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Agricultural Sector Credit and Output Relationship in Nigeria: Evidence from Nonlinear ARDL[1]

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This paper investigates the relationship between credit to agriculture and agricultural output in Nigeria by means of nonlinear autoregressive distributed lag (NARDL) model using a time series data from 1992Q1 to 2015Q4. Results show no evidence of asymmetry in the impact of credit to output growth in the agricultural sector (positive and negative changes) in the short-run, but different equilibrium relationships exist in the long-run. The dynamic adjustments show that the cumulative agricultural output growth is mostly attracted by the impact of the positive changes in credit to agriculture with a lag of four quarters of the prediction horizon. This calls for the need for a policy on moratorium on credit administration to agricultural sector.

Keywords: Agricultural output growth, Asymmetry, Private sector credit, ARDL model, Moratorium

JEL Classification: C01, C13, G20, O40

1.0 Introduction

The ratio of private sector credit to gross domestic product (GDP) has become an increasingly popular benchmark of sustainable levels of credit. In line with Kelly *et al.* (2013), allowing credit to grow naturally in proportion to the overall economic activity has been a focus of policy makers in recent time.. In the last two decades, several studies on the impact of credit from the banking sector to boost real economic activities like agricultural production has stimulated extensive academic and fascinating debates. A recent study by Okafor *et al.*(2016) shows that there is a unidirectional Granger causality from private sector credit to economic growth in Nigeria. This also follows an earlier report by Olowofeso *et al.* (2015) that there exists a positive and statistically significant effect of private sector credit on output in Nigeria.

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[1] The views expressed in this paper are those of the authors and do not necessarily represent the views of the Bank. The authors are grateful to the anonymous reviewers for their comments and recommendations on earlier draft of this paper.

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Over time, the Nigerian economy which is the largest in Africa with GDP estimate of US$ 405 billion as at 2016 has been majorly dependent on oil. Sequel to the depletion in its external reserves, rising inflation, exchange rate crunch and output contraction, triggered mostly by the global oil price crash and drastic drop in the country's oil production the country plagued into economic crisis. As a result, the need to diversify the economy away from dependence on oil revenue to agriculture has been one major discourse that has taken the centre stages in both national and international fora. A review of Lawal (2011) has suggested that the prospects of non-oil sub-sector and the overall economy of Nigeria are usually tied to the performance of agricultural sector. Oji–Okoro (2011) also posited that over 70% of the active labour force in Nigeria is in agricultural sector with 88% of non-oil foreign exchange earnings. These and other related studies that widely reported the existence of a positive and statistically significant effect of private sector credit on output in the literature added impetus to the motivation of this study. Howbeit, this study differs from the previous studies in two distinct ways: first, it specifically focus on how private sector credit to agriculture relates with agricultural output; and secondly, it employs a nonlinear autoregressive distributed lag (NARDL) approach to account for the asymmetric characteristics of credit in the relationship. According to Shin *et al.* (201), the NARDL model admits adjustment asymmetry captured by the patterns of a dynamic adjustment from initial equilibrium to a new equilibrium following an economic perturbation simultaneously in a coherent manner. This, to the best of our knowledge, brings a new innovation to the literature.

The objective of this study therefore is to investigate role of credit in agricultural production. In particular, the paper examines the short- and long-run pass-through of bank credit to agricultural output in Nigeria. The paper employs a nonlinear autoregressive distributed lag (NARDL) approach to cointegration in order to extricate the interactions between real growth of agricultural output and private sector credit to agriculture during both soothing and downturn periods. This approach will give us a dynamic measurement that will shed more light on the asymmetric credit elasticity of real agricultural output growth over time. It will also illumine possibly important differences in the response of agricultural output growth to positive and negative shocks to private sector credit.

The rest of the paper is organized as follows: Section 2 presents review of related literature; Section 3 discusses the methodology, which includes model specification and data. Sections 4 and 5 present empirical results and concluding remarks, respectively.

