# Can Foreign Direct Investment Complement or Substitute Public Agricultural Spending for the Sustainability of the Agricultural Sector in Nigeria? Empirical Evidence Using Monte Carlo Simulation

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**Abstract:**

The study analyzed the response of agricultural growth to foreign direct investment and public agricultural spending from 1980 to 2018. Data were collected from secondary sources and analyzed using Johansen Co integration, Vector Error correction model and Monte Carlo Simulation. The result showed that foreign direct investment and public agricultural spending increased agricultural production in the long but decreased it in the short run. The study concluded that an increase in foreign direct investment and an increase in public agricultural spending (scenario 3) provided the best alternative for the sustainability of agricultural growth in Nigeria. It was recommended friendly business policies should be made to attract more foreign direct investment into the country and the issues of insecurity and infrastructures should be handled for meaningful and sustainable FDI to be attracted into Nigeria.

**Keywords:** agricultural growth; agricultural sustainability; FDI; public spending; Monte Carlo simulations.

**JEL Classification:** C53; Q18; O11; R15.

## Introduction

Agriculture is the largest single economy sector that contributes to real GDP growth in Nigeria and a major source of employment for the country. In Nigeria, the agricultural sector employs the bulk of the people, who are subsistence farmers and are nonetheless impoverished when compared to workers in other industries. The World Bank reports that agriculture contribution to real GDP has steadily increased in recent years from 24.4% in 2016 to 25.1% in 2017, with a forecast of 25.4% in 2018. Although the sector's growth rate has fluctuated in recent years, it remained positively moderate from 4.3% in 2014 to 3.7% in 2015 and further declined with a negative value of -1.62% in 2016, then rose to 0.81% in 2017, 1.92 % and 2.21% in 2018 and 2019 respectively and it is expected to further decline due to the

COVID-19 lockdown effect where people stopped spending, “one person’s spending is another person’s income”. (World Bank Development Indicators 2020).

Government expenditure or public spending refers to outflow of resources from government to other sectors of the economy (Nurudeen and Usman 2010, Chiekezie *et al*. 2020). Public expenditures in agriculture have experienced a long-term increase over the past decades. Even when considering spending in real terms and in per capita terms (*i.e*. adjusting for population growth), public spending per person increased from about $1,900 in the 1980’s to about $2,450 in the 2000’s. In 2020, general government revenue for Nigeria was about ₦9,667 billion. Although the Nigeria general government revenue has witnessed instability substantially in recent years, it tends to increase through 2001 - 2020 period ending at ₦9,667 billion in 2020. However, general government total expenditure for Nigeria was about ₦18,672 billion. The overall government total expenditure in Nigeria increased from 2,510 billion LCU in 2001 to 18,672 billion LCU in 2020 growing at an average annual rate of 12.97%. (Evgenia 2016, World Bank Development Indicators 2020).

Foreign Direct Investment (FDI) is the largest and most stable indicator in capital flows and is important for economic growth. Relatively, it has become an important alternative in the development finance processes (Global Development Finance 2005). The Central Bank of Nigeria statistics shows that Nigeria’s FDI inflow reached US$2.23 billion in 2003, it rose to US$5.31 billion in 2004 (a 138% increase) and rose again to US$9.92 billion (an 87% increase) in 2005. The figure however declined slightly to US$9.44 billion in 2006 and averaged 1366.45 USD Million in 2007 reaching an all-time high of 3084.90 USD Million in the fourth quarter of 2012, and a record low of 501.83 USD Million in the fourth quarter of 2015 (CBN 2016).

In Nigeria, research on the impact of FDI on economic growth have shown various results and submissions across time, despite the agriculture sector's lucrativeness as a source of FDI that might contribute to economic development and progress (Obekpa *et al*. 2020).

The aim of this study is to examine if public agricultural spending’s (capital expenditures) crowds out foreign private investment or whether changes in public spending’s (capital expenditures) and foreign private investment are consistent with trends and patterns of Nigerian’s agricultural growth and sustainability considering a possible FDI substituting public agricultural spending. This study contributes to the existing literature in varying ways; firstly, analyzing the effects of public spending’s and foreign direct investment on agricultural growth and sustainability will serve as a benchmark to assess if there is a negative, neutral or positive relationship and if they are dependent of each other overtime (Adekunle 2020, Chiekezie *et al*. 2020, Chaudhary 2016, Iddrisu *et al*. 2015). Secondly, in Nigeria, the agricultural sector employs the bulk of the people, who are subsistence farmers and are nonetheless impoverished when compared to workers in other industries. A study like this can help the government decrease unemployment which is a surging problem in the country through correct policies for the expansion of the agricultural sector.

Furthermore, studies have focused either on FDI and agricultural growth, FDI and poverty, public expenditures or Foreign aid and FDI, agricultural growth such as: Iamsiraroj (2016), Magombeyi and Odhiambo (2017), Djomo *et al*. (2017), Younsi *et al.* (2021), Rao *et al.* (2020). However, little or no emphasis have been made to holistically look at the direct and indirect impact of FDI and public expenditure on agricultural growth in Nigeria. It is in consonance with this evident background that this study used one of the most causality econometric approach to conduct a comprehensive analysis of FDI and public spending on agricultural growth in Nigeria.

Finally, unlike other studies which have used dynamic computable general equilibrium model and the ARIMA/GARCH model to estimate and forecast outcomes, this study intends to employ the Vector Error Correction Model and the Monte Carlos simulation to test for the degree at which public agricultural spending and foreign direct investment affects agricultural growth in Nigeria at 10%. The superiority of this model is due to the fact that is able to test for robustness of the result of the model, identify model inputs that cause significant uncertainty, search for errors in the model, help fix model inputs that have no effect on the output and enhance communication from modelers to decision makers as well as finding regions in the space of input factors for which the model output is either maximum or minimum. In light of this, this study intends to contribute to this emerging field of research by examining the influence of foreign direct investment and public agricultural spending on Nigeria's agricultural sector while adjusting for other important variables. The study's data spans 1981 to 2018, allowing it to cover Nigeria's recession in 2016 as well as intermittent flooding in 2018.

The remainder of the paper is organized as follows: literature review (which explores relevant literature), methodology (which explains the data and method utilized), results and discussion (which displays and explains the analysis' conclusions), and concluding remarks (which concludes the paper and discuss the limitation of the study).

## 1. Literature Review

The review of this paper covers several empirical views about the level to which Foreign Direct Investment (FDI) and public agricultural spending for the sustainability of the agricultural sector in Nigeria. Capital inflows (private and public inflows) have been opined to boost the performance of the economy according to the endogenous and neoclassical growth theory taking into consideration a sustainable agricultural development (Obekpa *et al.* 2020, Adegbite and Adetiloye 2013).

