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An Econometric Simulation of Human Capital Development and Activity Sector Productivity in Nigeria

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Abstract

Several studies on human capital development have ignored its effects on activity sectors of the economy in developing countries like Nigeria. This paper examined the effects of human capital development on the Nigerian real sector activity 1981 to 2022 with data from Central Bank of Nigeria's Statistical Bulletin, and National Bureau of Statistics. This paper utilized a macro-econometric model approach anchored on the endogenous growth theory. Ex-ante forecast showed that a 4% increase in life expectancy led to improvement in industry output (50.9%) and service output (16.6%), and agriculture output decreased by 7.4%. 4% decrease in life expectancy improved agricultural output by 14.9% and worsened industry and service sectors' outputs by 31.2% and 65.9%, respectively. A 2.0% increase in number of schooling years improved service (9.3%) and industry (3.7%) while agriculture output shrunk by 2.0% deviation. A 2% decrease in schooling year's worsened service and industry output by 74.5% and 42.4%, respectively and improved agriculture output (24.1%). A 7.7% increase in the index of per capita GNI resulted in negative shock to service output (69%) and industry output (37%) and positive deviation of 21.5% in agriculture output. Under the index of per capita GNI decrease of 7.7%, service output deviated by 200%, industry output deviated by 47.7% and agriculture output by -19%. The study therefore recommended that quality education should be made available to all so that Nigeria's service and industrial sectors can be revolutionized.

Keywords: *Agriculture, Industry, Macro econometric modeling, Human capital development, Nigeria*

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Background to the Study

The activity sector of the Nigerian economy involves the agricultural, industrial and services sectors as recognized by the Central Bank of Nigeria (CBN, 2010, 2022). The activity sector includes agriculture, industry, building and construction, and services. The sector is strategic for a good number of reasons. First, it produces, and distributes tangible goods and services, required to satisfy aggregate demand in the economy. Second, the performance of the sector can be used to measure the effectiveness of macroeconomic policies as government policies can only be evaluated based on the impact of public policy to promote production and distribution of goods and services which improves the welfare of the citizenry. Third, a vibrant activity sector, particularly the agriculture and manufacturing activities creates more linkages in the economy than any other sector and thus reduces pressure on the external sector. Four, it has the capacity to create greater employment opportunities (Anyanwu, 2010).

Human capital has been variously defined and made empirical evident by different scholars (Appleton and Teal, 1998; Dae-Bong, 2009; Omojimite, 2011; Asaju et al, 2013; Shuaibu and Oladayo, 2014; World Bank, 2010, Ndulu, 2010; Odia and Omofonmwa, 2010; Kern, 2009). However, one thing that's outstanding is that human capital development is very critical for economic development and growth. Meanwhile, none of these existing studies examined the effect of human capital development on real sector activities in terms of agriculture, industry and services. As already established, these sectors have a higher linkage than any other sector of the Nigerian economy. There are scores of empirical studies that examined the relationship between human capital and single components of these activity sector (Amassoma and Nwosa, 2011; Adelowokan, 2012; Isola and Alani, 2012; Ajadi and Adebakin, 2014; Jaiyeoba, 2015; Borojo and Jiang, 2015; Osoba and Tella, 2017; Ogunleye et al., 2017; Dawud, 2020; Leshoro and Leshoro, 2013; Kifordu, 2015; Karim and Shabbir, 2020; Widani and Malanga, 2015; Asghar and et al.,2017; Adejumo and Adejumo, 2017; Hena et al., 2019; Obukwelu, 2019; Eichengreen and Gupta, 2009; Bingilar and Etate, 2014; Gidado et al., 2014 , Worlu and Omodero, 2016). The results of these studies are mixed-up and the macro econometric approach is quite novel to these studies. This is the justification of this study.

Theoretical Framework and Model Building

Theoretical Framework

The framework of this study is anchored on the endogenous growth theory of Romer (1990). Accordingly, endogenous growth occurs as a result of accumulating technology (or knowledge) and thus establishing a relationship between the level of human capital and growth. Thus, the theory assumes creation of knowledge as a side product of investment and takes knowledge as an input in the production function of the following form:

$$Y = A(R)F(Ri, K_i, L_i) \quad (1)$$

where Y is aggregate output: A is the public stock of knowledge from research and development R; R_i is the stock of results from expenditure on research and development by firm $_i$: and K_i and L_i are capital stock and labour stock respectively. Theory assumes the function F homogenous of degree one in all its inputs R_i, K_i and L_i and treats R_i as a rival good.

Model Specification

The equations built for this study consist a structure of small macroeconomic model of the activity sectors (agriculture, industry and services) as defined by the CBN (2010). The model considered measures of investment and output of the considered activity sectors as dependent variables and captured human capital development (HCD) as one of the key explanatory variables in the four sectors. The behavioral equations in the macro econometric model are estimated using ordinary least square (OLS) with the inclusions of lags for both dependent and independent variables in each behavioral equation. Fair (1984) describes the possible use of OLS in estimating the model of equations. According to Fair (1984), macroeconomic models are normally nonlinear, simultaneous and very large, thus they tend to have serially correlated error terms. However, the features of the model allows for the correction of these problems in modeling the equations. The macro model provides a convenient way of correcting for the problem of serial correlation by treating the serial correlation coefficients as structural coefficients and transforms the equations into equations with serially uncorrelated error terms. In the model, the variations in the output of the sectors are stated to be a function of HCD and other control variables. The algebraic form of Equation 2.2 is given as:

$$YG + f(HCD, C) \quad (2)$$

where YG is total output, HCD is human capital development and C is control variables

The Behavioral Equations

This block is primarily concerned with modeling the impact of human development index on productive activities in Nigeria. Remaining consistent with CBN (2010), production output is divided into three activities sectors. The key dependent variables captured in the output models are; YGRA (agricultural sector output), YIND (industrial sector output) and YS (services sector output). All variables in the model were captured in log form except variables in rate and percentage. The behavioral equations are stated below:

Agricultural Output Model

In this model, assuming other things being equal, agricultural output is influenced by rainfall, human capital index, private sector credit, government capital expenditure, Real exchange rate and agricultural investment.