2.0 Stylized Fact on Agricultural Financing in Nigeria

In Nigeria, agriculture played a vibrant role in stimulating economic growth in the early 1960's and contributed to over 70 percent of the nation's export earnings (Central Bank of Nigeria 1970). However, in early 1980's, there was a dire downturn of agricultural contribution to GDP growth that prompted increased financing to agricultural sector in the last decade (Figure 1). Some of the agricultural financing schemes by the Central Bank of Nigeria include:

a. N200 billion Commercial Agriculture Credit Scheme (CACS): This scheme that started in 2009 focused on the financing of large projects within the value chain in agriculture.
b. Agricultural Credit Guarantee Scheme Fund (ACGSF): This scheme was set up to encourage lending to the agricultural sector by providing guarantee to commercial banks. Here, the Bank complemented the scheme with an operation of interest drawback programme in the payment of interest rebate of 40 per cent to farmers that make timely repayment. The ACGSF has been very prominent in recent time.
c. Agricultural Credit Support Scheme (ACSS): Credit facilities under this scheme targeted at providing credits at a fixed rate of interest, where beneficiaries have the privilege of a certain percentage of the interest being refunded to when the loan is repaid on scheduled.

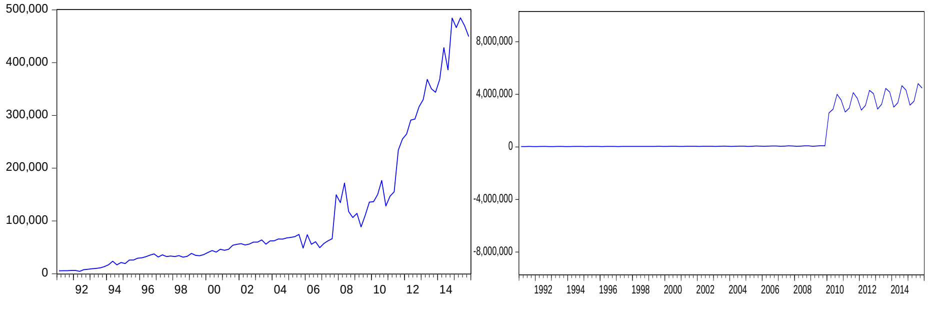

Figure 1: Total Sectoral Credit Distribution and Agricultural Sector Share of GDP Growth and the (Source: CBN Statistical Bulletin 2015)

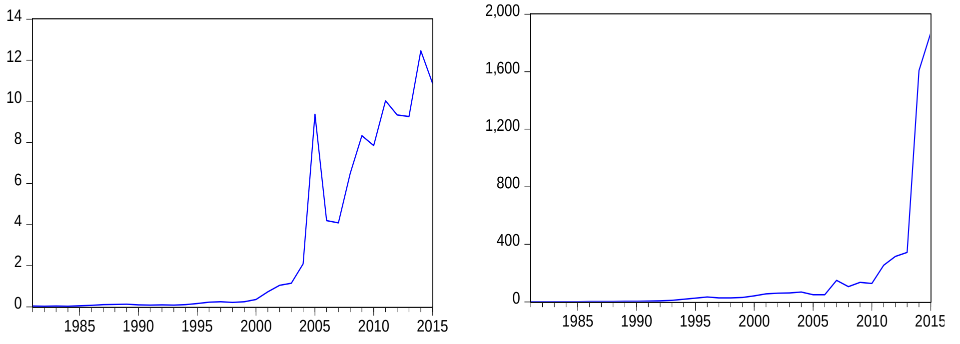

Figure 2: Loans Guaranteed under the ACGSF Operations (₦ ' Billion) and Sectoral Distribution of Commercial Banks' Loans and Advances from 1981 – 2015. (Source: CBN Statistical Bulletin 2015)

The commercial banks have been the main drivers of the steady growth of credit to the Agricultural sector since early 2006. From ₦48.6 billion in 2005, credit to the Agriculture sector by commercial banks rose to ₦1, 870.6 billion in 2015, representing a growth of over three thousand per cent. Within the period, however, loans guaranteed under the Agriculture Credit Guarantee Scheme Fund (ACGSF) rose by a paltry sixteen per cent from ₦9.37 billion in 2005, to ₦10.86 billion in 2015 (Figure 2).

2.1 Theoretical Literature

Varying opinions regarding the importance of the financial system for economic growth exist. Bagehot (1873) and Hicks (1969) argued that financial system facilitated the mobilization of capital for "immense works" in England's industrialization. Schumpeter (1912) posited that well-functioning banks spur technological innovation by identifying and funding entrepreneurs with the best chances of successfully implementing innovative products and production processes. In contrast, some other economists do not believe the existence of relationship between credit and growth (Lucas, 1988). However, Levine (1997) opined that the level of financial development is a good predictor of future rates of economic growth, capital accumulation, and technological change. Theory proponents have also suggested that financial instruments, markets, and institutions arise to mitigate the effects of information and transaction costs, while less developed theoretical literature showed that changes in economic activity could influence financial systems (Levine and Renelt, 1992).