### 1.1. Foreign Direct Investment (FDI) and Public Agricultural Spending

Many research papers show that FDI has become a sustainable strategy conducive to profitable investment, taking into account the future prospects of the allocated agricultural production. Agricultural production has the potential to attract FDI, especially in developing countries, which needs much more investment to enhance the positive and/or ameliorate the negative effect on agricultural productivity given the agricultural resources available.

Macro-economic adjustments and deregulation, plus policies to attract foreign direct investments are believed to strongly affect the overall productivity of the agricultural sector of a developing nation like Nigeria (Obekpa *et al.* 2020, Odior 2014). Edewor *et al.* (2018) observed that, Foreign Direct Investment and its attendant growth by the neo-classical theory of economic growth and the investment sustains agricultural productivity.

The agricultural productivity of Ghana's total public spending in agriculture, considering administrative costs within total public spending was observed to be very low from 2006 to 2012, while the total spending in agriculture, considering (EFC) administrative costs was significantly different from 2006 - 2012 indicating the low public spending on the agricultural sector. On the other hand, the researchers observed an increasingly private spending on the agricultural sector considering administrative costs and the focus of the private investor was about the sustainability of public spending to the agricultural sector (FAO 2014). In estimating and analyzing the public spending as against foreign direct investment, it was identified that the agricultural sectors from 2015-2016 will have a constant growth rate till 2022 and the farmers' income will increase by 9.23% annually with foreign direct investment compared to public spending. This shows a positive impact productivity of the agricultural sector in the short run, but has a negative impact on the agricultural sector productivity in the long run (Iddrisu *et al.* 2015, FAO 2014).

There is evidence from the Indian government, that public capital spending declined for the private capital spending to sustain the agricultural sector from Rs 1,02,269 crore, up from Rs 64,022 crore in 2015-16. This indicates the significant role of FDI in agricultural sector (https://www.downtoearth.org.in/news/agriculture/private-and-government-who-is-investing-how-much-on-agriculture--65296, accessed 27/12/2020).

### 1.2. Foreign Direct Investment (FDI) and Agricultural Sustainability

To examine the relationship of Foreign Direct Investment and sustainable agricultural productivity, Akinwale *et al.* (2018) used the Error Correction Model with Nigeria's public agricultural spending data on variables used from 1986 to 2015 period of time. They observed that Foreign Direct Investment has a direct significant relationship on agricultural sustainability when it comes to agricultural production, where a change in Foreign Direct Investment will make a significant change in agricultural sustainability considering productivity in same direction.

Foreign direct investment is gradually gaining popularity in the agribusiness in Africa however, foreign direct investment in Africa still remains low considering other countries in Africa including Nigeria with about 10.5% of the global foreign direct investment. For agricultural sustainability and growth, several relevant and significant avenues have been created for private-sector investments, in particular in the form of foreign direct investment to sustain agricultural productivity (Fiedler and Iafrate 2017).

Similarly, the sustainability of the agricultural sector in Indian is highly depended on the private sector investment compared to the public sector investment. In view of this, the prime minister of India; Prime Minister Narendra Modi calls for more private investment in agricultural production while the agricultural sector is already sustaining on private investments, mostly from the debt -ridden smallholder farmers. This is as a result of the very low level of the share of public investment and the capital investment by the Indian government on the agricultural sector. This indicates the need of private sector investment in the form of foreign direct investment since it's the backbone of the agricultural sector for sustainability (https://www.downtoearth.org.in/news/agriculture/private-and-government-who-is-investing-how-much-on-agriculture--65296, accessed 27/12/2020).

### 1.3. Agricultural Foreign Direct Investment (AFDI) and Monte Carlo Simulation

Agricultural foreign direct investment seems increasing in the global economy of agribusiness but the investment risk analysis is what most foreign investors considers before final investment decision. In considering this, Bela-Gergely and Botond (2016) observed that Montecarlo simulation for an investment risk analysis management will help to prepare the realization of any agricultural investment. They further found out a positive correlation with agricultural investment and Montecarlo simulation on investment risk analysis decision that brought a long run success in the finances of the Romanian farmers.

Jianweiand Renfu (2009) noticed that, Montecarlo simulation is a simple model to use and faster in measuring the level of risk involved with analyzing the systems of agricultural investment especially suitable for food and agricultural products investment. This helps increasing productivity and competitiveness of the agricultural sector with cost effectiveness and justified decisions on assessment of an agricultural investment (Bela-Gergely and Botond 2016).

## 2. Methodology

### The Study Area

The study was carried out in Nigeria, located in the West African region which lies between longitudes 3$^{o}$ and14$^{o}$ East and latitudes 4$^{o}$ and 14$^{o}$ North. It has a land mass of 923,768 sq.km. It is bordered to the north by the Republics of Niger and Chad; it shares borders to the west with the Republic of Benin, while the Republic of Cameroun shares the eastern borders right down to the shores of the Atlantic Ocean which forms the southern limits of Nigerian Territory.

### Method of Data Collection

Secondary data consisting of annual time series spanning a period of 38 years (1981-2018) based on the availability of data were used for the analysis. Particularly, data on the values agricultural growth, foreign direct investment, public agricultural spending, exchange rate, inflation and labor from World Bank database indicators and National Bureau of Statistics (NBS).

### Data Analysis Techniques

Augmented Dickey Fuller test (ADF) alongside Philip-Perron test were used for stationary test of variables. Vector error correction model (VECM) was used to analyze the effect of public expenditures and foreign direct investment on agricultural growth while Monte Carlo simulation was used to examine the effect of changes (10%) in public expenditures and foreign direct investment on agricultural growth.

Table 1. Description of variables

| Variables | Measurement | Source | Symbol |
|---|---|---|---|
| Agricultural growth | Naira equivalent | World Bank | AGRIC |
| Public expenditures in agriculture | Naira equivalent | NBS | PUB |
| Foreign direct investment in agriculture | Naira to USD equivalent | NBS | FDI |
| Agricultural labor | Number of people employed in the agricultural sector | World Bank | LB |
| Exchange rate | Naira to USD equivalent | World Bank | EX |
| Inflation rate | Naira equivalent | NBS | INF |

## Description of Analytical Tools

- *Augmented Dickey Fuller test (ADF)*

This analytical tool with the constant term and trend can be specified as follows:

$$\Delta Q_t = \alpha_0 + \alpha_1 t + \beta Y_{t-i} + \sum_{i=1}^{p} \delta_i \Delta Y_{t-i} + \varepsilon_t \tag{1}$$

*where*: Q = (agricultural sector growth; public agricultural spending in agriculture; agricultural labor; inflation rate; exchange rate; foreign direct investment in agriculture), $\alpha_0$ = constant, $\alpha_1$ = coefficient of the trend series, $p$ = lag order of the autoregressive process, $Y_{t-1}$ = lagged value of order one of $Y_{t-1}$ and $\varepsilon_t$ = error term.

