International Journal of Food and Agricultural Economics
ISSN 2147-8988, E-ISSN: 2149-3766
Vol. 10, No. 3, 2022, pp. 225-234

NEXUS OF AGRICULTURAL CREDIT AND SUSTAINABLE FOOD PRODUCTION IN NIGERIA: APPLICATION OF A MODIFIED REGRESSION MODEL

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Abstract

It is time for Nigeria to feed Nigerians with the aim of actualizing the United Nation's Sustainable Development Goals in the area of zero hunger (food security). Recent statistics show increasing food insecurity issues; the global COVID 19 pandemic has further worsened the country's food (in)security situation. This study econometrically assessed the nexus of agricultural credit and sustainable food production in Nigeria. Secondary data on variables of interest were gotten from World Development Indicators (WDI) of the World Bank and other relevant bodies. The data were analyzed using Unit Root Test (URT) and the Fully Modified Ordinary Least Square (FMOLS). The study revealed that Agricultural Credit Guarantee Scheme Fund (ACGSF) and loan to agriculture from the commercial banks statistically and positively influenced food security within the study period. Lending interest rate and official exchange rate inversely influenced food security. The study concluded that credit is key to achieving self-sufficiency in food production. The post estimation tests on the models confirmed that policy implications from this study are applicable to improving food security. Proper and efficient policy mix to support agricultural production including provision of credit was recommended.

Keywords: *Agricultural credit, food security, SDG 2, food production, interest rate, exchange rate*
JEL Codes: *Q01, 14, 18*

1. Introduction

The Food and Agriculture Organization, FAO (2019) statistics revealed that over 7 million Nigerians are food insecure. Significant proportion of this population rely on agricultural related activities for their income. Consequently, the FAO and World Food Programme (WFP) in 2018 positioned that, to meet the world's food demand-supply gap, projected to rise by 60 per cent in 2050, agricultural output ought to increase by more than 70 per cent. To attain national self-sufficiency in food production (national food security), Nigeria must prioritize agriculture through budgetary provisions and efficient implementation of relevant policies and programmes.

In Nigeria, there is recent attention on the diversification of the economy from the usual 'one-way' revenue system (exportation of crude petroleum) to other viable and sustainable sectors such as agriculture. The diversification involves various government actions and inactions. Furthermore, the place of credit and agricultural commodity prices cannot be overemphasized. The government has the responsibility of stabilizing the economy, regulating the economy, and distributing resources. Part of the regulatory and stabilization roles include various agricultural policies and programmes. There are also concerted efforts on rural infrastructural development and credit access to ensure self-sufficiency in food production.

Most existing empirical studies on food security and its drivers (see for example, Kumar & Sharma, 2013; Demeke *et al*., 2011) used aggregate values for food security while few used different indicators. Badolo and Kinda (2011) established the relationship between climatic shocks and food security from 1960-2008 for 77 developing countries. The authors used malnutrition and food production as food security indicators. However, giving over 200 definitions of food security as reported in existing literature, this study will disaggregate food security and use various proxies to accommodate key elements or indicators in the definition of food security. Edoja *et al*. (2016) used Johansen cointegration to establish the long run relationships among CO_2 emission, agriculture, and food security in developing countries, with focus on Nigeria between 1961 and 2010. Based on economic theory, this present study focused on key indicators of food security such as agricultural output and per capita food production.

Most reviewed studies on agricultural credit and agricultural growth also do not give preference to economic theories which are identified as key to economic research. It is expected that and as contribution to knowledge, research should validate previous research either by accepting or refusing existing theories. In addition to the scope and conclusions arising from previous researches which may not be applicable to contemporary economic challenges, most previous studies lacks the appropriate estimation techniques which may lead to misleading conclusion. The Ordinary Least Square (OLS) technique are mostly employed in most studies without taking note of spurious regression caused by non-stationary variables (see: Bahsi & Cetin, 2020; Okafor, 2020; Saheed, *et al.*, 2018; Orok & Anyim, 2017; Anyanwu, *et al*., 2017; Onyishi, *et al*., 2015; Zakaree, 2014; Udih, 2014; Adetiloye, 2012; Iqbal, *et al*, 2004). The conclusions and policy recommendations of these studies may be misleading. The FMOLS model used in this study has some econometric advantages over the OLS regression model. According to Arinze *et al*. (2015; 2000), FMOLS fix the serial correlation and heteroskedasticity issues with time series data and produce normal t-statistics.

