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FINANCIAL DETERMINANTS OF LIVESTOCK PRODUCTIVITY IN NIGERIA: A VECM APPROACH

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Abstract: The study examined the financial determinants of livestock productivity in Nigeria. Annual time series data were obtained from the Central Bank of Nigeria and Food and Agriculture Organization databases from 1981 to 2019. The data were subjected to compound growth function, Augmented Dickey-Fuller test, Johansen's co-integration test, optimal lag-order selection criteria, and vector error correction model. Based on the endogeneity of the variables in the systems equation, the study revealed that livestock ACGSF (-5.7), foreign direct investment to agriculture (-5.04), commercial banks loan to agriculture (-3.1) and livestock implicit price deflator (-11.9) would have statistically significant ($p<0.01$) positive impact on livestock productivity in the long-run. Findings also revealed that the error correction term for the livestock productivity model was correctly signed, lying between 0 and 1 (-0.51759) and the z-statistic (-2.6) statistically significant ($p<0.01$), suggesting the possibility of restoration to short-run equilibrium at an average speed of adjustment of 51.76%. It was recommended that policies on increasing livestock ACGSF, foreign direct investment to agriculture, and commercial banks loan to agriculture should be sustained by Central Bank of Nigeria and the Federal Government so that livestock productivity per capita per will increase to enhance national food security and increase foreign exchange earnings from the exportation of livestock products. In addition, the monetary authority should ensure that livestock inflation is checked to enhance affordability by average Nigerians.

Keywords: Agricultural Credit Guarantee Scheme Fund, Growth function, livestock financing tools, Vector Error Correction Model

Introduction

Livestock production is of immense importance to the poor and is one of the principal components of the rural and national economic growth. It is a natural and economic capital which contributes to human diets and livelihoods through home consumption and income generation, acting as a live bank, impacting social status, and providing draft, transport, and fertilizer, especially for resource-poor farmers (Silong & Gadanakis, 2020). The livestock subsector of the agricultural sector plays an important role in generating income and employment, augmenting income of marginal farmers and landless labourers and in meeting nutritional requirement (Awunyo-vitor and Sackey, 2018; Chand and Raju, 2008).Orji *et al.* (2021) stated that Nigeria has vast resources for livestock production.

The importance of livestock notwithstanding, its productivity, like the entire agricultural productivity has been on the decline. Ogunnaike *et al.* (2021) indicated that Nigeria suffers from protein deficiency, which is compounded by rapid population growth, low productivity in the agricultural sector, rural urban migration, and decline in productivity of the livestock sub-sector. This is largely due to neglect in funding. According to Dare *et al.* (2017), the lackluster performance and declining contribution of agriculture has been linked, among others, to the lack of (improperly coordinated) formal national agricultural credit policy and inadequate agricultural credit institutions. Osabohien et al. (2020) noted that one of the significant constraints to agricultural productivity is the inability of farmers to gain access to credit due to the perceived risk and volatility of the sector. In addition, banks and other financial institutions are still very reluctant to fund agricultural projects which is evident by stringent credit conditions. Studies have confirmed that the agriculture sector, especially in developing countries, is plagued with challenges such as credit access, thereby impeding farmers' access to productive resources and adoption of new technologies, which have the capacity to improve technical efficiency and facilitate agricultural development in the long-run(Abdallah, 2016) and pushing up the agricultural component of GDP (Seven &Tumen, 2020).

In order to address the challenges of financing, various policies of government emerged. Some of the policies are those of the Agricultural Credit Guarantee Fund Scheme, the directive of the Central Bank of Nigeria to reserve a portion of their profit for agricultural lending, direct foreign investment and exchange rate dynamics. The Agricultural Credit Guarantee Scheme Fund (ACGSF) is available to provide succor to banks that lend to farmers under the program. The Nigerian model of credit guarantee scheme is a targeted, funded and direct. It was established in 1977 and currently has an increased capital base of N 3 billion. It guarantees credit facilities extended to farmers up to 75 percent of the amount in default net of security realized. Recent innovations to the scheme by the Central Bank of Nigeria include Self-Help Group Linkage Banking, the Trust Fund Model and the Interest Drawback (Adetiloye, 2012; Ogbanje, Nyor and Yahaya, 2016; Dare *et al.*, 2017).