$$LogYAGR_t = \theta_{0,1} + \theta_{1,1}LogYAGR_{t-2} + \theta_{2,1}RF_t + \theta_{3,1}RF_{t-2} + \theta_{4,1}LogINVI_t + \theta_{5,1}LogINVI_{t-2} + \theta_{6,1}LogPSC_t + \theta_{7,1}LogGCE_t + \theta_{8,1}LogGCE_{t-2} + \theta_{9,1}YG + \theta_{10,1}HCD + \mu_1 \quad (3)$$

Industry Output Model

In this model, it is highlighted that industry output is influenced by index of energy consumption, human capital index, private sector credit, government capital expenditure, real exchange rate, Capacity utilization rate and manufacturing sector investment.

$$LogYIND_t = \beta_{0,2} + \beta_{1,2}LogYIND_{t-2} + \beta_{2,2}IEC_t + \beta_{3,2}LogPSC_{t-2} + \beta_{4,2}LogGCE_t + \beta_{5,2}LogGCE_{t-2} + \beta_{6,2}LogINVI_t + \beta_{7,2}LogINVI_{t-2} + \beta_{8,2}NER_t + \beta_{9,2}YG + \beta_{10,2}HCD + \mu_2 \quad (4)$$

Services Sector Output Model

Output of the service sector is influenced by private consumption, maximum lending rate, total government expenditure, Real exchange rate, manufacturing output and human development index

$$LogYS_t = \delta_{0,3} + \delta_{1,3}LogYS_{t-2} + \delta_{2,3}LogCONH\_\ _t + \delta_{3,3}RM_t + \delta_{4,3}LogTGE_t + \delta_{5,3}LogTGE_{t-1} + \delta_{6,3}LogYIND_t + \delta_{7,3}LogYIND_{t-2} + \delta_{8,3}YN_t + \delta_{9,3}HCD_t + \delta_{10,3}YG_t + \mu_3 \quad (5)$$

Oil Exports Equation

$$LogXO_t = \lambda_{0,4} + \lambda_{1,4}LogXO_{t-2} + \lambda_{2,4}PO_t + \lambda_{3,4}PO_{t-2} + \lambda_{4,4}OPEC_t + \lambda_{5,4}OPEC_{t-2} + \lambda_{6,4}LogYF_t + \lambda_{7,4}LogYF_{t-1} + \mu_4 \quad (6)$$

Non - Oil Exports Equation

$$LogXN_t = \Phi_{0,5} + \Phi_{1,5}LogXN_{t-2} + \Phi_{2,5}RER_t + \Phi_{3,5}LogYF_t + \Phi_{4,5}LogYF_{t-2} + \Phi_{5,5}YN_t + \Phi_{6,5}LogYN_{t-2} + \mu_5 \quad (7)$$

Service Export Equation

$$LogXS_t = \Pi_{0,6} + \Pi_{1,6}LogXS_{t-2} + \Pi_{2,6}YG_t + \Pi_{3,6}LogX_t + \Pi_{4,6}LogX_{t-2} + \Pi_{5,6}RER_t + \Pi_{6,6}RM_{t-1} + + \mu_6 \quad (8)$$

Import Equation

$$LogM_t = \Omega_{0,7} + \Omega_{1,7}LogM_{t-2} + \Omega_{2,7}YD_t + \Omega_{3,7}YD_{t-2} + \Omega_{4,7}RER_t + \Omega_{5,7}RM_t + \Omega_{6,7}RM_{t-1} + \Omega_{7,7}LogRES_t + \Omega_{8,7}LogRES_{t-1} + \mu_7 \quad (9)$$

External Reserves Equation

$$LogRES_t = \psi_{0,8} + \psi_{1,8}LogRES_{t-2} + \psi_{2,8}RER_t + \psi_{3,8}PO_t + \psi_{4,8}EDS_t + \psi_{5,8}EDS_{t-1} + \psi_{6,8}LogM_t + \psi_{7,8}LogM_{t-2} + \mu_8 \quad (10)$$

Nominal Exchange Rate Equation

$$NER_t = \chi_{0,9} + \chi_{1,9}NER_{t-2} + \chi_{2,9}LogRES_t + \chi_{3,9}LogRMT_t + \chi_{4,9}LogRMT_{t-1} + \chi_{5,9}IRD_t + \chi_{6,9}IRD_{t-1} + \chi_{7,9}X\_M_t + \chi_{8,9}CPI_t + \chi_{9,9}CPI_{t-1} + \chi_{10,9}LogTGE_t + \chi_{11,9}LogTGE_{t-1} + + \chi_{12,9}Po_t + \chi_{13,9}Po_{t-2} + \mu_9 \quad (11)$$

Foreign Direct Investment Equation

$$FDI_t = \eta_{0,10} + \eta_{1,10}FDI_{t-2} + \eta_{2,10}LogPCGDP_t + \eta_{3,10}PCGDP_{t-2} + \eta_{4,10}LogXN_t + \eta_{5,10}LogXN_{t-2} + \mu_{10} \quad (12)$$

Foreign Portfolio Investment Equation

$$FPI_t = \rho_{0,11} + \rho_{1,11}FPI_{t-2} + \rho_{2,11}LogYG_t + \rho_{3,11}LogYG_{t-1} + \rho_{4,11}LogYF_{t-2} + \rho_{5,11}SMR_t + \rho_{6,11}INTF_t + \rho_{7,11}INTF_{t-2} + \rho_{8,11}NER_t + \rho_{9,11}NER_{t-2} + \mu_{11} \quad (13)$$

Foreign Debt Equation

$$FDF_t = \sigma_{0,12} + \sigma_{1,12}FDF_{t-2} + \sigma_{2,12}LogM_t + \sigma_{3,12}LogMT_{t-2} + \sigma_{4,12}IRD_t + \sigma_{5,12}IRD_{t-1} + \sigma_{6,12}NER_t + \sigma_{7,12}NER_{t-2} + \sigma_{8,12}LogYF_t + \sigma_{9,12}LogYF_{t-2} + \mu_{12} \quad (14)$$