2. Theoretical Background and Literature Review

This study adopted the Loanable Funds Theory (LFT) to explain the nexus of credit policy and food security in Nigeria within the period under study. LFT is a neoclassical real and monetary theory of interest championed by Wickells and Robertson. It is an improvement over the classical theory of interest and positioned that the cost of capital (rate of interest) depends on the demand and supply of loanable funds (Wicksell, 1907 and Robertson, 1936 and 1937). Classical theory of interest focused on saving out of current income in the supply of saving. However, the neo-classical school of taught focused on both saving, bank credit, dishoarding and disinvestment (Pal, 2018). The major assumptions of LFT are: fully integrated market with specific features; perfectly competitive market which leads to the prevalence of one interest rate; flexible interest rate; flow of demand and supply of funds that are loanable; assumption on full employment of productive resources; and the role of money in interest rate determination.

The relevance of credit to Nigeria's agricultural sector is not in doubt. Its provision is an effective policy thrust that drives agricultural commercialization and food self-sufficiency (Zakaree, 2014). Furthermore, it is on record that, food security implies sustainable food production as well as income to meet dietary needs at the household, local, sub-national and national levels (Abdul-Jalil, 2015). Agricultural credit facility to farmers could come as resources (input and capital) that will propel increased food production.

Undoubtedly, credit financing deficit remains a bane to agricultural development in Nigeria. Against this background, several authors (see for example: Mubaraq *et* al. 2021; Eyo *et al*. 202; Bahsi & Cetin, 2020; Reuben, Nyam & Rukwe, 2020; Osabohien, *et al.*, 2018; Okafor, 2020; Anyanwu *et* al., 2017) adopted various econometric approach (threshold regression, OLS technique, the Autoregressive Distribution Lag - ARDL econometric approach, and the nonlinear autoregressive distributed lag - NARDL) and found a direct relationship between credit and agricultural development.

Nakazi and Nathan (2020) applied the Autoregressive Distributed Lag (ARDL) approach to examine the impact of the commercial banks' credit on agricultural sector growth. The study found that, credit significantly and positively influenced agricultural output in the long run. In a household survey study, Fowowe (2020) adopted the Generalized Household Survey (GHS) panel data set to report that financial inclusion and agricultural productivity are positively and significantly related. Osabohien *et al.* (2020) used the propensity score matching (PSM) technique from a cross-sectional data to show that households with access to credit have better yields than households without access to credit.

3. Methodology

3.1. Data Description

The study area is Nigeria; a West African country which has a population of more than 200,000,000 people (growth rate of 2.58 per cent by the National Population Commission, 2006). The country has spatial population distribution with about 63 per cent dwelling in rural areas and 37 per cent in the urban areas (National Bureau of Statistics, NBS, 2017). The two major seasons are; the wet season which lasts from April to October, and the dry season which lasts from November through March.

Secondary data for 1960-2020 on Nigeria's agricultural sector policy, agricultural output, per capita food production, loan to the agricultural sector, cost of capital, official exchange rate, public spending, and other relevant data in this study were gotten from the publications of: FAO, World Bank, Food and Agriculture Organization (FAO), and the Central Bank of Nigeria (CBN).

3.2. Analytical Framework and Statistical Model

Following Phillips and Hansen, (1990), the Fully Modified Ordinary Least Square; FM-OLS regression model is an estimator that adopts a partial parametric correction to handle the related long-run relationship issues among cointegrating and stochastic regressors equations. The FMOLS largely helps to overcome the main weakness of the static ordinary least squares and has a feature which enables standard Wald tests using asymptotic chi-square statistical inference (Omojimite, 2012).

The FMOLS method produces reliable estimates. This model was introduced for estimating a single co-integrating relationship that has a combination of I(1). It has an advantage over other techniques like the Engle-Granger (EG) in introducing appropriate correction to overcome the inference problem of the EG (Himanshu, 2007). The Kernel estimators of the Nuisance parameters is utilized by the FMOLS (Rukhsana & Shahbaz, 2008).

FMOLS has some econometric advantages over the traditional OLS for many reasons; among these reasons as highlighted by Arize *et al*. (2015) are:

- The estimates of the traditional OLS are consistent. Consequently, the t-statistic gotten without stationary or 1(0) terms are not econometrically reliable.
- The estimates of the traditional OLS usually suffer from serial correlation and heteroskedasticity. Hence, the 't' statistics for the estimates of OLS are spurious.
- FMOLS handles the problem of endogeneity by adding leads.

