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ECONOMETRIC MODELING OF THE NEXUS OF AGRICULTURAL POLICY AND FOOD SECURITY IN NIGERIA: A DUMMY VARIABLE REGRESSION APPROACH

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ABSTRACT

Sustainable food production is not negotiable if food security is to be achieved. Recent statistics show increasing food insecurity issues in Nigeria despite government policy and programmes in the agricultural sector. The study specifically described agriculture growth trend under three policy regimes and analysed the effects of agricultural sector policy on food security in Nigeria between 1960 and 2020. Secondary data on agricultural output, gross deficit financing, labour employed in the agricultural sector, land, and population were obtained from World Development Indicators (WDI) of the World Bank, Food and Agriculture Organization Statistics (FAOSTAT), Central Bank of Nigeria (CBN), and National Bureau of Statistics (NBS). The data were analysed using trend analysis and Dummy Variable Regression (DVR) model. The Instantaneous Growth Rate (IGR) and compound growth rate (CGR) were respectively 3 percent and 7.2 percent in 1960 – 1969, 0.5 percent and 1.2 percent in 1970 – 1985, and 3.4 percent and 8.1 percent in 1986 – 2020; the country experienced stagnated pattern of growth in the agriculture sector within the oil boom and policy reconstruction period with an instantaneous and compound growth rate of 0.5 percent and 1.2 percent, respectively. An IGR and CGR of 3.4 percent and 8.1 percent, respectively were recorded during the policy stabilization era with an accelerating growth pattern. The intercept of agricultural output and *per capita* food production of the period with complete agricultural policy document differs from the period with no policy document by 36.8 percent and 39.8 percent, respectively, revealing an increase in the value of agricultural output and *per capita* food production in the period with a national policy document. The study concludes that availability of agricultural sector policy document directly impacts food security. The post-estimation tests on the models confirmed that policy implications emanating from this study are adoptable to improve food security in Nigeria through the agricultural sector policy. Proper and efficient policy mix to support agricultural production was recommended.

Key words: Agricultural policy, Agricultural output, Acceleration, Dummy Variable Regression (DVR), Food security, Sustainability, Nigeria

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INTRODUCTION

The agricultural sector in sub-Saharan Africa (SSA) has huge potential for both consumption and export; hence, key to development; a significant percentage of the entire labour force is engaged in subsistence production with associated low level of productivity [1]. According to the International Labour Organization (ILO) [1], the agricultural sector of the SSA economy employs 54% of the labour force but could account for only 15% of the Gross Domestic Product (GDP) continent-wide; an indication that the sector is performing below its potential. More than 80% of the labour force in countries like Burundi, Burkina Faso and Madagascar is employed in the agricultural sector along the value chain. By contrast, in Angola, South Africa, and Mauritius, the agricultural sector only employs 5.1%, 4.6%, and 7.8% of the population, respectively. Employment in agriculture in Nigeria was reported at 36.4% in 2019 and was at the peak in 1992 with 50.2% [2, 3].

Evidence revealed that Nigeria did not have an explicit statement on National Agricultural Policy prior to 1988 [4]. At independence in 1960, national planning and policies were formulated to achieve economic growth and development. Nigeria used unarticulated administrative and political pronouncements to guide, support, and facilitate the operations of agricultural activities [5]. The 1988 National Agricultural Policy document produced by the Federal Ministry of Agriculture and Natural Resources (FMARD) was decreed by the Federal Government of Nigeria to be operationalised for a minimum of fifteen (15) years with the aim of improving agricultural production and creating export markets. The 1988 policy document which became operational in 1989 [6,7] was reviewed and the country came up with a new Agricultural Policy document of 2001 with the broad aim of achieving food self-sufficiency and food security [8]. In 2011, there was the formulation of the Nigerian Agricultural Transformation Agenda (ATA) to revitalize the agricultural sector [9]. The Agricultural Promotion Policy (APP) of 2016-2020 (Green Alternative) was developed by the current administration as the national agricultural policy framework to drive the growth and development of agriculture in Nigeria.

Originally, food security was founded on the experience of a country for which the supply of food imports had been threatened by hostile action during world wars in Europe and the term became associated with national self-sufficiency in food supplies [10]. According to Peng *et al.* [11,12] food security involves physical and economic access to food by persons, with emphasis on quantity and quality for healthy living. Individual, household, state and national food security is the application of the above concept accordingly. Food insecurity arises when there is uncertainty about future food quantity and quality for a healthy lifestyle [13].

Broadly, agricultural sector policies are aimed at supporting innovation for effective, efficient and sustainable food production for better food security situation, increased incomes, and improved nutrition that benefit the people [6, 9]. Increasing productivity among smallholder farmers is paramount to food security in developing countries [14]. The diversification efforts of the current administration from an oil-based economy has gained prominence. This diversification involves various government responsibilities; distributing limited resources, stabilizing and regulating the economy through policies and programmes.