Chand and Raju (2008) stated that livestock products are broadly divided into five categories namely milk, meat, poultry, dung, and wool and hair. However, this study focused on meat, which directly impacts on food security from the perspective of the provision of protein. Meat is also an import and export commodity. The common meat sources selected were chicken, goat, sheep, pig and cattle. Studies on the determinants of livestock productivity have focused on management problems, prevalence of major endemic diseases, nutrition, lack of support services such as extension services, veterinary services, insufficient data to plan improved services and inadequate information on how to improve animal breeding, marketing, processing and socioeconomic issues (Duguma &Debsu, 2019; Kechero et al., 2013), climate change (Sejian *et al.*, 2013; Gbenga *et al.*, 2020). Information on financial determinants is sparse. The few ones available focused on credit facilities. There has not been any study that combined domestic and foreign financial credits and aids with control variables that have direct impact on the valuation and pricing of livestock products. After all, Anh et al.(2020) reported that the issue of whether credit actually contributes to the development of the agricultural sector is still debatable.Orok &Ayim(2017) lamented that that the ACGSF

had given more funds and impacted more on the crop sector over the livestock and fishery sectors.

This study was designed to bridge the gap in empirical literature and contribute to the debate on effectiveness of agricultural financing in enhancing livestock productivity. Thus, the specific objectives of this study were to assess the growth rate in livestock financing tools and livestock productivity, investigate the existence or otherwise of long-run or short-run relationship between the financing tools and livestock productivity. The scope of the study was from 1981 to 2019.

Materials and Method

Study Area

The study focused on the entire Nigerian economy. Nigeria is African most populous country and has emerged as African largest economy as a result of recent "rebasing" exercise(Anwana &Affia, 2018; Ismail &Kabuga, 2016). Agriculture remains the mainstay of the Nigerian economy providing employment for 60 to 70% of the labour force(Ajayi, 2011; Ajayi *et al*., 2017; Anifowose, 2017). Agricultural holdings are generally small and scattered, farming is often subsistence mostly characterized by simple tools and shifting cultivation. Agricultural farming activities are largely in the hands of smallholder farmers(Aminu, 2020).

Data and sources

The study adopted the use of secondary data. Annual time series data on livestock subsector GDP, livestock ACGSF, commercial banks loans to agricultural sector, and livestock implicit price deflator were obtained from the Statistical Bulletin between 1981 and 2019. Data on FDI to agricultural sector and exchange rate were obtained from FAOSTAT and National Bureau of Statistics. All the variables were transformed into natural logarithm to reduce the problem of heteroskedasticity.

Analytical technique

Descriptive statistics, Growth function and Vector error correction model were used for the analysis of the data. The estimations were done with the aid of STATA software package.

Growth function

In order to capture the entire series, the study adopted a compound growth rate that was computed by fitting the exponential function in time to the data. Following the previous works that were done by Abah et al. (2021), Amos & Ayanda (2004) and Oparinde et al. (2017), the growth model is specified as:

$Y = b_0 e^{bt}$

Linearising,

$Log\ Y = b_0 + b_{1t}$

The growth rate, r is given by

$r = (e^b - 1) \times 100$

e is Euler's exponential constant, which is equal to 2.7183

Vector error correction model

The short run dynamic relationship was estimated using an error correction model. Following the works of Andrei & Andrei (2015) and Victor(2015), the model is specified as follows:

$$\Delta lnlgdp_t = \sigma + \sum_{i=1}^{k-1} \beta_1 \Delta lnlgdp_{t-i} + \sum_{j=1}^{k-1} \emptyset_j \Delta lnlacg_{t-j} + \sum_{m=1}^{k-1} \varphi_m \Delta lnfdia_{t-m} + \sum_{n=1}^{k-1} \emptyset_j \Delta lncbla_{t-n} + \sum_{o=1}^{k-1} \emptyset_j \Delta lnexr_{t-o} + \sum_{p=1}^{k-1} \emptyset_j \Delta lnlipd_{t-p} + \lambda_1 ECT_{t-1} + \mu_{1t}$$

