصناديق ضمان الائتمان الزراعي ومعدلات الفائدة كلها عناصر مرتبطة ارتباطا وثيقا بالإنتاج الزراعي. والمثير للاهتمام هو أننا توصلنا لكون الإنفاق الحكومي لا يرتبط بشكل وثيق بالإنتاج الزراعي، وهذا يعني أن مستوى إنتاج المزارعين، على المدى القصير، حين يرتبط بقنوات الائتمان يكون أحسن بالمقارنة مع الحالات التي يرتبط فيها بقنوات الإنفاق الحكومي التقليدية. وتؤكد النتائج الطويلة المدى أن القروض التجارية للبنوك والنفقات الحكومية وصناديق ضمان الائتمان الزراعي مهمة جدا على مستوى الإنتاج الزراعي وترتبط به ارتباطا وثيقا. وبناء على النتائج التجريبية التي توصلنا إليها، توصي الدراسة بالأخذ بعين الاعتبار سياسات الدعم الزراعي لجذب المزيد من مخصصات القروض للقطاع الزراعي.

**ABSTRAITE**

Cette étude analyse la production agricole au Nigeria entre 1987 et 2015 en modélisant l'existence d'une relation à long terme entre la production agricole, l'allocation de crédits bancaires au secteur agricole, les dépenses gouvernementales pour l'agriculture et les taux d'intérêt. Nous utilisons un modèle de correction d'erreur dans un cadre de retard distribué autorégressif (ARDL), comme le suggèrent Pesaran et al. (2001). Les résultats des tests de limites confirment l'existence d'une relation à long terme entre les variables. Les paramètres à court terme montrent que les prêts des banques commerciales, les fonds de garantie du crédit agricole et les taux d'intérêt sont tous en relation positive avec la production agricole. Il est intéressant de constater que les dépenses publiques ont un rapport négatif avec la production agricole, ce qui suggère une conclusion importante, à savoir qu'à court terme, la production des agriculteurs répond plus favorablement par les canaux du crédit que les dépenses publiques traditionnelles. Les résultats à long terme confirment que les prêts des banques commerciales, les dépenses publiques et le fonds de garantie du crédit ont une relation positive et significative avec la production agricole. Sur la base de nos conclusions empiriques, l'étude recommande que les politiques de soutien agricole soient envisagées pour attirer davantage de crédits pour le secteur agricole.

**Keywords:** agricultural policy, cointegration, ARDL Bounds Test, bank credit

**JEL Classification:** O2, O13

## 1. Introduction

Nigeria is a country endowed with an abundance of fertile land, water sources, forests and grasslands, as well as a large population that can sustain a productive and profitable agricultural sector (Nweze, 2014; Adubi, 2000; Obadan, 2000; Anyanwu, 1997). Nigeria also has a highly diversified agro-ecology, which makes possible the production of a wide range of agricultural products. This enormous resource base could support a vibrant agricultural sector, capable of self-sufficiency in food, raw materials for the industrial sector, gainful employment and the accumulation of foreign exchange through exports (CBN, 2000). Despite this enormous endowment, Nigeria spends about 60 per cent of its total crude oil revenue on food imports, among the highest in the world.[6] There has been an increase in the incidence and severity of poverty in Nigeria, arising in part from the sluggish performance of the agricultural sector where a preponderance of the poor is employed. In response, the government has initiated numerous policies and programs aimed at increasing productivity and output in the agricultural sector.

One of the oft-cited challenges of the Nigerian agricultural sector is inadequate funding by both the government and the private sector. Khandker and Binswanger (1989) argue that credit to the agricultural sector is important because agents in the sector who suffer from a cash flow problem and a liquidity constraint may use sub-optimal inputs. Farmers need financial resources to invest in improved agricultural inputs and technique to increase their output and income level and break the cycle of poverty. Investment in these technologies is usually not feasible without organizations and systems that are capable of adequately providing rural financial services to farmers. Consequently, the effort to develop agriculture may be ineffective in the absence of expanding access to credit for small farmers. Access to credit and agricultural extension services is limited in rural settings. Indeed, about 65% of Nigeria's labor force in the agricultural sector lack access to formal financial services

[6]In 2010 alone, Nigeria spent ₦635 billion on wheat imports, ₦356 billion on rice imports, ₦217 billion on sugar imports, and ₦97 billion imports of fish.