Remittances Equation

$$LogRMT_t = \Gamma_{0,13} + \Gamma_{1,13}RMT_{t-2} + \Gamma_{2,13}LogYUS_t + \Gamma_{3,13}LogNER_t + \mu_{13} \quad (15)$$

Government Recurrent Expenditure Equation

$$LogGRE_t = \omega_{0,14} + \omega_{1,14}LogGRE_{t-2} + \omega_{2,14}LogGCE_t + \omega_{3,14}CG_t + \omega_{4,14}FDF_t + \omega_{5,14}LogYG_t + \mu_{14} \quad (16)$$

Government Revenue (Non-Oil) Equation

$$LogGRVN_t = \Sigma_{0,15} + \Sigma_{1,15}GRVN_{t-2} + \Sigma_{2,15}LogYN_t + \Sigma_{3,15}LogM_t + \Sigma_{4,15}LogM_{t-2} + \Sigma_{5,15}TAR_t + \Sigma_{6,15}TAR_{t-2} + \mu_{15} \quad (17)$$

Government Revenue (Oil) Equation

$$LogGRVO_t = \Delta_{0,16} + \Delta_{1,16}GRVO_{t-2} + \Delta_{2,16}LogYO_t + \Delta_{3,16}LogYO_{t-2} + \Delta_{4,16}NER_t + \Delta_{5,16}PO_t + \Delta_{6,16}PO_{t-2} + \Delta_{7,16}LogPPT_t + \Delta_{8,16}LogPPT_{t-2} + \Delta_{9,16}LogXO_t + \Delta_{10,16}LogXO_{t-2} + \mu_{16} \quad (18)$$

Human Capita Development Equation

$$HCD_t = \Theta_{0,17} + \Theta_{1,17}HCD_{t-1} + \Theta_{2,17}LE_t + \Theta_{3,17}LE_{t-2} + \Theta_{4,17}SCH_t + \Theta_{5,17}GNI_t + \Theta_{6,17}GNI_{t-2} + \Theta_{7,17}LogYG_t + \Theta_{8,17}LogGCE_t + \Theta_{9,17}LogGCE_{t-2} + \mu_{17} \quad (19)$$

Oil Output Equation

$$LogYO_t = \Lambda_{0,18} + \Lambda_{1,18}LogYO_{t-2} + \Lambda_{2,18}PO_t + \Lambda_{3,18}OPEC_t + \Lambda_{4,18}OPEC_{t-2} + \mu_{18} \quad (20)$$

Non-Oil Output Equation

$$LogYN_t = \acute{Y}_{0,19} + \acute{Y}_{1,19}LogYN_{t-2} + \acute{Y}_{2,19}LogPSC_t + \acute{Y}_{3,19}RM_t + \acute{Y}_{4,19}IEC_t + \acute{Y}_{5,19}TAR_t + \acute{Y}_{6,19}LogMt_t + \acute{Y}_{7,19}HCD_t + \mu_{19} \quad (21)$$

Table 1: Data sources and Variable Definitions

S/NO	VARIABLE	DEFINITION/DESCRIPTION	SOURCE
ENDOGENOUS VARIABLES			
1	XO	Oil Export	CBN 2019
2	XN	Non - Oil Export	CBN 2019
3	XS	Services Export	CBN 2019
4	M	Imports	CBN 2019
5	RES	Reserves	CBN 2019
6	NER	Nominal Exchange Rates	CBN 2019
7	FDI	Foreign Direct Investments	CBN 2019
8	FPI	Foreign Portfolio Investments	CBN 2019
9	FDF	Foreign Debt Flow	CBN 2019
10	RMT	Remittances	World Bank (WDI), 2015
11	GRE	Government Recurrent Expenditure	CBN 2019
12	GRVN	Government Revenue (Non-Oil)	CBN 2019
13	GRVO	Government Revenue (Oil)	CBN 2019
14	HCD	Human Capital Development	UNDP 2019
15	YAGR	Output From Agriculture	CBN 2019
16	YIND	Output from Industries	CBN 2019
17	YS	Output from Service Sector	CBN 2019
18	YO	Oil Output	CBN 2019
19	YN	Non-Oil Output	CBN 2019
SHOCK VARIABLES			
20	LE	Index of Life Expectancy	UNDP 2019
21	SCH	Index of Number of School Years	UNDP 2019
22	GNI	Index of Per Capita Income	UNDP 2019
EXOGENOUS VARIABLES			
23	PO	World Oil Prices	UNDP 2019
24	OPEC	World Oil Supply	UNDP 2019
25	YUS	Output from United States of America	UNDP 2019
26	YF	Foreign Output (OECD)	OECD Data, 2017
27	X	Value of Exports	CBN 2019
28	RER	Real Exchange Rates	World Bank (WDI), 2019
29	YD	Personal Disposable Income	CBN 2019
30	EDS	External Debt Services	CBN 2019
31	IRD	Interest Rate Differentials	World Bank (WDI) 2019
32	X_M	Terms of Trade	World Bank (WDI)2019
33	CPI	Consumer Price Index	World Bank (WDI) 2019
34	TGE	Total Government Expenditure	CBN 2019
35	PCGDP	Per Capita Gross Domestic Product	CBN 2019
36	SMR	Stock Market Returns	CBN, 2019
37	INTF	Foreign Interest rates (OECD)	OECD Data, 2019
38	RM	Interest Rates	CBN, 2019
39	INVI	Investment Income	CBN, 2019
40	GCE	Government Capital Expenditure	CBN, 2019
41	YG	Total Output	CBN, 2019
42	FDF	Fiscal Deficit Financing	CBN, 2019
43	PPT	Petroleum Profit Tax	CBN, 2019
44	TAR	Tariffs	CBN, 2019
45	PSC	Private Sector Credit	CBN, 2019
46	CG	Credit to Government	CBN 2019
47	RF	Rainfall	CBN 2019
48	IEC	Index of Energy Consumption	NBS, 2019
49	CON_H	Consumption	CBN, 2019

Source: Researchers' Compilation (2023)

