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Sunday B. Akpan[1✉], Edet J. Udoh[2], Veronica S. Nkanta[3]
[1] Akwa Ibom State University, Nigeria
[2,3] University of Uyo, Nigeria

Agricultural Credit Policy and Livestock Development in Nigeria

Abstract. This research aimed to provide empirical information on the relationship between the livestock production index and the credit policy environment in Nigeria. Time series data were used, and an autoregressive distributed lag (ARDL) bound test approach was adopted to establish the presence of co-integration among series. The estimated long and short run models showed stability, best quality, efficiency and unbiased. The findings showed that in the long run, total credit to the agricultural sector from commercial banks and domestic credit to the private sector both had significant positive influence on livestock production, while agricultural credit guarantee scheme loans to livestock units exhibited a negative impact. In the short run, agricultural credit guarantee scheme loans to livestock, lending interest rate, and domestic credit to the private sector negatively relate to livestock production. However, the commercial banks' total credit to the agricultural sector showed a positive effect on livestock production in the short run. The implication of the findings indicates a need to increase total commercial credit to the agricultural sector and domestic credit to the private sector, to reassess the agricultural credit guarantee scheme, and to lower the lending interest rate for agricultural credit – these as a means for increasing livestock production in the country.

Keywords: livestock, credit, agricultural policies, economic growth, Nigeria

JEL Classification: Q14, Q18

Introduction

Agricultural credit is recognized as an essential tool for promoting agricultural production, especially among poor rural farmers who constitute the bulk of farming populations in most developing countries (Idiong et al., 2010; Akpan et al., 2012; Jeiyol et al., 2013; Akpan et al., 2020). Access to agricultural credit has been positively linked to agricultural productivity in several studies in Nigeria (Akpan et al., 2013; Awotide et al., 2015; Abu, et al., 2017; Adewale et al., 2022). Despite this positive correlation, several empirical studies have revealed cases of credit insufficiency among rural farmers in Nigeria (Adebayo &Adeola, 2008; Ololade &Olagunju, 2013; Assogba et al., 2017; Asom et al., 2023). Credit is regarded as an important instrument for generating income, mobilizing resources, and creating a competitive production and economic environment (Akpan et al., 2012; Akpan et al., 2013; Essien and Arene 2014). Credit is critical since most farmers are resource-poor, and agricultural production and processing are time-bound. Beck and

[1] Department of Agricultural Economics and Extension, Akwa Ibom state University, Ikot Akpaden, Mkpat Enin, Akwa Ibom State, Nigeria; e-mail: sundayakpan@aksu.edu.ng; https://orcid.org/0000-0002-0458-028X; Corresponding author
[2] Department of Agricultural Economics and Extension, University of Uyo, Nigeria; https://orcid.org/0000-0002-4550-4320
[3] Department of Agricultural Economics and Extension, University of Uyo, Nigeria; https://orcid.org/0000-0001-7035-7978

Demirguc-Kunt, (2006), noted that the provision of credit enhances the welfare of the vulnerable through income smoothening. According to Jeiyol et al., (2013) and Akpan et al., (2013), credit is an essential ingredient of sustainable agricultural production and processing; as such its accessibility and demand are prerequisites for attaining the national goal of reducing rural poverty, creating sustainable employment, and ensuring self-sufficiency in food production in the country.

In response to these assertions, the Federal Government of Nigeria has in the past initiated various agricultural credit policies and programs to improve agricultural production by providing cheap and subsidized financial resources to farmers at a concessional interest rate (Akpan et al., 2012). For example, community banks were introduced into the country's financial landscape in 1990 to provide banking and financial services to the rural economy and micro-enterprises in urban centers. In 1996, the Central Bank of Nigeria issued guidelines for sectoral concessional lending to agriculture (Manyong et al., 2005). In 2009, the Central Bank of Nigeria (CBN), in collaboration with the Federal Ministry of Agriculture and Water Resources (FMAWR), established the Commercial Agriculture Credit Scheme (CACS) to provide finance for agricultural processing, storage and marketing (Olomola & Yaro, 2015). In addition, other credit policies introduced by the Federal government include the Nigeria Incentive-Based Risk Sharing System for Agricultural Lending (NIRSAL) launched in 2011, and the Micro, Small, and Medium Enterprises Development Fund (MSMEDF) launched in 2013 (Salisu and Alamu, 2023). Furthermore, the manipulation of the macroeconomic environment through tools such as exchange rate policy, lending interest rate policy and other monetary and fiscal policy measures have been deliberately used to stimulate growth in the real sector of the economy (CBN, 2022).

