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Rising to meet new challenges: Africa's agricultural development beyond 2020 Vision



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Will public external debt and private investment sustain agricultural growth in Nigeria? A Monte Carlo simulation approach

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Abstract

The recent debate of research is the conflicting view with respect to public debt and empowerment of private sector as a driving force for the sustainability of the economy. Therefore this study was undertaken to evaluate the extent to which changes in public external debt and changes in private investment affect the agricultural growth. The result of the study showed that by increasing public external debt and decreasing domestic private investment the simulated data was higher compared to the baseline result implying that it supports the Keynesian view. By decreasing public external debt and increasing domestic private investment, the scenario simulated data, for agricultural growth were lower compared to the baseline implying that private investment alone cannot sustain agricultural growth in Nigeria. It was therefore recommended that specialized development agencies should be set up with the aim of implementing and evaluating government policies on foreign external debt and domestic private investment.

Keywords: Agricultural growth, simulation, baseline, scenarios

1. Introduction

External loan has the inherent capacity to promptly put a country on developmental pedestal, but, as it has been, its misuse involves huge social and human costs. External debt rather than decrease has been on the increase, particularly with the insurmountable regime of debt servicing and the insatiable desire of political leaders to obtain loans for the execution of projects without adequate planning (Essien & Onwuoduokit, 2009). Growth of economies is derived from investment in such economy. A key role is assigned to investment as a propellant of economic growth. Investment in various sectors of the economy stimulates aggregate employment, output, demand and income, it also increase the government revenue for further provision of basic industrial and agricultural growth and development of an economy.

Foreign private investment could play an important role in the economic development of a country especially a developing one like Nigeria, although foreign private investment is made up of foreign direct investment and foreign portfolio investment, according to the world latest development report. In 1988, foreign direct investment surpasses all other forms of lending as a source of foreign capital to developing countries because it disseminates advanced technology and managerial practices through the host country and thereby exhibit greater positive externalities compared to foreign portfolio investment which may not involve positive transfer but just a change in ownership. In addition, available data suggests that foreign direct investment flows tend to be more stable compared to foreign portfolio investment (Lipsey, 1999)

According to Nwosu, 2004, the 2005 Appropriation Bill presented to the National Assembly, projected the Nigerian economy to grow at the rate of 7 percent over the fiscal year. As evidenced in the bill, much of the expected growth of the economy was to be derived from growth in agricultural sector. This situation brings into focus the level of agricultural investments required to sustain the projected growth given that Nigerian agriculture consists of large numbers of smallholder farmers, scattered across the country. From the 2016 appropriation bill of ₦6.077 trillion (₦6,077,680,000,000), only ₦76.8 billion (₦76,753,672,273) was allocated to agriculture constituting only 1.2 percent of the total budget (Ministry of Budget and National Planning, 2016). This falls below the 10 percent required by the Maputo convention.

The main objective of this study was to simulate the extent to which changes in public external debt and private investment affect agricultural growth in Nigeria. The following hypotheses were tested.

H₀₁: Increase in public external debt and decrease in private investment have no significant effect on agricultural growth.

H02: Decrease in public external debt and increase in private investment have no significant effect on agricultural growth.

1.1. Scope of the Study

The study evaluated the role of public external debt and private investment on agriculture in Nigeria which covered a period of thirty seven years (1980-2016) using annual time series data.

2. Literature Review

2.1. Theoretical Framework

The theoretical background of this study is built from the Solow growth model. Following the Harrod-Domar model who emphasized on exogenous factor accumulation as a determinant of knife-edge growth. As a response to the Harrod-Domar model, Solow has shown that steady state growth is driven by technological change, while the adjustment to stable steady state growth is achieved by endogenous changes in factor accumulation. That is, the Solow model does not emphasize factor accumulation as a determinant of long-run growth. The Solow model assumes that GDP is produced according to an aggregate production function technology. Thus, following a Cobb Douglas form a representation of Solow model can be written as follows:

$$Y_t = A_t K_t^\alpha L_t^{1-\alpha} \quad (1)$$

$$0 < \alpha < 1$$

Where: Y_t is the output

K_t is the capital input

L_t is the labour input

Macroeconomists tend to call A_t as increase in the technological progress, but ultimately A_t is simply a measure of productive efficiency because an increase in A_t , it increases the productiveness of other factors. In the common empirical language A_t is also known as total factor productivity (TFP). Thus in addition to equation (1), Solow model also considered the following equations. The capital accumulation of each period depends positively on the savings and negatively on depreciation of capital which is assumed to take place at the rate δ .

