Developmental Flows and Agricultural Output in Nigeria

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Abstract: The challenge of the agricultural sector in Nigeria and most developing countries has been inadequate and improper funding, which has stifled the reducing of poverty and hunger in most African countries Nigeria Inclusive. Based on this issue this inquiry examines into the influence of developmental flows on agricultural output in Nigeria. The secondary data was sourced from the Food and Agriculture Statistics of the United Nation Organization, for the period of 1991 to 2023. The study employed the Auto-regressive Distributed Lag Length to determine the short and long-run relationship between the outcome variable and independent variable. The findings reveals that Credit to agriculture and Multi-lateral donor has positive significant effect on Agricultural output while foreign direct investment in agriculture has a negative significant effect on Agricultural output. These findings suggest that the effectiveness of funding mechanisms depends on alignment with local needs, efficient resource utilization, and appropriate policy frameworks. Policymakers must focus on enhancing credit accessibility to support farmers directly, as it demonstrates the most consistent positive impact on agricultural output. It therefore recommended that government should investigate the structural and operational barriers limiting the positive impact of FDI on agricultural productivity in Nigeria.

Keywords: Foreign direct Investment; Bi-lateral Donor; Multi-lateral Donor; agricultural productivity

1. Introduction

Among the many challenges facing the global economy and African countries in recent times, ensuring food security remains critical to reducing hunger a key target of the Sustainable Development Goals to be achieved by 2030 (Kehinde et al., 2021; Saleh, 2018). The agricultural sector continues to be a vital driver of urban and rural development and plays a central role in improving living standards in Sub-Saharan Africa, particularly Nigeria (Efanga et al., 2024). While studies such as Aginam

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(2024), Ebere et al. (2024), Okafor (2020), Obioma et al. (2021), and Efanga et al. (2024) have explored agricultural funding through government expenditure, the ACGSF scheme, foreign aid, and credit from financial institutions, Osuji et al. (2023) examined external debt stock, including Eurobonds, bilateral debt, and multilateral debt has channels that could improve agricultural productivity in Nigeria.

However, existing research like Aginam (2024), Okafor (2020), Ebere et al. (2021) and Efanga et al. (2024) has yet to comprehensively examine the various funding channels provided by the Food and Agriculture Organization of the United Nations, an international body that tracks and allocates significant flows of resources to agricultural production across developed, developing, and emerging economies. Above study have only considered internal institutional channels, CBN/Government Credit Schemes and government expenditure in enhancing agricultural output in Nigeria. This study intends to add to the body of knowledge in examining the various funding channels available by the Food and Agriculture Organization of the United Nations to improve agricultural output and productivity in Nigeria.

Apart from supporting the world's growing population and providing employment in developing countries like Nigeria, agriculture significantly contributes to the gross domestic product. For instance, the sector accounted for 34.4% of Nigeria's GDP in 2021, compared to 1.1% in Argentina, 13% in China, 9% in South Africa, and 9% in the United States. Between 2016 and 2020, Nigeria's agricultural imports totaled 3.35 trillion naira, four times higher than agricultural exports of 803 billion naira during the same period (Ademola, 2019; Ebere et al., 2021).

However, the agricultural sector in Nigeria has suffered neglect as a critical hub for economic growth and development, largely due to the discovery of oil in the 1950s. Challenges such as limited irrigation farming, low technological adoption, inadequate credit facilities, corruption in agricultural financing, inefficient fund allocation, high interest rates for farmers, and insufficient technical knowledge among funded farmers have hindered its progress (Menson et al., 2023). Additional factors contributing to the sector's decline include poor infrastructure, climate change, and inadequate distribution of agricultural inputs. These issues have exacerbated food insecurity and increased poverty levels in both urban and rural areas of the country (Ayinde et al., 2020; Osabohien et al., 2020).

To address these challenges, various interventions and schemes have been implemented to bridge the financing gap in Nigeria's agricultural sector. Programs such as the Agricultural Credit Guarantee Scheme Fund, Small and Medium Enterprises Equity Investment Scheme, Refinancing and Rediscounting Facility, the Nigeria Incentive-Based Risk Sharing System, and the Rural Banking Scheme have been introduced to enhance financing options and availability for agriculture (Akanbi et al., 2019; Aginam, 2024). However, with Nigeria's population projected to reach 400 million by 2050, there is a pressing need for new funding channels, technological adaptation, and innovation to ensure food security and eliminate hunger in Nigeria and other developing countries (FOA, 2018, 2019, 2022).Based on these premises, this study examines the impact of developmental financial flows on agricultural output, as Nigeria remains one of the highest recipients of aid and other financial options from international bodies and agencies worldwide.