- *Johansen Co Integration Test*

A linear combination of two or more *I*(1) series may be stationary or *I*(0), in which case the series are co-integrated. The null hypothesis for the Johansen Co-integration test ($H!$:$r$ = 0) implies that co-integration does not exist, while the alternative hypothesis ($H!$: $r$> 0) implies that it does. If the null for non-co-integration is rejected, the lagged residual from the co-integrating regression is imposed as the error correction term in a Vector Error Correction Model (VECM) given below as:

$$\nabla Y_t = \prod Y_{t-1} + \sum_{i=1}^{k-1} \tau_i \nabla Y_{t-1} + u + \varepsilon_t \tag{2}$$

*where:* $\nabla Y_t$ = First difference of a $(n \times i)$ vector of the n variables of interest (malnutrition); $\prod = (n \times n)$ Coefficient matrix associated with lagged values of the endogenous dependent variables; $Y_{t-1}$ = Lagged values of $Y_t$; $\tau = (n \times (k-1))$ Matrix of short-term coefficients; $u = (n \times 1)$ Vector of constant; $\varepsilon_t = (n \times 1)$ vector of white noise residuals.

- *Vector Error Correction Model*

A vector error correction (VECM) model is a restricted VAR designed for use with non stationary series that are known to be cointegrated. The cointegration term is known as the error correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments (Lutkepohl 2005).

VECM enable to interpret long term and short-term equations by determining the number of co-integrating relationships. The benefit of VECM over VAR is that the subsequent VAR from VECM representation takes more efficient coefficient estimates (Maitra 2019). Following Andrei and Andrei (2015), VECM is specified as follow:

$$lnAGRIC_{t-1}^{*} = \alpha_{0i} + \alpha_1 lnPUB_{t-1} + \alpha_2 lnLB_{t-1} + \alpha_3 lnFDI_{t-1} + \alpha_4 lnINF_{t-1} + \alpha_5 lnEX_{t-1} + ECT_{t-1} + \varepsilon_{t-1} \tag{3}$$

*where:* AGRIC = agricultural growth (% contribution to GDP in Naira); PUB = Public expenditure in Agriculture (Naira); FDI = Foreign Direct investment in agriculture (Naira); LB = Agricultural labor; EX = Exchange rate (Dollar/Naira); INF = Inflation rate; $ECT_{t-1}$ is the error correction term.

- *Monte Carlo Simulation*

Monte Carlo simulation also known as Monte Carlo method or multiple probability simulation is used to generate random variables that represent uncertainties in the model by specifying inputs as probability distributions (Gentle 2010). This approach is useful in the sense that it does not rely on point estimate but rather involves randomness to solve problems that might be deterministic in nature. Thereby, the impact of varying scenarios of effect of public agricultural spending and foreign direct investment in agriculture on agricultural growth was analyzed using Monte Carlo simulation.

Specifically, the simulation agricultural growth (AGR) model is:

$$E\big(f(X_i)\big) = \acute{\theta}_N = \frac{1}{N}\sum_{i=1}^{N} f(X_{it}) \tag{4}$$

*where:* X is a vector of AGR determinants; $\theta$ is the dependent va$riable$ $(AGR)$.

Agricultural growth was simulated from the stochastic model:

$$AGRIC_{it}^{*} = \alpha_{0i} + \alpha_1 * (PUB_{it} + \vartheta_{1,it}) + \alpha_2 LB_{it} + \alpha_3 * (FDI_{it} + \vartheta_{3,it}) + \alpha_4 INF_{it} + \alpha_5 EX_{it} + \alpha_6 AGR_{t-1} + \zeta_{it} \quad (5)$$

*where:* AGRIC = agricultural growth (% contribution to GDP in Naira); PUB = Public expenditure in Agriculture (Naira); FDI = Foreign direct investment in agriculture (Naira); LB = Agricultural labor; EX = Exchange rate (Dollar/Naira); INF = Inflation rate; $\vartheta_{1,it}$ $and$ $\vartheta_{3,it}$ are uncertainties in the measurement of PUB and FDI; $\zeta_{it}$= exogenous white noise disturbance.

Due to stochastic nature of the conceived relationship, the response of agricultural growth in numerous settings was assessed. The simulation settings consist of variations in public expenditures and foreign direct investment at 10%.

## 3. Results and Discussion

### 3.1. Descriptive Statistics

Table 2 presents the descriptive statistics of the variables used in the analysis. The result shows that AGRIC, exchange rate, FDI, inflation rate, interest rate, labor and public expenditure are all positively skewed to the right tail and are they are also all platykurtic. Also, the Jarque-Bera probability test of normality indicates all variables were normally distributed.

Table 2. Descriptive Statistics

| Descriptive Statistics | AGRIC | Exch. Rate | FDI | Infl. Rate | Int. Rate | Labor | Pub. Exp |
|---|---|---|---|---|---|---|---|
| Mean | 22.86158 | 83.10158 | 6.92E+09 | 19.35289 | 1.81E+09 | 5.61E+09 | 2.61E+10 |
| Median | 22.04500 | 57.20500 | 1.21E+09 | 12.95000 | 19.50870 | 37876500 | 6.58E+09 |
| Maximum | 36.97000 | 348.0000 | 8.24E+10 | 72.80000 | 3.62E+10 | 8.24E+10 | 1.38E+11 |
| Minimum | 12.24000 | 0.550000 | 1.17E+08 | 5.400000 | 8.431600 | 23366000 | 2.86E+08 |
| Std. Dev. | 4.765109 | 87.33094 | 1.86E+10 | 17.23975 | 7.75E+09 | 1.86E+10 | 3.31E+10 |
| Skewness | 0.439044 | 1.094688 | 3.344826 | 1.741705 | 4.031842 | 3.486421 | 1.477827 |
| Kurtosis | 4.424333 | 4.054653 | 13.24745 | 4.836442 | 17.32942 | 13.96896 | 5.025417 |
| Jarque-Bera | 4.432956 | 9.350631 | 237.1225 | 24.55221 | 428.0626 | 267.4861 | 20.32716 |
| Probability | 0.108992 | 0.009323 | 0.000000 | 0.000005 | 0.000000 | 0.000000 | 0.000039 |
| Sum | 868.7400 | 3157.860 | 2.63E+11 | 735.4100 | 6.86E+10 | 2.13E+11 | 9.91E+11 |
| Sum Sq. Dev. | 840.1317 | 282187.6 | 1.27E+22 | 10996.73 | 2.22E+21 | 1.29E+22 | 4.06E+22 |
| Observations | 38 | 38 | 38 | 38 | 38 | 38 | 38 |

*Source:* Author's compilation (2020)

### 3.2. Unit Root Test

Table 3 presents the result preliminary investigation of the properties of variables prior to regression using Phillip-Perron (PP) and Augmented Dickey–Fuller test (ADF). The result is presented for. The PP and ADF test results indicate that all the variables were not stationary at level but stationary at first difference. The result implies that random walk or multiple means of covariance or both is identified by the level form of these variables. The first difference of these variables, however, is integrated or stationary. The presence of the unit root in the variable level form required a co-integration test to decide if these variables have a long-term relationship.