Given the incentives provided by the government to farmers and agribusinesses in the country to improve their performance (Akpan et al., 2012), the existence of a dualistic credit market structure that provides flexibility in credit access and demand, as well as the spread of an effective market system, many researchers have reported that the abysmal performance of the agricultural sector is due to insufficient credit to farmers and agribusinesses in the country (Essien &Arene, 2014; Essien et al., 2016; Assogba et al., 2017; Asom et al., 2023). As reported by Essien et al. (2016), Akpan et al. (2016) and Akpan et al. (2019), the low performance of farmers and small agribusinesses would likely increase poverty, hunger, unemployment, and poor living standards for many rural families. Likewise, Adebayo & Adeola, (2008) and Adewale et al., (2022) stated that credit is a good means of acquiring facilities to improve agricultural production to increase participants' income and improve living standards.

In light of the crucial role of agricultural credit in promoting agricultural production, there is a need to establish the empirical connection between the credit policy environment and agricultural production indicators in the country. The livestock subsector is one of the components of the agricultural sector that has played a significant role in rural livelihoods and in the economy of developing countries (Akpan, 2022). Its rich and complex value chain is a source of income and employment for many rural households. The subsector serves as an important capital reserve and safety net for many poor rural agricultural households. Livestock plays a significant role in rural household dynamics and family social status. The subunit also contributes to global protein and energy supplies (Herrero, et al., 2013; Varijakshapanicker et al., 2019; Hennessy et al., 2021; Pexas, et al., 2023). In mixed and integrated farming systems, complementary relationships between livestock and crops have contributed to both the intensification and diversification of farmers' income streams (Thornton et al., 2002). Given these myriad contributions of the livestock subsector to the Nigerian economy, there is an overwhelming need to examine its relationship with the country's credit policy environment. Despite the implementation of several credit policies in the country, Nigerians' protein intake remains well below the WHO recommended standard (Akpan &Udo, 2021; Akpan &Nkanta, 2022; Akpan, 2022). According to Hatab et al. (2019), several development policies and programs for the livestock subsector in sub-Saharan African economies tend to contribute less to livestock production, productivity, poverty reduction, and food security of rural households. According to Oyelade (2019), one of the reasons for the decline in the agricultural sector's contribution to GDP is the lack of access to credit from commercial banks. These claims need to be verified in Nigeria, particularly given the high levels of poverty, malnutrition and increasing food insecurity in the country.

Several authors in developing countries have recognized the importance of the relationship between the credit policy environment and agricultural production and have tried to establish empirical facts. For example, Chisasa and Makina (2013) reported that a 1% increase in credit would stimulate about 0.6% upsurge in agricultural production in South Africa. Khan et al. (2007) claimed in Pakistan that loans disbursed to livestock farmers were grossly misused by the majority of beneficiaries and did not improve their socio-economic characteristics. Later, Khan et al., (2018) found credit as a stimulant to livestock production in the Pakistan region. In Ethiopia, Duguma and Debsu (2019) identified the importance of credit services to livestock production. Similarly, Abedullah et al. (2009); Khan et al. (2018) in Pakistan and Adewale et al. (2022) in Nigeria found a positive relationship between agricultural credit and livestock production and farmers' income. In Nigeria, Olagunju and Babatunde (2011) found a significant positive relationship between the productivity of poultry farmers and credit acquisition. Elsewhere, Rahman et al. (2011) found a strong direct relationship between agricultural credit and animal production (milk, meat, and eggs) in Bangladesh. Also in Nigeria, Kuye (2013) found that microcredit makes a positive contribution to livestock production in the southern region of the country. Using time series, Zakaree (2014) postulated that the Agricultural Credit Guarantee Scheme Fund (ACGSF) operating in Nigeria has a negative and statistically significant impact on domestic food production. In Ethiopia, Shiferaw et al. (2015) identified the positive role of credit for livestock production. When Orok and Ayim (2017) expanded their study on ACGSF in Nigeria, they claimed that the ACGSF has a greater impact on the crop production sub-sector than on the livestock and fisheries sub-sectors. Also, Abu (2017) and Reuben et al. (2020) reported that ACGSF increased the productivity of the livestock subsector from 1981 to 2014. Udoka et al. (2016), Asekome and Ikojie, (2018),and Iliyasu, (2019), found that the lending interest rates impact negatively on agricultural investment in Nigeria. Carrer et al. (2020) highlighted the importance of rural credit policies for the implementation of integrated cropping and livestock production systems in Brazil. Umboh et al. (2021) found that agricultural credit combined with other agricultural inputs increases the productivity of livestock farmers. Salisu and Alamu (2023) asserted that commercial bank lending to agriculture, along with interest rates, has a positive and statistically significant effect on agricultural output in Nigeria.

From the literature reviewed, it appears that the focus of this research in Nigeria has not been adequately addressed. Furthermore, a lot has happened in Nigeria's macroeconomic environment over the last two decades and the country has sunk even deeper into the scourge of poverty and urgently needs proactive policy interventions based on current realities. Therefore, there is a need to update the available information on the relationship between the production of the livestock subsector and the credit environment in Nigeria. In addition, most of the studies reviewed considered a single source of credit for livestock farmers, whereas there are multiple sources with their specific issues. This study differs from other related studies in that multiple sources of credit and enhancers of farm credit (lending rate) are incorporated in the model to isolate their respective impact on livestock production. The findings would have wider implications on the growth of the livestock subsector in developing countries, since agricultural financing is a huge problem in this region. The study therefore specifically sought to establish the empirical relationship between the agricultural credit policy environment and the growth of livestock sub-sectors in Nigeria.