2. Literature Review

2.1. The Structural Change Theory

This theory was developed by Lewis Arthur in 1954. This theory was analysed and modernized by Agbenyo (2020) in an inquiry titled the structural change model. The assumption of the theory is that an economy is a component of two sectors. The first sector is the agricultural sector which is traditional in existence while the second sector is industrial sector which is the modern sector. It is of the notion that, it is of the notion that the combination of the two sector that improves the overall economic growth and development of an economy. It is depicted in a formulae as:

$$Y = (Agric_{Output}; Industry) \tag{2.1}$$

Where Y is the economic development and growth; Agric_output is the traditional sector and Industry is the modern sector.

In relation to this study, the Agricultural output is a sector when given capital would spur the industrial and the overall growth an economy.

$$Agric\_out = f(k) \tag{2.2}$$

K is the capital that is been used to improve the contribution of the agricultural sector in the economy. This capital could either be physical capital or human capital.

$$Agric\_out = f(k_j) \tag{2.3}$$

k_j is relation to the this inquiry is the physical capital in form of developmental flows of FDIA stands for foreign direct investment in Agriculture, CAG stands for credit to agriculture from foreign institutions, BD stands for Bi-lateral donor to agriculture; MD stands for Multi-lateral donor to agriculture.

$$Agric\_out = f(FIDA, CAG, BD, MD) \tag{2.4}$$

Theoretically

$$Y = (Agric_{Output}(k_j); Industry) \tag{2.5}$$

2.2. Hypothesis Development

Emerging empirical evidence suggests that developmental financial flows significantly influence agricultural output in developing economies such as Nigeria. These flows—comprising bilateral and multilateral aid, foreign direct investment (FDI) in agriculture, and credit facilities—play vital roles in enhancing capital availability, technological adoption, and input accessibility in the agricultural sector. Drawing from Aginam (2024), Zwingina et al. (2023), and Ebere et al. (2021), agricultural credit schemes and commercial loans have consistently shown a positive impact on agricultural performance, suggesting that credit availability is a key determinant of output expansion. Similarly, Efanga et al. (2024) and Obioma et al. (2021) highlight how targeted government and donor funding mechanisms, especially under effective governance, can stimulate sectoral productivity.

Moreover, FDI in agriculture has been widely observed to contribute to increased food productivity, technology transfer, and infrastructure development (Edeh et al., 2020; Ifeanyi, 2022). While Menson et al. (2023) and Badu-Prah et al. (2023) extend this view by showing how FDI and trade flows

support food security and export-led growth, exchange rate volatility and poor investment climates can counteract these benefits. Osuji et al. (2023) and Yerima and Tahir (2020) further expand the developmental financing narrative by emphasizing the positive role of bilateral and multilateral debt in stimulating agricultural production when well managed. However, the mixed findings by Agbede (2023), who identifies a negative impact of foreign aid and exchange rate volatility, and Ebere et al. (2021), who found agricultural expenditure to be less effective, suggest that the form, structure, and utilization efficiency of financial flows critically determine their outcome on agricultural output.

Based on this synthesis, the following hypothesis is proposed:

H_0: Developmental flows measured by bilateral donor aid, multilateral donor aid, foreign direct investment in agriculture, and agricultural credit do not have a significant impact on agricultural output in Nigeria.

H_1: Developmental flows measured by bilateral donor aid, multilateral donor aid, foreign direct investment in agriculture, and agricultural credit have a significant positive impact on agricultural output in Nigeria.

2.3. Empirical Review

Aginam (2024) investigated the relationship between banking sector financing and agricultural sector output in Nigeria. The study aimed to examine how loans, advances, lending rates, and loans guaranteed under the ACGSF Scheme, along with its repayment compliance rate, enhance agricultural output in Nigeria. This research extended beyond the work of Okafor (2020), which only explored the impact of bank credit/lending rates on agricultural output. Although similar in scope to the works of Obioma et al. (2021) and Ebere et al. (2021), which addressed the ACGSF Scheme's characteristics, this study uniquely incorporated the repayment compliance rate, a critical factor for evaluating the scheme's efficiency and effectiveness in boosting agricultural output. However, the use of ordinary least squares may undermine the findings' validity for policy formulation and implementation. The results revealed a significant positive relationship between the value of loans under the ACGSF Scheme, repayment compliance rates, and agricultural output in Nigeria. Efanga et al. (2024) examined the relationship between government funding and agricultural sector output, with corruption moderating the relationship. The study analyzed the impact of government expenditure on agriculture and the corruption index on agricultural output. It aligned with the works of Ebere et al. (2021), Okafor (2020), and Otu and Itesi (2021) in terms of government expenditure as a funding mechanism. Additionally, it adhered to the theoretical framework of Obioma et al. (2021) in validating the structural change theory. The findings revealed a positive relationship between government expenditure and agricultural output, consistent with the summarized works mentioned above. Osuji et al. (2023) investigated the relationship between external debt and agricultural production in Nigeria. The study examined various components of Nigeria's external debt portfolio, including external debt stock, payments, multilateral debt stock, Eurobond stock, and bilateral debt stock, and their impact on agricultural output. This research is more robust than the work of Yerima and Tahir (2020), which focused solely on external debt stock over a short period. The findings indicated that external debt stock, payments, Eurobond stock, and bilateral loans have a positive relationship with agricultural output.