(CBN, 2007). Financial market underdevelopment and disintermediation in less developed countries (LDCs) is often characterized by high interest rates and inadequate financing for both agricultural and non-agricultural activities. Few people have access to financial services because commercial banks consider lending to small farmers risky and costly. Such lending farmers is marked by high transaction costs, low collateral and managerial skill, and insufficient record-keeping. The financial constraint also impacts other parts of the farm's production function, which results in lower human capital, lower infrastructure investments, and reliance on household labor relative to larger firms (Ishrat *et al.,* 2019).

Several scholars have investigated the relationship between bank credit and agricultural performance in Nigeria.[7] These studies employ a variety of statistical and econometric techniques, but focus primarily on the long run relationship between bank credit and agricultural output.[8] This paper contributes to the existing literature by estimating both the short run and long run relationships between bank credit allocation and agricultural output in Nigeria using the Autoregressive Distributive Lag (ARDL) bounds testing approach of Pesaran and Shin (1996) and Pesaran *et al.* (2001). In addition, we test the effectiveness of two agricultural support policies aimed at increasing farmers' production. The paper is organized as follows. In section 2, we review the existing literature and focus on empirical studies of agricultural output in developing countries. The theoretical basis for the ARDL modeling strategy is described in section 3, followed by a discussion of the results in section 4. Section 5 offers some concluding remarks and potential avenues for future research.

## 2. Related Literature

Most of the literature has heretofore focused on the relationship between institutional credit and agricultural output. For example, Qureshi *et al.* (1992) analyze rural credit policy in Pakistan. Their study observed that institutional credit affects agricultural output through the financing of

[7] These studies include Aduralere (2019), Kolawole (2013), Obilor (2013), Salami and Arawomo (2013), Toby and Peterside (2014) and Anthony *et al.*, (2015).
[8] Other studies using similar methods include Rahji and Fakayode (2008), Olagunju and Adeyemo (2007), Oboh and Ekpebu (2011), and Adetiloye (2012).

capital investment.[9] Iqubal *et al*. (2003) study the impact of institutional credit on agricultural production in Pakistan and found that institutional credit and the share of production loans in total loan advanced has been increasing from 1981 to 1990s. Their regression analysis confirmed that institutional credit is directly related to agricultural production. Water availability at the farm gate, labor and cropping intensity are the other variables that positively affect agricultural output.

Olangunju and Adeyemo (2007) investigate the extent to which the Small Holder Loan Scheme (SHLS) program has been able to meet the credit needs of farmers to improve agricultural production in Nigeria. Their study evaluated the production efficiency of farmers participating in the credit scheme. Using regression on a sample of 216 beneficiaries, they found significant differences in the production behavior of farmers who received loans. Farmers who received a loan were more productive than those that did not. Such findings are not unique to Nigeria. Artha and Dartanto (2018), Ismail *et al*. (2017) and Kasali *et al*. (2016) provide evidence that access to microcredit can lessen supply constraints, increase farm productivity, and alleviate poverty.

Iganiga and Unemhilin (2011) examine the effect of federal government agricultural expenditure on the value of agricultural output in Nigeria, from 1970 to 2008 using total commercial credits to agriculture, consumer price index, annual average rainfall, population growth rate, food importation and GDP growth rate as the model variables. The study employed the Cobb-Douglas growth model and Johansen co-integration and the error correction mechanism methodology to distill both long-run and short-run dynamic impacts of these variables on the value of agricultural output. Their results indicate that federal government capital expenditure was positively related to agricultural output.

Examining the dual role of commercial and non-commercial agricultural credit, Anthony *et al*. (2015) model the role of farm credits from banks and agricultural credit guarantees on the growth of the agricultural sector in Nigeria between 1988 and 2011. Results from their analysis reveal that both bank loans and the agricultural credit guarantee fund have a positive relationship with the output of the agricultural sector. Using standard

[9]They also find that the responsiveness of agricultural output is larger to institutional credit than that of output to fertilizer.

