**Exploring the Effects of Human Development Index on Agricultural Output in Nigeria (1999 – 2022)**

**ABSTRACT**

This study empirically analysed the impact of Human Development Indices (HDI) on agricultural output in Nigeria from 1999 to 2022. The research employed the Error Correction Model (ECM) and utilised annual secondary data obtained from the Central Bank of Nigeria Statistical Bulletin and the Index Mundi Database. The Autoregressive Distributed Lag Error Correction Model to ascertain both short and long run effects of HDI indicators on agricultural output. Findings indicated that, in the long run, the birth rate had a positive and significant effect on agricultural output, while government expenditure on education had a negative and significant impact. In the short run, the birth rate remained positive and significant at the 5% level, whereas both the death rate and life expectancy showed negative and significant effects. The study recommended that the government should leverage on the population growth resulting from an increased birth rate to promote agricultural participation and consequently enhance productivity.

**Keywords:** Birth rate, death rate, life expectancy, government expenditure on education, Agricultural output

**Introduction**

According to United Nations Development Programme (2024), Human Development Index (HDI) is a measure of a country's average achievements in health, knowledge and standard of living. Each component is measured separately. Healthy is measured by life expectancy at birth; Knowledge, is measured by mean years of schooling or expected years of schooling; Standard of living on the other and is measured by GNI per capita. The HDI is expressed between 0 and 1. The higher the higher its HDI value (closer to 1), the higher the country's human development.

While economic progress is often measured through GDP or GNI per capita which primarily considers income, human development encompasses a broader spectrum of factors that provide a more comprehensive view of a nation's development. These include health, education, physical environment, and freedom.

Human development has become a central indicator of a nation's ability to evolve effectively.. The growth of the agricultural sector and the Human Development Index (HDI) are closely intertwined. Human development refers to a state in which individuals are empowered to make choices that enhance their overall well-being. Kubalu et al. (2017) emphasize that social development is critical for every society, yet political entities, especially in developing countries like Nigeria, often neglect to allocate significant portions of their annual budgets toward social development, which is crucial for human development. Although HDI overlooks critical issues like poverty, empowerment, inequalities, security, and safety, the HDI remains an important measure for assessing a country's economic standing. Proper integration of HDI indicators into national budgets and effective implementation growth.

The United Nations Development Programme (UNDP) introduced the concept of human development in its inaugural report in 1990, highlighting the ultimate goal of development: to create an environment where individuals can live long, healthy, and creative lives. The HDI, a tool for comparing countries' true economic development. It places less emphasis on economic progress and more on the quality of life and education and well-being of the people. HDI developed by Nobel Laureate Amartya Sen and an economist Mahbub ul Haq, with input from Gustav Ranis of Yale University and Lord Meghnad Desai of the London School of Economics, the HDI was later adopted by the UNDP as a standard measure for assessing national performance (UNDP, 2018).

Studies havesuggested a strong link between human development and agricultural output. Increased production in agriculture can provide workers with the necessary nutrients to remain engaged in productive activities across sectors. However, high death rates and low life expectancy can severely hinder agricultural labour in developing economies (World Bank, 2018). The challenges of low productivity in the agriculture sector are compounded by labour loss due to mortality and insufficient knowledge. Agriculture, however, provides significant market-mediated linkages by supplying labour, expanding markets for industrial goods, and generating export earnings that fund the import of capital goods (Anowor et al., 2013a). It is also seen as a critical avenue for improving income and health for the world’s poorest populations, offering opportunities for raising living standards (Anowor et al., 2013b). The World Bank (2017) asserts that agricultural growth can reduce inequality and uplift the poor. Consequently, improvements in human development indicators such as birth rate, mortality rate, life expectancy, and school enrolment can influence productivity in the agricultural sector.

Human development plays a pivotal role in achieving holistic development. As Omolara (2017) points out, human development is fundamental for sustainable long-term growth. A country may experience physical expansion, but without significant human development, such growth is likely to be unsustainable. Many developing nations still prioritize growth first, leaving human development as a secondary concern. Omolara (2017) argues that policymakers should focus on continuous progress in education, health, and living standards. Amartya Sen’s concept of human development, which centres on human capabilities, emphasizes the importance of providing citizens the ability to improve their circumstances. Human development is the extent to which individuals can acquire things of value and live meaningful lives by reducing barriers to their independence, decision-making, and reasoning abilities (Malakar et al., 2021). Also, Human development ~~as~~ is the expansion of people's freedoms, similarly he, stresses the importance of increasing opportunities for people to achieve their full potential (Osmani, 2016).