In this study, the inter relationships between the components of the domestic economy and the effects of changes in the HCD are examined using a structural macroeconomic model. Structural macroeconomic models are built using economic relationships established from theory. The model relies on a system of simultaneous equations in trying to measure the whole economy or a sub – sector of the economy, with each equation specifying a single relationship (Cohen, 2004). The model methodology follows, in principle the Cowles Commission approach as used in Tinbergen's (1939) macroeconomic model. Other studies that initially employed the SMM approach include Klein (1950), Klein and Goldberger (1995), and Duesenberry *et al* (1965, 1969). In this approach, economic theory determines the nature of relationship between the right-hand side and left-hand side variables for all stochastic equations used in building the macro- model. The resulting equations can then be estimated using a consistent estimation technique (Fair, 2013). Abstracting form Fair (2013, 2004) SMM model, the SMM model is specified in its non – linear form;

$$f_i = (y_t, y_{t-1}, y_{t-p}, x_t, \alpha_i) = \mu_{it} \qquad i = 1 \ldots n, \qquad t = 1 \ldots T,$$

Where y is an n – dimensional vector for all endogenous variables, x, is also a vector of all predetermined exogenous variables including lags of endogenous variables, α, is a vector of all unknown coefficients and represents the stochastic error term for equations i for period 1. The f_i equations are assumed to be stochastic and the remaining equations identities. Thus, specifying the model will entail choosing the variables that will enter into each equation with non – zero elements, the functional form for each equation, and the probability structure of the error term (for the SMM to be used in this study, we will ensure that the variables of interest are trend stationary).

Empirical Results and Analysis

The starting point of the simulation exercise is the presentation of the macro econometric model summary statistics of model validation. These results are presented in Table 2

Table 2: Summary Statistics of Validation of the Macroeconomic Model

S/N	Variables	Theil's inequality	Bias proportion	Variable proportion	Covariance proportion	Root mean square error
1	FDF	0.4	0.004	0.28	0.7	210.94
2	FDI	0.24	0.03	0.03	0.92	234.61
3	FPI	0.3	0.000	0.11	0.87	415.7
4	GRE	0.03	0.003	0.11	0.88	173.59
5	GRVn	0.14	0.000	0.008	0.99	156.99
6	GRVo	0.16	0.009	0.08	0.90	114.13
7	HCD_Un	0.003	0.000	0.01	0.98	0.003
8	M	0.08	0.09	0.3	0.5	852.23
9	NER	0.13	0.02	0.04	0.92	27.60
10	RES	0.18	0.03	0.02	0.94	264.73
11	RMT	0.2	0.000	0.21	0.78	138.98
12	Xn	0.19	0.002	0.000	0.99	167.04
13	Xo	0.12	0.01	0.02	0.96	167.16
14	Xs	0.09	0.01	0.02	0.96	343.03
15	Yagr	0.004	0.006	0.001	0.99	128.21
16	Yind	0.01	0.003	0.003	0.99	293.64
17	Yn	0.01	0.06	0.02	0.90	183.22
18	Yo	0.03	0.02	0.06	0.90	238.83
19	Ys	0.000	0.3	0.01	0.62	0.018

Source: Researchers' Computation using Stata 11

The graphs for the simulated values of variables on actual values of some endogenous variables are as shown in Figure 1. As the figures showed, most of the simulated values closely mirror the actual values, suggesting the possibility of a low bias in the model. Hence, it could be inferred that the model's dynamic performance is considerably good and considered adequate for analyzing the effects of Human Capital Development on the activity sector performances in Nigeria.

The percentage deviation of the baseline from the actual is presented in Table 3. Between 2003 Q1 to 2019 Q4, on the average, the simulated values of agricultural output from its actual was a marginal value of 0.07%. Similarly, the deviation for Industry output was -0.27%, while the deviation of the Services output was the highest at 0.40%. Markedly, the result showed a positive deviation in agricultural output (0.07%) and Services output (0.04%) from their actual values respectively, while the Industry output (-0.27%) turned out negative. From the results, the Services output was revealed to have the highest deviation, compared to the other sectors. In addition, a closer look at Table 3. further showed that the highest deviation of the simulated values of agricultural output from its actual was recorded in Q2017 (0.83%) and lowest in 2010 Q1 (-0.104%). In the industry output, the highest deviation of the simulated values from its actual was in 2013 Q1 (0.19%) and lowest in 2017 Q4 (-0.45%). Similarly, that of Services output was shown to be highest in 2013 Q1 (0.16%) and lowest in 2011 Q1 (-0.21). Overall, the seemingly low average deviation of the simulated values from the actual suggests that the model of the study has a good fit.