OLS estimation, they find that the agricultural credit guarantee fund and bank deposit interest rate are both insignificant.

Adetiloye (2012) and Obilor (2013) evaluate the impact of commercial banks' credit to agricultural sector performance under an agricultural credit guarantee fund (ACGSF) in Nigeria, spanning from 1978 to 2006, and 1983 to 2001 respectively. The ACGSF is one of the policies used by the Nigerian government to support farmers and the agricultural sector. Established in 1978, this program is an effort by the government (in collaboration with the central bank) to ameliorate the constraints faced by farmers in accessing credit facilities. The purpose of the fund is to guarantee credit facilities extended to farmers up to 60 percent of the total sum in default net of any security realized (Nwosu *et al*., 2010). That is, government covers losses up to 60 percent arising from failure of the farmers to repay the loan due to unforeseen circumstances, while the banks in direct contact with the farmers bear the remaining 40 percent (Atagana and Kalu, 2014). Adetiloye (2012) finds that the ACGSF variable is positive and significant, but notes that funding has not been maintained relative to the growth of the economy. The study recommends public awareness campaigns and programs to bring the youth into agriculture and the management of the ACGSF by highly trained professionals.

Kolawole (2013) examines the impact of interest rates and other macroeconomic variables on agricultural performance in Nigeria, from 1980 to 2011. Constructing a vector error correction model (VECM), they find a negative relationship between agricultural value added and the interest rate spread in the country. Finally, Chisasa and Makina (2015) analyze the relationship between bank credit and agricultural output in South Africa, using data from 1970 to 2011. Bank credit and agricultural output are found to be cointegrated, and in the long run credit and capital formation have a significant positive impact on agricultural output. Perhaps unexpected, the VECM reveals a short run negative relationship between bank credit and agricultural output. This result could be attributed to the credit cycle whereby banks may require farmers to repay loans even before harvesting and selling their produce (i.e., a mismatch between production and repayment cycles would adversely affect output).[10]

## 3. Methodology

The objective of this study is to investigate the relationship between bank credit allocation and agricultural sector performance in Nigeria. We estimate an ARDL model that hypothesizes an endogenous long run relationship among the following variables:

$$agdp = f\,(cbla, gexpa, acgsf, intr) \qquad (1)$$

where *agdp* is agricultural performance proxied by agricultural GDP; *cbla* is bank credit proxied by commercial bank loans to the agricultural sector; *gexpa* is government expenditure (in local currency) on the agricultural sector; *acgsf* is the value of the agricultural credit guarantee fund (in local currency), and *intr* is the interest rate for one-year bank deposits.

### 3.1 Model specification

We posit that access to bank credit (*cbla*) and agricultural support programs (*gexpa* and *acgsf*), will, *ceteris paribus*, positively influence agricultural output (*agdp*). As a measure of the cost of borrowing, the interest rate (*intr*) is often hypothesized to have a negative impact on output. However, there are several complicating factors that make any *a priori* assumptions about the relationship between the interest rate and agricultural output unclear.[11]

An econometric form of equation (1) is expressed as:

$$agdp_t = \beta_0 + \beta_1 cbla_t + \beta_2 gexpa_t + \beta_3 acgsf_t + \beta_4 intr_t + \xi_t \qquad (2)$$

[10] High interest rates charged on loans to farmers, and the uncertain nature of agricultural output are likely contributing factors. Notwithstanding the negative impact in the short term, the adjustment process to positive equilibrium position is rapid and evidenced with a highly significant, negative error correction coefficient.

[11] These factors include the elasticity of agricultural output to the interest rate, and the business cycle.

where $\beta_0$ is the constant; $\beta_1 ... \beta_4$ are the coefficients of the variables, and $\xi_t$ is the stochastic error term. Equation (2) is re-specified in log form as:

$$lnagdp_t = \beta_0 + \beta_1 lncbla_t + \beta_2 lngexpa_t + \beta_3 lnacgsf_t + \beta_4 lnintr_t + \xi_t \quad (3)$$

### 3.2 Estimation technique

Most studies using endogenous time series data have employed the Johansen cointegration technique to determine the long-term relationships among variables of interest. This remains the technique of choice for many researchers who argue that it is the most accurate method to apply for $I(1)$ variables. However, a series of papers by Pesaran[12] introduced an alternative to cointegration known as the autoregressive distributed lag (ARDL) bounds test. This technique has several advantages over the Johansen cointegration technique.