Research methodology

Study area

Nigeria is rich in agricultural resources and over 60 percent of the population is involved in the production of staple foods such as cassava, maize, rice, yams, various beans and pulses, sorghum, ginger, onions, tomatoes, melons, and vegetables etc., (FAO, 2023; Federal Ministry of Agriculture and Food Security [FMAFS], 2023). In Nigeria animal production such as poultry, goats, sheep, pigs and cattle flourished in all regions of the country (FMAFS, 2023). The most important cash crops are cocoa, cotton, peanuts, palm oil and rubber (Federal Ministry of Environment, 2021).

Data source

The study used secondary data from the World Bank, Central Bank of Nigeria and Food and Agriculture Organization (FAO). The data covered the period from 1991 to 2021. The timespan chosen was based on data availability.

Model specification / analytical technique

The contribution of the agricultural credit policy environment to the growth of the livestock subsector (proxy by livestock production index) in Nigeria has been implicitly stated in a Cobb-Douglas form as shown in Equation 1. The specification of the model followed the production theory. Acquired credit is assumed to be used for acquired factors of production such as labor, capital, and land etc. According to Omolade and Adepoju (2019), agricultural credit is directly related to agricultural production factors. Implicitly, agricultural production is a function of agricultural credit. The estimated coefficients of the given model represent the elasticity. However, we consider different categories of credit that are directly or indirectly available to the agricultural sector. In the model, each credit variable was transformed by weighting to reduce the tendency for multicollinearity.

$$LISP\_t = f(ACGL\_t, CAGR\_t, LENR\_t, DCPS\_t) \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where:
$LISP_t$ = Livestock gross production index (2014-2016 = 100) (%);

$ACGL_t$ = Guarantee loan for livestock sub-sector/total fund guarantee by Agricultural Credit Guarantee Fund Scheme (%);
$CAGR_t$= Total credit to the agricultural sector from the commercial bank/economy GDP (%);
$LENR_t$ = National lending rate (%);
$DCPS_t$ = Domestic credit to private sector (% of GDP).

The explanatory variables represent independent credit policy instruments implemented by the Nigerian government over the years. For example, the Agricultural Credit Guarantee Fund was established to guarantee funds/credit to farmers with the Central Bank of Nigeria acting as the sole guarantor (ACGLt) (Umoren et al., 2016 and Umoren et al., 2018). Furthermore, the Federal Government of Nigeria has over the years required commercial banks to disburse a certain proportion of their total loans and advances to the agricultural sector (CAGRt). Additionally, the Central Bank of Nigeria has maintained a market-regulated lending rate in the country to moderate the volume of credit in the economy (LENRt). In addition, the central government has introduced a credit policy that incentivizes the financial sector to stimulate private investment in the real sector of the economy (DCPSt).

The relationship between the agricultural credit environment and livestock growth

The Autoregressive Distributed Lag (ARDL) model was estimated to determine the relationship between livestock growth and variables representing the agricultural credit environment or agricultural credit policy. The ARDL-bound test developed by Pesaran and Shin (1999) and Pesaran et al., (2001) was used to confirm the presence of cointegration among series. After confirming cointegration, the short- and long-run models of livestock growth were estimated. The ARDL-bound model has some advantages compared to the two-stage method of Engle and Granger (1987) and the cointegration method developed by Johansen and Juselius (1990). The ARDL-bound test method is used to handle series with mixed stationary problems (i.e. a mixture of 1(0) and 1(1)). Therefore, the assumption that all series must be integrated in the same order is relaxed. However, ARDL can also be applied to series that are stationary at the level or the first difference. The next advantage is that ARDL test is relatively more efficient for small and finite sample data sizes. The method provided unbiased and sufficient estimates of the long-run model (Harris &Sollis, 2003). The bounds test is a simple technique because, unlike other multivariate co-integration methods, it allows the co-integration relationship to be estimated by OLS once the lag order of the model is identified.