According to Enger and Granger (1987), the linear combination of non-stationary variables is often co-integrated. Given the possible break points of each variable with their respective break point year, variables were stationary at first difference with Zivot and Andrew from the test result in Table 4 to account for the bias in Philip-Perron and ADF statistics that could not account for the structural break in the model.

Table 3. Unit Root test for all Variables (PP and ADF)

| Variables | Phillip-Perron (PP) | | Augmented-Dickey Fuller (ADF) | | | |
|---|---|---|---|---|---|---|
| | At level | Difference | At level | | Difference | |
| | T-statistic | T-statistic | T-statistic | Prob | T-statistic | Prob. |
| LnAGRIC | -3.24544 | 0.0423 | -3.02434 | 0.0423 | -6.181854 | 0.0000 |
| LnEX__RATE | 1.6287 | 0.458 | 1.628706 | 0.4582 | -5.219192 | 0.0000 |
| LnFDI | -3.0225 | 0.0455 | -3.02278 | 0.0425 | -4.856616 | 0.0002 |
| LnINF_RATE | -2.54550 | 0.1139 | -2.545516 | 0.1139 | --6.656395 | 0.0000 |
| LnINT_RATE | 0.53116 | 0.9856 | 0.53176 | 0.9856 | -6.153935 | 0.0000 |
| LnLABOUR | -1.9854 | 0.2917 | -1.985404 | 0.2917 | -5.873151 | 0.0001 |
| LnPUB | -0.6422 | 0.8488 | -0.642202 | 0.8481 | -6.948744 | 0.0000 |

*Note*: *** denotes rejection of the null hypothesis at 1 percent level of significance; EX_RATE= exchange rate, INF_RATE= inflation rate PUB =public expenditure.
*Source:* Author's compilation (2020)

Table 4. Unit Root test for all Variables using Zivot and Andrew Test

| Variables | Level | | First Difference | |
|---|---|---|---|---|
| | t-statistic | Break Year | t-statistic | Break Year |
| LnAGRIC | -3.2674 | 2006 | -3.4845 | 1999 |
| LnEX_RATE | -2.0672 | 2001 | -6.5312 | 1995 |
| LnFDI | -2.9788 | 2001 | -3.7841 | 1999 |
| LnINF_RATE | -2.5673 | 2004 | -7.856322 | 1995 |
| LnINT_RATE | -2.0311 | 2001 | -4.5515 | 1999 |
| LnLABOUR | -3.2135 | 2006 | -6.2334 | 1999 |
| LnPUB | 2.02321 | 2001 | -3.6641 | 1989 |

*Note*: Lag Length selection criteria.
*Source:* Author's Compilation (2020)

Table 5 presents the result of lag length from six different selection criteria; AIC was chosen because of its lowest value 8.797 at lag 2. Therefore, Lag 2 is the appropriate lag to be in used for the model.

Table 5. Lag Structure for the Model

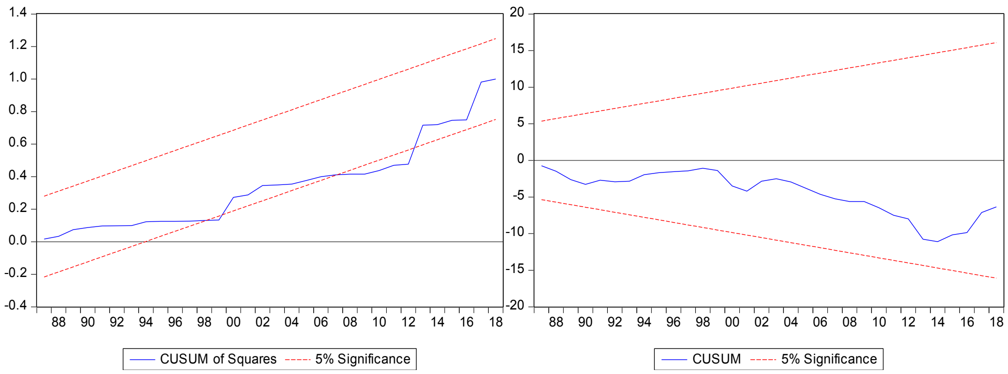
| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -327.1103 | NA | 0.271619 | 18.56168 | 18.86959 | 18.66915 |
| 1 | -152.5118 | 271.5977 | 0.000267 | 11.58399 | 14.04724 | 12.44373 |
| 2 | -53.35303 | 115.6852* | 2.28e-05* | 8.797391* | 13.41599* | 10.40940* |

*Note*: * indicates lag order selected by the criterion
*Source:* Author's compilation using EViews (2020)

### 3.3. Chow Test for Structural Break

The result for structural break of the model using the CUSUM and CUSUM of squares test is presented in Figure 1. The CUSUM line is positioned between the gridlines, which means that it is between two standard deviations or a 95 percent confidence interval level. The graphs show that for policy direction, the fitted model is parsimonious, stable, and appropriate.

Figure 1. CUSUM and CUSUM sum of squares graphs




*Source*: Author's computation

### 3.4. Johansen Co-integration Test

In order to decide whether long-run linear combinations of non-stationary variables are stationary, a co-integration test investigation was carried out on the series properties of I(1) variables via the Johansen co-integration test. This assumes that non-stationary variables can be stationary in a linear combination (Enger and Granger 1987). The result of the Johansen Co-integration test is shown in Table 6 and Table 7. Using trace statistics, the result revealed that combination of these variables has four co-integrating equations and this implies that linear combination of these variables has up to four long run linear combinations or relationships.

However, maximum Eigen statistics criterion also shows two co-integration equation, and this means that linear combination of these variables has two long run linear combination or relationships. The implication is that linear combination of these variables can be modeled with OLS without the risk of spurious result. However, the maximum eigen statistics is adopted in this research for the purpose of simplicity in analysis and discussion. Thus, a long run relationship exists between GDP, exchange rate, FDI, inflation rate, interest rate, labor and public expenditure with two co-integrating equations.