In the last few years, tremendous research studies using the concept of credit channel theory that policy variables have effects on both credit supply and demand in any economy abound in the literature. Dobrinsky and Markov (2003) in the recently proposed “credit channel view” suggested that shocks from monetary policy impacts on real economic performance via the credit supply by commercial banks and other financial institutions owing to movements in their supply schedules.

Mishkin (2004) posited that an undeveloped financial system is one of the reasons why developing or transition countries have low rates of growth. This proposition is affirmed by Duican and Pop (2015) that the stability of financial sector plays an important role in economic development of any country, with evidences in the literature that there is a correlation between economic growth and credit market.

Korkmaz (2015) also opined that banks can ensure effective distribution of resources in economy by transferring resources that they have collected to certain regions and sectors. But when they contract credits that they let use, they can cause economic stagnation and for some sectors to go through a difficult period.

In general, most theoretical literature on financial development and economic growth supports the argument that credit market development has a positive influence on economic growth by enhancing capital accumulation and technological changes. According to Sassi (2014), there exists a general consensus among economists that a well-developed credit system stimulates economic growth by improving resources allocation channeled into investment, reducing information and transaction costs and allowing risk management to finance riskier but more productive investments and innovations.

The law of returns to scale also provides the theoretical linkage between credit and agricultural output. In view of this, this work hinges on the law of returns to scale. This law in economic literature explains the proportional change in output with respect to proportional change in input variables. In other words, the law of returns to scale states that when there is a proportionate change in inputs, the behavior of output changes. For instance, an output may change by a large proportion, same proportion, or small proportion with respect to change in input.

Thus, this study is based on these theories underpinning the importance of credit market development for growth.

2.3 Empirical Literature

Empirical studies on the relationship between credit and aggregate output is replete not only in Nigeria, but globally. Among this plethora of research endeavours, many had investigated the nexus between various sectoral credits and output; the impact of credit channeled to the agricultural sector on economic growth has witnessed tremendous research attention.

On the general note, Okafor *et al.* (2016) examined the causal relationship between deposit money banks' credit and economic growth in Nigeria over the period 1981-2014 using Vector autoregressive (VAR) Granger causality test. The findings show a unidirectional causality from private sector credit to economic growth.

In a similar development, Olowofeso *et al*. (2015) examined the impacts of private sector credit on economic growth in Nigeria for the period 2000:Q1 to 2014:Q4 using the Gregory and Hansen (1996) cointegration test to account for structural breaks and endogeneity problems. They found a cointegrating relationship between output and its selected determinants, though with a structural break in 2012Q1. Furthermore, the error correction model confirmed a positive and statistically significant effect of private sector credit on output, while increased prime lending rate was inhibiting growth.

Marshal *et al.* (2015) examined the impact of bank domestic credits on the economic growth of Nigeria using annual data for 1980 – 2013. In the study, credit to private sector (CPS), credit to government sector (CGS) and contingent liability were used as proxy for bank domestic credit while gross domestic product proxied economic growth. Relative statistics of the estimated model showed that CPS and CGS positively and significantly correlate with GDP in the short run. Analysis revealed the existence of poor long run relationship between bank domestic credit indicators and gross domestic product in Nigeria.

Fapetu and Obalade (2015) investigated the impact of sectoral allocation of Deposit Money Banks' (DMBs) loans and advances on economic growth in Nigeria. The study covered the intensive regulation, deregulation and guided deregulation regimes. The results obtained showed that only the credit allocated to government, personal and professional had significant positive contributions on economic growth during the regime of intensive regulation. It was discovered however that during the regime of regulation, bank credits generally do not contribute significantly to economic growth. The introduction of guided deregulation in the economy appears to have been a success as BMBs' loans and advances to production and other subsector were discovered to be both positive and significant in determining growth.

Nwakanma *et al*. (2014) evaluated the nature of the long-run relationship that existed between bank credits to the private sector and economic growth of Nigeria's economy. The study which covered the period 1981 to 2011, also investigated the directions of prevailing causality between them. The Autoregressive Distributed Lag Bound (ARDL) and Granger Causality techniques were employed. The results indicated significant long-run relationship between the study variables but without significant causality in any direction.