Where,

lgdp = livestock gross domestic product (N)
lacg = livestock component of ACGSF (N)
fdia = foreign direct investment in agriculture (N)
cbla = commercial banks loan to agriculture (N)
exr = Exchange rate
lipd = livestock implicit price deflator (%)
β,φ,ϕ, = short-run dynamic coefficients of the model's adjustment to long-run equilibrium
λi = speed of adjustment parameter which comes negative sign to ensure convergence to long-run
ECT_{t-1} = the error correction term which is the lagged value of the residuals obtained from the long-run
U_{it} = stochastic error term called impulses or innovations or shocks in VAR

Results and Discussion

Descriptive Statistics

The descriptive statistics of the variables in the study are presented in Table 1. The result shows that the commercial banks lent out a whooping average of N138 billion between 1981 and 2019. Within the same period, the foreign direct investment in agriculture averaged N18.8 billion. In addition, livestock ACGSF averaged N492 million. These amounts are substantial enough to have remarkable impact on livestock productivity. Also, foreign direct investment to agriculture had the highest coefficient of variation (2.50), while meat production per capita per day had the least coefficient of variation (0.09). Average livestock price deflator implied that the value of livestock products increased by 57.41% over the period of the study. The exchange of the naira to the US dollar averaged N99.92. The ratio of livestock GDP to the overall GDP shows that the subsector contributed only 2.51%. This is quite low and can be responsible for some level of neglect at the level of policy formulation. Mean meat production per capita per day was very low (0.0000207), implying a high level of malnutrition among most Nigerians.

Table 1: Descriptive Statistics

Statistics	Mean	Standard deviation	Coefficient of variation
LGDP	554,000,000,000.00	690,000,000,000.00	1.25
LACG	492,000,000.00	699,000,000.00	1.42
FDIA	18,800,000,000.00	47,000,000,000.00	2.50
CBLA	138,000,000,000.00	205,000,000,000.00	1.48
LIPD	57.41	58.59	1.02
EXR	99.92	89.62	0.90
rlgtgdp	2.51	0.72	0.29
totmt	952,703.50	246,611.00	0.26
mppcpd	0.0000207	0.00000191	0.09

Source: Authors' Computation of Data from CBN and FAOSTAT Databases

Growth Rate of Livestock Financing Tools and Productivity

The analysis of the growth rate of the variables in the model is presented in Table 2. The result shows that the livestock implicit price deflator recorded the highest growth rate (6.194), implying that the prices of livestock product increased six times within the period. This means that the Price was highly unstable, making the products relatively Unaffordable for the average Nigerian. The variable with the least growth rate was livestock ACGSF (4.636%).

Table 2: Growth Rate of Livestock Financing Tools and Productivity

Variables	Growth Rate 1981 to 2019	z	P<z
lnLGDP	5.203	34.72	0.001
lnLACG	4.636	10.48	0.001
lnFDIA	4.519	10.46	0.001
lnCBLA	5.251	37.64	0.001
lnLIPD	6.194	24.64	0.001
lnEXR	5.218	13.58	0.001

Source: Authors' Computation of Data from CBN and FAOSTAT Databases

Stationarity Test

The result of stationarity test is presented in Table 3. The result shows that the variables were non-stationary at levels. However, after the first differencing, they became stationary at the same lag one and 5% critical level. Hence, the variables can be subjected to co-integration test for short-run or long-run relationship.

Table 3: Stationarity test

	At level		At first difference	I(1)
Variable	Test statistic (Z(t))	5% Critical value	Test statistic (Z(t))	5% Critical value
lnLGDP	-1.000	-3.552	-2.689	-1.692
lnLACG	-2.088	-3.552	-4.356	-3.556
lnFDIA	-1.365	-1.691	-7.679	-1.692
lnCBLA	-2.097	-3.552	-4.792	-3.556
lnEXR	-1.46	-3.552	-3.708	-3.556
lnLIPD	-0.938	-3.552	-2.426	-1.692
lnPLR	-2.444	-3.552	-5.889	-3.556

Source: Authors' Computation of Data from CBN and FAOSTAT Databases

These results were confirmed by the line graphs of livestock financing tools and productivity as shown in Figures 1 and 2. For instance, Figure 1 shows that the variables wee trending upwards and drifting apart. This implied that, at levels, the series had unit roots. In Figure 2, the series exhibited mean reversion at first differencing, implying they became stationary at the level of differencing as they moved together.