Table 6. Unrestricted Co-integration Rank Test (Trace)

| Hypothesized no of (ECS) | Eigen Value | Trace Statistic | 0.05 - Critical value | Probability ** |
|---|---|---|---|---|
| None * | 0.946410 | 252.6750 | 125.6154 | 0.0000 |
| At most 1* | 0.843418 | 147.3247 | 95.75366 | 0.0000 |
| At most 2* | 0.588531 | 80.57450 | 69.81889 | 0.0054 |
| At most 3 * | 0.492091 | 48.60576 | 47.85613 | 0.0424 |
| At most 4 | 0.363647 | 24.21748 | 29.79707 | 0.1914 |
| At most 5 | 0.184100 | 7.945390 | 15.49471 | 0.4713 |
| At most 6 | 0.017094 | 0.620708 | 3.841466 | 0.4308 |

*Note*: ** denote rejection of null hypothesis at 5% significant level. *Sources:* Author's Computation from EViews (2020)

Table 7. Unrestricted Co-integration Rank Test (Maximum EigenValue)

| Hypothesized | Eigen Value | Trace Statistic | 0.05 | Probability ** |
|---|---|---|---|---|
| None * | 0.946410 | 105.3503 | 46.23142 | 0.0000 |
| At most 1 * | 0.843418 | 66.75024 | 40.07757 | 0.0000 |
| At most 2 | 0.588531 | 31.96874 | 33.87687 | 0.0830 |
| At most 3 | 0.492091 | 24.38828 | 27.58434 | 0.1217 |
| At most 4 | 0.363647 | 16.27209 | 21.13162 | 0.2094 |
| At most 5 | 0.184100 | 7.324682 | 14.26460 | 0.4515 |
| At most 6 | 0.017094 | 0.620708 | 3.841466 | 0.4308 |

*Note*: ** denote rejection of null hypothesis at 5% significant level. *Sources:* Author's Computation from EViews (2020)

### 3.5. Determinants of Agricultural Growth in the Long Run

The result of the determinants of agricultural growth in the long run is presented in Table 8. The result shows two cointegrating-equations. The coefficient of determinant ($R^2$) of the first equation is 0.746 indicating that 74.6% of the variation in agricultural growth was explained by agricultural growth, exchange rate, FDI, inflation rate, interest rate, labor and public expenditure on agriculture in the previous year. Specifically, the coefficient of FDI (0.26) is positive and significant at 1% level, this is in line with the *apriori* expectation. This implies that a unit increase in foreign direct investment will increase agricultural growth by 2.6% in the same direction. The increase in GDP per unit increase in FDI could be due to attractive macroeconomic fiscal and monetary policies such as tax reduction, stabilization of exchange and interest rate and increase in government spending on basic infrastructures such as roads, pipe borne water, electricity and health center, *etc*. The increase in FDI means increase in the nation's gross capital formation, increase in economic activities as well as increase in employment. This result is in harmony with Edewor *et al.* (2017) that found a positive relationship between FDI and agricultural growth in Nigeria.

The coefficient of public agricultural expenditure (0.11) was positive and significant at 1% implying that a unit increase in public agricultural expenditure will increase agricultural growth by 1.1% in the same direction. Public agricultural spending has positive on the country' capital stock reflecting higher flows of public funds and increase in human capital as explained by Agenor and Moreno-Dodson (2007). This result agrees with the finding of Armas *et al*. (2012) who found public agricultural spending had positive impact on agricultural growth in Indonesia. The influence of other variables was not statistically significant except for labor. The results from the first cointegrating equation was explained because it has higher R-squared.

Table 8. Estimated Long run coefficients

| Cointegrating Eq. | CointEq1 | CointEq2 |
|---|---|---|
| AGRIC (-1) | 1.000000 | 0.000000 |
| Exchange Rate (-1) | 0.000000 | 1.000000 |
| FDI (-1) | 0.264096 | -1.643873 |
| | (0.02744) | (0.14874) |
| | [-9.62423] | [-11.0522] |
| Inflation Rate (-1) | 0.067413 | 1.552737 |
| | (0.03457) | (0.18736) |
| | [ 1.95018] | [ 8.28724] |
| Interest (-1) | -0.089895 | -1.275371 |
| | (0.05949) | (0.32243) |
| | [-1.51120] | [-3.95553] |
| Labour (-1) | 0.374865 | 3.366913 |
| | (0.10906) | (0.59116) |
| | [ 3.43710] | [ 5.69545] |
| Public Expenditure (-1) | 0.113725 | 0.380552 |
| | (0.02109) | (0.11433) |
| | [ 5.39177] | [ 3.32865] |
| Constant | -6.792591 | -36.88864 |
| R-squared | 0.746041 | 0.720686 |

*Note*: Standard errors in ( ) & *t*-statistics in [ ]. *Source:* Author's Compilation (2020)

### 3.6. Determinants of Agricultural Growth in the Short Run

The short run impact of FDI on agricultural growth is presented in the Table 9. The first cointegrating equation is explained for the obvious advantage of its high $R^2$ (0.74). The agricultural growth (GDP) is 0.6266 and statistically significant at 1% probability level with an adjustment speed of 62.66%. This means that previous year's error is corrected in the current year, implying that the system came back to equilibrium in less than a year. The variables that affects agricultural growth in the short run are agricultural growth in the previous year, FDI in the previous year and labor. Specifically, the coefficient of agricultural growth in the previous year was 0.49 and significant at 1% implying that an increase in agricultural growth in the previous year will lead to an increase in the current year by 0.49%. FDI was negative (-1.91) and significant at 1 % probability level. This means that a unit increase in FDI in the previous year will decrease agricultural growth by 1.91%.

This could be as a result of foreign investors not investing in the entire agricultural chain to bring about a significant impact in agricultural growth; this is not surprising as FDI can only contribute to growth only when the host country has reached a developmental level capable of absorbing the advanced technology that it brings. This result is in contrast with Oloyede (2014) who found a positive impact of FDI on agricultural growth in Nigeria in the short run. The influence of other variables in the short run were not significant.