Nnamdi and Nwiyordee (2014) examined the nature and direction of causal relationships that might exist between classified sectoral microcredit allocations and sectorally classified entrepreneurship contributions to Nigeria's economic growth using data covering the period 1992 to 2011. The study concluded that: (i) in the sectors where microcredit operations have become significant and/or near significant, they only function to service rather than promote entrepreneurial activities, (ii) for majority of the sectors, entrepreneurship ventures are largely independent of microcredit institution's operations.

Olusegun *et al.* (2014) reviewed the impact of commercial bank lending on Nigeria's aggregate economic growth using annual data for the period 1970-2011. It also reviewed the impact of bank credit on the growth of Services and 'Others' sectors as well as their sub-sectors of transport/communication and public utilities; government and personal/professionals respectively. The results showed that both previous and current year's credit to 'Others' sector had negative relationship with economic growth. In terms of the subsectors, the previous year's credit to public utilities and transport/telecommunications sub-sectors showed positive contributions to economic growth while the impact of that of current year was negative.

Emecheta and Ibe (2014) employed the reduced Vector Autoregresion approach using annual data for the period 1960-2011 to investigate the relationship between bank credit and economic growth in Nigeria. They found a significant positive relationship between bank credit and economic growth during the sample period.

With respect to agriculture, studies like Anthony (2010) and Lawal (2011) have shown that agricultural variables have a lot of impact on economic growth and exports. Anthony (2010) highlighted the contributions of agricultural credit, interest rate, exchange rates to aggregate output in Nigeria.

Udoka *et al.* (2016) examined the effect of commercial banks' credit on agricultural output in Nigeria. Estimated results showed that there was a positive and significant relationship between agricultural credit guarantee scheme fund and agricultural production. This means that an increase in agricultural credit guarantee scheme fund could lead to an increase in agricultural production in Nigeria; there was also a positive and significant relationship between commercial banks credit to the agricultural sector and agricultural production in Nigeria. In addition, the study also confirmed a positive and significant relationship between government expenditure on agriculture and agricultural production. However, the study also showed negative relationship between interest rate and agricultural output in line with theoretical postulations. This is because an increase in interest rate discourages farmers and other investors from borrowing and thus less agricultural investment and output.

Nnamocha and Eke (2015) investigated the effect of Bank Credit on Agricultural Output in Nigeria via Error Correction Mode (ECM) using yearly data (1970- 2013). Empirical results from the study showed that, in the long-run bank credit and industrial output contributed a lot to agricultural output in Nigeria, while only industrial output influenced agricultural output in the short-run.

Imoisi *et al.* (2012) examined the effects of credit facilities on agricultural output and productivity in Nigeria from 1970-2010. Results showed that there is a significant relationship between Deposit Money Banks loans and advances, and agricultural output. Similarly, Ammaini (2012) investigated the relationship between agricultural production and formal credit supply in Nigeria. Results obtained indicated that formal credit is positively and significantly related to the productivity of the crop, livestock and fishing sectors. In addition, Onoja (2012) analyzed the trends and pattern of institutional credit supply to agriculture during pre- and post-financial reforms (1978 - 1985; and 1986 -2009) along with their determinants. Results obtained showed an exponentially increasing trend of agricultural credit supply in the economy after the reform began. It was also discovered that stock market capitalization, interest rate and immediate past volume of credit guaranteed by ACGSF significantly influenced the quantity of institutional credit supplied to the agricultural sector over the study period. Overall, there was a significant difference between the credit supply function during the pre-reform and post reform periods.

3.0 Methodology

Consider a simple static model that postulates a relationship between real growth of agricultural output (y) and credit to agricultural sector (X) of the form

$$y_t = \beta_0 + \beta_1 X_t + \mu_t \tag{1}$$

where β_1 indicates the credit elasticity of real growth of agricultural output, which typically is expected to take a positive value. Equation (1) implies that credit expansion (contraction) leads to a rise (fall) in real growth of agricultural production. In other word, under a linear and symmetric setting, growth responses to a change in credit during soothing period is no more than a mirror image of those during downturn period. To examine the impact of the two periods simultaneously, we employ an asymmetric ARDL technique (also called NARDL) developed by Shin *et al*. (2009 and 2013). The NARDL model introduces nonlinearity by means of partial sum decompositions into the conventional ARDL model by Pesaran *et al.*(2001). In other word, it allows for capturing both the short-run and long-run asymmetries in the transmission mechanism by modeling the long-run relationship and the pattern of dynamic adjustment simultaneously in a coherent manner.