Thus:

$$K_t = Y_t - C_t - \delta K_t \quad (2)$$

The labour input grows at the rate “n”

$$\frac{L_t}{L_n} = n \quad (3)$$

Technological progress grows at rate “g”

$$\frac{A_t}{A_t} = g \quad (4)$$

A fraction of output is saved each period.

$$Y_t - C_t = sY_t \quad (5)$$

According to the Solow model the steady growth rate is

$$\frac{Y_t}{Y_t} = \frac{g}{1-\alpha} + n \quad (6)$$

$$\frac{Y_t}{Y_t} = \text{GDP growth rate} \quad (7)$$

and only the rate of technology, g and the factor controlling the extent of diminishing marginal return to capital, α can affect the growth rate of output per worker. Thus, the source of economic growth is exogenous (Solow, 1956). Similar argument is found in the study conducted by Senhadji (2000) that estimated a Cobb-Douglas production function and discriminates between growths due to capital accumulation on the one hand and factor productivity growth on the other and found large regional

disparities and a particularly high contribution of productivity growth to real GDP growth in underdeveloped countries.

2.2. Empirical Review

Iyoha and Iyare (1994) adopted a simulation approach to investigate the impact of external debt on economic growth in sub-Saharan African countries. An important finding in this study was the significance of debt overhang variables in the investment equation, suggesting that mounting external debt depresses investment through both a “disincentive” effect and a “crowding out” effect. Policy simulation was undertaken to investigate the impact of alternative debt stock reduction scenarios (debt reduction packages of 5%, 10%, 20% and 50%) on investment and economic growth. It was found that debt stock reduction would have significantly increased investment and growth performance. Morriset (1991) analyzed the possibility of debt-reduction policies restoring investment and economic growth in highly indebted countries. The short term simulation results indicated that the real private investment is significantly responsive to external debt changes. An initial 20% debt reduction leads to an increase in private investment and in the GDP level of 11.7 per cent and 1.16 per cent respectively (5 years impact).

Chen-Min (1995) set up a market-clearing or neoclassical growth model to analyze the effects of public investment with debt financing. By utilizing Taiwanese data to simulate the model they found that crowding-out effects on private investment do exist in both the open economy case and the closed economy case. Moreover, the researcher also confirmed a known result that the Ricardian equivalence theorem does not hold when an income tax system is introduced. He also found that public investment financed by debt causes both current account and government budget deficits in the open economy.

Abiad, Furceri, and Topalova (2016) provided a new evidence of the macroeconomic effects of public investment in advanced economies. Using public investment forecast errors to identify the causal effect of government investment in a sample of 17 OECD economies since 1985 and model simulations. The results of this simulation suggest that a 1 percent of GDP permanent increase in public investment increases output by about 2 percent in the same year. Output declines in the third year after the shock as monetary policy normalizes, then increases to 2.5 percent over the long term because of the resulting higher stock of public capital. Similarly, the permanent increase in public investment boosts private investment both in the short and in the long term. The large output effects imply that the debt-to-GDP ratio declines by about 3 percentage points of GDP three years after the shock after which it increases somewhat stabilizing at about 1.5 percentage points of GDP below the baseline five years after the shock.