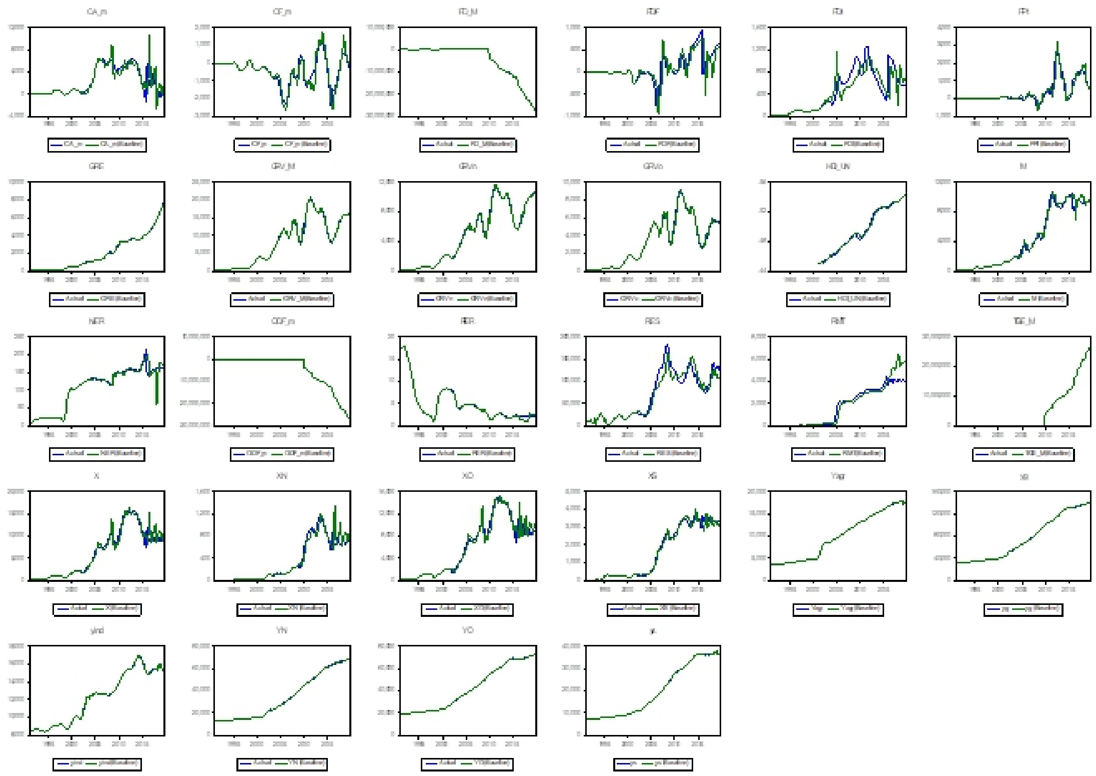

Table 3: Statistics for the Historical Simulation of Baseline Deviation from the Actual (Selected Years)

YEAR	Agricultural output	Industry Output	Services Output
2003Q1	-0.07	0.08	0.03
2004Q1	-0.07	0.01	0.14
2005Q1	-0.09	0.06	-0.09
2010Q1	-0.104	0.04	-0.001
2011Q1	0.2	0.02	-0.21
2012Q1	-0.18	-0.23	-0.05
2013Q1	0.05	0.19	0.16
2015Q4	0.12	-0.16	-0.06
2016Q4	-0.05	-0.06	0.004
2017Q4	0.83	-0.45	-0.69
2018Q4	-0.17	-1.26	-1.51
2019Q4	0.34	-1.89	-2.6

Note: The figures are in percentage deviation of the baseline from the actual. Hence, a minus implies a decrease and a positive sign implies an increase in the endogenous variable

The Result for Ex-post Forecast of 2017Q1 to 2019Q4

In the ex-post forecast, the model allowed the estimation period to stop at 2018Q4and assumed that the data for 2019 do not exist. Using the model, values for these years- 2017Q1 to 2018Q4 were forecasted. The main aim of this exercise is to test the forecasting accuracy of the model. The result of the ex-post forecast presented in Table 4 show that the model has a high predictive power as the forecasted values virtually match the actual values. For instance, in average term, the forecasted value of agricultural output for 2019 only deviated from the actual by -0.26% (that is, the forecasted value marginally dropped from the actual). Similarly, the average forecasted percentage difference for Industry output and Services output were 1.4% and 2.6% respectively. (That is, the forecasted value for Industry output and Services output slightly increased from the actual).

A critical review of the absolute value of the forecast across the four quarters in 2019, showed that the percentage difference between the actual and the forecasted output values of agriculture was highest in Q1 (0.58%) compared to Q3 (0.12%) where the difference was lowest. For the Industry sector, the magnitude of the departure of the forecasted from the actual values was highest in Q4 (1.89%) and lowest in Q3 (1.1%). The difference in the forecasted values from the actual of the Services output was equally revealed to be higher in Q1 (4.6%) compared to Q2 (1.03). Again, these slight deviations of the forecasted values from the actual values depict the reliability of the forecasting ability of the model of this study.

Table 4: Ex Post Forecast of 2017Q1 to 2019Q4

YEAR	Agricultural output	Industry Output	Services Output
2017Q1	0.00	0.00	0.00
2017Q2	0.07	0.09	-0.05
2017Q3	0.33	0.03	-0.4
2017Q4	0.88	-0.45	-0.69
2018Q1	1.06	-1.05	-1.06
2018Q2	0.84	-3.68	-2.67
2018Q3	0.35	-2.6	-4.29
2018Q4	-0.17	-1.2	-6.5
2019Q1	-0.58	-1.47	-4.6
2019Q2	-0.64	-1.34	-1.03
2019Q3	-0.12	-1.1	-2.5
2019Q4	0.3	-1.89	-2.6

Source: Researchers' computation using Stata 11

Note: Figures are in absolute percentage deviation from the baseline forecast.

The Effects of HCD Changes

Apart from using the validated model to carry out an ex-post forecast, attempt was also made to dig further by conducting ex-ante forecast which enables one peep into the future effects of the different time paths assigned to the exogenous shock variables of interest - Life Expectancy, Index of number of schooling years, and index of per Capita GNI on the endogenous variables. To drive this exercise, various assumptions were made. The first major assumption is that changes in HCD and its components are bound to have major consequences on performance of the activity sectors of the Nigerian economy. In determining the time path for the shock variables, it is assumed that they would either increase or decrease by their five years average change (Life Expectancy, Index of number of schooling years, and index of per Capita GNI increases by 4%, 2%, and 7.7%, respectively). In addition, decision was also made about the length of the forecast period. It was chosen to limit the projection of data into the future to 2022Q4. Even though the period may not be long enough for examinations of the model's steady state properties, it is enough to make inferences about the model's long-run simulation behaviour (Osigwe, 2014). This is anchored on the fact that the model does not contain long lags and as such, the period is assumed to be long enough for the effects of changes in the shock variables to work through the model. Also, it would be inappropriate to assume that all other policy variables that entered the model would continue to remain constant over a long period. Note: 4% is the average change in life expectancy data over the years; 2% is the average change in number of schooling years data over the years; 7.7% is the average change in per capita GNI data over the years. The scenarios of the ex-ante forecast experiment are based on the following assumptions;