Agbede (2023) explored the combined effect of foreign aid, exchange rate volatility, and agricultural output in Nigeria. The study examined how foreign aid and exchange rate fluctuations influence agricultural output, employing the GARCH model to analyze the effects of aid, exchange rate, trade openness, and borrowing on crop production and agricultural output. The results showed that foreign aid and exchange rate volatility negatively affect agricultural output in Nigeria. Despite lacking a theoretical framework, the study is unique in combining foreign aid and exchange rate effects on agricultural output. Zwingina et al. (2023) investigated the effect of commercial bank loans and advances on agricultural value-added growth in Nigeria. The subject matter aligns with the works of Aginam (2024), Okafor (2020), and Obioma et al. (2021), focusing on sector financing through credit availability from financial institutions. However, the use of the ARDL technique in this study may not be econometrically appropriate, as a simple ordinary least squares method could suffice for determining the findings. The results indicated that commercial bank loans and advances significantly and positively affect agricultural output.

Eno and Eze (2023) examined the relationship between agricultural financing and agricultural output in Nigeria. The study focused on how access to bank credit, high-interest rates, and exchange rate fluctuations influence agricultural output. The findings revealed that bank lending has the potential to increase agricultural output in Nigeria, but high-interest rates discourage agricultural growth. This study uniquely analyzed how financial institutions influence agricultural output, differing from the works of Ikpesu and Okpe (2019) and Menson et al. (2023), which emphasized capital inflows and macroeconomic variables. Badu-Prah et al. (2023) investigated how trade and foreign direct investment (FDI) influence agriculture in developing countries. The study tested how inward and outward FDI affects trade openness across 150 developing countries, using the Heckscher-Ohlin framework, which considers trade and capital as substitutes in a two-factor, two-country/product model. Data were sourced from FAOSTAT and WDI, and the GMM technique revealed that inward FDI stimulates exports, imports, and trade openness, while outward FDI has the opposite effect. The study suggests that additional capital inflows peculiar to agriculture should be considered to improve agricultural output. Menson et al. (2023) examined the combined influence of foreign direct investment, agricultural productivity, and food security in Sub-Saharan Africa. Data were sourced from the World Bank's World Development Indicators, the UN FAO, and the UNCTAD. The study employed the System Generalized Method of Moments (GMM), with Arellano-Bond tests confirming no autocorrelation. The findings revealed that FDI in agriculture significantly improves food security metrics, such as the food consumption score and dietary energy consumption. Control variables like crop production, food exports, and rural population were also significant determinants. The study recommends securing equitable land access through tenure reforms and improving investment climates to promote agricultural development. Ifeanyi (2022) explored the potential of foreign direct investment in improving food production in Nigeria. The study highlighted FDI's role in introducing essential skills, investment capital, technological innovations, and infrastructure to enhance food production. Using a literature review approach, the findings revealed a positive correlation between FDI and improved food productivity. However, persistent political crises and insecurity hinder sustainable agricultural growth, leading to food shortages, high prices, and reliance on imports. The study recommends creating a conducive environment for FDI to catalyze food productivity and security.

Otu and Itesi (2021) examined the impact of domestic investment on agricultural productivity in Nigeria. Anchored on the endogenous growth model, the study analyzed agricultural productivity, gross capital formation, population growth, government expenditure on education, and lending rates.

The ARDL technique revealed that domestic human and physical investment negatively affects agricultural productivity. The study is unique in exploring how domestic investment can spur agricultural productivity, aligning with the works of Ikpesu and Okpe (2019).

Ebere et al. (2021) investigated the co-existence relationship between agricultural credit and agricultural output in Nigeria. The study examined how agricultural credit schemes and agricultural expenditure influence agricultural output, using causality techniques and Johansen co-integration. The findings indicated that credit availability improves agricultural output, but expenditure on agriculture may not stimulate it. The study aligns with Eno and Eze (2023), emphasizing the importance of credit availability. Obioma et al. (2021) explored how agricultural financing contributes to the performance of the agricultural sector in Nigeria. The study examined how credit and expenditure on the sector improve its performance, using the structural change theory. Findings revealed that agricultural credit schemes and commercial loans significantly positively affect the agricultural sector. Okafor (2020) investigated the effect of commercial bank credit on agricultural development. The study, anchored on bank lending theory, analyzed how bank credit, government expenditure, and agricultural credit guarantee schemes contribute to agricultural output. While similar to Ebere et al. (2021) and Eno and Eze (2023), the study combined financing challenges of financial institutions with policymakers' interventions.