First, the ARDL model is a more statistically significant approach to determining the cointegration relation in small samples (Ghatak and Siddiki, 2001), while the Johansen cointegration techniques require large data samples for validity. A second advantage of the ARDL approach is that while the cointegration technique requires all the regressors to be integrated of the same order, the ARDL approach can be applied whether the regressors are $I(1)$ or $I(0)$. Thus, the ARDL approach avoids the pre-testing problems associated with standard cointegration, which requires that the variables be already classified into $I(1)$ or $I(0)$ (Pesaran *et al.*, 2001). According to Pesaran and Pesaran (1997), the ARDL approach requires two steps. In the first step, the existence of any long-term relationship among the variables is determined using an F-test. The second step of the analysis involves an estimation of the coefficients of the long run relationship and determination of their values, followed by the estimation of the short run elasticity of the variables with an error correction representation of the ARDL model. By applying the ECM version of the ARDL, the speed of adjustment to equilibrium can be computed. The ARDL model is represented by equation (4).

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[12] Pesaran and Shin (1996); Pesaran and Pesaran (1997); Pesaran and Smith (1998) and Pesaran *et al*. (2001).

$$\phi(L,p)y_t = \sum_{i=1}^{k} \beta_i(L,q_i)x_{it} + \delta' w_t + u_t \qquad (4)$$

where

$$\phi(L,p) = 1 - \phi L - \phi_2 L^2 - \ldots \phi_p L^p$$

*and*

$$\beta_i(L,q_i) = 1 - \beta_{i1}L - \beta_{i2}L^2 - \ldots - \beta_{iqi}L^{qi}, \qquad i = 1, 2, ..., k$$

In equation (4), $y_t$ is the dependent variable, $x_{it}$ denotes the independent variables, L is a lag operator, and $w_t$ is a vector of deterministic variables, including intercept terms, dummy variables, time trends and other exogenous variables. The optimum lags are selected according to the Akaike Information Criterion (AIC) and Schwarz Bayesian Criteria (SBC). The long-run coefficients and their asymptotic standard error are then computed for the selected ARDL model.

The ECM version of the selected model can thus be obtained by writing equation (4) in terms of the lagged levels and the first difference of $y_t$, $x_{it}$, and $w_t$ as follows:

$$\Delta y_t = -\phi(1,\hat{p})EC_{t-1} + \sum_{i=1}^{k} \beta_{i0}\Delta x_{1t} + \delta'\Delta w_t - \sum_{j=1}^{\hat{p}-1} \varphi^* y_{t-j} - \sum_{i=1}^{k}\sum_{j=1}^{\hat{q}_{i-1}} \beta_{ij}^* \Delta x_{i,t-j} + u_t \qquad (5)$$

In equation (5) above, $\phi$, $\delta$ and $\beta_{ij}$ are the coefficients related to the short run dynamics of the model's convergence to equilibrium, and $\phi(1,\hat{p})$ is the speed of adjustment. The bounds test for this study starts with the estimation of an unrestricted error-correction model (UECM) of the form:

$$\triangle lnagdp_t = \beta_0 + \sum_{i=0}^{n} \beta_{1i} \triangle lncbla_{t-i} + \sum_{i=0}^{n} \beta_{2i} \triangle lngexpa_{t-i} +$$

$$\textstyle\sum_{i=0}^{n} \beta_{3i} \triangle lnacgsf_{t-i} + \sum_{i=0}^{n} \beta_{4i} \triangle lnintr_{t-i} + \xi t \qquad (6)$$

where $\Delta$ is a first difference operator and $\xi_t$ is the stochastic disturbance term assuming white noise is normally distributed.