FMOLS was used to understand the nexus of agricultural credit and food security in Nigeria within the study period as specified in equation 1 – equation 4. The explanatory variables in these models were chosen in line with the theoretical background and literature reviewed in this study.

FMOLS Model 1

$$AGO_t = f(AGS, CBA, LIR, OER, IFR)] \quad (1)$$

FMOLS Model 2

$$PCF_t = f(AGS, CBA, LIR, OER, IFR)] \quad (2)$$

Equations 1 and 2 could be explicitly written as:

$$AGO_t = \beta_0 + \beta_1 AGS + \beta_2 CBA + \beta_3 LIR + \beta_4 OER + \beta_5 IFR + \mu_{it} \quad (3)$$

$$PCF_t = \beta_0 + \beta_1 AGS + \beta_2 CBA + \beta_3 LIR + \beta_4 OER + \beta_5 IFR + \mu_{it} \quad (4)$$

Where

AGO_t = agricultural output, PCF_t = per capita food production, AGS = Agricultural Credit Guarantee Scheme Fund, CBA = Commercial Bank Credit to the Agricultural Sector, LIR = Lending Interest Rate, OER = Official Exchange Rate, and IFR = Inflation Rate

The stationarity tests statistics (Augmented Dickey-Fuller; ADF and the Phillips- Peron; PP) are based on the test regression in equation 5.

$$Y_t = \alpha_0 + \beta_1 Y_{t-1} + \sum_{i=1}^{k} \lambda_i \Delta Y_{t-1} + ei \quad (5)$$

Where;

Δ = the first – difference operator, Y = the variable under consideration, α_0, β_s and $\lambda 1$ = parameters to be estimated and e_i = the error term.

4. Results and Discussion

Prior to the estimation of the impact of credit on food security, the included variables in the model were subjected to stationarity tests (see Table 1). Decision was made based on the outcome of the Philips-Perron (PP) unit root test as presented in Table 1. On application of PP test, all the variables attained stationarity after differencing. Following Philips and Hansen (1990), the FM-OLS is used for estimating series that are I(1). Further econometric test (cointegration) was conducted to ensure the series do not have a long run relationship. Hence,

the FM-OLS was used to establish the nexus of agricultural credit and food security as summarized in Table 2.

Table 1. Result of ADF and PP Tests

Variables	Augmented Dickey-Fuller				Phillips – Perron				Decision
	ADF stat	Prob.	Critical value@ 5%	Order	PP Stat	Prob.	Critical value @ 5%	Order	
AGO	-3.407342	0.01460**	-2.912631	Δ I(1)	-10.88099	0.0000***	-2.911730	Δ I(1)	STN
PCF	-3.452359	0.0130**	-2.912631	Δ I(1)	-11.17025	0.0000***	-2.911730	Δ I(1)	STN
AGS	-8.148200	0.0000***	-2.912631	Δ I(1)	-12.96971	0.0000***	-2.911730	Δ I(1)	STN
CBL	-1.896286	0.3318	-2.912631	Δ I(1)	-6.443329	0.0000***	-2.911730	Δ I(1)	STN
LIR	-3.342756	0.0174**	-2.913549	Δ I(1)	-8.620612	0.0000***	-3.487845	Δ I(1)	STN
OER	-5.125240	0.0001***	-2.911730	Δ I(1)	-5.094225	0.0001***	-2.911730	Δ I(1)	STN
IFR	-13.13693	0.0000***	-2.911730	Δ I(1)	-53.11618	0.0001***	-3.487845	Δ I(1)	STN

Source: Author's Computation using EViews 11

Note: Δ = difference operator, STN=Stationary, *** and ** = figures are significant at 1% (P < 0.01) and 5% (P < 0.01) level of significance, respectively.

Table 2 shows that, the test for model fitness gave an R squared values of 0.98 each, for AGO and PCF; which implies that 98% each, of variations in agricultural output and per capita food production, were accounted for by variability in the explanatory or independent variables in the regression model. The Adjusted R^2 values implies that all the explanatory variables can only explain 98 per cent, each of the total variation in agricultural output and per capita food production.