Considering the issue of food security in developing nations, there is a great need to contribute to this trending menace. An extensive review of available literature revealed that serious econometric investigation on the nexus of agricultural policy and food security is scrimpy at the international level; and seems unavailable in Nigeria's situation. An attempt by Awu and Rufus [15] was on the content analysis and concluded that with policy consistency especially in implementation, Nigeria could meet its food needs and export excess. Daniel and Ihechituru [16] used descriptive statistical tools to analyse the effects of agricultural reforms on the performance of the Nigeria agriculture; and concluded that the performance of the Nigeria agriculture with respect to output, market, foreign exchange and capital formation or transfer was insignificant due to policy instability, mismanagement of policy instruments, and lack of transparency. The use of descriptive statistical tools for this kind of inference or conclusion could be worrisome; this current study employed recent econometric tool "The Dummy Variable Regression (DVR)" technique in place of Chow test which is commonly used to test for structural change [17, 18]. The Chow test procedure establishes if two or more regressions are different without indicating the source of such difference [19]. The DVR model establishes the source of difference and significance using the differential intercept and differential slope coefficient. This study combined theories on food security and economic production to model the nexus of agricultural sector policy and indicators of food security.

Theoretical Framework

This study is guided by the economic production function. The theory of production function shows the relationship between inputs and output. Generally, a simple production function is given as:

$$Q = f(L,K) \quad \text{..........1}$$

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Where Q denotes the quantity of output produced and L and K denote the respective quantities of labour (the human resource) and capital (the physical resource) used. By using L and K in a production process, output (Q) is obtained.

Food security depends on a number of physical, social, economic and political factors both national and worldwide [20]. Food security is influenced by factors such as population growth, demographic changes, rapid urbanization, income growth, and technological development, on the demand side, agricultural productivity growth on the supply side [21]. Essentially, agricultural production and productivity growth in agriculture depend on a mixture of micro-economic and macro-economic policies, which are also important along with other factors such as land, labour, technology, and capital.

The theory of food security is also based on the dimensions of food security, such as availability, access, utilization, and stability. The availability dimension of food security depends on agricultural production, while stability could be in the form of government actions and inactions. From the basic theory of production, the food security function is given by:

$$FS = f(P{:}\, L, X, K, T) \quad \text{..........2}$$

Where, FS represents various food security indicators such as agricultural output, food production index, depth of food deficit, human development index, and standard of living [4]. These food security indicators are influenced by government policies (P) for the transformation of the agricultural sector or farmers' productivity; while L, X, K, and T represents Land, Labour, Capital and Technology, respectively.

Chawarika [22] posited that food security is a function of a vector of quantity of agricultural output, the vector of quantity of input and a vector of quantity of fixed factor.

$$FS = f(\mathrm{q}, \mathrm{x}, \mathrm{z}) = 0 \quad \text{..........3}$$

Equation 3 is dependent upon the availability of the variable and fixed inputs which are used for production up to an optimal point (point of bliss [22]).

Following Debertin [23], food security can further be depicted by the use of the Cobb Douglas function which is represented in equation 4:

$$FS = AX_1^{\alpha}X_2^{\beta} \qquad \text{……4}$$

Where X_1 and X_2 represent capital and labour, respectively.
α and β represent the returns to scale during production where the sum greater than one represents increasing returns to scale, less than one shows decreasing returns to scale and equals to one means constant returns to scale.

From equation 3, the maximising conditions of an individual farmer given the production function is represented as:

$$FS = q(\mathrm{p}, \mathrm{z}) \qquad \text{……5}$$

Where p represents the prices, z is private and public factors and FS is the food security indices or output supply. The supply of the agricultural products is driven by the inherent farm factors and the exogenous factors which the farmer cannot control. The exogenous factors could be in terms of government policies in the agricultural sector. To maximize the output, the farmer must be able to minimize the costs which are at the farm and be able to deal with the external circumstances which have an impact on the prices of the supply which is received. This is represented in equation 6.

$$FS_t = \alpha L + \alpha P + \alpha T + u \qquad \text{……6}$$

Where FS_t represents the food security indicators; L, P, T, and μ represent explanatory variables and other unaccounted factors, respectively. From equation 6, food security depends on agricultural labour supply, price of agricultural produce/products, technological development or agricultural innovation and other factors not accounted for in this equation. The factors affecting food security are hence, dependent upon the stated explanatory variables which have to be addressed to increase agricultural output, supply or productivity.

Analytical Framework: Dummy Variable Regression (DVR) Model
In statistics and econometrics, particularly in regression analysis, a dummy variable (also known as an indicator variable, design variable, binary variable, or qualitative variable) is one variable that takes the value 0 or 1 to indicate the absence or presence of some categorical effect that may be expected to shift the outcome. Dummy variables are used as devices to sort data into mutually exclusive categories (such as beneficiaries/non-beneficiaries). In econometrics time series, dummy variables may be used to indicate the occurrence of wars or

major strikes or economic shocks [19]. A dummy variable can thus be sought as a true value represented numerically as 0 and 1.

Dummy variables are "proxy" variables or numeric stand-ins for qualitative facts in a regression model. In regression analysis, the dependent variable may be influenced not only by quantitative variables (income, output, prices) but also by qualitative variables (policies, gender, religion, geographical region) [19]. A dummy independent variable (also called a dummy explanatory variable) which for some observations has a value of 0 will cause that variable's coefficient to have no role in influencing the dependent variable, while when the dummy takes on a value of 1, its coefficient acts to alter the intercept [19].