Yerima and Tahir (2020) examined the impact of external debt on agricultural production in Nigeria. Anchored on the Solow growth model, the study analyzed how external debt attributes improve agricultural production as a percentage of GDP. Findings revealed a positive impact of external debt but negative relationships between inflation, exchange rates, and agricultural output.

Edeh et al. (2020) investigated the effect of foreign direct investment on agricultural output in Nigeria. Anchored on the eclectic model, the study analyzed variables like FDI, agricultural sector output, government expenditure, labor force, and inflation. Findings revealed that FDI has a significant positive effect on agricultural output, with short-run effects being more pronounced.

Ikpesu and Okpe (2019) examined the combined effect of capital inflows on agricultural output. Anchored on the neoclassical growth production function, the study analyzed private and public capital inflows, labor force, domestic investment, and real exchange rates. Findings revealed that private and public capital inflows positively influence agricultural output, while exchange rates negatively affect it. However, the measurement of public inflow was unclear.

3. Methodology

The secondary data was sourced from the Food and Agriculture Statistics of the United Nation Organization 2023, for the period of 1991 to 2023. The developmental flows was measured with FDIA stands for foreign direct investment in Agriculture, CAG stands for credit to agriculture from foreign institutions, BD stands for Bi-lateral donor to agriculture; MD stands for Multi-lateral donor to agriculture. The Auto regressive distributed Lag (ARDL) was used to draw inference after stationary test gave validity of order (0) and order (I).

Following from equation (2.5), the structural form of the relationship between developmental flows and agricultural output can be written on a functional form of:

$$Agric\_out_t = f(a_t k_{jt}) \tag{3.1}$$

Where $Agric\_out_t$ represent Agricultural output, k_{jt} represents the developmental flows, a_t are the parameters of interest.

Equation (3.1) can be written in an explicit form as

$$Agric\_out_i = \gamma_t + a_t k_{jt} \quad (3.2)$$

Including the white noise, we can re-write equation (3.2) in an econometric form as:

$$Y_i = \gamma_t + a_t k_{jt} + \mu \quad (3.3)$$

Where Y_i is defined as agricultural output and k_{jt} is defined as developmental flows to agriculture; γ_t represent the intercept and t represents the time dimension.

Thus, aligning the model to the study's empirical the study modified the works of Ikpesu and Okpe (2019) and Edeh et al (2020). The equation can therefore be presented as:

3.1. Linear Representation

$$Agric\_out_t = (\beta_0 + \beta_1 FDIA_t + \beta_2 CAG + \beta_3 BD_t + \beta_4 MD + \varepsilon_t) \quad (3.4)$$

The short-run (error-correction model) model and the long-run model (co-integration model) of the ARDL model equation can be specified below is written as:

$$\Delta LAgric\_out_t = \rho\varrho_{t-1} + \sum_{i=1}^{q} \alpha_{1i}\, \Delta LAgric\_out_{t-i} + \sum_{i=0}^{q} \alpha_{2i}\, \Delta LFDIA_{t-i} + \sum_{i=0}^{q} \alpha_{3i}\, \Delta LCAG_{t-i} + \sum_{i=0}^{q} \alpha_{4i}\, \Delta LBD_{t-i} + \sum_{i=0}^{q} \alpha_{5i}\, \Delta LMD_{t-i} + \beta_1 LFDIA_{t-1} + \beta_2 LCAG_{t-1} + \beta_3 LBD_{t-1} + \beta_4 LMD_{t-1} + \varepsilon_t \quad (3.5)$$

The short-run model (Error-correction model):

$$\Delta LAgric\_out_t = \rho\varrho_{t-1} + \sum_{i=1}^{q} \alpha_{1i}\, \Delta LAgric\_out_{t-i} + \sum_{i=0}^{q} \alpha_{2i}\, \Delta LFDIA_{t-i} + \sum_{i=0}^{q} \alpha_{3i}\, \Delta LCAG_{t-i} + \sum_{i=0}^{q} \alpha_{4i}\, \Delta LBD_{t-i} + \sum_{i=0}^{q} \alpha_{5i}\, \Delta LMD_{t-i} + \varepsilon_t \quad (3.6)$$

The Long-run model (co-integration model):

$$\Delta LAgric\_out_t = \gamma_o + \beta_1 LFDIA_{t-1} + \beta_2 LCAG_{t-1} + \beta_3 LBD_{t-1} + \beta_4 LMD_{t-1} + \varepsilon_t \quad (3.7)$$

Agric_out stands for agricultural output, FDIA stands for foreign direct Investment in Agriculture, CAG stands for credit to agriculture, BD stands for Bi-lateral donors to agriculture, MD stands for Multi-lateral donors to agriculture,, $\rho\varrho_{t-1}$ is the lagged error correction term for equation 3.4-3.6 and α_1- α_6 are the short-run coefficient and β_1- β_4 are the long-run parameter for that explanatory variables, t is the time period in the inquiry, ε_t are the error term.