Table 2. FM-OLS parameter estimates to model the effect of credit variables on food security indicators in Nigeria, 1960 – 2020

Variables	AGO		PCF	
	Coeff.	Std. Err.	Coeff.	Std. Error
LNAGS	0.3816 (3.81)***	0.1002	0.0133 (0.91)NS	0.0146
LNCBA	0.0954 (2.95)***	0.0285	0.0655(1.76)*	0.0371
LNLIR	-0.0211 (-0.28)NS	0.0742	-0.0081 (-0.08)NS	0.0953
LNOER	-0.1629 (-4.24)***	0.0385	-0.1891 (-3.83)***	0.0494
LNIFR	0.0153 (1.29)NS	0.0118	0.0178 (1.17)NS	0.0153
C	16.3558 (103.89)***	0.1574	3.1711 (15.69)***	0.2021
	R – Squared = 0.985		R – Squared = 0.983	
	Adj. R-Squared = 0.984		Adj. R-Squared = 0.981	
	Jarque – Bera = 0.0389 Probability = 0.9807 Kurtosis = 2.9		Jarque – Bera = 0.4636 Probability = 0.7931 Kurtosis = 3.0	
Remark on correlogram Residuals Squared	Significant @ 5% only in the first 1 but not sig. thereafter		Significant @ 5% only in the first 2 but not sig. thereafter	

Source: Author's Computation using EViews 11

Notes: *** and ** = figures are significant at 1% (P < 0.01) and 5% (P < 0.01) level of significance, respectively. NS = Not Significant. LN = Natural Logarithm.

Figures in parentheses are t-values.

AGO = Agricultural Output, PCF = Per Capita Food Production, AGS = Agricultural Credit Guarantee Scheme, CBA = Commercial Bank Credit to the Agricultural Sector, LIR = Lending Interest Rate, OER = Official Exchange Rate, IFR = Inflation Rate.

The post estimation tests conducted revealed that the correlogram of the residuals squared did not show significant values at 5 per cent for majority of the lags; implying that the threat of serial correlation at the various lags examined in the study was not severe in the model. Further diagnosis of the model (Table 2) shows that the model also had residuals which were normally distributed with insignificant Jarque Bera statistic in each case, thus affirming that the distribution of the residuals of the estimated model was normal.

The slope coefficient of Agricultural Credit Guarantee Scheme Fund (ACGSF) was positive across the food security indicators within the study period. It was not significant in influencing per capita food production, but was however significant at 1 percent level of measurement in influencing agricultural output. The direct relationship implies that a percent increase in ACGSF leads to a 38.2 per cent increase in agricultural output vis-à-vis food security. The outcome of this study corroborates the mandate of the scheme and theoretical framework underpinning credit availability and food security.

The ACGSF is one of the key credit policies of the Federal Government of Nigeria and has shown to directly influence agricultural output. The ACGSF operation in 1978 has the Federal Government holding 60% and Central Bank of Nigeria 40% of the shares. The focus of ACGSF is to encourage banks to increase and sustain lending to agriculture. Bank loans to farmers under the ACGSF are guaranteed 75% against default by the CBN (CBN, 2020). The results of this study is in tandem with Reuben *et* al. (2020) and Eyo *et al.* (2020) when they reported a direct relationship between ACGSF and agricultural output. Osabohien *et al*. (2018) also found a positive correlation between ACGSF and depth of food deficit in Nigeria. The result also corroborate Paul *et al*. (2018) who found that agricultural credit enhances agricultural productivity. This finding is an indication that the ACGSF encourages agricultural commercialization with a multiplier effect on greater agricultural output and per capita food production.

The slope coefficient of commercial bank loan (CBA) to the agricultural sector was positively signed across the food security indicators. The relationship is significant at 1 per cent and 10 per cent in influencing agricultural output and per capita food production, respectively. The direct relationship (positive sign) implies that a per cent increase in bank loan to the agriculture will lead to a per cent increase in national food security. Pointedly, one per cent increase in commercial bank loan to the agricultural sector increases agricultural output and per capita food production by 9.5 per cent and 6.6 per cent, respectively. This finding follows the *a priori* expectation. Commercial banks serve as key agents in lending to the agricultural sector and such lending remains critical to economic growth and food production. The result of this study agrees with the common Keynesian postulation – an increase in investment or expenditure gives rise to multiple increase in output, vis-à-vis agricultural output. The result of this study further corroborates the position of Qureshi *et al.* (2004) that, bank credit provides incentives to enable famers adopt recommended production technologies, which encourages productivity and growth. The finding also agrees with Ojiya *et al* (2017) who found that one per cent increase in agricultural credit available to farmers leads to about 3 per cent increase in agricultural productivity in Nigeria. Further, Osabohien *et al.* (2020), Nakazi and Nathan (2020), Okafor (2020), Emenuga (2019), and Anyanwu *et al*. (2017) found similar result on bank credit to the agricultural sector and agricultural development (output).