Monte Carlo simulation can be considered as a methodical way of doing so-called what-if analysis (Raychaudhuri, 2008). According to Vose (2000), Monte Carlo simulation is widely accepted as a valid technique with results that are acknowledged to be genuine. Mooney (1997) also states that by building an artificial world, or pseudo population, Monte Carlo simulation seeks to resemble the real world in all relevant respects. In Monte Carlo simulation, a statistical distribution is identified which can be used as the source for each of the input parameters. Then, random samples are drawn from each distribution, which then represent the values of the input variables. For each set of input parameters, a set of output parameters are obtained. The value of each output parameter is one particular outcome scenario in the simulation run. Such output values are collected from a number of simulation runs.

3.0 Methodology

3.1 Study Area

The study was conducted in Nigeria, a West African country and lies between longitudes 3° and 14° East and latitudes 4° and 14° North.

3.2 Data collection

Secondary data consisting of annual time series for public external debt, domestic private investment and agricultural output covering a period of 37 years were obtained from the World Bank development indicators data base.

3.3 Data Analysis Techniques

Monte Carlo simulation technique was used to simulate the extent to which increase in public external debt and decrease private investment affect agricultural growth; and simulate the extent to which decrease in public external debt and increase in private investment affect agricultural growth.

3.4 Model Specification

3.4.1 Monte Carlo Simulation Techniques

The impact of varying scenarios of public external debt and private investments on agricultural growth was assessed using Monte Carlo simulation. Specifically, the simulation agricultural growth (AG) model is

$$E(f(X_i)) = \theta_N = \frac{1}{N} \sum_{i=1}^N f(X_{it}) \quad (8)$$

where X is a vector of AG determinants

θ is the dependent variable (AG)

The agricultural growth was simulated from the stochastic model,

$$AG_{it}^* = \alpha_{0i} + \alpha_1 * (PED_{it} + \vartheta_{1,it}) + \alpha_2 * (DPI_{it} + \vartheta_{2,it}) + \zeta_{it} \quad (9)$$

Where:

AG = agricultural growth (Metric tons)

PED = public external debt (US\$)

GDPI = gross domestic private investment (US\$)

$\vartheta_{1,it}$ and $\vartheta_{2,it}$ = uncertainties in the measurements of PED and DPI

ζ_{it} = exogenous white noise disturbance on the model.

Given the stochastic nature of this model, the behaviour of agricultural growth under various scenarios was investigated. The simulation scenarios consist of increases in public external debt and decreases in domestic private investment as well as increases in domestic private investment and decreases in public external debt.

4. Results and Discussion

4.1. Effect of simulating 5% decrease in public external debt and 5% increase in domestic private investment

The extent to which 5% decrease in public external debt and 5% increase in private investment affect agricultural growth is shown in Table 1 and Figure 1. The results show that the simulated data (scenario1 mean) ranged between 8690.62 metric tons and 92967.01 metric tons with a mean of 35954.16 metric tons and standard deviation of 1.97 as compared to the baseline (baseline mean) which ranged between 15521.79 and 90219.42 metric tons with a mean value of 43044.94 metric tons and standard deviation of 1.73. This is explained by the inability of private sector to solely sustain the agricultural sector.

Table 1: Summary Statistics of effect of simulating 5% decrease in public external debt and 5% increase in domestic private investment

	Simulated data (Scenario 1 mean)	Baseline data (Baseline mean)
Mean	35954.16	43044.94
Maximum	92967.01	90219.42
Minimum	8690.62	15521.79
Std. dev.	1.97	1.73