## 4. Empirical Results

We used the annual value of agriculture output in Nigeria to measure the performance of the agricultural sector. Commercial bank loans to agriculture represents the total commercial bank credit given to the agricultural sector while the agricultural credit guarantee fund is a government policy aimed at supplementing bank credit for the agricultural sector. The interest rate variable reflects the cost of borrowing in the economy. The time series data were collected from the Central Bank of Nigeria Statistical Bulletin for the period of 1987 to 2015. Descriptive statistics of the variables, which are all normally distributed, are shown in Table 1.

**Table 1:** Descriptive Statistics

| **Variable** | **Observations** | **Mean** | **Std. Dev.** | **Min** | **Max** |
|---|---|---|---|---|---|
| lnagdp | 36 | 13.3637 | 2.490869 | 9.21149 | 16.86003 |
| lncbla | 36 | 9.867496 | 2.067113 | 6.135998 | 13.12547 |
| lngexpa | 36 | 7.34586 | 2.974377 | 2.549445 | 11.08828 |
| lnacgsf | 36 | 13.10121 | 2.2139057 | 10.19939 | 16.45457 |
| intr | 36 | 17.69176 | 4.767831 | 7.8 | 29.8 |

In Tables 2 and 3 below, the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) unit root tests confirm that all the variables for this study are non-stationary at level excluding the interest rate. This implies the existence of unit roots. Both tests confirm that they are stationary after first difference. Therefore, the variables are integrated of order one, *I*(1), except for the interest rate, which is integrated of order zero, *I*(0). The results of these tests support the choice of an ARDL estimation technique. Next, we test for the existence of a cointegrating relationship among the variables.

**Table 2:** Unit root test (Augmented Dickey Fuller test)

| Levels | | | | | | First difference | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Variable | t-statistic | Critical values | | | Prob. | Variable | t-statistic | Critical values | | | Prob. |
| | | 1% | 5% | 10% | | | | 1% | 5% | 10% | |
| lnagdp | -1.330 | -3.68 | -2.97 | -2.61 | 0.6152 | lnagdp | -4.353 | -3.68 | -2.9 | -2.61 | 0.004** |
| lncbla | -0.929 | -3.68 | -2.97 | -2.61 | 0.7782 | lncbla | -6.769 | -3.68 | -2.9 | -2.61 | 0.0000** |
| lngexpa | -1.158 | -3.68 | -2.97 | -2.61 | 0.6915 | lngexpa | -8.204 | -3.68 | -2.9 | -2.61 | 0.0000** |
| lnacgsf | -0.090 | -3.68 | -2.97 | -2.61 | 0.9504 | lnacgsf | -6.162 | -3.68 | -2.9 | -2.61 | 0.0000** |
| intr | -3.271 | -3.68 | -2.97 | -2.61 | 0.016** | intr | -9.883 | -3.68 | -2.9 | -2.61 | 0.0000** |

*** indicates significance at the 5% level*
Source: Authors' computation using Stata 13

**Table 3:** Unit root test (Phillips-Perron)

| Levels | | | | | | First difference | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Variable | t-statistic | Critical values | | | Prob. | Variable | t-statistic | Critical values | | | Prob. |
| | | 1% | 5% | 10% | | | | 1% | 5% | 10% | |
| lnagdp | -1.252 | -3.68 | -2.97 | -2.61 | 0.6508 | lnagdp | -4.304 | -3.68 | -2.97 | -2.61 | 0.0004** |
| lncbla | -1.011 | -3.68 | -2.97 | -2.61 | 0.7492 | lncbla | -6.970 | -3.68 | -2.97 | -2.61 | 0.0000** |
| lngexpa | -1.107 | -3.68 | -2.97 | -2.61 | 0.7124 | lngexpa | -8.792 | -3.68 | -2.97 | -2.61 | 0.0000** |
| lnacgsf | -0.040 | -3.68 | -2.97 | -2.61 | 0.9617 | lnacgsf | -6.209 | -3.68 | -2.97 | -2.61 | 0.0000** |
| intr | -3.428 | -3.68 | -2.97 | -2.61 | 0.010** | intr | -10.250 | -3.68 | -2.97 | -2.61 | 0.0000** |