Dummy variables are used frequently in time series with regime switching, seasonal analysis, and qualitative data applications. Dummy variables are involved in studies for economic forecasting and response modelling. According to Gujarati and Porter [19], dummy variables may be incorporated in traditional modelling paradigms.

The use of dummy variable regression (DVR) can be considered as a test of the stability of the parameters to be estimated in the regression equation. When an equation includes both a DV for the intercept and a multiplicative dummy variable for each of the explanatory variables, the intercept and each partial slope are allowed to vary, implying different underlying structures for the two conditions (0 and 1) associated with the DV. Hence, using DVR is like conducting a test for structural stability [19].

The dummy variable regression equation is specified as follows:

$$Y_t = \beta_0 + \beta_1 DUMY + \beta_2 X_{1t} + \beta_3 X_{2t} + \beta_4 X_{3t} + \beta_5 X_{4t} + {}_{+} U_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. 7$$

Equation 7 contains only a Dummy with coefficient β_1, while equation 8 contains Dummy and a multiplicative Dummy with β_1 and β_6 respectively.

$$Y_t = \beta_0 + \beta_1 DUMY + \beta_2 X_{1t} + \beta_3 X_{2t} + \beta_4 X_{3t} + \beta_5 X_{4t} + \beta_6 DUMY * X_{1t} * X_{2t} * X_{3t} * X_{4t} * \ ..8$$

Note: for a multiplicative Dummy, the dummy variable must be related to the list of explanatory variables.

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MATERIALS AND METHODS

Study Area and Data

The study area is Nigeria, a West African nation with a population of over 200 million, using the country's population growth rate of about 3 per cent [24]. This study relied on secondary data. Annual time series data from 1960 to 2020 were used. Time series data for the period 1960-2020 on variables of interest were sourced from publications of: the World Development Indicators (WDI; https://databank.worldbank.org/source/world-development-indicators) of the World Bank, Food and Agriculture Organization (FAO; https://www.fao.org/statistics/en/), Central Bank of Nigeria (CBN; https://www.cbn.gov.ng/), and National Bureau of Statistics (NBS; https://www.nigerianstat.gov.ng/).

Model Specification

1. Trend Analysis

The trend equation used in this study is given as:

$Y_t = \alpha + \beta t + e$ ……………………………………………………………………….. 9

Where Y = share of agricultural production to Nigeria's GDP
α = intercept; β = slope/coefficient; t = time (year); e = error term
The compound annual growth function (semi-log equation) used to examine the growth rate within policy periods specified as follows [25]:

$\ln Y_t = \alpha + \beta t + e$ ………………………………………………………………………10

Where Y = share of agriculture contribution to GDP
α = intercept
β = 1 + r (the slope coefficient 'β' measures the instantaneous relative change in Y for a given absolute change in the value of explanatory variable 't') – instantaneous growth rate.
t = time (year); e = error term; r = growth rate
when the relative change in Y is multiplied by 100, the percentage change or growth rate in Y for an absolute change in variable 't' is obtained while the slope coefficient 'b' measures the instantaneous rate of growth. Therefore, the compound growth rate was then estimated using the following equation:

CGR = [antilog β – 1] * 100 ……………………………………………………………11

NOTE: multiplying β by 100, gives the instantaneous growth rate (IGR) at a point in time.

Equation 11 was estimated with the Ordinary Least Square (OLS) regression model. Following OLS, the significance of β was determined using t-values. The key assumption in this model is that a change in share of agricultural production in a given year would depend upon the percentage share in the succeeding year [26]. If β is positive and statistically significant there is acceleration in growth, if β is negative and statistically significant there is deceleration in growth, if β is not statistically significant there is stagnation in the growth process.

2. Dummy Variable Regression (DVR)

The effect of agricultural sector policy on food security in the country was determined using the Dummy Variable Regression (DVR) approach.

In this study, two different equations were estimated from the coefficients of a single equation model. The differential impact of agricultural policy on Nigeria's food security (using agricultural output and *per capita* food production as proxies) was estimated using a DVR specified as follows:

DVR Model 1

$$AGO_t = [f(DMY, GDF, LBA, LND, POP)] \quad \ldots 12$$

$$AGO_t = \alpha_0 + \beta_1 DMY + \beta_2 LNGDF_{1t} + \beta_3 LNLBA_{2t} + \beta_4 LNLND_{3t} + \beta_5 LNPOP_{4t} + U_t \quad \ldots 13$$

DVR Model 2

$$PCF_t = [f(DMY, GDF, LBA, LND, POP)] \quad \ldots 14$$

$$PCF_t = \alpha_0 + \beta_1 DMY + \beta_2 LNGDF_{1t} + \beta_3 LNLBA_{2t} + \beta_4 LNLND_{3t} + \beta_5 LNPOP_{4t} + U_t \quad \ldots 15$$

Where:

AGO_t = agricultural output; PCF_t = *per capita* food production; α_0 = intercept; DMY = agricultural policy (dummy); GDF = Government deficit financing; LBA = Labour employed in the agricultural sector; LND = area of land under cultivation; POP = population.