3.1 The NARDL Model Specification

The first step in the asymmetric cointegrating relationship under the NARDL specification by Shin *et al*. (2013) method is to decompose the exogenous variable in Eqn. (1) into partial sum processes as follows:

$$y_t = \beta^+ X_t^+ + \beta^- X_t^- + \mu_t \qquad (2)$$

where y_t is a $k \times 1$ vector of real agriculture output growth at time t; X_t is a $k \times 1$ vector of multiple regressors defined such that $X_t = X_0 + X_t^+ + X_t^-$, representing natural logarithm of private sector credits to agriculture; μ_t is the error term; β^+ and β^- are the associated asymmetric long-run parameters, indicating that agriculture output growth respond asymmetrically during ups and down periods of private sector credit. The X_t^+ and X_t^- are partial sum processes of positive (+) and negative (–) changes in X_t defined as:

$$X_t^+ = \sum_{j=1}^{t} \Delta X_j^+ \; ; \; X_t^- = \sum_{j=1}^{t} \Delta X_j^- \qquad (3)$$

$$\Delta X_j^+ = \sum_{j=1}^{t} max\left(\Delta X_j, 0\right), \qquad \Delta X_j^- = \sum_{j=1}^{t} min\left(\Delta X_j, 0\right) \qquad (4)$$

were ΔX_j are the changes in independent variables (X_t) while the '+' and the '–' superscripts indicate the positive and negative processes around a threshold of zero, which delimits the positive and the negative shocks in the independent variables. This implies that the first differenced series is assumed to be normally distributed with zero mean.

we first consider the following nonlinear ARDL(p; q) framework with which the relationships exhibit combined long- and short-run asymmetries dynamic model:

$$y_t = \sum_{j=1}^{p} \varphi_j y_{t-j} + \sum_{j=0}^{q} \left(\pi_j^{+\prime} X_{t-j}^+ + \pi_j^{-\prime} X_{t-j}^-\right) + \epsilon_t \qquad (5)$$

Thus, in line with Pesaran and Shin (1998) and Pesaran *et al.* (2001), the conditional error correction model for Eqn. (5) in terms of the positive and negative partial sums can be written as:

$$\Delta y_t = \rho y_{t-1} + \theta^+ X_{t-1}^+ + \theta^- X_{t-1}^- + \sum_{j=1}^{p-1} \varphi_j \Delta y_{t-j} + \sum_{j=0}^{q-1} \left(\pi_j^+ X_{t-j}^+ + \pi_j^- X_{t-j}^- \right) + \epsilon_t \quad (6)$$

According to Shin *et al.* (2013), Eqn. (6) perfectly corrects for the potential weakly endogeneity of non-stationary regressors for a NARDL model and ensures that causal relationship only runs from the credit to the output both in the short and long run (see also Coers and Sanders, 2013, Jaunky, 2011). The long-run coefficients will be calculated using the relationship: $\beta_X^+ = -\theta^+/\rho$ and $\beta_X^- = -\theta^-/\rho$. The null hypothesis of no long-run relationship between the levels of y_t, X_t^+ and X_t^- $(i.e., \rho = \theta^+ = \theta^- = 0)$ will be tested with the (nonstandard) bounds-testing method of Pesaran *et al*, (2001), which remains valid irrespective of the time series properties of X_t. The long-run and short-run asymmetries will also be estimated using standard Wald test. In particular, we will investigate the null hypotheses of no asymmetry in the long-run coefficients ($\beta_X^+ = \beta_X^-$) and in the short-run ($\pi_j^+ = \pi_j^-$) in which a rejection of one or both will result in one of the following model specifications:

(i) long-run and short-run symmetry model:

$$\Delta y_t = \rho y_{t-1} + \theta X_{t-1} + \sum_{j=1}^{p-1} \varphi_j \Delta y_{t-j} + \sum_{j=0}^{q-1} \pi_j X_{t-j} + \epsilon_t \quad (7)$$

(ii) long-run symmetry, short-run asymmetry model:

$$\Delta y_t = \rho y_{t-1} + \theta X_{t-1} + \sum_{j=1}^{p-1} \varphi_j \Delta y_{t-j} + \sum_{j=0}^{q-1} \left(\pi_j^+ X_{t-j}^+ + \pi_j^- X_{t-j}^- \right) + \epsilon_t \quad (8)$$

(iii) long-run asymmetry, short-run symmetry model:

$$\Delta y_t = \rho y_{t-1} + \theta^+ X_{t-1}^+ + \theta^- X_{t-1}^- + \sum_{j=1}^{p-1} \varphi_j \Delta y_{t-j} + \sum_{j=0}^{q-1} \pi_j X_{t-j} + \epsilon_t \quad (9)$$

(iv) long-run and short-run asymmetry model of Equation (5).