The Human Development Index (HDI) evaluates a country's performance using non-income indicators. Biswas and Caliendo (2007) highlighted that HDI provides valuable insights into human welfare, beyond the annual GDP figure. According to Graham (2010), HDI challenges the global development community to rethink traditional measures of welfare and human progress. ~~Graham~~ He defines HDI as a simple statistic that ranks countries based on life expectancy, education, and per capita income indicators. For this study, HDI is measured using four key dimensions: birth rate, death rate, life expectancy, and government expenditure on education.

Despite numerous studies examining the agricultural sector's stagnation, little attention has been paid to the it’s relationship with HDI. Previous research, such as those by Anowor et al. (2019), Tuaneh and Dododei (2025), Tuaneh and Nmegbu (2021), Tuaneh and Okidim (2019), Obasanmi and Idogun (2020), Isaac et al. (2016), and Keji and Efuntade (2020), Tuaneh and Ewubare (2017), Ewubare and Tuaneh (2018) ~~has~~ have explored other factors affecting agricultural output, often overlooking the role of HDI components like birth rate, death rate, life expectancy, and school enrolment . This study aims to bridge this gap by analyzing the relationship between HDI indicators and agricultural Production in Nigeria. The research questions guiding this inquiry include: How does birth rate affect agricultural output in Nigeria? How does life expectancy influence agricultural output? To what extent does death rate impact agricultural productivity? How does government expenditure on education affect agricultural output in the sector?

This study explores the impact of HDI on agricultural output in Nigeria from 1999 to 2018measuring HDI using birth rate, death rate, life expectancy, and government expenditure on education~~.~~ This research seeks to determine whether HDI promotes agricultural growth. The findings is expected to inform policymakers at both federal and state levels, enabling them to leverage the agricultural sector's potential for economic growth. Additionally, this the study contribute to the existing body of knowledge and empirical literature, providing valuable insights for future research.

**Objectives of the study**

The primary objective of this study is to examine the impact of Human Development Indices (HDI) on agricultural output in Nigeria. Specifically, the study aims to:

1. Analyze the trends in agricultural output, birth rate, death rate, life expectancy, and government expenditure on education in Nigeria.
2. Investigate the impact of birth rate on agricultural output in Nigeria.
3. Assess how variations in the death rate influence agricultural output in Nigeria.
4. Examine the relationship between life expectancy and agricultural productivity in Nigeria.
5. Evaluate the effect of government expenditure on education on agricultural output in Nigeria.

### Empirical Literature Review

Several studies have explored the relationship between socioeconomic factors and agricultural productivity in Nigeria. Tuaneh and Okidim (2019) assed agricultural performance amidst Macroeconomic Instability in Nigeria using the Autoregressive distributed lag model. Tuaneh and Ewubare (2017) investigated the implication of financial deepening on agricultural performance. Anowor *et al*. (2019) investigated how health-related variables influence agricultural output. The study employed a dynamic error correction model, incorporating mortality rate and life expectancy as key indicators of health status, with agricultural output serving as the dependent variable. The research also included HIV/AIDS as a control variable. Findings indicated that adverse health conditions, particularly the prevalence of HIV/AIDS, negatively affect workforce productivity and, consequently, agricultural output. The study emphasized the need for enhanced healthcare policies and investment to improve the well-being of agricultural labourers, thereby fostering sectoral growth. Public-private partnerships in expanding healthcare access were recommended as a viable strategy for increasing agricultural productivity.

In a similar study, Obasanmi and Idogun (2020) explored the impact of human capital development on economic growth, focusing on the agricultural and petroleum industries. By employing the Error Correction Mechanism (ECM), the research found a long-term relationship between human capital investment and sectoral output. While increased government spending on education and healthcare significantly contributed to growth in the petroleum industry, its impact on the agricultural sector was less pronounced. Additionally, investment in research and development (R&D) was found to be crucial in driving output across both industries. Based on these findings, the study recommended a strategic increase in educational funding to improve learning infrastructure and enhance human capital development, which could indirectly benefit agricultural productivity.