The multiplicative Dummy of Equations 13 and 15 were specified as:

$$AGO_t = \alpha_0 + \beta_1 DMY + \beta_2 LNGDF_{1t} + \beta_3 LNLBA_{2t} + \beta_4 LNLND_{3t} + \beta_5 LNPOP_{4t} + \beta_6 DMY * GDF_{1t} * LBA_{2t} * LND_{3t} * POP_{4t} + U_t \quad \ldots 16$$

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$PCF_t = \alpha_0 + \beta_1 DMY + \beta_2 LNGDF_{1t} + \beta_3 LNLBA_{2t} + \beta_4 LNLND_{3t} + \beta_5 LNPOP_{4t} + \beta_6 DMY * GDF_{1t} * LBA_{2t} * LND_{3t} * POP_{4t} + U_t$ ……………………………………..17

NOTE: for a multiplicative Dummy, the dummy variable are related to the list of explanatory variables [19].

Where;

α_1 = differential intercept; $\beta_1 - \beta_5$ = slope coefficient; β_6 = differential slope coefficient.

$DMY * GDF_{1t} * LBA_{2t} * LND_{3t} * POP_{4t}$ = multiplicative dummy.

The differential intercept indicates how much the intercept of the second period of the food security function (the category that receives the dummy value of 1) differs from that of the first period. The differential slope coefficient indicates how much the slope coefficient of the second period's food security function (the category that receives the dummy value 1) differs from that of the first period. The probability value of the t statistics from the slope coefficient indicates the significant influence of policy proxied by the dummy variable on food security [19].

Decision Rules

The decision rule is based on the following hypotheses:

1. Differential intercept

H_0: intercept of the second period differs from the first period.
H_1: intercept of the second period does not differ from the first period.

2. Differential slope coefficient

H_0: the slope coefficient of the second period differs from that of the first period.
H_1: the slope coefficient of the second period does not differ from that of the first period.
NOTE: the decision of the estimated coefficient of both differential intercept and the differential slope coefficient depends on the t-values or the values of the probabilities. That is, accept H_0 if $t_{cal} < t_{tab}$ or Prob < 0.05, otherwise, accept the alternative.

3. Structural instability

H_0: $\beta_1 = \beta_2 = \beta_3 = ….. = \beta_n$; the parameters are stable for the data set (evidence of stability in both period).

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H_0: $\beta_1 \neq \beta_2 \neq \beta_3 \neq \ldots.. \neq \beta_n$; the parameters are not stable for the data set (evidence of instability in both period).

NOTE: that the F-test is the conventional overall test where we accept H_0 if F_{cal} < F_{tab} or Prob < 0.05. If otherwise, we accept the alternative.

RESULTS AND DISCUSSION

Trends of Agriculture growth under different policy regimes

This study introduced three specific periods: the independence and first decade (1960 – 1969), oil boom and policy reconstruction (1970 – 1985), and policy stabilization era (1986 – 2020). It could be observed in Figures 1 and 2 that the overall share of agriculture to Nigeria GDP has a steady downward trend in the first policy period or regime (1960 – 1969). Despite the observed downward trend, the agricultural sector of Nigeria significantly contributed to its GDP, especially in the early 60's. This observation is consistent with earlier findings by Anyanwu [27] which showed the dominance of agriculture share of GDP in the 60's, though at a declining rate.

Correlatively, the estimated trend regression equation in Table 1 showed a 3% and 7.2% instantaneous and compound growth rate, respectively within the first identified policy period. The instantaneous growth rate (growth at a point in time) for the agricultural sector was 3%. By implication, the relative change in agricultural output with respect to absolute change in the trend was 3%. The compound growth rate (growth over the period) was 7.2%; implying that there was a general improvement in agricultural growth in Nigeria over the period. Additionally, the result on Table 1 showed accelerated pattern of growth within the period of independence and first decade (1960-1969).