The ARDL model for Equation 1 in logarithm form is expressed as follows in Equation 2:

$$\Delta LISP_t = \beta_0 + \beta_1 \sum_{i=1}^{n_1} \Delta LISP_{t-i} + \beta_2 \sum_{i=1}^{n_2} \Delta ACGL_{t-i} + \beta_3 \sum_{i=1}^{n_3} \Delta CAGR_{t-i} + \beta_4 \sum_{i=1}^{n_4} \Delta LENR_{t-i} + \beta_5 \sum_{i=1}^{n_5} \Delta DCPS_{t-i} + \delta_1 LISP_{t-i} + \delta_2 ACGL_{t-i} + \delta_3 CAGR_{t-i} + \delta_4 LENR_{t-i} + \delta_5 DCPS_{t-i} + U_t \text{ ....(2)}$$

When using ARDL, the dependent variable is assumed to be a vector, and this implies that Equation 2 is also applied to the remaining variables specified in Equation 1. The coefficients from β1 to β5 represent the short-run coefficients, while the coefficients from δ1 to δ5 represent the long-run coefficients of the ARDL model. In addition, β0 is the drift component, n is the maximum lag length, and Ut is the stochastic error term. The bounded F-statistic test was used to verify the presence of a stable, long-term relationship between variables in the model. For instance, if the calculated bound F-statistic in Equation 2 is greater than the corresponding upper critical limits of one of the conventional probability levels defined at 1%, 5%, or 10%, the null hypothesis is rejected, meaning the existence of co-integration relationship. The tested hypothesis is stated as follows:

H_0: $\delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$ (There is no cointegration);

H_α: $\delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq 0$

However, if the value of the F-statistic is below the lower limits, the null hypothesis cannot be rejected, indicating the absence of co-integration. Furthermore, if the F-statistic value is within or between the lower and upper bounds, the result is considered inconclusive (Pesaran et al., 2001). If the bound test shows evidence of co-integration between variables, the long- and short-run models (an error correction model (ECM)) are specified. Using the equation of interest to us, the long-term and short-term models used in the study are given in Equations 3 and 4 respectively as follows:

The long run model:

$$LISP_t = \delta_0 + \delta_1 ACGL_t + \delta_2 CAGR_t + \delta_3 LENR_t + \delta_4 DCPS_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

The short run model (ECM model):

$$\Delta LISP_t = \beta_0 + \beta_1 \sum_{i=1}^{q_1} \Delta LISP_{t-i} + \beta_2 \sum_{i=1}^{q_2} \Delta CAGR_{t-i} + \beta_3 \sum_{i=1}^{q_3} \Delta LENR_{t-i} + \beta_4 \sum_{i=1}^{q_4} \Delta DCPS_{t-i} + \beta_5 \sum_{i=1}^{n_5} \Delta ACGL_{t-i} + \emptyset ECM_{t-1} + U_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where Ø is the error correction term and it measures the speed of adjustment towards the long-run equilibrium, and the remaining coefficients provide the short-run dynamics. To test the performance of the estimated short run model, RESET test, Serial correlation, normality, and heteroscedasticity tests were conducted, whereas the cumulative sum (CUSUM) test was conducted to verify the stability nature of the model.

Results and discussion

Descriptive Statistics

The descriptive statistics of the variables used in the study are presented in Table 1. The coefficient of variability of the variables was less than 50%, implying minimal fluctuations in the specified variables. For example, the loan interest rate and livestock production index had a variability coefficient of 20.14% and 20.08%, respectively. The exponential growth rate values showed that the variables had a single-digit growth rate, implying minimal fluctuations within the study period. However, the Agricultural Guarantee Fund for Livestock Beneficiaries (ACGLt) and Loan Interest Rate (LENRt) had a negative annual exponential growth rate of -3.38% and -1.59%, respectively. This implies that these variables decrease as time increases.

Table 1. Descriptive statistics of variables used in the estimated models.

Variable	Min	Max	Mean	Std. deviation	CV	Skewness	Exponential growth rate (%)
LISP	50.040	103.820	84.472	16.962	0.20080	-0.83950	2.300
ACGL	4.942	20.721	12.279	4.8575	0.39560	0.29799	-3.380
CAGR	15.824	76.661	43.488	19.647	0.45178	0.19264	4.710
LENR	11.483	31.650	18.739	3.7735	0.20137	1.29410	-1.590
DCPS	5.241	19.626	10.446	3.4607	0.33129	0.88032	2.690

Source: Computed by the authors data from the FAO and World Bank.

Unit root test

The study used the ADF test developed by Dickey and Fuller (1979) and the ADF-GLS unit root test developed by Elliott, Rothenberg, and Stock (1996) to confirm the unit root of certain variables. The results for the ADF and ADF-GLS unit root tests are presented in Table 2. The results showed that one variable (LENRt) was stationary at the level, while others were stationary at the first difference for the ADF equation containing constant and trend. However, for the ADF-GLS equation with constant and trend, all specified variables were stationary at the first difference. Since the result gave a mixture of stationarity of the variables (i.e. 1(0) and 1(1)), it implies that the ARDL model can be used to test the co-integration in the given model.

Table 2. ADF and ADF-GLS unit root tests on variables used in the specified equation.