The asymmetric cumulative dynamic multiplier effects of a unit change in X_t on y_t would be obtained through the following equation:

$$m_h^+ = \sum_{j=0}^{h} \frac{\partial y_{t+j}}{\partial X_t^+}, \qquad m_h^- = \sum_{j=0}^{h} \frac{\partial y_{t+j}}{\partial X_t^-}; h = 0,1,2,\cdots \qquad (10)$$

where $h \to \infty, m_h^+ \to \theta^+$ and $m_h^- \to \theta^-$ are the dynamic adjustment patterns.

3.2 Data Source

This study uses quarterly data of real agricultural output growth (AGDPg) and private sector credit to agriculture (SCA) from 1992Q1 to 2015Q4. All data are obtained from the CBN Statistical Bulletins of various editions.

4.0 Empirical Analysis and Results

4.1 Descriptive Statistics

Prior to the econometric estimation, we examined the statistical characteristics of the variables used in this study. Table 1 shows the descriptive statistics of real agriculture output growth (AGDPg) and log of private sector credit to agriculture (LSCA) over the sample periods.

Table 1: Summary Statistics of AGDPg and LSCA (1992Q1 – 2015Q4)

STATISTICS	AGDPG	LSCA
Mean	182.7577	4.822175
Median	4.211784	4.767145
Maximum	4.686547	5.685695
Minimum	-8.359329	3.656989
Std. Dev.	860.8128	0.473299
Skewness	4.620656	0.037795
Kurtosis	22.464700	2.607672
Jarque-Bera	1857.106	0.638541
Probability	0.000000	0.726679
Sum	17544.74	462.9288
Sum Sq. Dev.	70394874	21.28109
Observations	96	96

The descriptive statistics shows an average growth of 182.76% for agricultural production between 1992Q1 and 2015Q4, while total credit to agricultural sector averages about 4.82%. The Jarque-Bera estimates show that LSCA is relatively normally distributed across the period with a kurtosis of 2.61 which is approximately 3. Agricultural production growth on the other hand tends to be positively skewed with a maximum of 4.69% and a minimum of -8.36%. The kurtosis of 22.47 shows that it has a leptokurtic distribution as validated with the estimated value of the Jarque-Bera test of normality.

4.2 NARDL Estimation Results

Prior to the estimation, we carried out unit root tests to determine the order of integration of the series. This is to ensure that the stationary conditions of the series are sufficient for the application of ARDL technique. The results of the Augmented Dickey-Fuller (ADF) unit root tests are as presented in Table 2.

Table 2: Unit Root Test Result

Null Hypotheses: 1. AGDPG has a unit root 2. LSCA has a unit root		AGDPG		LSCA			
		Level		Level		1st Difference	
		t-Statistic	Prob.[a]	t-Statistic	Prob.[a]	t-Statistic	Prob.[a]
Augmented Dickey-Fuller test statistic		-3.028122	0.036	-1.8669	0.3465	-14.24271	0.0001
Test critical values:	1% level	-3.5039		-3.501445		-3.5014*	
	5% level	-2.8936**		-2.892536		-2.8925**	
	10% level	-2.5839***		-2.583371		-2.5834***	
(*) = Not Sig. at 1% level; (**) = Not Sig. at 5% level; (***) = Not Sig. at 10%							
[a]MacKinnon (1996) one-sided p-values.							

The result in Table 2 shows that AGDPG is stationary at level, while LSCA is stationary after first difference. This is the justification for adopting ARDL approach to cointegration. In the case of maximum lag selection, we followed a general-to-specific lag selection technique, and the maximum dependent and dynamic regressors lags were selected using Akaike Information Criterion (AIC).

Table 3 shows the selected ARDL optimal model used with the maximum lag selection via a general-to-specific lag selection technique, and the maximum dependent and dynamic regressors lags selected using Akaike Information Criterion (AIC) was ARDL(4,0,4). The selected model is as presented in Table 3.