3.2. Description of Variables

S/N	Description	Unit	Source
	Explanatory Variables		
1	Foreign Direct Investment in agriculture (FDIA)	US Dollars	FAO STAT (2022)
2	Credit to agriculture (CAG)	US Dollars	
3	Bi-lateral donors (BD)	US Dollars	
4	Multi-lateral donors (MD)	US Dollars	
	Outcome Variable		

6	Agricultural output (Agric_out)	US Dollars	FAO STAT (2022)

Author's Compilation, 2024

4. Results and Discussions

4.1. Descriptive Analysis

	Agric_Out	MD	BD	CAG	FDIA
Mean	5.264578	1.867801	0.922032	4.243255	3.328801
Median	5.440320	1.930998	1.179701	4.563669	3.359342
Maximum	5.754730	2.946309	2.395542	4.910058	3.950121
Minimum	4.694626	-0.136106	-1.943858	3.346662	1.225114
Std. Dev.	0.407054	0.766175	0.951604	0.576427	0.519237
Skewness	-0.266268	-1.198198	-1.182972	-0.364633	-2.138637
Kurtosis	1.329162	4.371588	4.049790	1.428048	9.544725
Jarque-Bera	4.228528	10.48296	9.212163	4.128932	84.05169
Probability	0.120722	0.005292	0.009991	0.126886	0.000000
Sum	173.7311	61.63744	30.42704	140.0274	109.8504
Sum Sq. Dev.	5.302172	18.78479	28.97762	10.63256	8.627417
Observations	33	33	33	33	33

Author's Compilation, 2024

Note: Agric_out (Agricultural_output), MD (Multi-lateral donor), BD (Bi-lateral donor), CAG (Credit to agriculture), FDIA (Foreign direct Investment in agriculture)

Agric_Out has a mean of 5.26 and a median of 5.44, suggesting that its distribution is slightly skewed left (negative skewness). MD (mean: 1.87; median: 1.93) and BD (mean: 0.92; median: 1.18) are similarly slightly skewed left, with negative values in their data range. CAG (mean: 4.24; median: 4.56) and FDIA (mean: 3.33; median: 3.36) are closer to symmetry, though FDIA has the most leftward skew among all. The range (maximum - minimum) is widest for BD (4.34), reflecting high variability, with a standard deviation of 0.95. FDIA also shows notable variability, with a range of 2.73 and a standard deviation of 0.52. Agric_Out has the lowest standard deviation (0.41), indicating relative stability in its data. Skewness values reveal left-skewed distributions for all variables. FDIA has the most pronounced skewness (-2.14), followed by MD (-1.20). Kurtosis indicates the "peakedness" of data distribution. FDIA exhibits extreme kurtosis (9.54), suggesting heavy tails and potential outliers. In contrast, Agric_Out and CAG have low kurtosis (1.33 and 1.43), indicating flatter distributions. Jarque-Bera values and probabilities test the hypothesis that data are normally distributed. Agric_Out and CAG have probabilities > 0.05, failing to reject normality at the 5% significance level. MD, BD, and FDIA have probabilities < 0.05, indicating significant deviation from normality.

4.2. Correlation Matrix

	Agric_Out	FDIA	CAG	BD	MD
Agric_Out	1				
FDIA	0.1275	1			
CAG	0.5867	0.1818	1		
BD	0.6773	-0.0707	0.6842	1	

MD	0.6241	0.1148	0.5929	0.6033	1

Author's Compilation, 2024

The table above shows the relationship between the outcome variables and explanatory variables. Agricultural output has a positive relationship with foreign direct investment in agriculture, credit to agriculture, bi-lateral donor and multi-lateral donor.

4.3. Unit Root Analysis

Variable	Level T-Stat	Critical Value @ 5%	First Difference T-stat	Critical Value @ 5%	Prob	Order of Integration
Agric_Out	-0.4266	-2.9571	-4.0714	-2.9604	0.0036	I(I)
FDIA	-1.3307	-2.9810	-3.1853	-2.9604	0.0306	I(I)
CAG	-1.1672	-2.9639	-3.5827	-2.9639	0.0123	I(I)
BD	-1.5862	-3.7240	-5.5030	-2.9862	0.0001	I(I)
MD	-3.3406	-2.9571	---------	----------	0.0212	I(0)

Author's Compilation, 2024

The Augumented Dickey-Fuller unit root results is a pre-estimation test, that helps to give direction to the actual and precise econometrics analysis that would employed for this inquiry. Agricultural output, foreign direct investment in agriculture, credit to agriculture, bi-lateral donor are stationary at first difference I(I), while multi-lateral donor is stationary at level I(0).