	ADF-GLS (with constant and trend)				**ADF (with constant and Trend)**			
	Lag	**Level**	**1st Diff.**	**Dec.**	**Lag**	**Level**	**1st Diff.**	**Dec.**
LISP	0	-1.4693	-5.6776***	1(1)	0	-1.2386	-6.1430***	1(1)
ACGL	0	-2.6993	-6.3978***	1(1)	0	-2.6004	-6.2492***	1(1)
CAGR	0	-2.9062	-6.1434***	1(1)	0	-2.9158	-5.9859***	1(1)
LENR	0	-3.2602**	-	1(1)	0	-3.1941	-5.7211***	1(1)
DCPS	0	-2.7776	-4.7252***	1(1)	0	-2.8146	-5.2125***	1(1)
		Critical values				**Critical values**		
1%		-3.7700	-3.7700		1%	-4.2967	-4.3098	
5%		-3.1900	-3.1900		5%	-3.5684	-3.5742	
10%		-2.8900	-2.8900		10%	-3.2184	-3.2217	

Note: ***, ** and * indicate 1%, 5% and 1% significance levels respectively. Note, variables are expressed in natural logarithms. Dec. means decision.

Source: computed by the authors.

The optimal lag length of the ARDL Model

Before estimating the ARDL model, the optimal lag length for the series were determined using the appropriate information criteria, i.e. Akaike information criterion (AIC), Schwarz-Bayes criterion (SBC) and Hannan-Quinn criterion. The corresponding lag length is shown in Table 3. The result showed that lag 4 is the best lag for the ARDL model. Figure 3 shows 20 computed ARDL models based on AIC criterion.

Table 3. Optimal lag length of series.

Lags	Loglik	P(LR)	AIC	BIC	HQC
1	54.41897	-	-3.724536	-3.434206	-3.640931
2	55.34065	0.17456	-3.718512	-3.379793	-3.620973
3	59.75960	0.00295	-3.981508	-3.594401	-3.870035
4	63.04103	0.01041	-4.157002*	-3.721507*	-4.031596*
5	63.86913	0.19812	-4.143779	-3.659896	-4.004438

Note: The asterisks below indicate the best (that is, minimized) values of the respective information criteria, AIC=Akaike criterion, BIC=Schwarz Bayesian criterion and HQC=Hannan-Quinn criterion.

Source: computed by the authors.

The ARDL bound test for cointegration

The bound test was used to confirm the presence of cointegration among specified variables in the model. The calculated F-statistic for the selected equation (6.4579) is shown in the upper part of Table 4. The result implies that the calculated F-test at the 1% probability level is greater than the tabulated upper bound of 4.37. This means that there is cointegration among the variables specified. The null hypothesis is rejected in this case.

The finding implies the following: For the equation of the gross production index for livestock, the long-run equilibrium or stability equation exists. Furthermore, the short-run or ECM model was generated to capture the short-run dynamics and identify the speed of adjustment in response to the deviation from the long-run equilibrium. After establishing cointegration for the specified variables, Table 5 shows the long-run coefficients or parameters for the ARDL model.

Table 4. ARDL bound test (restricted constant and no trend).

Equations	Lag	F-Statistic	Decision
F_{LISPt}(LISPt │ ACGLt, CAGRt, LENRt, DCPSt)	(1, 1, 2, 1, 4)	6.4570	Co-integration
	Critical Values at Bound (at K = 4 and Asymptotic: n = 1000)		
Significant level	Lower (1(0)	Upper 1(1)	
10%	2.20	3.09	
5%	2.56	3.49	
2.5%	2.88	3.87	
1%	3.29	4.37	
	Critical Values at Bound (at K = 4 and Finite sample: n = 35		
10%	2.460	3.460	
5%	2.947	4.088	
1%	4.093	5.532	

Actual sample size (n) =27. Null hypothesis: No level relationship.
Source: Extracted from analysis by author.

The estimated long run coefficients of ARDL model

The long-run results showed that the total credit granted to the agricultural sector (CAGRt) by commercial banks has a positive significant association with livestock production with a probability of 1%. This result implies that an increase in total agricultural sector credit per unit will result in a 0.364% increase in livestock production index in Nigeria. The finding also shows the inelastic relationship between total credit to the agricultural sector and livestock production in Nigeria. This means that the change in total livestock production is less than the change in total credit allocated to the agricultural sector by commercial banks in the country. The finding is similar to empirical reports by Khan et al. (2007), Abedullah et al. (2009), Khan et al. (2018), Olagunju and Babatunde (2011), Rahman et al. (2011), Kuye (2013) and Shiferaw et al. (2015).