**Materials and method**

This study focuses on Nigeria, a West African nation with a population of around 140 million (NPC, 2006). It is divided into six geopolitical zones: North Central, North West, North East, South West, South East, and South South. Nigeria has three agro-ecological zones: dry savannah (North East, North West, parts of North Central), humid forest (South West, South East, parts of North Central, South South), and moist savannah (mainly South South, with parts of South West and South East). Covering 923,768 square kilometers, Nigeria shares borders with Chad, Cameroon, and Benin, and consists of 36 states, with Abuja as the Federal Capital Territory. Administratively, there are approximately 774 local government areas (LGAs) across these states and the FCT. The population distribution is uneven, with about 63% residing in rural areas, while the remainder lives in urban centers.

### Research Design and Data Collection

This study employs a quasi-experimental research design, chosen for its suitability in analyzing quantitative data derived from secondary sources. The research utilizes time series data spanning 23 years, covering the period from 1999 to 2022. Data were sourced from credible publications such as statistical bulletins~~,~~ of the Central Bank of Nigeria (CBN), and the Food and Agriculture Organization (FAO) database.

### Stationarity Test

Prior to analysis, the study conducted a Unit Root test on both dependent and independent variables to assess their time series properties. This step was crucial to ensuring that the mean and variance of the dataset remained stable over time, thereby preventing misleading regression results. The Augmented Dickey-Fuller (ADF) test was applied to determine the presence of unit roots, ensuring that the regression model’s residuals exhibited white noise characteristics. If a variable was found to be non-stationary, first differencing was applied; in cases where necessary, second differencing was performed to achieve stationarity.

### Cointegration Test

The study used the ARDL Bounds test to determine long-term equilibrium relationships among variables with different integration orders.

### Model Specification

For this study, the dependent variable is agricultural output, while the independent variables include birth rate, death rate, life expectancy, and school enrolment. The specified model for analysis is represented as follows:

OUTPUT = 0 +1BR + 2DR + 3LE + 4GEE + u

Where:

OUTPUT= Agricultural Output (MT)

BR = Birth rate (%)

DR = Death rate (%)

LE = Life expectancy (Years)

SE = Government expenditure on education (%)

U = Stochastic Error Term

Where: ’s = The Parameters of the independent variables to be estimated.

**Results and Discussion:**

**Descriptive Statistics**

This section presents a summary of the descriptive statistics for the variables examined in this study. The analysis includes measures of central tendency, such as the mean and median, alongside measures of dispersion, including standard deviation. The dataset comprises information on agricultural output (Output), birth rate (BR), death rate (DR), life expectancy (LE), and government expenditure on education (GEE), covering the period from 1999 to 2022.

**Table 1: Descriptive statistics of the variables used**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | AO | BR | DR | GEE | LE |
| Mean | 24.66682 | 40.09432 | 14.75064 | 7.833636 | 50.37100 |
| Median | 24.17000 | 40.13000 | 14.63900 | 7.735000 | 50.82850 |
| Maximum | 37.35000 | 44.38000 | 17.84200 | 13.00000 | 52.88700 |
| Minimum | 20.24000 | 35.21000 | 11.38200 | 1.690000 | 46.61400 |
| Std. Dev. | 4.243099 | 3.362578 | 2.168582 | 2.803697 | 1.919162 |
| Skewness | 1.640859 | 0.025017 | 0.009514 | -0.476805 | -0.495666 |
| Kurtosis | 5.470880 | 1.454129 | 1.655385 | 3.112317 | 1.999147 |
| Jarque-Bera | 15.46868 | 2.192870 | 1.657654 | 0.845153 | 1.819074 |
| Probability | 0.000438 | 0.334060 | 0.436561 | 0.655356 | 0.402711 |
| Sum | 542.6700 | 882.0750 | 324.5140 | 172.3400 | 1108.162 |
| Sum Sq. Dev. | 378.0817 | 237.4456 | 98.75770 | 165.0751 | 77.34685 |
| Observations | 22 | 22 | 22 | 22 | 22 |

**Source: Author’s Computation from E-views 10.**

The average values for agricultural output, birth rate, death rate, life expectancy, and government expenditure on education over the 22-year period examined in this study were 24.66682, 40.09432, 14.75064, 50.37100, and 7.833636, respectively. These mean values represent the central tendencies of the variables during the specified timeframe. The descriptive analysis further revealed that all variables exhibited low standard deviations, indicating that the data points were closely clustered around their respective means.