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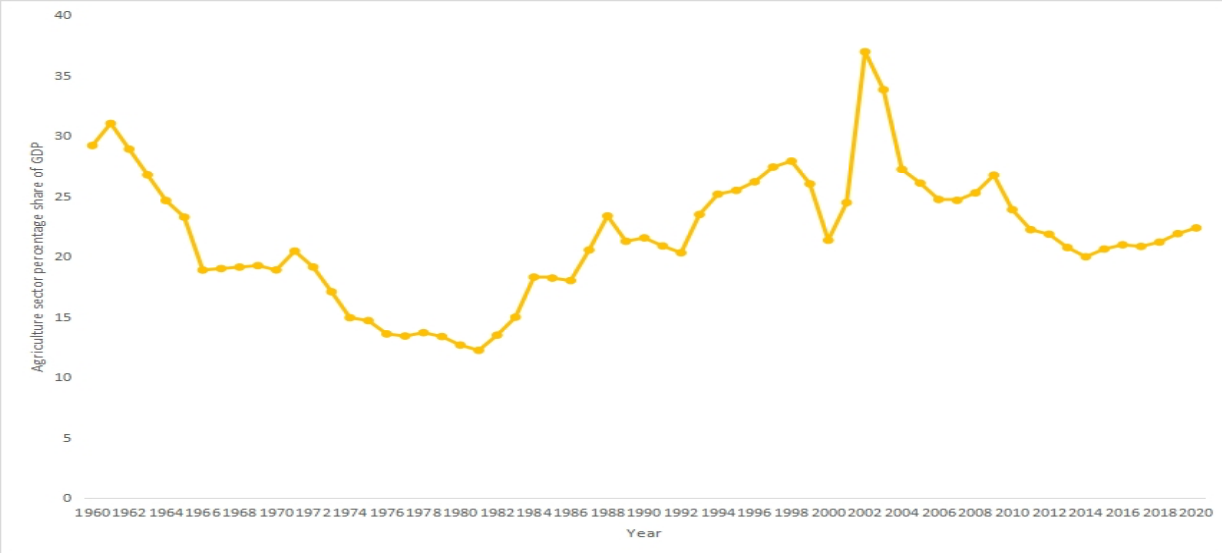

Figure 1: Trend of agriculture sector percentage share to Nigeria GDP, 1960 – 2020
Source: Researcher's Computation using FAO and WDI Data, 2021

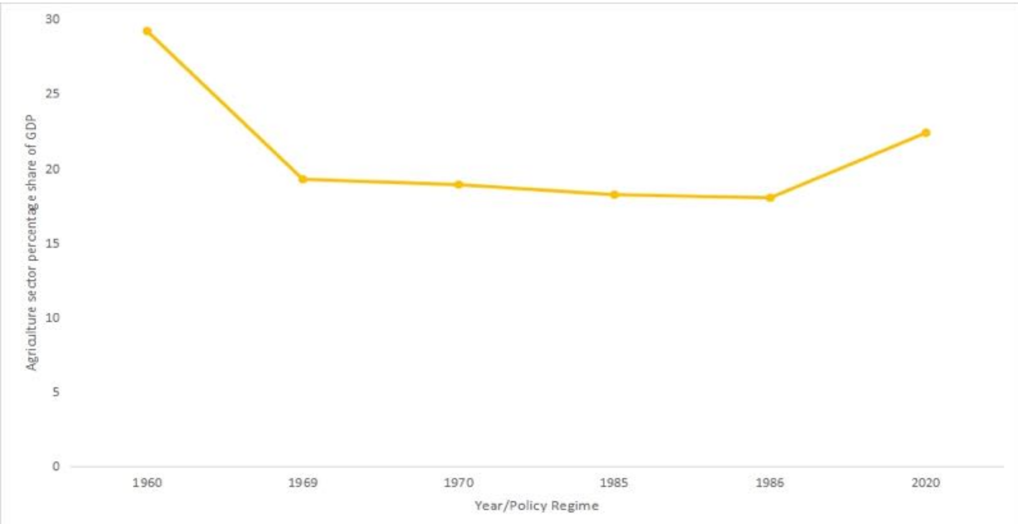

Figure 2: Trend of agriculture sector percentage share to Nigeria GDP under Policy Regimes
Source: Researcher's Computation using FAO and WDI Data, 2021

The dominance of agriculture over the period could further be attributed to the focused regional strategies and programmes that were based on commodity comparative advantage as reported by Azih [28]. Consequently, the agricultural sector guaranteed the greater percentage of the food security of an average household within the period. The observed share of agriculture to Nigeria's GDP in this study is in consonance with long time report of Michael [29] who attributed the trend to exportation of crops like cocoa, groundnut, cotton, rubber, palm oil and palm kernel, that accounts for an average of between 65-75% of Nigeria's foreign exchange earnings and provide the most important source of revenue for the country.

During the oil boom and policy reconstruction period (1970 – 1985), the agricultural sector of Nigeria experienced a general decline. The sharp decline was basically observed in 1970 – 1981. The observed trend within this period was however not surprising due to oil boom, which turned the trend against agriculture and its associated sectors (for example, the industrial sector). The oil boom of Nigeria was supposed to have favoured the agricultural sector, especially with regards to mechanization and rural development. However, the oil boom portends serious decrease in agricultural output and its contribution to Nigeria's economy. The graphical trend was further confirmed by the trend regression equation in Table 1 which shows a stagnated pattern of growth in the agriculture sector within this period with an instantaneous and compound growth rate of 0.5% and 1.2%, respectively; implying that the relative change in agricultural output with respect to absolute change in the trend was 0.5%, while there was general improvement in Nigeria's agricultural output growth over this period of 1.2%. The graphical trend agrees with Ahungwa [30] when they found an unstable trend, intertwining with the industrial sector of Nigeria within 1970 – 1989. The findings of this study further corroborate the report of Sekumade [31] that the oil boom era, which resulted in extensive exploration and export of petroleum and its products led to neglect of agriculture and light manufacturing bases in favour of an unhealthy dependence on oil.