*** indicates significance at the 5% level*

Table 4 confirms the existence of a long run relationship among the variables using the bounds testing method of Pesaran *et al*., (2001). For testing the null hypothesis of no levels relationship, the test above uses the F-statistic and the critical bounds values. The decision rule is that if the computed F-statistic value is less than the critical value for the *I*(0) regressors, we accept the null of no levels relationship, but we reject the null if the value is greater than the critical value for the *I*(1) regressors. In the table, the computed F-statistic of 7.86 was found to be greater than the critical value for the *I*(1) regressors of 4.01 at the 5 percent significance level. This confirms that the variables *lnagdp*, *lncbla*, *lngexpa*, *lnacgsf* and *intr* exhibit are cointegrated. Having determined a long run equilibrium relationship among the variables, we proceed to the estimation of an unrestricted ARDL model to determine the short run and long run dynamics of the model.

**Table 4:** ARDL Bounds Test for Cointegration

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Critical values (0.1 – 0.01), F-statistics | [I_0] L_0.1 | [I_1] L_0.1 | [I_0] L_.05 | [I_1] L_.05 | [I_0] L_.025 | [I_1] L_.025 | [I_0] L_.01 | [I_1] L_.01 |
| k_4 | 2.45 | 3.52 | 2.86 | 4.01 | 3.25 | 4.49 | 3.74 | 5.06 |

*$H_o$ : no levels relationship*
*F-statistic = 7.864*
*Accept if F < critical value for I(0) regressors*
*Reject if F > critical value for I(1) regressors*

Table 5 shows the long run and short run estimates for the variables of this study. The long run elasticities for bank credit allocation to agriculture, government expenditure on agriculture, the ACGS fund and interest rate are 0.39, 0.39, 0.18 and 0.02 respectively. The estimates carry the expected signs and are statistically significant at the 5 percent level except for the interest rate, which is not significant. The results imply that for a one percent increase in bank credit allocation to agriculture, there is a 0.39 percent increase in agricultural output. Moreover, a one percent increase in government expenditure on agriculture induces a 0.39 percent increase in agricultural output, and a one percent addition to the agricultural credit guarantee fund leads to a 0.18 percent increase in agricultural output.

**Table 5:** Results of autoregressive distributed lag (ARDL) model

| **Dependent Variable** *Δlnagdp* | **Coef.** | **Std. Err.** | **t-stat** | **Prob.** |
|---|---|---|---|---|
| **Error Correction term** | | | | |
| $EC_{t-1}$ | -0.4537*** | .1330 | -3.41 | 0.004 |
| **Long Run Model** | | | | |
| *lncbla* | 0.3950*** | .1313 | 3.01 | 0.009 |
| *lngexpa* | 0.3990*** | .0832 | 4.79 | 0.000 |

| | | | | |
|---|---|---|---|---|
| *lnacgsf* | 0.1819*** | .0564 | 3.22 | 0.006 |
| *intr* | 0.0217 | .01757 | 1.24 | 0.235 |
| **Short Run Model** | | | | |
| $\Delta lncbla_{t-2}$ | 0.1567* | .0774 | 2.02 | 0.061 |
| $\Delta lngexpa$ | -0.1263** | .0439 | -2.88 | 0.012 |
| $\Delta lngexpa_{t-1}$ | -0.1136*** | 0.036 | -3.11 | 0.007 |
| $\Delta lngexpa_{t-2}$ | -0.1128*** | .0280 | -4.02 | 0.001 |
| $\Delta lnacgsf_{t-2}$ | 0.1231** | .0551 | 2.23 | 0.041 |
| $\Delta intr_{t-1}$ | -0.0146** | .0063 | -2.32 | 0.035 |
| $\Delta intr_{t-2}$ | -0.0104** | .0047 | -2.32 | 0.042 |
| constant | 1.836 | .5230 | 3.51 | 0.003 |

Note: ***, **, * indicate significance at 1%, 5%, and 10% level respectively.