Scenario 1/Benchmark: All variables in the model continue on their trend path – i.e. assume no changes in all variables.
Scenario 2: This scenario assumes that only index of life expectancy increases by 4% and remains at that level, while other components of HCD remain constant.
Scenario 3: This scenario assumes that only index of Number of schooling years increases by 2% and remain at that levels, while other components of HCD remain constant
Scenario 4: This scenario assumes that only index of per Capita GNI increases by 7.7% and remains at that level, while other components of HCD remain constant
Scenario 5: This scenario assumes that only index of life expectancy decreases by 4% and remains at that level, while other components of HCD remain constant Scenario
Scenario 6: This scenario assumes that only index of Number of schooling years decreases by 2% and remains at that level, while other components of HCD remain constant
Scenario 7: This scenario assumes that only index of per Capita GNI decreases by 7.7% and remains at that level, while other components of HCD remain constant

Table 5: Scenarios of the Ex-Ante Forecast

XO	12,983.90	13,408.80	13,857.00	14,279.40	14676.4	15052.2	15404.7	15735	16046.7	16344.1	16630.4	16908.6
XS	3,553.70	3,696.50	3,839.30	3,975.50	4106.5	4228.4	4339.7	4441.4	4533.1	4616	4691.7	4761.4
Yagr	17,259.50	17,567.90	17,988.40	18,183.50	18779.1	19430.9	19917.1	20542.7	21153.2	21661.9	22243.3	22841.6
yg	141,055	141,471	141,543	141,058	140263	139074	137432	135487	133243	130715	128002	125141
yind	13,890.30	14,847.30	15,774.70	16,201.10	16499.8	16355.5	15761.2	15143.2	14527.9	13960.6	13558.6	13232.9
YN	68,977.60	69,204.90	69,089.70	68,412.70	67418.9	66023	64172.1	62018.8	59571.5	56849.2	53949.5	50908
YO	72,077.10	72,266.30	72,453.40	72,645.20	72844.6	73050.8	73260.3	73468.5	73671.2	73866	74052.6	74232.8
ys	31,959.10	32,139.00	32,033.30	31,185.00	30596.6	29792.5	28453	26851.9	24733.9	22101.5	19304.7	16500.5

Source: Author's computation using Stata 11

Forecast period from 2020Q1 to 2022Q4 assuming a no change in the trend of the endogenous variables. For reference, we call this Scenario 1. Deviations from this assumed path will detail the response to shocks from the HCD components.

Changes in Life Expectancy Simulation Results

First, the model simulations for positive and negative shocks of life expectancy on the endogenous variables are presented in Table 5. In simulating the effects of this shock, the model assumed that life expectancy will increase and decrease by its 5 years average percentage change and that all the other exogenous variables will continue on their trend path and not deviate within the forecast period. Scenario 1 represents the benchmark; a situation where nothing changes, Scenario 2 represents a 4% increase in life expectancy and Scenario 5 represents a 4% decrease in life expectancy.

From the results, it is evident that a 4% increase in life expectancy would trigger a moderate deviation and improvement in Industry output (50.9%) and Service output (16.6%), while it worsens Agriculture output by 7.4%, compared to the baseline. This implies that the agriculture sector fared better under the baseline arrangement than under a situation of 4% increase in life expectancy. The Agricultural output under the scenario of 4% decrease in life expectancy, showed 14.9% deviation from the baseline, while its worsened Industry output and Services output by 31.2% and 65.9% deviations respectively, from the baseline. Empirically, the average result for the forecasted period showed that Agriculture sector under the baseline arrangement surpasses the scenario of a 4% increase in life expectancy. The net deviation of 4% increase and decrease in life expectancy was negative for service output (-15%) and Industry Output (-14.6%), while it was positive for agriculture output (7.8%). These small percentage deviations suggest that shocks to life expectancy could have a short-term impact on Agriculture output, Industry output and Services output. However, regardless of how short these impacts could be, a quick revert of these sectors to their initial trend, would largely depend on policy responses over the short and medium term.

Again, it is striking to observe that 4% increase and decrease in life expectancy would cause a significant deviation of Capital Finance Flows by 214.4% and 500% respectively. This result implies that any shock to life expectancy would trigger a permanent deviation to Capital Finance Flows from its normal trend or it would take a longer time to revert to its initial trend; indicating that shock to life expectancy has a significant effect on Capital Finance Flows.

Precisely, some of the variables such as Non-oil Output, Total Output, Foreign Direct, Capital Account Balance, Foreign Portfolio Investment, etc., deviated slightly from the baseline under scenario of 4% increase in life expectancy, compared to the scenario of 4% decrease in life expectancy. Further, the results revealed similar deviations of about 32% to Human Capital Development under the scenario of 4%- decrease or increase in life expectancy. However, Human Capital Development fared better under the scenario of 4% increase in life expectancy with an improved deviation of 32.3%, compared to the scenario of 4% decrease where it deteriorated by 32.4%. The forecasted results under these scenarios are presented in Table 6. The graphs of scenarios 2 and 5 are presented in the appendix.

Table 6: Forecast Results for Scenarios 2 and 5

Variable	Scenario 2 (Increase by 4%) % Maximum Difference from Benchmark	Scenario 5 (Decrease by (4%) % Maximum Difference from Benchmark
Capital Finance Flows	214.4%	500%
Non-oil Export	125.6%	-81.2%
Foreign Direct Investment	87%	-73.7%
Service Output	50.9%	-65.9%
Human Capital Development	32.3%	-32.4%
Non-oil Output	28.1%	-42.2%
Industry Output	16.6%	-31.2%
Total Output	9.8%	-22.9%
Foreign Portfolio Investment	-7.4%	28.8%
Agriculture Output	-7.1%	14.9%
Capital Account Balance	5.6%	-29.2%
Non-Oil Government Revenue	4%	-10.3%
Government Revenue	2.3%	--6.3%
Service Export	2.1%	-10.2%
Government Recurrent Revenue	2.0%	-5.9%
Exports	1.16%	-9.3%
Total Government Expenditure	0.0000078%	-0.000024%
Fiscal Deficit	-0.0000039%	0.00001%
Other Deficit Financing	-0.0000039%	0.00001%
Real Exchange Rate	-0.00000092%	0.00000083%
Imports	0.00000084%	0
Nominal Exchange Rate	-0.00000052%	0.0000007%
Fiscal Deficit Financing	0.00000049%	0.00000073%
Remittances	0.000000039%	-0.00000039%
Reserves	-0.00000011%	0
Oil government Revenue	0	0
Oil Exports	0	0
Oil Output	0	0

Figures are in percentage deviation from the baseline with positive sign indicating that the scenario favours the sector more than the baseline, vice versa.