The results also showed that the guaranteed loan to livestock farms/farmers from the Agricultural Credit Guarantee Scheme Fund (ACGt) has a negative significant correlation with livestock production in the long run with a probability of 1%. This suggests that an increase in the guaranteed loan for the livestock subsector will reduce the productivity index of the subsector by 0.222%. The finding contradicts the a priori expectation. Several factors could be responsible for the occurrence of this result. First, the question of timely provision of the credit facility is a serious issue that needs to be addressed. Since agricultural activities are largely regulated by natural phenomena such as rainfall, seasons, etc., timely disbursement of loans is of utmost importance for increasing livestock production. Second, widespread corruption among loan managers also contributed to this result. However, if, for example, loans are diverted to unintended beneficiaries, the amount of loans disbursed is allocated to the livestock subsector. The third factor is attributed to the poor monitoring and evaluation of the credit process and the high default rate, which prevented efficient reuse of the credit process. The finding confirms the reports of Zakaree (2014), but contradicts the empirical submissions of Orok and Ayim (2017), Khan et al. (2007), Abedullah et al. (2009), Khan et al. (2018), Olagunju and Babatunde (2011), Rahman et al. (2011), Kuye (2013), Shiferaw et al. (2015), Abu (2017) and Reuben et al. (2020).

Table 5. The long-run coefficients for livestock gross production index equation.

Variable	Coefficient	Standard error	t-value		Probability
Constant	2.944236	0.615501	4.783482	***	0.0004
$CAGR_t$	0.364708	0.120002	3.039175	***	0.0095
ACG_t	-0.221529	0.073657	-3.007576	***	0.0101
LEN_t	0.143117	0.172987	0.827327		0.4230
$DCPS_t$	0.145806	0.032323	4.510906	***	0.0006

Note: ***, and ** indicate 1% and 5% significance level respectively. Note, variables are expressed in natural logarithms. ARDL (1, 1, 2, 1, 4) selected based on Schwarz Bayesian Criterion.
Source: computed by the authors.

The coefficient of domestic credit to the private sector has a significant positive relationship with the gross livestock production index in Nigeria. The findings revealed that a 0.146% increase in domestic credit to the private sector would lead to an increase in the livestock production index. Alternatively, increasing domestic credit to the private sector would increase livestock production in Nigeria. The result meets the a priori expectation as the increase in domestic credit to the private sector increases investment in the real sectors of the economy. The country has recently made massive investments in agro-industrial units, particularly poultry feed, agrochemicals, and hatchery production, mainly driven by the private sector. Since the agriculture sector is one of the preferred sectors for private sector investment, it has enjoyed the support of investors, which has resulted in a corresponding increase in the sector's production. The finding is consistent with the reports of Khan et al.

(2007), Abedullah et al. (2009), Khan et al. (2018), Olagunju and Babatunde (2011), Rahman et al. (2011), Kuye (2013) and Shiferaw et al. (2015).

The estimated short run coefficients of ARDL model

The result in Table 6 shows estimates of the error correction representation of the ARDL model. The ECM coefficient is negative and statistically significant at 1% probability level. This confirms the existence of cointegration between the specified variables. The coefficient of the ECM represents the speed of adjustment in the long-run equilibrium after short-run shocks. This shows that annually about 45.19% of the short-run disequilibrium is adjusted towards its long-run equilibrium. Alternatively, about 45.19% of the disequilibrium from the previous year's shock converge back to the long-run equilibrium in the current year. The diagnostic tests for the ECM model revealed an R2 value of 0.7828, which indicates that the agricultural credit policy variables explained about 78.29% of the adjusted total variations in livestock production in the country.

The empirical result showed that the total credit provided to the agricultural sector by the commercial banks at the current level has a positive and significant short-run impact on livestock production in Nigeria. For instance, a 100% increase in the commercial bank total credit to the agricultural sector will positively change the gross livestock production index by 5.19% in the short run. This means that an increase in the current commercial bank total credit to the agricultural sector would boost livestock production. A similar result was obtained for the long-run relationship. This finding is consistent with the empirical claim of Abedullah et al. (2009), Khan et al. (2018), Olagunju and Babatunde (2011), Rahman et al. (2011), Kuye (2013), Shiferaw et al. (2015), Abu (2017), Reuben et al. (2020), Umboh et al. (2021), and Adewale et al. (2022).

The Livestock Subsector Guarantee Loan through ACGS showed a significant negative association with livestock production in the short run. This means that if the value of the loan guarantee for livestock beneficiaries increases by one unit, the livestock production index will decrease by 0.052% in the short run. This result is similar to the long-run relationship and is supported by Zakaree (2014). However, the previous year's value of the guaranteed loan for the livestock subsector correlates positively with the current year's livestock production index. The finding leads to the fact that the slope coefficient of the previous year's loan guarantee in the livestock subsector has a stimulating influence on the current year's gross livestock production in Nigeria. The result is consistent with the reports of Orak and Ayim (2017), Khan et at. (2007), Abedullah et al. (2009), Khan et al. (2018), Olagunju and Babatunde (2011), Rahman et al. (2011), Kuye (2013), Shiferaw et al. (2015), Abu (2017), and Reuben et al. (2020). The coefficient of the lending interest rate has a significant negative relationship with the livestock production index in the short run. For example, a 10% increase in the lending rate results in a 1.03% decrease in the gross livestock production index. This means that as lending interest rates rise, livestock production will decline in the short run. The result is consistent with the a priori finding, as an increase in the lending rate is known to increase agricultural risk and limit farmers' capacity to expand production and agricultural investment. The finding is consistent with the reports of Udoka et al. (2016), Asekome and Ikojie, (2018), and Iliyasu, (2019); however, it contradicts the submission of Salisu and Alamu (2023).