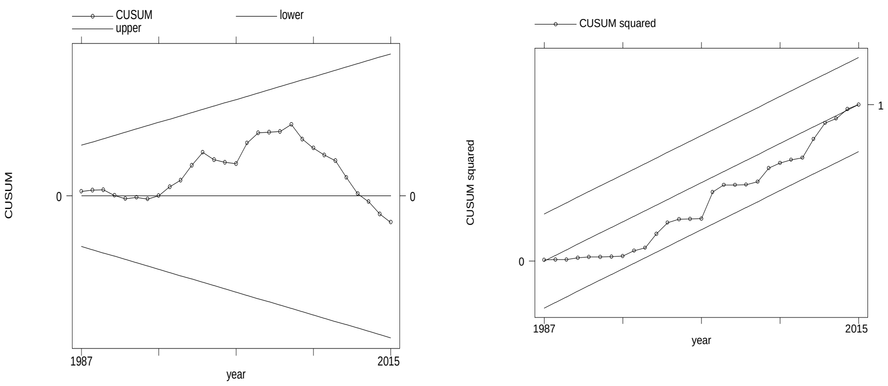
The coefficients for the short run estimates in Table 5 are significant and correctly signed, apart from $\Delta lngexpa$. The hypothesized positive affect of government spending on agriculture in the short run is rejected, but it is not entirely unexpected. Government expenditures on agriculture may not yield the desired impact instantaneously due to various implementation lags, and most agricultural ventures take some time to yield output. Furthermore, rent-seeking and corruption—particularly in the short run when it can be difficult to audit programs—cannot be ruled out as a possible explanation as well. According to our estimates, the elasticity of bank credit to agriculture is 0.15 and is (weakly) significant, while that of the ACGSF fund and interest rate are 0.12 and 0.14 respectively, and both are significant at the 5 percent level.

The error correction term, $EC_{t-1}$, carries the correct (negative) sign and is statistically significant at the one percent level. This confirms the existence of a long run relationship among the model variables. The error correction term coefficient of -0.45 implies that following a shock, the variables will return to their long run equilibrium at a rate of approximately 45 percent per year. In Figure 1, we confirm the stability of the parameters with the Cumulative Sum and the Square of the Cumulative Sum tests for recursive residuals. Other standard diagnostic tests indicate that the model conforms to standard statistical properties.[13]

[13] The Ramsey RESET test shows that the model for this study is well specified, while the Breusch-Godfrey LM test for serial autocorrelation indicates that there is no serial correlation. The Lagrange Multiplier Jarque-Bera Normality test confirms that the error

**Figure 1:** Cumulative Sum (CUSUM) Test for Stability

**(a) CUSUM at 5% Significance** **(b) CUSUM of Square at 5% Significance**




## 5. Conclusion

In this paper, we estimated the impact of credit and government support programs on agricultural performance in Nigeria. We employed an autoregressive distributed lag (ARDL) bounds testing approach to model the long run equilibrium relationship among the variables. The diagnostic tests confirmed the model is robust, reasonably specified, stable with normally distributed errors, and has no autocorrelation.

The long run estimates reveal that commercial bank loans, government expenditure, and the ACGS fund each has a significant, positive relationship with agricultural output. The interest rate is not statistically significant. In the short run analysis, the Wald test confirms a positive joint effect of commercial bank loans, agricultural credit guarantee fund and the interest rate on agricultural output. However, the coefficient of government expenditure (*lngexpa*) is negative, suggesting an important finding that in the short run agricultural output responds more favorably through credit channels than conventional government spending.

terms are normally distributed. Lastly, White's test demonstrates the model's errors are homoscedastic. These test results are available as an appendix upon request from the authors.

These results hold policy implications for both individual investors and the government of Nigeria. Our findings imply that agricultural output can be increased through targeted credit and spending levers. Given the enormous potential of the agricultural sector in Nigeria, government can complement private sector investment by increasing credit allocation to farmers. Government spending on public goods and infrastructure (e.g. accessible roads, power supply and security) would also be a cost-effective policy that would likely attract private sector participation and crowding-in investments. A limitation of the study is based on the relatively small data set of a single country. The results for Nigeria may not hold more generally, and thus future research that applies the ARDL and panel methods to other developing countries has great promise.

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