4.4. Lag Length Selection Criteria

Lag	LogL	LR	FPE	AIC	SIC	HQ
0	-57.74648	NA	3.94e-05	4.048160	4.279449	4.123555
1	35.16421	149.8560	5.05e-07	-0.333175	1.054554*	0.119190
2	67.77089	42.07313*	3.55e-07*	-0.823929*	1.720242	0.005408*

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The table above showed different lag length criterion (LR, FPE, AIC, SIC and HQ).The Akaike information criterion depicting lag order length of (II) for the model is selected. After establishing the lag order length, the ARDL, short and long-run equation results were estimated and explained in the below.

4.5. ARDL Bound Test

The ARDL Bound test is the test that helps to ascertain the existence of either a short-run relationship or a long-run relationship among the variables.

Bound Test Result

t-statistics	Value	K	I(0)	I(1)
F-statistics	6.709021	4	2.86	4.01

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Bound test at 5% level of significance

The above shows that F-statistics value which is 6.709021 is higher than the lower bound and the upper bound values of 2.86 and 4.01 respectively at 5% level of significance. This indicates that there exists a long-run co-integration among the selected variables.

4.6. Autoregressive Distributed Lag (ARDL)

Dependent Variable: Agric_Output

Variable	Coefficient	Std. Error	t-statistic	Prob
Agric_Output(-1)	0.451739	0.121179	3.727860	0.0010
BD	-0.023227	0.014652	-1.585205	0.1255
CAG	0.383233	0.083638	4.582018	0.0001
FDIA	-0.027940	0.017697	-1.578804	0.1270
MD	0.015596	0.015500	1.006219	0.3240
MD(-1)	0.026943	0.014681	1.835237	0.0784
C	1.308501	0.310806	4.210023	0.0003
R-squared	0.989299		Mean dependent	5.279883
Adj R-squared	0.986730		S.D dependent	0.403806
F-statistic	385.1936		Durbin-Watson	1.674544
Prob(F-statistic)	0.000000			

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The previous Agric_out (-1) has positive significant effect on Agric_out. BD has negative significant effect on Agric_out. CAG has positive significant effect on Agric_out. FDIA has negative insignificant effect on Agric_out. MD (-1) previous has positive significant effect on Agric_out. The measure of the goodness of fit, R^2, shows that 98% variation in the dependent variable can be explained by the independent variable leaving 2% unexplained. The Adjusted R-square depicted that if additional variable is added to the independent variable, the independent variable will still be able to explain at 98% variation in the dependent variable .The F-statistics (385.19) which is greater than its prob (F-statistics) 0.0000 at 5% level of significance indicated that the linear relationship between the independent and dependent variables were statistically significant.

4.7. Co-integration Form

Variable	Coefficient	Std-Error	t-Statistic	Prob
D(FDIA)	-0.027940	0.017697	-1.578804	0.1270
D(CAG)	0.383233	0.083638	4.582018	0.0001
D(BD)	-0.023227	0.014652	-1.585205	0.1255
D(MD)	0.015596	0.015500	1.006219	0.3240
ECM(-1)	-0.548261	0.121179	-4.524384	0.0001

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The table above explained the short-run relationship between developmental flows and agricultural output. The results shows that the speed of adjustment from an earlier disturbance away from the long run identified by the CointEq(-1) is negative and significant with a coefficient estimate of -0.548261. The value of the error correction term is -0.548261 depicts the deviation from the long-run equilibrium in one year is corrected by 57%. These outcomes further validates the presence of long-run relationship among the variables in the model. At the speed of adjustment of 54%, there is a short-run relationship among developmental flows and agricultural output.

4.8. Long Run Coefficients

Variable	Coefficient	Std-Error	t-Statistic	Prob
FDIA	-0.050960	0.030812	-1.653892	0.0107
CAG	0.698997	0.046533	15.021474	0.0000
BD	-0.042364	0.026750	-1.583680	0.1258
MD	0.077590	0.035058	2.213177	0.0362
C	2.386640	0.167618	14.238567	0.0000

Author's Compilation 2024

Foreign direct investment in agriculture has a negative significant effect on Agric_out. Credit to agriculture has a positive significant effect on Agric_out. Bi-lateral donor has negative insignificant effect on Agric_out. Multi-lateral donor has positive significant effect on Agric_out. In terms of magnitude, the interpretation is important due to the fact that the model is a log-log model, in such cases the functional form should be considered. A percentage increase in foreign direct investment in agriculture leads to -0.05 unit decrease in Agric_out. A percentage increase in credit to agriculture leads to 0.69 unit increase in Agric_out. A percentage increase in bi-lateral donor leads to -0.04 unit decrease in Agric_out. A percentage increase in multi-lateral donor leads to 0.07 unit increase in Agric_out.