Source: EViews 8 computation, 2017

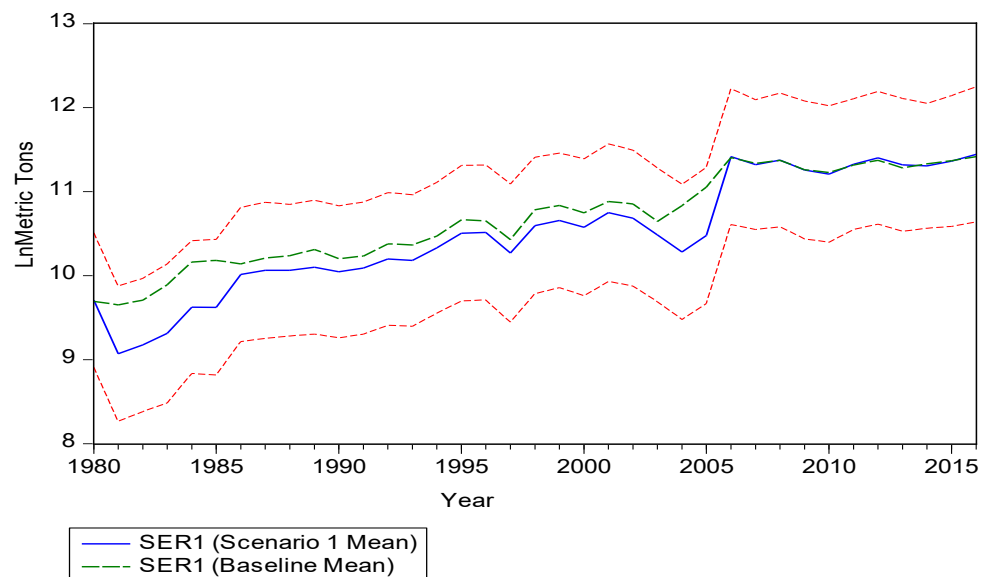


Figure 1: 5% Decrease in Public External Debt and 5% increase in Domestic Private Investment effect

Source: EViews 8 computation, 2017

4.2. Effect of simulating 10% increase in public external debt and 10% decrease in domestic private investment

The extent to which 10% increase in public external debt and 10% decrease in domestic private investment affect agricultural growth is shown in Table 2 and Figure 2. The results show that the simulated data (Scenario 2 mean) ranged between 16317.61 metric tons to 189094.1 metric tons with a mean of 62943.95 metric tons and standard deviation of 1.54 as compared to the baseline data (baseline mean) which ranged from 15521.79 metric tons to 90219.42 metric tons with mean of 43044.94 metric tons and standard deviation of 1.73. This indicates that the more the government increased debt, the more it generated revenue for infrastructural development, research and development and targeted agricultural programmes which positively affected agricultural growth such as capital expenditures of government towards the sustainability of the agricultural sector.

Table 2: Summary statistics of Effect of simulating 10% increase in public external debt and 10% decrease in domestic investment

	Simulated data (Scenario 2 mean)	Baseline data (Baseline mean)
Mean	62943.95	43044.94
Maximum	189094.1	90219.42
Minimum	16317.61	15521.79
Std. dev.	1.54	1.73

Source: EViews 8 computation, 2017

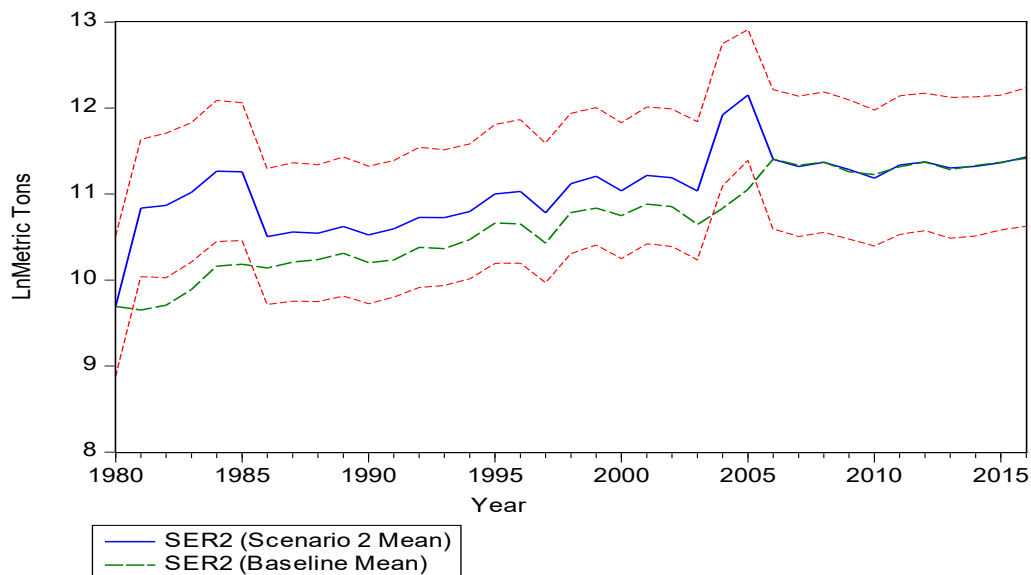


Figure 2: 10% increase in Public External Debt and 10% Decrease in Domestic Private Investment effect