Table 9. Estimated Short Run Coefficients

| Error Correction | D(AGRIC) | D(EX-Rate) | D(FDI) | D(Inf-Rate) | D(Int-Rate) | D(Labour) | D(Pub) |
|---|---|---|---|---|---|---|---|
| CointEq1 | -0.626693 | 1.573090 | 0.726560 | 4.552252 | -4.176870 | 0.135935 | -0.709801 |
| | (0.19361) | (0.55108) | (1.19054) | (1.04227) | (5.91076) | (2.64565) | (1.30195) |
| | [-3.23687] | [ 2.85455] | [ 0.61028] | [ 4.36763] | [-0.70666] | [ 0.05138] | [-0.54518] |
| CointEq2 | -0.062836 | -0.393322 | -0.048641 | -0.474208 | 0.303708 | -0.186497 | 0.167265 |
| | (0.02709) | (0.07711) | (0.16658) | (0.14583) | (0.82703) | (0.37018) | (0.18217) |
| | [ 2.31954] | [-5.10100] | [-0.29200] | [-3.25170] | [ 0.36723] | [-0.50380] | [ 0.91820] |
| D(AGRIC(-1)) | 0.489705 | -1.768509 | 0.657219 | 1.173916 | 0.674353 | -1.260906 | 0.401515 |
| | (0.17652) | (0.50243) | (1.08544) | (0.95025) | (5.38893) | (2.41208) | (1.18700) |
| | [ 2.77425] | [-3.51992] | [ 0.60549] | [ 1.23537] | [ 0.12514] | [-0.52275] | [ 0.33826] |
| D(AGRIC(-2)) | -0.133147 | -1.313479 | -1.029271 | -3.529461 | 0.254373 | 0.119997 | -1.334837 |
| | (0.18904) | (0.53808) | (1.16246) | (1.01769) | (5.77136) | (2.58326) | (1.27124) |
| | [-0.70432] | [-2.44103] | [-0.88542] | [-3.46811] | [ 0.04407] | [ 0.04645] | [-1.05003] |
| D(EX-Rate(-1)) | 0.005679 | -0.019093 | 0.020544 | 1.479139 | -0.238254 | -0.476909 | -0.270939 |
| | (0.05299) | (0.15084) | (0.32587) | (0.28528) | (1.61785) | (0.72415) | (0.35636) |
| | [ 0.10717] | [-0.12658] | [ 0.06305] | [ 5.18484] | [-0.14727] | [-0.65858] | [-0.76030] |
| D(Ex-Rate(-2)) | 0.086662 | 0.137608 | 0.295607 | -0.201293 | -2.679108 | -0.197871 | 1.273415 |
| | (0.05505) | (0.15669) | (0.33851) | (0.29635) | (1.68062) | 0.75224) | (0.37019) |
| | [ 1.57425] | [ 0.87822] | [ 0.87326] | [-0.67924] | [-1.59412] | [-0.26304] | [ 3.43994] |
| D(FDI(-1)) | -0.191947 | 0.087846 | 0.774201 | 1.198318 | 3.030567 | 1.962421 | -0.617431 |
| | (0.05593) | (0.15920) | (0.34394) | (0.30110) | (1.70757) | (0.76431) | (0.37612) |
| | [-3.43175] | [ 0.55178] | [ 2.25099] | [ 3.97975] | [ 1.77478] | [ 2.56758] | [-1.64157] |
| D(FDI(-2)) | -0.067944 | 0.099015 | 0.733068 | 0.669274 | -0.109169 | 0.856021 | -0.336804 |
| | (0.06003) | (0.17085) | (0.36910) | (0.32313) | (1.83251) | (0.82023) | (0.40364) |
| | [-1.13193] | [ 0.57954] | [ 1.98608] | [ 2.07119] | [-0.05957] | [ 1.04364] | [-0.83441] |
| D(Inf-Rate(-1)) | -0.010331 | 0.354353 | -0.183257 | 0.211971 | 0.170104 | 0.168898 | -0.133543 |
| | (0.03018) | (0.08589) | (0.18556) | (0.16245) | (0.92129) | (0.41237) | (0.20293) |
| | [-0.34235] | [ 4.12544] | [-0.98756] | [ 1.30481] | [ 0.18464] | [ 0.40958] | [-0.65808] |
| D(Inf-Rate(-2)) | -0.059319 | 0.388958 | 0.105510 | -0.310576 | 0.239153 | 0.242902 | -0.187347 |
| | (0.03049) | (0.08678) | (0.18749) | (0.16414) | (0.93083) | (0.41664) | (0.20503) |
| | [-1.94554] | [ 4.48189] | [ 0.56276] | [-1.89218] | [ 0.25693] | [ 0.58301] | [-0.91375] |
| D(Int-Rate(-1)) | -0.004695 | -0.326724 | 0.085915 | -0.027385 | 0.919441 | 0.234493 | 0.003808 |
| | (0.01996) | (0.05682) | (0.12274) | (0.10746) | (0.60939) | (0.27276) | (0.13423) |
| | [-0.23519] | [-5.75061] | [ 0.69996] | [-0.25485] | [ 1.50879] | [ 0.85970] | [ 0.02837] |
| D(Int-Rate(-2)) | 0.043335 | -0.101817 | -1.521494 | -0.206803 | 2.317911 | -1.617313 | 0.076615 |
| | (0.04131) | (0.11759) | (0.25403) | (0.22239) | (1.26120) | (0.56451) | (0.27780) |

| Error Correction | D(AGRIC) | D(EX-Rate) | D(FDI) | D(Inf-Rate) | D(Int-Rate) | D(Labour) | D(Pub) |
|---|---|---|---|---|---|---|---|
| | [ 1.04898] | [-0.86589] | [-5.98943] | [-0.92990] | [ 1.83786] | [-2.86497] | [ 0.27579] |
| D(Labour(-1)) | 0.073700 | 0.576526 | -0.520453 | -0.407511 | -2.255569 | -1.000817 | 0.191353 |
| | (0.04287) | (0.12203) | (0.26362) | (0.23079) | (1.30883) | (0.58583) | (0.28829) |
| | [ 1.71908] | [ 4.72457] | [-1.97422] | [-1.76571] | [-1.72334] | [-1.70837] | [ 0.66375] |
| D(Labour(-2)) | -0.057593 | 0.149941 | 2.813462 | 0.221144 | -4.728352 | 2.997246 | -0.111636 |
| | (0.08669) | (0.24674) | (0.53305) | (0.46666) | (2.64645) | (1.18455) | (0.58293) |
| | [-0.66439] | [ 0.60770] | [ 5.27808] | [ 0.47389] | [-1.78668] | [ 2.53029] | [-0.19151] |
| D(Pub(-1)) | 0.002372 | 0.107476 | -0.262774 | -0.514677 | 0.296742 | 0.155365 | -0.268805 |
| | (0.02825) | (0.08041) | (0.17372) | (0.15209) | (0.86248) | (0.38605) | (0.18998) |
| | [ 0.08396] | [ 1.33656] | [-1.51262] | [-3.38414] | [ 0.34406] | [ 0.40245] | [-1.41494] |
| D(Pub(-2)) | -0.001983 | 0.131889 | 0.035757 | 0.076209 | -0.875417 | -0.334361 | -0.385004 |
| | (0.02920) | (0.08312) | (0.17957) | (0.15720) | (0.89152) | (0.39904) | (0.19637) |
| | [-0.06792] | [ 1.58674] | [ 0.19913] | [ 0.48478] | [-0.98194] | [-0.83791] | [-1.96059] |
| C | -0.004761 | 0.329141 | -0.024460 | -0.193866 | 0.627752 | 0.088688 | 0.093485 |
| | (0.02263) | (0.06441) | (0.13915) | (0.12182) | (0.69083) | (0.30921) | (0.15217) |
| | [-0.21042] | [ 5.11024] | [-0.17579] | [-1.59146] | [ 0.90870] | [ 0.28682] | [ 0.61436] |
| R-squared | 0.746041 | 0.720686 | 0.859765 | 0.791551 | 0.596173 | 0.732203 | 0.707408 |
| F-statistic | 3.304849 | 2.902722 | 6.897262 | 4.272003 | 1.660847 | 3.075936 | 2.719950 |