Table 6. The short-run coefficients for livestock gross production index equation (restricted constant).

Variable	Coefficient	Standard error	t-value		Probability
D(CACG)	0.051871	0.025990	1.995818	*	0.0673
D(ACG)	-0.080722	0.018495	-4.364484	***	0.0008
D(ACG(-1))	0.056655	0.017037	3.325331	***	0.0055
D(LEN)	-0.102767	0.054502	-1.885555	*	0.0819
D(DCPS)	0.034730	0.042041	0.826089		0.4237
D(DCPS(-1))	-0.060044	0.029710	-2.020994	*	0.0644
D(DCPS(-2))	-0.042697	0.025257	-1.690489		0.1148
D(DCPS(-3))	-0.121366	0.030932	-3.923610	***	0.0017
ECM (-1)	-0.451944	0.061706	-7.324124	***	0.0000
		Diagnostic Test			
R-Squared	0.782829	Adjusted R-Squared			0.6863309

Note: ***, and ** indicate 1% and 5% significance level respectively. Variables are expressed in natural logarithm difference. ARDL (1, 1, 2. 1, 4) selected based on Schwarz Bayesian Criterion.

Source: computed by the authors.

Furthermore, the coefficients of domestic credit to the private sector in the previous year and the previous three-year period show a negative significant association with livestock production in Nigeria. The results showed that there will be a decrease in the livestock production index by 0.060% and 0.121% with an increase in domestic credit to the private sector in the previous one- and three-year periods, respectively. The risky nature of agribusiness, the low returns of the agricultural sector and the reluctance of the private sector and banks to invest in the agricultural sector in the short run could help explain the results. For example, the risky nature of agricultural production in the country has prevented several private investors and financial institutions from investing in agriculture in the short run. The finding is supported by the empirical results of Zakaree (2014).

Diagnostic test of the short run model

The Breusch-Godfry serial correlation (LM test) of 1.917466 shows that the serial correlation is insignificant. The ECM model has proven to be robust to residual autocorrelation. Therefore, even the presence of serial autocorrelation does not affect the estimates (Laurenceson, 2003). In addition, the null hypothesis was not rejected for the RESET test, the Breusch-Pagan test, the normality test and the CUSUM test. This means that the estimated ECM model has structural rigidity, no heteroscedasticity, a normally distributed error term, and is stable within the specified time frame.

Table 7. Diagnostic statistics

Test	Value	Probability
Ramsey RESET Test	0.510192	0.6192
Normality test (Jarque-Bera)	0.525004	0.7691
Heteroscedasticity (Breusch-Pagan-Godfrey)	1.226676	0.3590
Breusch-Godfrey Serial Correlation LM Test	1.917466	0.1930

Note: prepared by authors.

Source: Authors' calculations.

Test of the Stability of the ARDL ECM

The cumulative sum (CUSUM) and cumulative sum of squares (CUSUMQ) plots derived from the recursive estimation of the ARDL-ECM model are shown in Figures 1 and 2, respectively. The results indicate stability of the ARDL-ECM coefficients over the sample period, as the representation of the CUSUM and CUSUMSQ statistics lies within the critical bands of the 5% confidence interval (or 95% probability levels) of parameter stability.

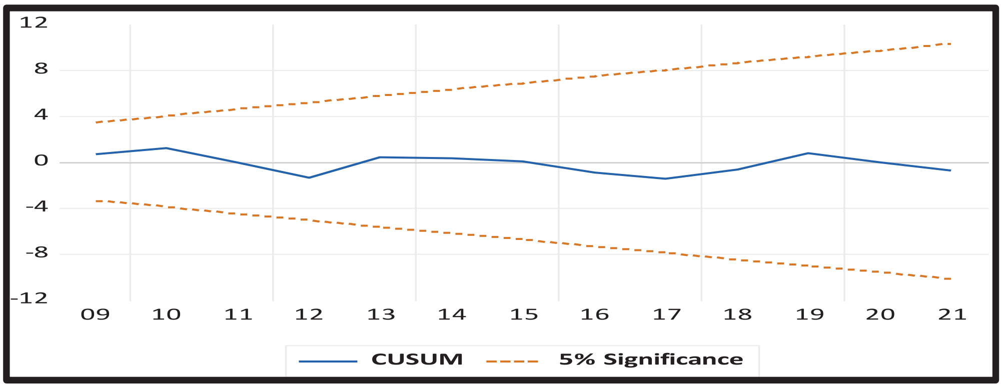

Fig. 1. Plot of CUSUM for coefficients' stability of ARDL model

Source: Generated from data analysis by authors.