Source: EViews 8 computation, 2017

The result on Table 3 further showed that t-value (3.38) was significant at 1% indicating that 10% increase in public external debt and 10% decrease in domestic private investment had significant effect on agricultural growth by increasing it.

Table 3: Test of Difference between Simulated Data (Scenario 2 Mean) and Baseline Data (Baseline Mean)

	T value	df	Significance	Decision
Equal variance assumed	3.38	72	0.000*	Reject H ₀₂
Equal variance not assumed	3.38	70.5	0.000*	

*Significant at 1%

Source: Author's computation, 2017

4.3. Effect of simulating 10% increase in public external debt and 5% decrease in domestic private investment

The extent to which 10% increase in public external debt and 5% decrease in private investment affect agricultural growth is shown in Table 4 and Figure 3. The results show that the simulated data (scenario 3 mean) ranged from 15994.5 metric tons to 105873.5 metric tons with mean of 43477.55 metric tons and standard deviation of 1.75 as compared to the baseline data (baseline mean) which ranged from 15521.79 metric tons to 90219.42 metric tons with a mean of 43044.94 metric tons and standard deviation of 1.73. Specifically, from 1980 to 1986, the simulated data (scenario 3 mean) was above the baseline data (baseline mean) implying that the more the government invested through foreign debt funds in infrastructure, research and development and targeted agricultural programmes such as National Agricultural Land Development Authority (NALDA), Directorates of Food, Road and Rural infrastructure (DFRRI), Fadama Development Projects, construction of the spillway and the main canals of the Watari irrigation Scheme and the establishment of Export and Import Bank (NEXIMB) through the funds from public external debt, the agricultural sector is improved.

Table 4: Summary statistics of effect of simulating 10% increase in public external debt and 5% decrease in domestic private investment

	Simulated data (Scenario 3 mean)	Baseline data (Baseline mean)
Mean	43477.55	43044.94
Maximum	105873.5	90219.42
Minimum	15994.5	15521.79
Std. dev.	1.75	1.73