*Note*: EX-Rate: Exchange rate, Inf-Rate: Inflation rate, Int-Rate: Interest rate and Pub: Public expenditure on agriculture
*Source:* Author's Computation (2020)

### 3.7. Effect of Increase in Foreign Direct (FDI) Investment and Decrease in Public Agricultural Spending by 10% (Scenario 1) on Agricultural Growth (Scenario 1).

The sensitivity of agricultural growth to increase in FDI and decrease in public agricultural spending is shown in figure 2 while Table 10 shows the summary statistics. The result in table 10 shows 10% increase in value of log of FDI and 10% decrease in public agricultural spending.

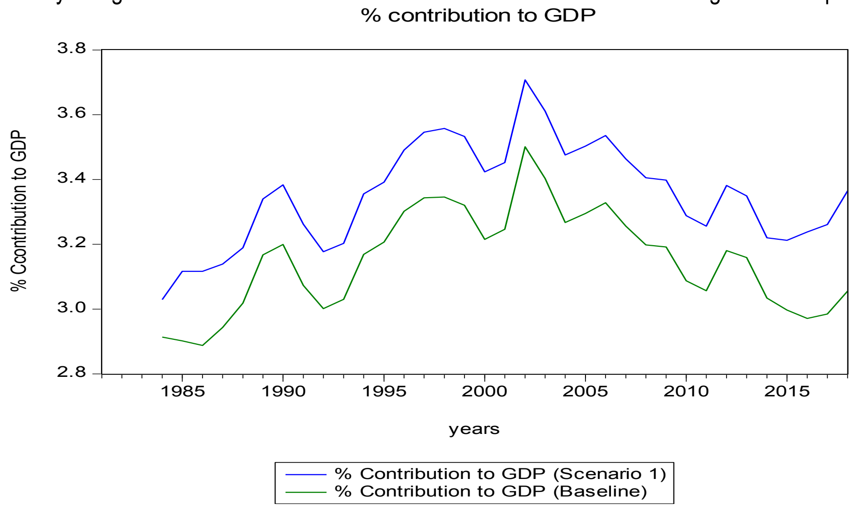
The adjusted R-square value of 0.746 signifies that only 74.6% variation in agricultural growth is accommodated by the FDI and other variables used in the first cointegrating equation. The simulation shows a 6.46% increase in the log of growth with a mean value of 3.35 in scenario 1. This positive increase was significantly different at 1% significant level ($t = -3.862 \leq 0.001$). This result disagrees with Omankhanlen (2011) who found no empirical strong evidence that FDI has been pivotal to economic growth in Nigeria.

Table 10. Summary Statistics for the Simulated Scenario 1 and Baseline Agricultural Growth

| | Baseline | Scenario 1 | %Change |
|---|---|---|---|
| Mean | 3.150026 | 3.353624 | **6.46** |
| Median | 3.168780 | 3.364686 | |
| Maximum | 3.501099 | 3.707481 | |
| Minimum | 2.887582 | 3.029191 | |
| Std. Dev. | 0.155740 | 0.158372 | |
| Skewness | 0.121773 | 0.043817 | |
| Kurtosis | 2.194595 | 2.384016 | |
| Jarque-Bera | 1.032489 | 0.564544 | |
| Probability | 0.596758 | 0.754069 | |
| Sum | 110.2509 | 117.3768 | |
| Sum Sq. Dev. | 0.824663 | 0.852780 | |

*Note*: t value = $-3.862 \leq 0.001$. *Source:* Author's Computation (2020)

Figure 2. Sensitivity of Agricultural Growth to Increase in FDI and decrease in Public Agricultural Spending by 10%




*Source:* Author's Computation (2020)

### 3.8. Effect of Decrease in Foreign Direct (FDI) Investment and Increase in Public Agricultural Spending by 10% on Agricultural Growth (Scenario 2)

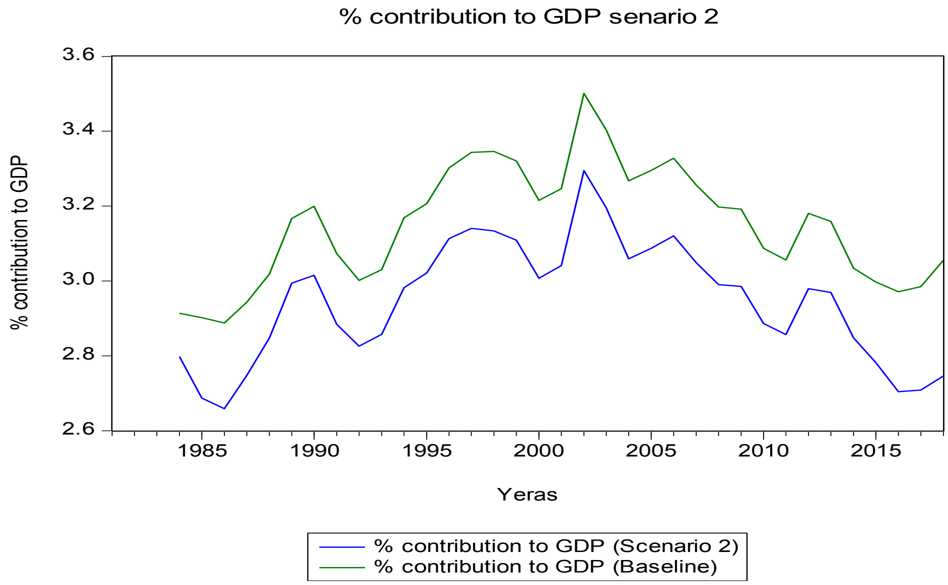
The sensitivity of agricultural growth to decrease in FDI and increase in public agricultural spending is shown in Figure 3 while Table 11 shows the summary statistics. The result in Table 11 shows 10% decrease in value of log of FDI and 10% increase in public agricultural spending. The adjusted R-square value of 0.746 signifies that only 74.6% variation in agricultural growth is accommodated by the FDI and other variables used in the first cointegrating equation. The simulation shows a 6.46% decrease in the log of growth with a mean of 2.94 in scenario 2. This positive decrease was significant at 1% significant level ($-4.862 \leq 0.001$). This result disagrees with the findings of Uboh *et al.* (2012) who found that increase in government agricultural spending led to increase in agricultural growth in Nigeria.