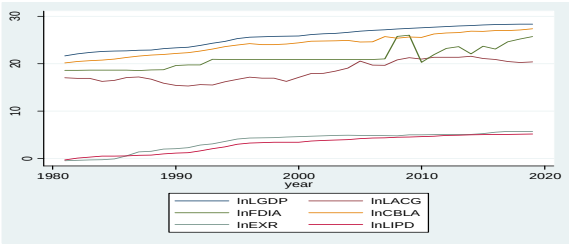

Figure 1: Line graphs of livestock financing tools and productivity at levels

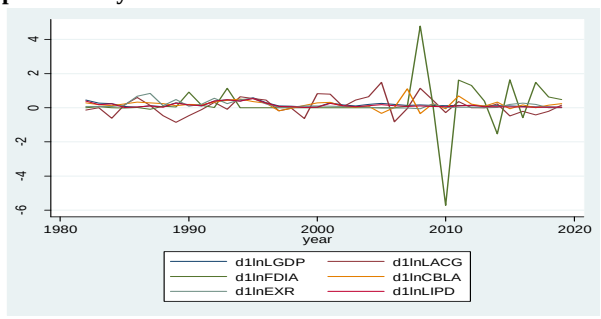

Figure 2: Line graphs of livestock financing tools and productivity at after first differencing

Johansen's test of co-integration

The result of the Johansen's test of co-integration is presented in Table 4. The result shows that the null hypothesis of no co-integration was rejected because the trace statistic was greater than the 5% critical value. For the same reason, the null hypothesis of one co-integration equation was rejected. However, the study could not reject the null hypothesis of at least two co-integration equations since the trace statistic was less than the critical value. The maximum statistics confirmed these results. Hence, it was resolved that there was long-run relationship among the variables in the systems equation.

Null hypotheses	Trace statistic	5% Critical value	Maximum statistic	5% critical value
0	123.4355	94.15	47.5961	39.37
1	75.8394	68.52	28.7025	33.46
2	47.1369*	47.21	19.0585	27.07
3	28.0785	29.68	16.5202	20.97
4	11.5582	15.41	9.9663	14.07
5	1.5919	3.76	1.5919	3.76

* Rejection of null hypothesis of no co-integration

Source: Authors' Computation of Data from CBN and FAOSTAT Databases

Optimal lag-order selection

As shown in Table 5, different lag-order selection criteria recommended various lags. Since there are no hard and fast rule on which of the recommended lag to use for further computation, the study adopted lag which was recommended by Schwarz Information Criterion (SBIC).

Table 5: Optimal Lag Selection

lag	LL	LR	Df	P	FPE	AIC	HQIC	SBIC
0	-125.229				4.50E-06	7.55592	7.6633	7.86699
1	119.044	488.54	49	0.001	6.80E-11	-3.60251	-2.74346	-1.11395*
2	174.312	110.54	49	0.001	6.80E-11	-3.96066	-2.34994	0.705385
3	274.44	200.26*	49	0.001	1.10E-11	-6.88231*	-4.51992*	-0.03878
4	.	.	49	.	-3.1e-28*	.	.	.

Source: Authors' Computation of Data from CBN and FAOSTAT Databases

Estimation of long-run relationship

The estimation of long-run relationship was done with Johansen normalization with restriction imposed on livestock productivity, the target variable, and presented in Table 6. Because the variables are endogenous, the result shows that the lag one of LIPD had positive impact on LGDP in the long-run since z-statistic (-11.9) was statistically significant ($p<0.01$). The implication is that a 10% increase in LIPD will lead to 8.04% increase the value of livestock productivity in the long-run. This implies the sensitivity of the pricing of livestock products to inflation, meaning also that the prices can be unaffordable to the low-income class, translating to less than optimal consumption of animal protein which also causes food insecurity.