The country experienced a visible sharp decline in 1973 and 1974 despite the prioritization of food production in Nigeria's Second National Development Plan of 1970 – 1974. The prioritization was necessitated by the Nigerian civil war which created economic hardship and hunger due mainly to food shortages [32]. Shimada [33] however criticized this strategy stating that government's pretence towards agriculture was obvious, considering the budgetary allocation to the agricultural sector which did not reflect the claimed priority (7.7% against the 23.1% expenditure on transportation sector).

Figures 1 and 2 further shows that the percentage share of agriculture sector to the GDP of Nigeria generally experienced an increasing trend in the era of policy stabilization (1986-2020). The increasing trend could be attributed to the available national policy document on agriculture, which propelled the rolling out of various programmes and strategies targeted at massive national self-sufficiency in food production. The period also marked the beginning of Structural Adjustment

Programme (SAP) and a deregulated economy. Exchange rate deregulation was the major policy instrument during the SAP of 1986. Ahungwa [34] associated the increasing trend to the involvement of Federal Government in direct food production, provision of subsidies to smallholder farmers and creation of more commodity boards for various agricultural and food products under programmes like Operation Feed the Nation. The observed increment in the percentage share of agriculture sector to the country's GDP was further confirmed in Table 1 with an IGR and CGR of 3.4% and 8.1% respectively. The implication of the IGR and CGR is that the relative change in agricultural output with respect to absolute change in the trend was 3.4%.

The compound growth rate (growth over the period) was 8.1% and this implies that there was a general improvement in agricultural growth in Nigeria over the period. The finding also shows that the growth rate pattern within the policy stabilization era was accelerating. This acceleration could be associated with the availability of productive resources like credit facilities for improved agricultural production. This position is in consonance with Azih [28] who stated that credit flow to the agricultural sector (amount of guaranteed loan that flowed to the sector under the agricultural credit guarantee scheme fund and the total bank credit) increased about 9.55% in 1986 – 1990 when compared to 1981 – 1985. Government programmes, interventions (during the democratic dispensation) and subsequent national policy documents on agricultural production could further be associated with the trend and growth pattern experienced in the third policy era. The finding in this period further agrees with Ochalibe [34] who reported an IGR and CGR of 5.90% and 6.08% respectively, for Nigeria's agricultural sector between 1980 and 2018. The authors further reported acceleration in growth rate. Generally, this study found an IGR and CGR of 3.3 percent and 7.9 percent, respectively for Nigeria's agricultural sector in 1960-2020.

Effect of agricultural sector policy on food security

The effects of agricultural sector policy on food security in Nigeria within the period under study using Dummy Variable Regression (DVR) model is presented in Table 2. From the result, two proxies were used as food security indicators – agricultural output (AGO) and *per capita* food production (PCF). The variables of interest from the DVR output include the dummy variable (DMY), the multiplicative dummy – interaction between other explanatory variables and the dummy variable (DMI), and the F-statistic.

From the result, the differential intercept of -0.368382 (for agricultural output) and -0.398003 (for *per capita* food production) shows that the intercept of agricultural

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output and *per capita* food production of the period with complete agricultural policy differs from the period with no policy by 0.37 and 0.40, respectively. The result shows a reduction in the value of agricultural output and *per capita* food production in the country within the period under study. The differential slope coefficient (coefficient of DMI) shows an increase in the value of agricultural output and *per capita* food production in the period with national policy document against the period without a national policy document in the agricultural sector. This increment in favour of the period with policy document was 0.03% and 0.02% for agricultural output and *per capita* food production, respectively. The result also shows that agricultural policy significantly influenced food security (proxied by agricultural output and *per capita* food production) at 1% level of significance. The calculated F-statistic is an indication that the parameters are stable for the entire data set and agricultural policy have structural effect on agricultural output and the *per capita* food production.

The findings of this study conform to the *a priori* expectation and theoretical framework guiding this study. Agricultural policy is deliberate plan of actions to guide decisions and achieve desirable goals in food self-sufficiency and food security. These plans are however achieved when they are implemented through interplay with other production variables. Successive policy in the agricultural sector emphasized the need to provide food for the nation (food security and self-sufficiency) and export excess, provide agricultural support and rural development services.

In establishing further stability and relevance of the model, some econometric tests were conducted. For good economic policy, the model has to be stable, which is the essence of a long- term economic goals or macroeconomic objectives. According to the results of Jarque-Bera test (Figures 3 and 4), errors are normally distributed in the food security variables within the period under study. The normal distribution of errors is very important especially when interpretations are made according to the estimated econometrical equation.