Table 11. Summary Statistics for the Simulated Scenario 2 and Baseline Agricultural Growth

| | Baseline | Scenario 2 | %Change |
|---|---|---|---|
| Mean | 3.150026 | 2.946428 | **-6.46** |
| Median | 3.168780 | 2.982062 | |
| Maximum | 3.501099 | 3.294716 | |
| Minimum | 2.887582 | 2.658567 | |
| Std. Dev. | 0.155740 | 0.159672 | |
| Skewness | 0.121773 | -0.036448 | |
| Kurtosis | 2.194595 | 2.208884 | |
| Jarque-Bera | 1.032489 | 0.920469 | |
| Probability | 0.596758 | 0.631136 | |
| Sum | 110.2509 | 103.1250 | |
| Sum Sq. Dev. | 0.824663 | 0.866831 | |

*Note*: $t = -4.862 \leq 0.001$
*Source:* Author's Computation (2020)

Figure 3. Sensitivity of Agricultural Growth to Decrease in FDI and Increase in Public Agricultural Spending by 10%




*Source*: Author's Computation (2020*)*

## 3.9. Effect of Increase in Foreign Direct (FDI) Investment and Increase in Public Agricultural Spending by 10% on Agricultural Growth (Scenario 3).

The sensitivity of agricultural growth to increase in FDI and increase in public agricultural spending is shown in Figure 4 while Table 12 shows the summary statistics. The result in Table 12 shows 10% increase in value of log of FDI and 10% increase in public agricultural spending. The adjusted R-square value of 0.746 signifies that only 74.6% variation in agricultural growth is accommodated by the FDI and other variables used in the first cointegrating equation. The simulation shows a 1.00 % increase in the log of growth with a mean of 3.18 in scenario 3. This positive increase was significant at 1% significant level ($-3.0114 \leq 0.031$).

The increase in foreign direct investment and public agricultural spending increases agricultural growth marginally. This slight increase may be explained by the complementary policy of increasing both foreign direct investment and public expenditures to sustain the agricultural sector. This result opposes that of Husnain *et al.* (2011) who claimed that excessive involvement of government in economic activity might hinder the beneficial effects of FDI.

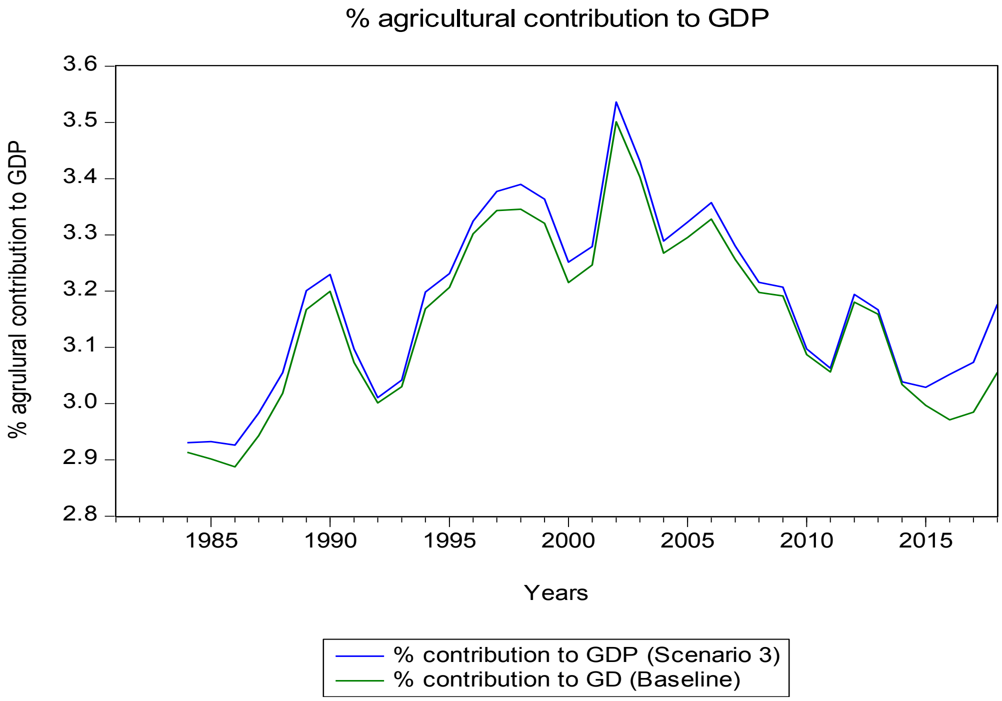
Table 12. Summary Statistics for the Simulated Scenario 3 and Baseline Agricultural Growth

| | Baseline | Scenario 3 | %Change |
|---|---|---|---|
| Mean | 3.150026 | 3.181568 | **1.00** |
| Median | 3.168780 | 3.198350 | |
| Maximum | 3.501099 | 3.536332 | |
| Minimum | 2.887582 | 2.926493 | |
| Std. Dev. | 0.155740 | 0.154522 | |
| Skewness | 0.121773 | 0.158417 | |
| Kurtosis | 2.194595 | 2.285138 | |
| Jarque-Bera | 1.032489 | 0.891642 | |
| Probability | 0.596758 | 0.640298 | |
| Sum | 110.2509 | 111.3549 | |
| Sum Sq. Dev. | 0.824663 | 0.811817 | |

*Note*: $t = -3.0114 \leq 0.031$

*Source:* Author's Computation (2020)

Figure 4. Sensitivity of Agricultural Growth to Increase in FDI and Increase in Public Agricultural Spending by 10%




*Source:* Author's Computation (2020)

## Conclusion and Recommendations

The study analyzed the response of agricultural growth to foreign direct investment and public agricultural spending from 1980 to 2018. The study showed that increase in foreign direct investment and decrease in public agricultural spending (scenario 1) provided the best alternative for the sustainability of agricultural growth in Nigeria. Based on the findings, it is suggested that friendly business policies should be made to attract more foreign direct investment into the country. The issues of insecurity and infrastructures must be handled for meaningful and sustainable FDI to be attracted as the drop in FDI could be tagged on the insecurity and poor infrastructures in Nigeria. The study has some limitations, data used for agricultural growth lumped al the sub-sectors in agriculture together, future research could leverage on this limitation and further narrow down simulations to the different sub-sectors for contextual policies to be made.

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