Further, lag one of LACG has positive relationship with livestock productivity in the long-run since its z-statistic (-5.7) was statistically significant ($p<0.01$). The implication is that a 10% increase in LACG will increase the livestock productivity in the long-run by 1.05%. This result suggests a low level of utilization of the fund because the response rate was quite low.This result is consistent with Egwu(2016) that Agricultural Credit Guarantee Scheme Fund Loan to Nigeria's Agricultural sector (ACGSF) was significant to Agricultural sector output percentage to gross domestic product from 1980 to 2010.Ayeomoni & Aladejana(2016) also found that short and long run relationship existed between agricultural credit and economic growth in both short and long run, respectively. However, the result contradicts Anetor *et al.*(2016) who found that ACGSF performed poorly in explaining agricultural sector performance in the short-run between 1981 and 2013.

Similarly, lag one of FDIA has positive relationship with LGDP in the long-run since its z-statistic (-5.04) was statistically significant ($p<0.01$). The implication is that a 10% increase in FDIA will increase the livestock productivity by 0.64% in the long-run. Owing to the low level of response, this result also suggests poor or inappropriate utilization of the foreign investment. The result agreed with Awunyo-vitor and Sackey (2018) who found a positive and significant relationship between economic growth and foreign direct investment flow to the agricultural sector and volume of trade in Ghana. However, the result is at variance with Aminu (2020) that there is no significant relationship between economic growth and foreign direct investment in the short run, between 1989 and 2019. The result of the study contradicts the position of Evans et al. (2018) that the probable effect of FDI on economic growth is limited to the short-run. Further, the result is at variance with Epaphra & Mwakalasya (2017) who found that FDI inflows has no significant effect on agriculture value added-to-GDP ratio in Tanzania between 1990 and 2015.

Finally, lag one of CBLA has positive relationship with LGDP in the long-run since its z-statistic (-3.1) was statistically significant ($p<0.01$). The implication is that a 10% increase in CBLA will increase livestock productivity by 1.24% in the long-run. This result suggests more effective

loan utilization targeting. The reason is obvious because commercial banks are domestic financial institutions that monitor the application of their funds in order to forestall fungibility and chances of loan default. The result conforms with Anetor *et al.*(2016), Egwu(2016) and Sulaimon (2021) that commercial loans to agricultural sector had a significant impact on agricultural production. Ajao & Oseyomon(2019) stated that the Nigeria banking sector has recently become more sophisticated in terms of operations due to various developments in the regulatory frameworks institutionalized by the central monetary authority with the aim of complying with global best practices in banking operation.

Table 6: Long-run equation with Johansen normalization restriction imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce1						
lnLGDP	1	.	.	.	.	.
lnLACG	-0.10528	0.0184672	-5.7*	0.001	-0.14147	-0.06908
lnFDIA	-0.0642	0.0127437	-5.04*	0.001	-0.08918	-0.03922
lnCBLA	-0.12381	0.0399789	-3.1*	0.002	-0.20217	-0.04545
lnEXR	-0.06591	0.0426167	-1.55	0.122	-0.14943	0.017621
lnLIPD	-0.80412	0.0675564	-11.9*	0.001	-0.93653	-0.67171

* Statistical significance, confirming long-run relationship, at 0.01 level

Source: Authors' Computation of Data from CBN and FAOSTAT Databases

Estimated Vector Error-Correction Model of GDP (Short-run dynamics)

Following the establishment of long-run impact in the systems equation, the error correction model (ECM) was estimated to determine the short-run adjustments to long-run equilibrium as well as the short-run behaviour between LGDP and other endogenous variables. The short-run dynamics of the system equation is presented in Table 7. The result shows that the error correction term conformed to *apriori* expectations, that is, it has a negative sign and the magnitude (-0.51759) lies between 0 and 1. Further, it was statistically significant ($p < 0.01$). The negative sign suggested that the long run equilibrium would be normalized back if there is any shock to the economic system. The result of the short-run dynamics also showed that the value of the coefficient of the error correction term was average. The implication is that the speed of adjustment that is required to restore to equilibrium, if the system is disturbed, is 51.76% annually.