**Unit root test**

A unit root test was conducted to check stationarity in the variables, using the Augmented Dickey-Fuller (ADF) test at both levels and first differences to determine the order of integration. The results are shown in Table 2.

**Table 2: Unit Root Test Results**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables** | **Augmented Dickey-Fuller** | | |
|  | **Level** | **1st difference** | **Remarks** |
| AO | -2.158086  (0.2257) | -4.370871  (0.0026) | 1(1) |
| BR | -0.558583  (0.8617) | -4.747110  (0.0011) | 1(1) |
| DR | 0.111203  ( 0.9595) | -4.851016  (0.0000) | 1(1) |
| GEE | -3.665417  ( 0.0130) |  | 1(0) |
| LE | -3.070817  (0.0445) |  | 1(0) |

**Source: Author’s Computation from E-views 10.**

Since the study applied a 5% significance level, the decision criterion was to reject the null hypothesis of a unit root if the p-value was below 0.05. A p-value lower than 0.05 indicated that the data was stationary. Initially, the stationarity of each variable was examined, and those found to be non-stationary at level were differenced once to achieve stationarity. The results showed that government expenditure on education and life expectancy were stationary at level, indicating they were integrated of order zero, I(0). However, agricultural output, birth rate, and death rate were non-stationary at level but became stationary after first difference implying integration of order one, I(1). Given this mix of integration, further testing was required to determine whether a long-run relationship existed among the variables. The study employed the Autoregressive Distributed Lag (ARDL)-Bounds Cointegration Test. This method was chosen because it accommodates variables integrated at different orders, unlike the Johansen Cointegration Test, which requires all variables to be integrated at the same order. The results of the ARDL-Bounds test are presented in Table 4.

### ARDL-Bounds Cointegration Test

The ARDL-Bounds test was utilized to evaluate the existence of a long-run relationship between the dependent and independent variables. The approach aligns with the recommendation of Pesaran, Shin, and Smith (2001).

**Table 3: ARDL-Bonds Cointegration Test**

|  |  |  |
| --- | --- | --- |
| (Dependent variable: AO)  F(BR, DR, GEE, LE) | | **F-Statistics**   8.991206 |
| **Critical Values**   |  | | --- | | K=4; n=22 | | 10% | | 5% | | **Lower Bound 1(0)**  2.45  2.86 | **Upper Bound 1(1)**  3.52  4.01 |

**Source: Author’s Computation from E-views 10.**

As shown in Table 3, the results of the cointegration test confirmed the presence of a long-term relationship among the variables. The F-statistic value of 8.991206 exceeded the upper critical bounds of 3.52 and 4.01 at the 5% significance level (Keji, 2018). Based on this, the null hypothesis of no long-run relationship was rejected. Therefore, the study concluded that agricultural output, birth rate, death rate, life expectancy, and government expenditure on education maintain a long-run equilibrium relationship. This suggests that these variables tend to move together over time, and any short-term deviations caused by external disturbances will eventually be corrected.

### Error Correction Model (ECM) Results for HDI and Agricultural Output

The ARDL regression analysis was conducted to assess the relationship between agricultural output (dependent variable) and key Human Development Index (HDI) indicators—birth rate, death rate, life expectancy, and government expenditure on education (independent variables). The regression results are detailed in Table 4.