The significant negative effect of FDI on agricultural output highlights the challenges of effectively leveraging FDI for agricultural development. While studies like Edeh et al. (2020) found a positive relationship between FDI and agricultural output, the current findings align with Agbede (2023), who reported negative effects of foreign aid and exchange rate volatility. Persistent issues such as misallocation of resources, policy instability, and inadequate infrastructure may contribute to this negative outcome. The positive significant effect of credit on agricultural output emphasizes the importance of accessible financing for agricultural productivity. This aligns with findings by Ebere et al. (2021) and Obioma et al. (2021), where agricultural credit schemes significantly improved agricultural performance. This suggests that well-structured credit mechanisms directly enhance productivity by enabling farmers to access necessary resources. The negative and insignificant effect of bilateral donor funding reflects potential inefficiencies in the utilization or disbursement of such funds. This result diverges from the findings of studies like Osuji et al. (2023), which showed a positive impact of bilateral loans, indicating that factors such as donor conditions, administrative inefficiencies, and lack of alignment with local agricultural priorities may hinder effectiveness. The positive significant effect of multilateral donor funding corroborates the findings of Menson et al. (2023), where international funding improved food security and agricultural output. Multilateral institutions often provide structured funding mechanisms with technical assistance, which may explain their more impactful contribution compared to bilateral aid.

4.9. Diagnostic Test Developmental Flows and Agricultural Output in Nigeria

Heteroskedacity

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	5.975531	Prob. F(4,28)	0.6013
Obs*R-squared	15.19726	Prob. Chi-Square(4)	0.3043
Scaled explained SS	9.456930	Prob. Chi-Square(4)	0.0506

The F-statistics obtained from the heteroskedasticity test is insignificant at p>0.05 at 0.601, depicting no presence of heteroskedasticity in the parameters revealed from the econometric extimation.

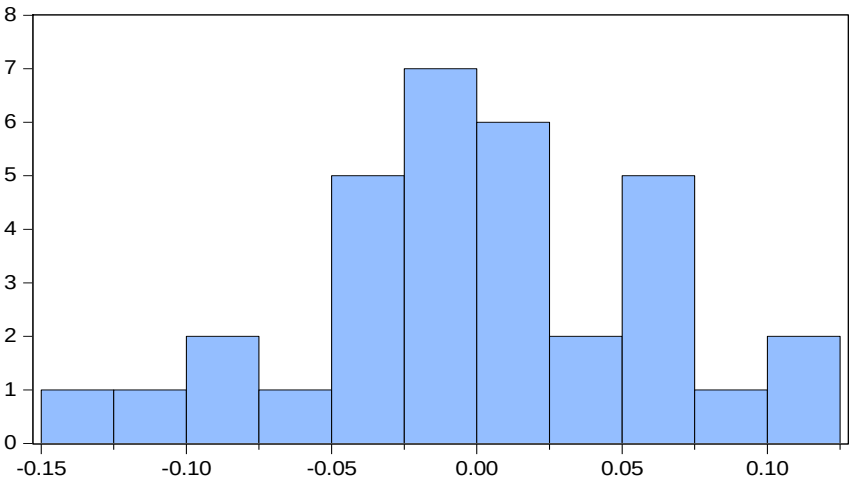
Auto-correlation Test

Date: 11/04/24 Time: 21:35
Sample: 1991 2023
Included observations: 33

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |** |	. |** |	1	0.262	0.262	2.4714	0.116
. | . |	. *| . |	2	-0.038	-0.115	2.5263	0.283
. *| . |	. *| . |	3	-0.103	-0.067	2.9356	0.402
.**| . |	. *| . |	4	-0.222	-0.195	4.8923	0.299
. *| . |	. | . |	5	-0.136	-0.042	5.6560	0.341
. |*. |	. |*. |	6	0.105	0.133	6.1240	0.409
. |*. |	. |*. |	7	0.204	0.122	7.9705	0.335
. | . |	. | . |	8	0.064	-0.059	8.1570	0.418
. | . |	. *| . |	9	-0.061	-0.083	8.3340	0.501
. *| . |	. *| . |	10	-0.152	-0.084	9.4868	0.487

The table above shows no presence of auto-correlation with the Q-stat (prob) all above 0.05%.

Normality Test



Series: Residuals
Sample 1991 2023
Observations 33

Mean	-1.23e-16
Median	-0.002077
Maximum	0.111577
Minimum	-0.131195
Std. Dev.	0.057872
Skewness	-0.203372
Kurtosis	2.728728
Jarque-Bera	0.328666
Probability	0.848459

The jarque-bera normality shows that variables in the model are normally distributed at probability above 0.05 (0.84)