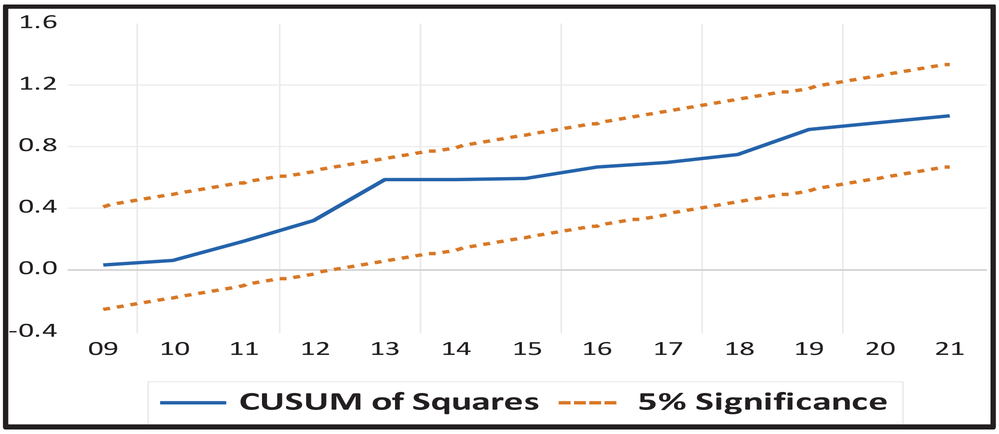

Fig. 2. Plot of CUSUMSQ for coefficients' stability of ARDL model

Source: Generated from data analysis by authors.

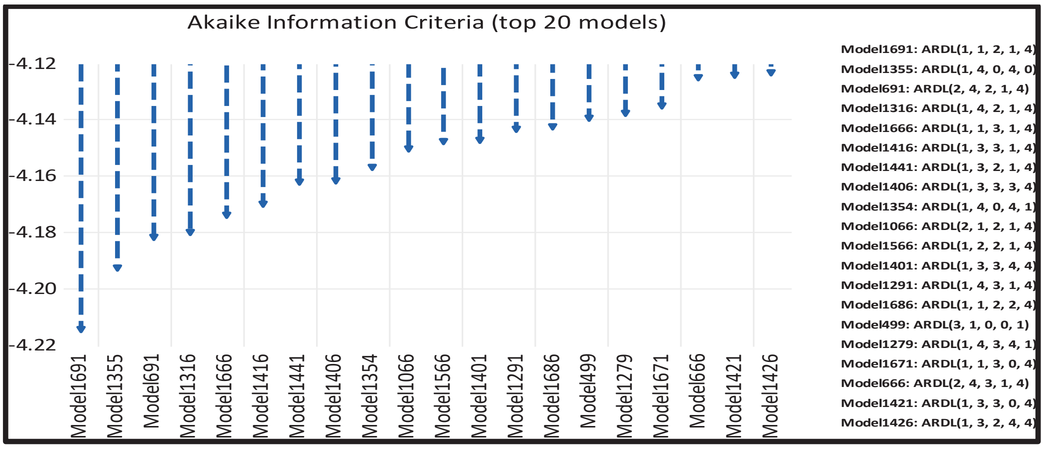

Fig. 3. Akaike information criteria graph.

Source: Generated from data analysis by authors.

Conclusion

The main objective of this research was to establish an empirical relationship between some agricultural credit policy variables and the growth of the livestock sub-sector in Nigeria. Time series data were sourced from the World Bank (WB), Food and Agriculture Organization (FAO) and Central Bank of Nigeria (CBN).

ADF and ADF-GLS were used to check the stationarity or unit root of series. The estimated results of ADF and ADF-GLS showed that the lending interest rate was stationary at level I(0), while other variables were stationary at the first difference 1(1). The autoregressive distributed lag (ARDL)-bound co-integration test was used to analyze the data. After confirming cointegration of the specified variables, the long- and short-run models of the livestock gross production index equations were estimated with the error term having the appropriate sign and being statistically significant at the conventional probability level. The results showed that the commercial bank total credit to the agricultural sector had a positive and significant impact on livestock production in both the long and short runs. On the other hand, the agricultural credit guarantee scheme loan allocated to the livestock subsector had a negative correlation with livestock production index in both the short and long run. The lending interest rate had a negative short-run relationship with the livestock production index. The total domestic credit to the private sector showed a positive relationship with gross livestock production index in the long run and a negative relationship in the short run. The results suggest that credit policy variables have a significant impact on the output of the livestock subsector in Nigeria.

Based on these empirical facts and the need to boost livestock production in Nigeria, it is recommended that the overall credit to the agricultural sector from the commercial banks be increased to provide an incentive to increase livestock production. Additionally, domestic lending to the private sector should be strengthened or increased to boost livestock production. In addition, the current lending interest rate in the country should be reduced to improve access to credit for livestock farms. The Agricultural Credit Guarantee Scheme loan for the livestock sub-sector should be reassessed and monitored to achieve the desired objective.

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