**Table 4: Error Correction Model result of HDI and Agricultural output**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Regressor** | **Coefficient** | **Standard error** | **T-Statistic** | **Probability** |
| **Long-Run Result** | | | | |
|  |  |  |  |  |
| AO1)\* | -1.433043 | 0.322046 | -4.449804 | 0.0021 |
| BR | 1.129717 | 0.352303 | 3.206660 | 0.0125 |
| DR | -2.463227 | 1.916774 | -1.285090 | 0.2347 |
| GEE | -0.543166 | 0.194102 | -2.798353 | 0.0233 |
| LE | -3.389313 | 2.273002 | -1.491117 | 0.1743 |
| **Short-Run Result** | | | | |
| C | 272.6132 | 32.30920 | 8.437635 | 0.0000 |
| D(AO(-1)) | 0.494532 | 0.153033 | 3.231551 | 0.0120 |
| D(BR) | 1.336736 | 0.536383 | 2.492129 | 0.0374 |
| D(BR (-1)) | 1.575527 | 0.607616 | 2.592965 | 0.0320 |
| D(DR) | -1.120542 | 9.005469 | -0.124429 | 0.9040 |
| D(DR (-1)) | -18.85528 | 3.688375 | -5.112083 | 0.0009 |
| D(GEE) | -0.199743 | 0.092729 | -2.154046 | 0.0634 |
| D(LE) | -2.513497 | 1.384304 | -1.815711 | 0.1070 |
| D(LE \_(-1)) | -10.23218 | 3.053725 | -3.350720 | 0.0101 |
| ECM(-1)\* | -1.433043 | 0.174510 | -8.211823 | 0.0000 |

|  |  |  |  |
| --- | --- | --- | --- |
| R² | 0.911 | Adj. R² | 0.844 |
| S.D. Dep. Var | 3.455 | Mean Dep. Var | 0.112 |
| S.E. Regression | 1.367 | Sum Sq. Resid | 22.411 |
| Log-Likelihood | -31.420 | AIC | 3.766 |
| SC | 4.261 | HQC | 3.882 |
| F-Stat (2,36) | 13.580 | Prob(F-Stat) | 0.00005 |
| Durbin-Watson Stat | 2.889 |  |  |

**Source: Author’s Computation from E-views 10.**

Table 4 presents the estimated long-run and short-run effects of key factors on agricultural output. In the long run, the birth rate demonstrated a significant positive impact on agricultural output, with an estimated coefficient of 1.129717. This suggests that a rise in the birth rate contributes to increased agricultural productivity, which aligns with economic expectations. Similar findings have been reported by Tartiyus, Dauda, and Peter (2015) and Mohsen and Chua (2015), who argue that population growth enhances economic expansion. In Nigeria, a growing population increases the available labor force, thereby boosting agricultural productivity. Furthermore, a larger population creates demand for agricultural products, supporting domestic food production.

However, government expenditure on education exhibited a significant negative relationship with agricultural output in the long run, with a coefficient of -0.543166. This outcome contrasts with conventional expectations, as increased investment in education is generally associated with economic development, including agricultural growth. A similar negative impact of education expenditure on agricultural output was reported by Adeneye and Anuolam (2023).

### Short-Run Dynamics

In the short run, the birth rate had a positive effect on agricultural output in both the current and first lag periods. The coefficient for the current period was 1.336736, while that of the first lag stood at 1.575527, suggesting that a higher birth rate leads to immediate and short-term growth in agricultural production.

Conversely, the death rate negatively influenced agricultural output in both the current and first lag periods. The coefficient for the current period was -1.120542, while the first lag recorded -18.85528, with significance in the latter. This aligns with economic expectations, as increased mortality rates lead to a decline in the workforce, thereby reducing agricultural productivity. Similar findings were reported by Anowor, Nwonye, Okorie, and Ojiogu (2019), who identified a negative correlation between mortality rates and agricultural output in Nigeria.

Life expectancy also exhibited a negative relationship with agricultural output, with coefficients of -2.513497 for the current period and -10.23218 for the first lag. The significant negative effect in the first lag suggests that an aging farming population may contribute to declining agricultural productivity. While older farmers possess valuable experience, their ability to adopt modern farming techniques may be limited. A comparable trend was observed in China by Guancheng, Qiyu, and Jingjuan (2015), who found that aging farmers had a less favourable impact on agricultural production.

### Model Validation and Post-Estimation Tests

The error correction term (ECT) had the expected negative sign, confirming gradual correction of deviations from long-run equilibrium. It was statistically significant (P = 0.0000 < 0.05), with a coefficient of -1.433, indicating a 43.3% speed of adjustment.

An R-squared value of 0.910 suggests that 91% of variations in agricultural output were explained by the model, while the adjusted R-squared (0.843) confirms that 84% of variations were accounted for. The Durbin-Watson statistic (2.8) indicated serial autocorrelation.