Table 3: Selected Model -Asymmetric ARDL(4,0,4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(AGDPG(-1))	0.213357	0.104187	2.047832	0.0439
D(AGDPG(-2))	0.347497	0.103027	3.372875	0.0011
D(AGDPG(-3))	0.285802	0.102567	2.786505	0.0067
D(LSCA_NEG)	-59.72571	1702.06	-0.03509	0.9721
D(LSCA_NEG(-1)	5501.876	1681.244	3.272503	0.0016
D(LSCA_NEG(-2)	1423.53	1807.695	0.787484	0.4333
D(LSCA_NEG(-3)	-3745.582	1783.381	-2.100271	0.0389
C	267.566	243.0213	1.100998	0.2742
LSCA_POS(-1)	-916.4871	575.7408	-1.59184	0.1154
LSCA_NEG(-1)	-1878.533	1073.317	-1.750213	0.0839
AGDPG(-1)	-0.533106	0.101317	-5.261762	0.0000
R-squared	0.380366	Mean dependent var		0.020829
Adjusted R-squarec	0.302912	S.D. dependent var		656.9583
S.E. of regression	548.5063	Akaike info criterion		15.5652
Sum squared resid	24068734	Schwarz criterion		15.86871
Log likelihood	-697.2166	Hannan-Quinn criter.		15.68765
F-statistic	4.910851	Durbin-Watson stat		1.878324
Prob(F-statistic)	0.000016			

The result of a cointegration test for the nonlinear specifications is presented in Table 4. The result shows that there is evidence of long-run relationship between agricultural output growth and the deposit money bank credit to agricultural sector.

Table 4: Bounds-test for Nonlinear Cointegration

Null Hypothesis: No long-run relationships exist		
F-statistic	95% Lower Bound	95% Upper Bound
7.169678**	3.1	3.87

** Significane at 5% critical value bounds

Further to these analyses, we investigated the asymmetric characteristic of the credit and the result is presented in Table 5

Table 5: Analytical Summary for Asymmetry Test

stimated Coefficients		
Parameter	Estimate	Prob
ρ	-0.533216	0.000***
β^{+}	-1914.935	0.0774
β^{-}	-3879.323	0.0507
π_0^{+}	211.8573	0.8983
π_0^{+}	4670.305	0.1257
$\sum_j^{p-1} \pi_j^{+}$	-1021.074	0.1096
$\sum_j^{q-1} \pi_j^{-}$	211.8573	0.8983

Symmetry Tests		
$\beta^{+} = \beta^{-}$	4.766232	0.029**
$\pi^{+} = \pi^{+}$	0.573686	0.4488
$\sum_j^{p-1} \pi_j^{+} = \sum_j^{q-1} \pi_j^{-}$	1.093182	0.2958

*** and *** indicate significance at 5%.and 1%, respectively*

The upper panel of analytical result in Table 5 shows that at 5% level of statistical significance, increase or decrease in private sector credit allocation to support agricultural production does not yield any significant output in the short run. This implies that there is a nonlinear relationship between private sector credit and agricultural output growth in the long run. From the lower panel of Table 5, the null hypothesis of no asymmetry in the long-run coefficients $(\beta_X^{+} = \beta_X^{-})$ could not be accepted while that of the short-run $(\pi_j^{+} = \pi_j^{-})$ could not be rejected. In other word, the result in Table 5 shows evidence of asymmetry in the long-run coefficients, upholding the NARDL specification of Equation (8). The results also show that variation in credit allocation imposes different long-run equilibrium relationships on agricultural output growth in real terms. This impact is captured by the patterns of the dynamic adjustment from initial equilibrium to the new equilibrium as shown in the long-run multiplier (Figure 1).