Table 7: Estimated Vector error-correction model (short-run dynamics)

Variables	ECM	Std. Err.	z	P>|z|	[95% Conf.	Interval]
D_lnLGDP	-0.51759	0.198746	-2.6*	0.009	-0.90713	-0.12806
D_lnLACG	0.418648	0.842689	0.5	0.619	-1.23299	2.070289
D_lnFDIA	6.776224	1.882646	3.6	0.001	3.086306	10.46614
D_lnCBLA	0.626201	0.394851	1.59	0.113	-0.14769	1.400094
D_lnEXR	-0.13839	0.340191	-0.41	0.684	-0.80515	0.528373
D_lnLIPD	-0.42622	0.204518	-2.08*	0.037	-0.82706	-0.02537
_cons	0.155077	0.021626	7.17	0.001	0.112691	0.197463

Source: Authors' Computation of Data from CBN and FAOSTAT Databases

Test of autocorrelation

The first postestimation test that was performed on the results is that of autocorrelation. As shown in Table 8, within the range of lags selected, there is no autocorrelation of errors. Hence, the result is perfect.

Table 8: Lagrange-multiplier test of autocorrelation

Lag-order	**chi2**	**df**	**Prob > chi2**
1	47.6054	36	0.09339
2	30.2476	36	0.73828

H0: no autocorrelation at lag order

Source: Authors' Computation of Data from CBN and FAOSTAT Databases

Tests of normality

The second postestimation test that was performed is that of normality. Three different tests of normality namely, Jarque-Bera, skewness and kurtosis were involved. As shown in Tables 9 to 11, the null hypothesis was rejected in each of three tests, implying that the system is normal and reliable.

Table 9: Jarque-Bera test of normality

Equation	Chi^2	df	Prob > chi^2
D_lnLGDP	2.975	2	0.22599
D_lnLACG	1.759	2	0.41504
D_lnFDIA	0.122	2	0.94105
D_lnCBLA	3.261	2	0.19587
D_lnEXR	2.159	2	0.33974
D_lnLIPD	4.679	2	0.09639
ALL	14.953	12	0.24401

Source: Authors' Computation of Data from CBN and FAOSTAT Databases

Table 10: Skewness test

Equation	Skewness	chi2	df	Prob > chi2
D_lnLGDP	0.69318	2.883	1	0.08952
D_lnLACG	0.42948	1.107	1	0.2928
D_lnFDIA	0.02964	0.005	1	0.94213
D_lnCBLA	-0.16415	0.162	1	0.68762
D_lnEXR	0.59701	2.139	1	0.14364
D_lnLIPD	-0.83925	4.226	1	0.03981
ALL		10.521	6	0.10435

Source: Authors' Computation of Data from CBN and FAOSTAT Databases

Table 11: Kurtosis test

Equation	Kurtosis	chi2	df	Prob > chi2
D_lnLGDP	2.7529	0.092	1	0.76221
D_lnLACG	3.6593	0.652	1	0.41937
D_lnFDIA	2.7216	0.116	1	0.73314
D_lnCBLA	4.4373	3.099	1	0.07835
D_lnEXR	3.1172	0.021	1	0.88585
D_lnLIPD	3.5493	0.453	1	0.50114
ALL		4.432	6	0.61844

Source: Authors' Computation of Data from CBN and FAOSTAT Databases

Conclusion

The study concludes that livestock ACGSF, foreign direct investment to agriculture, commercial banks loan to agriculture and livestock implicit price deflator would have statistically significant and positive impact on livestock productivity in the long-run. It was concluded that there would be restoration to short-run equilibrium at an average speed of adjustment of 51.76%.

It was recommended that policies on increasing livestock ACGSF, foreign direct investment to agriculture, and commercial banks loan to agriculture should be sustained by Central Bank of Nigeria and the Federal Government so that livestock productivity per capita per will increase to enhance national food security and increase foreign exchange earnings from the exportation of livestock products. In addition, the monetary authority should ensure that livestock inflation is checked to enhance affordability by average Nigerians.

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