Source: EViews 8 computation, 2017

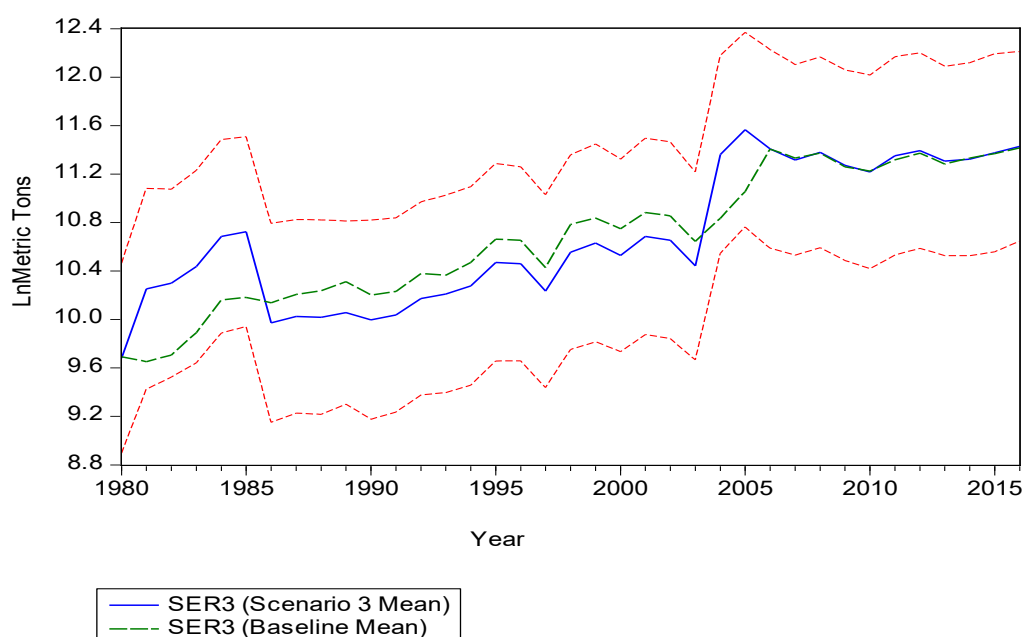


Figure 3: 10% increase in Public External Debt and 5% Decrease in Domestic Private Investment effect on Agricultural Growth

Source: EViews 8 computation, 2017

4.4. Effect of simulating 5% decrease in public external debt and 10% increase in domestic private investment

The extent to which 5% decrease in public external debt and 10% increase in private investment affect agricultural growth is shown in Table 5 and Figure 4. The graph shows that simulated data (scenario 4 mean) ranged from 4964.16 metric tons to 91126.14 metric tons with the mean of 24834.77 metric tons and standard deviation of 2.44 as compared to the baseline data (baseline mean) which ranged from 15521.79 metric tons to 90219.42 metric tons with a mean of 43044.94 metric tons and standard deviation of 1.73. These results imply that there is dwindling macroeconomic performance of fiscal policy variables.

Table 5: Summary statistics of effect of simulating 5% decrease in public external debt and 10% increase in domestic private investment

	Simulated data (Scenario 4 mean)	Baseline data (Baseline mean)
Mean	24834.77	43044.94
Maximum	91126.14	90219.42
Minimum	4964.16	15521.79
Std. dev.	2.44	1.73

Source: EViews 8 computation, 2017

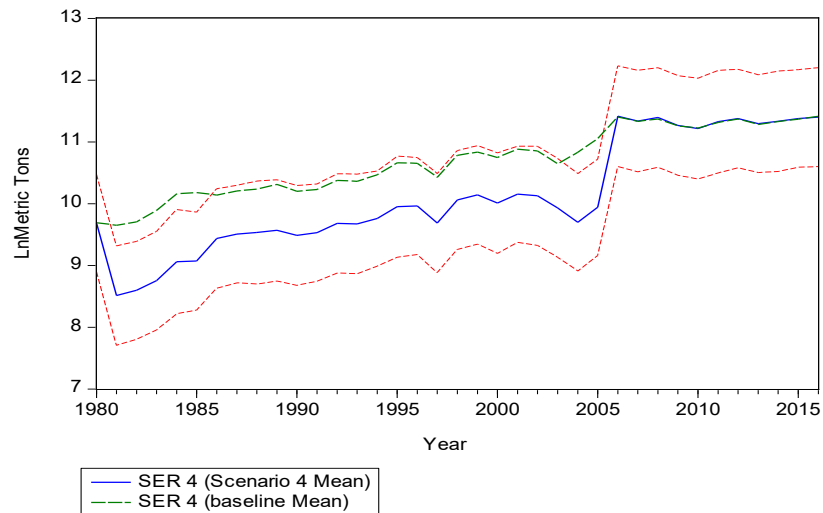


Figure 4: 5% Decrease in Public External Debt and 10% increase in Domestic Private Investment effect

Source: EViews 8 computation, 2017

5. Conclusion and Recommendations

The study showed that increasing the public external debt and decreasing gross domestic private investment give a higher level of agricultural output as compared to increasing gross domestic private investment and decreasing public external debt which validates the Keynesian theory which assumes that government borrowing is necessary to sustain the economy.

Based on the conclusion afore made it was therefore recommended that specialized development agencies should be set up with the aim of implementing and evaluating government policies on foreign external debt and domestic private investment. Government should also put in place appropriate measures aimed at the optimal use of borrowed funds so that servicing such funds will not invoke economic crisis with its growth rate.

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