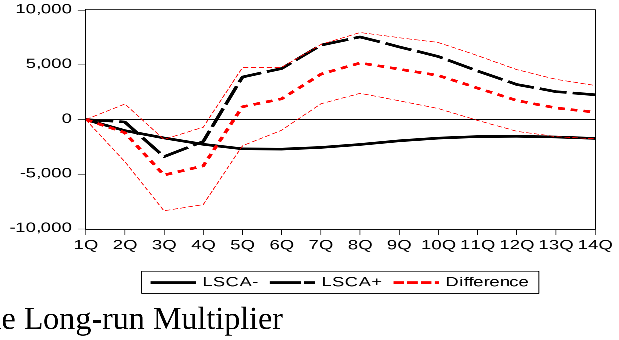

Figure 1: The Long-run Multiplier

It is clear from Figure 1 that the cumulative growth of agricultural output continued to be attracted to increased allocation of credit after the 3rd quarter. This suggests, at least initially, that there exist a nonlinear trend in the relationship. In Figure 1, the upper (lower) solid dashed line represents the cumulative dynamics of agricultural output growth with respect to a 1% increase (decrease) in credit to agricultural sector, the difference between positive and negative responses indicates the asymmetry, while the thin dash lines provide bootstrapped 95% confidence intervals. Hence, drawing inference with a nonlinear relationship will provide more insight on the impact of credit on agricultural output growth. The NARDL long-run relationship is presented in Table 6.

The NARDL estimates in Table 6 extricate interactions between real agricultural output growth and private sector credit to agriculture in both the short-run and long-run periods. The estimated coefficient of the error correction term indicates that credit to agricultural sector exhibits a significant impact on agricultural output growth in the long run.

Table 6: NARDL Cointegrating and Long Run Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(AGDPG(-1))	0.212072	0.102072	2.077665	0.0409
D(AGDPG(-2))	0.338859	0.1006	3.368363	0.0012
D(AGDPG(-3))	0.286326	0.101119	2.831572	0.0059
D(LSCA_POS)	-712.102646	1045.812944	-0.680908	0.4979
D(LSCA_NEG)	169.189348	1525.007382	0.110943	0.9119
D(LSCA_NEG(-1))	5487.811215	1557.807056	3.52278	0.0007
D(LSCA_NEG(-2))	1705.810934	1541.932226	1.106281	0.2719
D(LSCA_NEG(-3))	-3551.551622	1567.437411	-2.265833	0.0262
CointEq(-1)	-0.535576	0.098419	-5.441809	0.0000

Cointeq = AGDPG - (-1914.9350*LSCA_POS -3879.3231*LSCA_NEG + 647.52

Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LSCA_POS	-1914.935024	1070.269346	-1.789209	0.0774
LSCA_NEG	-3879.323084	1955.768974	-1.983528	0.0507
C	647.52301	501.972586	1.289957	0.2008

The estimates in Table 6 specify the asymmetric long run relation between the private sector credit and agricultural output growth with the speed of adjustment of about 0.536 in absolute value, which indicates about 54% of the adjustment towards the long-run equilibrium per quarter. There is a pass-through of credit to agricultural output growth, and this is in line with existing literature (e.g. Agunuwa, Inaya and Preso (2015), Ammani, A. A. (2012) and Udoka, Mbat and Duke (2016)), however, this study contradicts the relationship being linear. The asymmetry in the long-run relationship implies that any inference based on linear relationship may be an error in inference, and hence leads to misinformation in policy formulation.

5.0 Conclusion and Policy Implications

This paper has employed one of the recently developed econometric techniques to examine the relationship between private sector credit to agriculture and agricultural output growth in Nigeria. Considering the precariousness in credit allocation, which may be due to liquidity crunch, to determine credit impact on agricultural output growth, we employed a dynamic model of autoregressive distributed lag type called nonlinear ARDL (NARDL). This approach captures the nonlinear characteristic of credit and is not affected by serial correlation, but captured both the short-run and long-run asymmetries in the transmission mechanism simultaneously and in a coherent manner. Our findings suggest that in the short-run, credit unevenness (positive and negative) has no significant impact on agricultural output growth but imposes different long-run stability relationships on agricultural output growth. In particular, we find that credit is statistically significance at 10% level in predicting real agricultural output with about 54% of adjustment towards the long-run equilibrium per quarter. This conclusion is consistent even when there is volatility in the credit content. The dynamic adjustments show that the cumulative agricultural output growth is mostly attracted by the impact of the positive changes in credit to agriculture with a lag of four quarters of the prediction horizon.

These results underscore the importance of using NARDL approach in examining the credit – output relationship. Based on the results therefore, it would be worthwhile to increase access to credit to agriculture to boost agricultural production, but with proper monitoring on such credit to ensure that it is optimally used. There is also need for a policy on moratorium on credit administration to agricultural sector. In other word, beneficiaries of agriculture credit should be given a one year grace period before commencement of repayment.

This work has added credence to earlier conclusions about the predictive ability of private sector credit on output. Further work is therefore needed to understand the extent to which different components of agriculture, as well as other sectors' output, react under asymmetric credit elasticity in each sector.

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