Stability Test

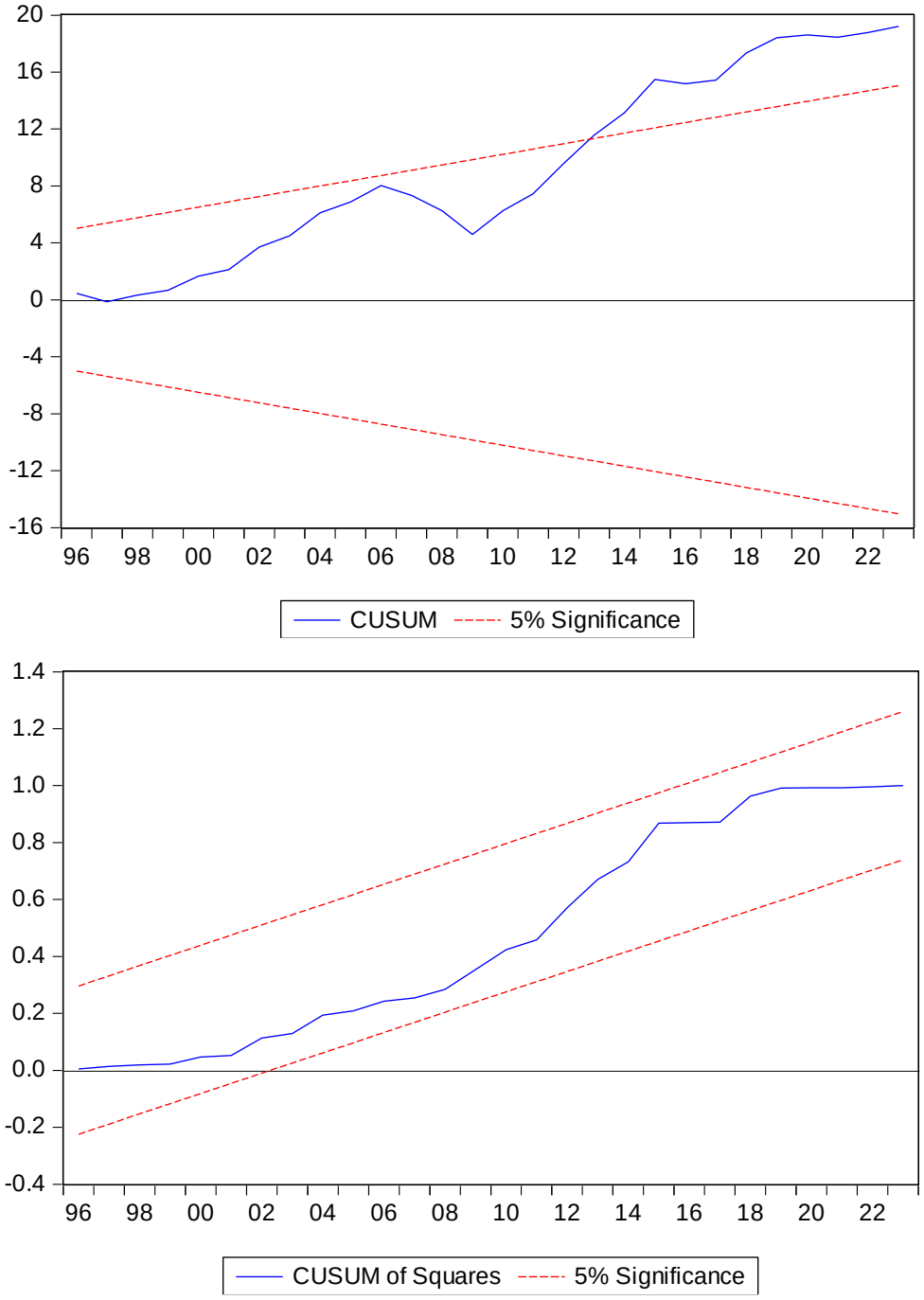


Figure 1. Stability Test (CUSUM) Test and (CUSUM) of Squares test

The stability test results for CUSUM of squares test showed that the model estimates are within the critical boundaries of a 5% level of significance, but a different level of stability for CUSUM Test. The results employs that the model is fairly dynamically stable and the inference drawn from it are fairly reliable for policy formulation.

5. Conclusion and Recommendations

The findings depicts that foreign direct investment in agriculture has a negative significant effect on Agric_out. Credit to agriculture has a positive significant effect on Agric_out. Bi-lateral donor has negative insignificant effect on Agric_out. Multi-lateral donor has positive significant effect on Agric_out. These findings suggest that the effectiveness of funding mechanisms depends on alignment with local needs, efficient resource utilization, and appropriate policy frameworks. Policymakers must focus on enhancing credit accessibility to support farmers directly, as it demonstrates the most consistent positive impact on agricultural output. Efforts to attract FDI should include creating a stable policy environment and addressing structural challenges that limit its effectiveness in agriculture. Multilateral funding should be prioritized and expanded, given its significant positive impact, while addressing inefficiencies in bilateral funding channels. It therefore recommended that government should investigate the structural and operational barriers limiting the positive impact of FDI on agricultural productivity in Nigeria. Analyze the administrative and policy frameworks governing bilateral and multilateral funding to identify best practices for effective resource allocation. Explore how institutional quality and governance influence the effectiveness of various funding mechanisms in the agricultural sector. Examine how credit impacts different agricultural sub-sectors to develop targeted financial interventions.

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