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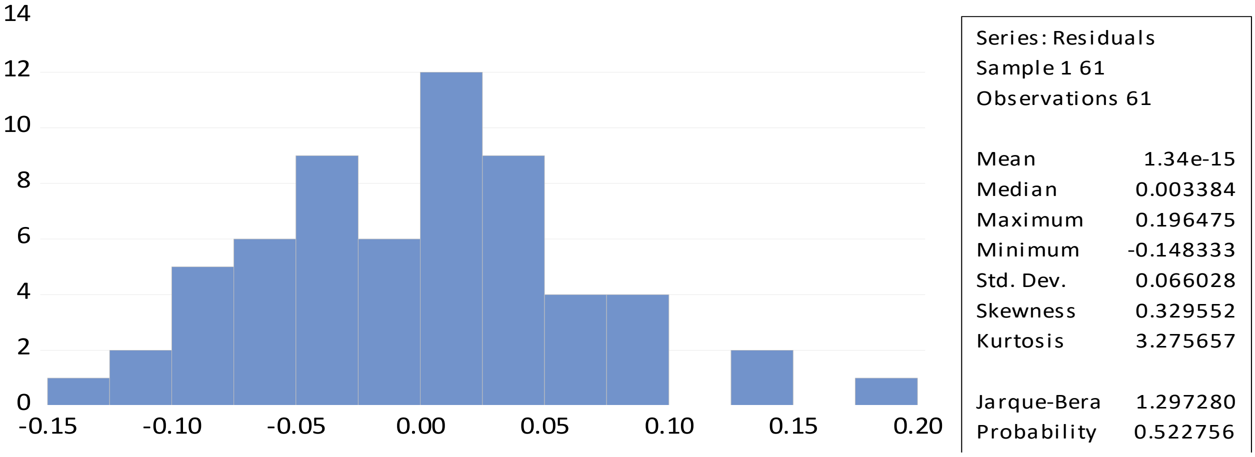

Figure 3: Jarque – Bera Test for Agricultural Output

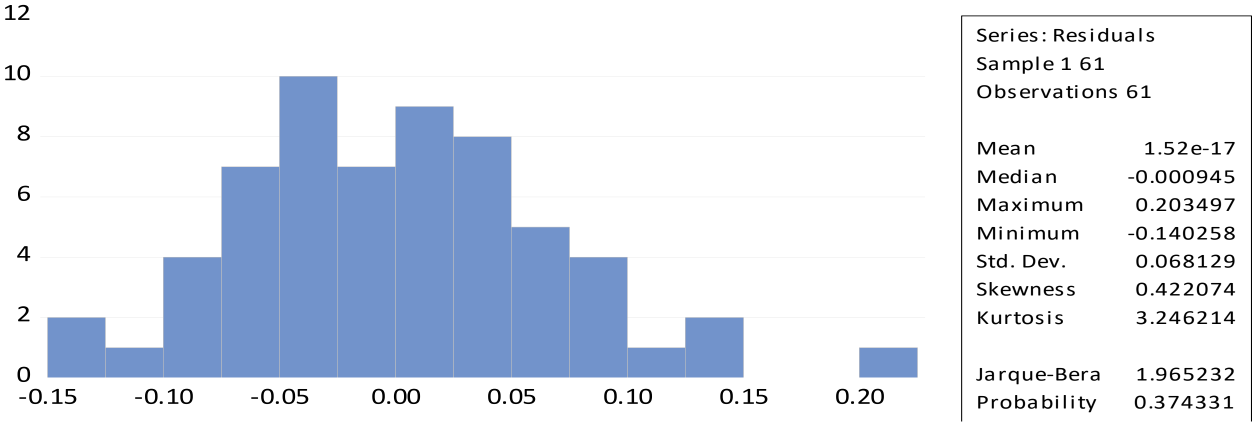

Figure 4: Jarque – Bera Test for *Per Capita* Food Production

For reliability of the result, further post-estimation tests were also conducted. In econometrics, the most used tests of stability are: Cumulative Sum (CUSUM) and CUSUM of squares tests. The outcome of CUSUM square tests is presented in Figures 5 and 6 for agricultural output and the *per capita* food production, respectively. CUSUM test is based on the cumulative sum of the equation errors in regression. The cumulative sum of errors together with critical lines of 5% are graphically represented above.

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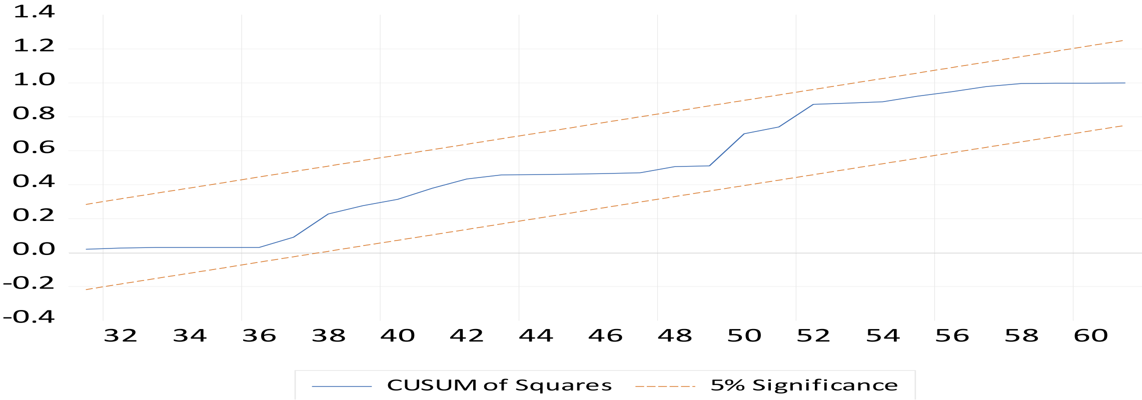