The slope coefficient of lending interest rate (LIR) was negatively signed in influencing food security within the period under study. The inverse relationship is an indication that a per cent increase in lending interest rate will lead to a per cent decrease in food security. On the specifics, the variable did not significantly influence agricultural output and per capita food production in the country. The outcome of this study on lending interest rate and food security is not surprising. High interest rate may affect borrowers' willingness to access fund for production activities that will improve welfare. The interest rate in Nigeria' financial

institutions has undergone series of changes by different administrations through the country's monetary regulator, the CBN. Each of these changes have different implications on the interest rate. Following the basic economic principle; high interest rate increases lending and decreases borrowing. The insignificant relationship between lending interest rate and agricultural output agrees with the pattern (interest rate and economic output) reported by Malede (2014) in Ethiopia and Osabohien *et al* (2018) in Nigeria.

Table 2 also shows that the slope coefficient of official exchange rate (OER) negatively influenced food security in Nigeria within the period under study. From the result, a per cent increase in OER will lead to a 16.3 per cent and 18.9 per cent decrease in agricultural output and per capita food production, respectively. This result follows the *a priori* expectation. Exchange rate is a key variable in investment decision in agriculture; especially commercial agricultural production and value addition along the production line. The outcome of this study agrees with basic economic theories (see for example; the interest rate parity theory, purchasing power parity, traditional flow theory, amongst others). These theories suggest that investment decisions are based on macroeconomic uncertainty such as the exchange rate. The established effect of exchange rate on agricultural output and per capita food production could also affect international trade and the general economy of Nigeria. The finding of this study agrees with Fatbardha *et al*. (2020) who found a significant inverse relationship between OER and real economic growth.

The slope coefficient of inflation rate (IFR) was positively signed and insignificant in influencing food security indicators used in this study. From Table 2, a per cent increase in IFR will increase agricultural output and per capita food production by 1.5 per cent and 1.8 per cent, respectively. The role of inflation in self-sufficiency in food production vis-à-vis food security cannot be over emphasized as it is usually caused by the shortage of goods and services used in production with a resultant effect on rise in prices occasioned by supply shocks of specific food items. This is in accordance with Keynesian theory which posit that inflation is associated with increase in demand and in cost. The finding of this study on inflation and food security is in contrary with the *a priori* expectation as higher inflation rate could be associated with increased poverty level since more than half of the budget of low wage earners goes toward food. In explaining the nexus of inflation and agricultural productivity, Olatunji *et al*. (2012) posited that inflation is due to changes in agricultural productivity and not vice-versa. The authors found a positive relationship between agricultural output change and inflation rate.

5. Conclusion and Policy Implications

The motivation for this study stems from the need to add to exiting empirical findings that will help in proffering evidence based solutions to the issue of food security, as the study established the nexus of agricultural credit and food security in Nigeria. It can be inferred from findings of this study that Agricultural Credit Guarantee Scheme Fund (ACGSF) and bank loan to agriculture were statistically significant and positively influenced food security; while lending interest rate and official exchange rate inversely influenced food security. An increase in ACGSF and bank loan to agriculture will increase agricultural output and per capita food production. However, agricultural output and per capita food production decreases with increase in lending interest rate and official exchange rate. Policy implications based on findings from this study are:

- The ACGSF positively impacted food security within the period under study. This calls for continuous financing of the ACGSF by the Nigerian government and appropriate monitoring of banks' lending interest rates imposed on credit facilities.

- Commercial banks' credit to agriculture and food security were directly related. This underscores the relevance of credit to Nigeria's agriculture. The Central Bank of Nigeria (CBN) should further reduce the cost of agricultural borrowing to encourage commercialization.
- The negative effects of interest rate on food security found in this study further underscores the need for financial regulator and government to implement relevant policy in reducing cost of capital, as this will increase agricultural investments and thus reducing food insecurity in the country.

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