* **Note**: Higher percentage deviation implies that the shock has a permanent deviation from the normal trend of the variable or the variable may take a longer time to revert to its initial trend; indicating that the shock has a significant effect on the variable, vice versa.

Changes in Number of Schooling Years Simulation Results

Table 6 showed the model simulations for positive and negative shocks of number of schooling years on the endogenous variables. In simulating the effects of this shock, it is assumed that the number of schooling years will increase and decrease by its 5 years average percentage change and that all the other exogenous variables will continue on their trend path and not deviate within the forecast period. Scenario 1 represents the benchmark – if nothing changes, Scenario 3 represents a 2% increase in Number of schooling years and Scenario 6 represents a 2% decrease in number of schooling years.

From the forecast results, it is observed that over the 3year forecast period (2020Q1 to 2022Q4), services output and Industry output appeared to be better under a scenario of 2% increase in number of schooling years than in the baseline, with a maximum deviation of 9.3% and 3.7% respectively. On the contrary, the baseline of Agriculture output was better than under the scenario of 2% increase in number of schooling years which shrunk the sector by 2.0% deviation. Similarly, the baseline relating to Service output and Industry output was better than under the scenario of 2% decrease in number of schoolings. In particular, it is noticed that 2% decrease in number of schooling years worsened Service and Industry output by 74.5% and 42.4% maximum deviation respectively. The results for the Service output and Industry output sector were procyclical with scenarios 3 and 6- both sectors showed a positive deviation when there was a 2% increase in number of schooling years and also a negative deviation when there was a 2% decrease in number of schooling years. On the other hand, 2% decrease or increase in number of schooling years was shown to be countercyclical with the agriculture output. Thus, given the moderate deviations in these sectors, if improving Service output and Industry output sector is the goal, then short to medium term policies that increase the number of schooling years should be pursued. Whereas, if the goal is to enhance the agriculture output, then short to medium term policies that decrease the number of schooling years should be given priority.

Further, the forecast result showed that, a decrease of 2% in number of schooling years was shown to have permanent shock to Capital Finance Flows with a deviation of 500%, while an increase of 2% have a temporal but negative impact with a deviation of 2.8% from the baseline. Meanwhile, increasing the number of schooling years was revealed to have a moderate and positive impact on; Non-oil Export, Foreign Direct Investment and Human Capital Development (8.9%), with a deviation of 29%, 20.4% and 8.9% respectively, from the baseline. However, the effect of a 2% decrease in the number of schooling years exerted more negative impact on Non-oil Export and Foreign Direct Investment with a maximum deviation of 94% and 88.4% respectively. Given the magnitude of these deviations, it could be suggested that a short to medium term policy response could be deployed to address deviation in Non-oil Export and Foreign Direct Investment due to an increase in number of schooling years, while it will take medium to long term policy response to address deviation in Non-oil Export and Foreign Direct Investment in the event of a decrease in number of schooling years. The forecasted results under these scenarios are presented in Table 7. The graphs of scenarios 3 and 6 are presented in the appendix.

Table 7: Forecast Results for Scenarios 3 and 6

Variable	Scenario 3 (Increase by 2%) % Maximum Difference from Benchmark	Scenario 6 (Decrease by 2%) % Maximum Difference from Benchmark
Capital Finance Flows	-2.8%	500%
Non-oil Export	29%	-94.2%
Foreign Direct Investment	20.4%	-88.4%
Service Output	9.3%	-74.5%
Human Capital Development	8.9%	-46.1%
Non-oil Output	7.2%	-56.8%
Industry Output	3.7%	-42.4%
Total Output	2.8%	-34.9%
Foreign Portfolio Investment	-3%	78.4%
Agriculture Output	-2.0%	24.1%
Capital Account Balance	2.2%	-60.7%
Non-Oil Government Revenue	0.7%	-11%
Government Revenue	0.4%	-6.8%
Service Export	0.6%	-20.9%
Government Recurrent Revenue	0.4%	-6.9%
Exports	0.5%	-27.7%
Total Government Expenditure	0.0000016%	-0.000028%
Fiscal Deficit	-0.00000065%	0.0000094%
Other Deficit Financing	-0.00000065%	0.0000094%
Real Exchange Rate	0	0.00000083%
Imports	0	0.00000071%
Nominal Exchange Rate	0	0.00000070%
Fiscal Deficit Financing	0.0000002.8%	0.00000073%
Remittances	0	-0.00000039%
Reserves	0	0
Oil government Revenue	0	0
Oil Exports	0	0
Oil Output	0	0

Figures are in percentage deviation from the baseline with positive sign indicating that the scenario favours the sector more than the baseline, vice versa.

* **Note:** Higher percentage deviation implies that the shock has a permanent deviation from the normal trend of the variable or the variable may take a longer time to revert to its initial trend; indicating that the shock has a significant effect on the variable, vice versa.

Changes in Per Capita GNI Simulation Results

Table 8 showed the model simulations for positive and negative shocks of the index of per capita GNI on the endogenous variables. In simulating the effects of this shock, it is assumed that the index of per capita GNI will increase and decrease by the percentage change over the past 5 years and all the other exogenous variables will continue on their trend path and not deviate from it within the time of the simulated results. Scenario 1 represents the benchmark –

if nothing changes, Scenario 4 represents a 7.7% increase in Index of per Capita GNI and Scenario 7 represents a 7.7% decrease in the index of per capita GNI.