Figure 5: Graphical representation of CUSUM of squares stability test for agricultural output

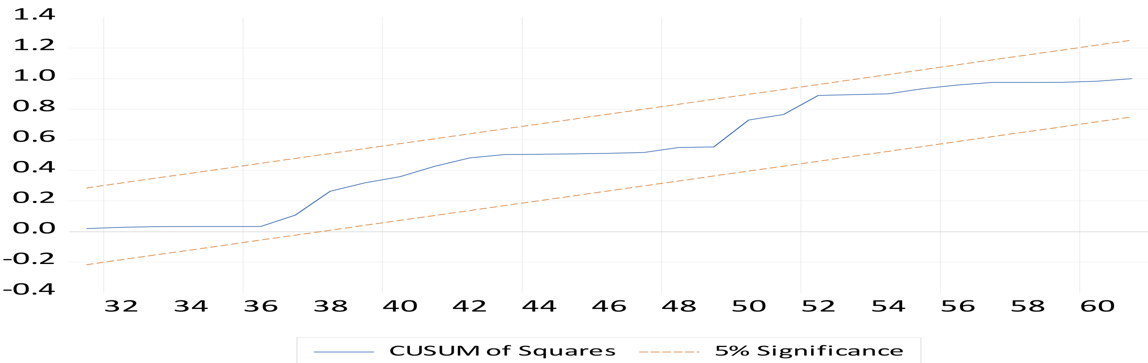

Figure 6: Graphical representation of CUSUM of squares stability test for *per capita* food production

From the results of this study, the equation parameters could be considered as stable since the blue lines in the CUSUM squares fall between the other two red lines. As a rule of thumb, the equation parameters are not considered stable if the sum of recursive errors gets outside the two critical lines. The difference between CUSUM and CUSUM squares is the use of recursive double errors in the latter as against the use of recursive errors in the former.

CONCLUSION, AND RECOMMENDATIONS FOR DEVELOPMENT

Following the Sustainable Development Goal 2, which aims at eliminating hunger and achieve sustainable food security globally by the year 2030, this study was motivated by the need to contribute to the frontiers of knowledge that will help to overcome the issue of food security. The study examined the potential of agricultural sector policy towards improving food security in Nigeria. The intercept of agricultural output and *per capita* food production of the period with complete agricultural policy document differs from the period with no policy document by 36.8 percent and 39.8 percent, respectively. The differential slope coefficient reveals an increase in the value of agricultural output and *per capita* food production in the period with national policy document against the period without a national policy document in the agricultural sector, implying that agricultural policy document significantly influenced food security in Nigeria. Agriculture must be consciously and deliberately prioritized through policy approaches in Nigeria. Increased investment in agricultural policy will help to redress the current food inequalities in the country.

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Table 1: Estimated trend equations for Nigeria's agriculture sector GDP under three policy periods, 1960 – 2020

Policy Regime	Year	β_0	β_1	R^2	F-value	IGR (%)	CGR (%)	Pattern of Growth
Period I, n = 10	1960 – 1969	-41.62*** (-6.40)	0.03*** (8.90)	0.91	79.23***	3	7.2	Acceleration
Period II, n = 16	1970 – 1985	6.63 (0.84)	0.005 (1.24)	0.10	0.235	0.5	1.2	Stagnation
Period III, n = 35	1986 – 2020	-50.18*** (-14.64)	0.034*** (19.72)	0.92	389.02	3.4	8.1	Acceleration
Pooled, n = 61	1960 – 2020	-48.02*** (-22.46)	0.033*** (30.41)	0.94	924.62	3.3	7.9	Acceleration

NOTE: ***=significant at 1% ($P < 0.01$); t-values are in parentheses. IGR and CGR = Instantaneous Growth Rate and Compound Growth Rate, respectively

Source: Researcher's Computation from FAO and WDI Data, 2021

Table 2: Effects of Agricultural Sector Policy on Food Security in Nigeria from 1960-2020

Variables	AGO			PCF		
	Coefficient	Std. Error	Prob.	Coefficient	Std. Error	Prob.
Constant	6.277740	2.672153	0.0225	-9.171107	2.757213	0.0016
DMY	-0.368382	0.109854	0.0015	-0.398003	0.113351	0.0009
LNGDF	0.010991	0.017142	0.5241	0.011072	0.017688	0.5340
LNLBA	0.526713	0.254015	0.0429	0.749560	0.262101	0.0060
LNLND	-0.007028	0.022575	0.7568	-0.005678	0.023293	0.8083
LNPOP	0.451217	0.111148	0.0002	0.524059	0.114686	0.0000
DMI	0.000208	2.82E-05	0.0000	0.000213	2.91E-05	0.0000
F-statistic	728.8480		0.0000	705.6862		0.0000

Source: Author's Computation using EViews 11. NOTE: LN = Natural log. DMY = agricultural policy (dummy), GDF = Government deficit financing, LBA = Labour employed in the agricultural sector, LND = Land area under cultivation POP = Population. DMI = Multiplicative dummy (interaction between agricultural policy and other explanatory variables)

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