From the forecast results, it is noticed that over the forecasted period, a 7.7% increase in the index of per capita GNI, would cause more than average negative shock to Service output and a moderate negative shock to Human Capital Development and Industry output. In particular, Service output would deviate by -69%, Human Capital Development would deviate by -43.7% and the Industry output by -37%. The magnitude of these shocks implies that while it would take short term for Human Capital Development and Industry output to revert to their original trend path, it would take a longer term for Service output to revert to its initial mean considering the extent of the deviation. Agriculture output showed a moderate positive deviation of 21.5% from the baseline under the scenario of 7.7% increase in the index of per capita GNI. Again, the top 5 variables that experienced a significant maximum deviation due to 7.7% increase in the index of per capita GNI were; Capital Finance Flows (-500%), Non-oil Export (-92%), Foreign Direct Investment (-85.1%), Foreign Portfolio Investment (59.7%) and Capital Account Balance (-52.2%). The sizes of these deviations imply that it would take medium to long term for these variables to revert to their original mean.

In addition, the forecast result showed that, when the index of per capita GNI decreased by 7.7%, Service Output deviated by 200%, Human Capital Development deviated by 100%, Industry Output deviated by 47.7% and Agriculture Output by -19%. These results suggest that, a decrease in index of per capita GNI are more likely to have permanent shock to Service Output and Human Capital Development, compared to Industry and agriculture output Meanwhile, decreasing the index of per capita GNI by 7.7%, was revealed to have a moderate and positive deviation on Total Output (24.5%), Non-Oil Government Revenue (12.1%), Capital Account Balance (10.3%), amongst others, from the baseline. However, the effect of 7.7%, per capita GNI decrease, exerted negative deviation on Foreign Portfolio Investment (-17%). The forecasted results under these scenarios are presented in Table 8. The graphs of scenarios 4 and 7 are presented in the appendix.

Table 8: Forecast Results for Scenarios 4 and 7

Variable	Scenario 4 (Increase by 7.7%) % Maximum Difference from Benchmark	Scenario 7 (Decrease by 7.7%) % Maximum Difference from Benchmark
Capital Finance Flows	-500%	-200%
Non-oil Export	-92%	500%
Foreign Direct Investment	-85.1%	400%
Service Output	-69%	200%
Human Capital Development	-43.7%	100%
Non-oil Output	-52.2%	93.8%
Industry Output	-37%	47.7%
Total Output	-30.8%	24.5%
Foreign Portfolio Investment	59.7%	-17%
Agriculture Output	21.1%	-19%
Capital Account Balance	-52.2%	10.3%
Non-Oil Government Revenue	-9.6%	12.1%
Government Revenue	-5.8%	6.7%
Service Export	-16.3%	4.7%
Government Recurrent Revenue	-5.8%	5.6%
Exports	-21.5%	3.5%
Total Government Expenditure	-0.000023%	0.00002%
Fiscal Deficit	0.0000084%	-0.000012%
Other Deficit Financing	0.0000084%	-0.000012%
Real Exchange Rate	0.00000083%	-0.00000092%
Imports	0.00000071%	0.0000014%
Nominal Exchange Rate	0.0000007%	-0.00000054%
Fiscal Deficit Financing	0.00000073%	-0.00000022%
Remittances	-0.00000039%	0.00000039%
Reserves	0	-0.00000011%
Oil government Revenue	0	0
Oil Exports	0	0
Oil Output	0	0

Source: Researchers' computation using Dtata 11

Figures are in percentage deviation from the baseline with positive sign indicating that the scenario favours the sector more than the baseline, vice versa.

* **Note:** Higher percentage deviation implies that the shock has a permanent deviation from the normal trend of the variable or the variable may take a longer time to revert to its initial trend; indicating that the shock has a significant effect on the variable, vice versa.

Conclusions and Policy Recommendations

Conclusion

The result of the ex-post forecast showed that the model has a high predictive power as the forecasted values virtually match the actuals. On the average, the forecasted value of agriculture output for 2019 only deviated from the actual by -0.26% (that is, the forecasted value marginally dropped from the actual). Similarly, the average forecasted percentage difference for Industry output and Services output were 1.4% and 2.6% respectively.

Further, the results of the ex-ante forecast showed that a 4% increase in life expectancy triggered a moderate deviation and improvement in Industry output (50.9%) and Service output (16.6%), while its worsened Agriculture output by 7.4%, compared to the baseline. The Agriculture output under the scenario of 4% decrease in life expectancy, showed 14.9% deviation from the baseline, while its worsened Industry output and Services output by 31.2% and 65.9% deviations respectively, from the baseline.

Services output and Industry output were better under a scenario of 2% increase in number of schooling years than in the baseline, with a maximum deviation of 9.3% and 3.7%, respectively. On the contrary, the baseline relating to Agriculture output was better than under the scenario of 2% increase in number of schooling years which shrunk the sector by 2.0% deviation. Similarly, the baseline relating to Service output and Industry output was better than under the scenario of 2% decrease in number of schooling. In particular, it is noticed that 2% decrease in number of schooling years worsened Service and Industry output by 74.5% and 42.4% deviations, respectively. On the other hand, 2% decrease in number of schooling years was shown to be countercyclical with the Agriculture output. A 7.7% increase in the index of per capita GNI resulted in more than average negative shock to Service output and a moderate negative shock to Human Capital Development and Industry output. Agriculture output showed a moderate positive deviation of 21.5% from the baseline under the scenario of 7.7% increase in the index of per capita GNI. The forecast result further showed that, when the index of per capita GNI decreased by 7.7%, Service Output deviated by 200%, Human Capital Development deviated by 100%, Industry Output deviated by 47.7% and Agriculture Output by -19%.

Based on the empirical findings of this study vis-à-vis the effects of HCD on the individual activity sectors, the following conclusions were made;

i. HCD is a significant determinant of agricultural output in Nigeria.
ii. HCD does not have significant effect on industrial output, though its relationship with the sector is positive.
iii. HCD is a significant determinant of output in the services sector.

Policy Recommendations

The following policy options were recommended.

i) The government should ensure that health policies capable of boosting life expectancy are initiated or strengthened to achievement of health lives for the citizenry.
ii) The ministry of agriculture should ensure that agriculture is not just a gainful venture business but also incentivize for greater output.
iii) The findings of the study demonstrated that increase in per capita GNI should be one of the viable policy options towards improving the agriculture output in Nigeria.

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