Post-estimation diagnostic tests, including normality, heteroscedasticity (ARCH test), and serial correlation (Breusch-Godfrey test), were conducted, with results presented in Table 5.

**Table 5: Post Estimation Test on AO Model**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test** | **Test Statistics** | **Value** | **PV** |
| Normality | Jarque-Bera | 1.035 | 0.59 |
| Breusch-Godfrey Serial Correlation LM | F-Statistics | 3.784 | 0.08 |
| Heteroskedasticity | F-Statistics | 0.138 | 0.87 |

The post-estimation results, as shown in Table 5, indicate that the residuals were normally distributed (P > 0.05). The Breusch-Godfrey Serial Correlation LM test revealed no evidence of serial correlation (P > 0.05) in the model, and the heteroskedasticity test confirmed that the model was homoscedastic (P > 0.05).

### Conclusion and Recommendations

The primary objective of this study was to assess the impact of the Human Development Index (HDI) on agricultural productivity in Nigeria from 1999 to 2022. The HDI was represented by indicators such as birth rate, death rate, life expectancy, and government expenditure on education. The study utilized the Error Correction Model to examine the influence of these factors on agricultural output. The results showed that, between 1999 and 2022, birth rate and government expenditure on education had a significant long-term effect on agricultural output in Nigeria. In the short run, birth rate, death rate, and life expectancy significantly impacted agricultural output. The key findings are as follows:

1. Birth rate had a significant positive effect on agricultural output in both the long and short runs.
2. Government expenditure on education negatively impacted agricultural output in the long run.
3. The death rate had a negative impact on agricultural output in the short run.
4. Life expectancy had a significant negative effect on agricultural output in the short run.

These findings suggest that prioritizing human development policies in Nigeria could significantly boost the agricultural sector. The coefficients obtained align with the expectations, and the results underscore the potential benefits of early policy interventions in enhancing agricultural productivity. Based on the study’s conclusions, it is evident that agricultural output is strongly influenced by the Human Development Index (HDI).

The following recommendations are made based on the findings of the study:

1. The government should ensure that the growing population, due to higher birth rates, is directed toward agricultural activities to enhance agricultural output.
2. The government should establish monitoring mechanisms to oversee educational expenditure and ensure its proper utilization.
3. The federal government should explore ways to improve access to primary healthcare services. Expanding and enhancing basic healthcare will help reduce death rates and increase life expectancy, which in turn will benefit the agricultural sector.

**Disclaimer (Artificial intelligence)**

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

**References**

Adeneye, O.A. & Anuolam, M.O. (2023). Econometrics Analysis of the Effect of Human Capital Development on Economic Growth in Nigeria. *International Journal of Multidisciplinary Research and Analysis*, 6(6), 2582 -2592.

Anowor, O. F., Ukwueni, N. O. & Ezekwem, S. O. (2013a). Agricultural productivity and poverty alleviation: An econometric analysis. *American Journal of Sustainable Cities and Society,* 2:(1): 109–29.

Anowor, O. F., Ukwueni, N. O. & Ikeme, M. (2013b). The impact of trade liberalisation on Nigeria agricultural sector. *Journal of Economics and Sustainable Development,* 4:(8): 14-24.

Anowor, O.F. Nwonye, N.G., Okorie, G.C. & Ojiogu, M.C. (2019). Health Outcomes and Agricultural Output in Nigeria. *International Journal of Economics and Financial Research,* 5:(5): 106-111.

Biswas, B. & Caliendo, F, (2007). A multivariate analysis of the human development index. Economics and finance, paper 244

Ewubare, D. B. & Tuaneh, G. L. (2016) [Impact of electronic banking instruments on monetary policy efficiency In Nigeria](https://scholar.google.com/citations?view_op=view_citation&hl=en&user=7svd4NAAAAAJ&citation_for_view=7svd4NAAAAAJ:UeHWp8X0CEIC). International Journal of Business and Applied Social Science 2 (2), 8

Graham, C. (2010).The challenge of incorporating empowerment into the HDI: Some lessons from happiness economics and quality of life research*. United Nations Development programme, human development report.*

Guancheng, G., Qiyu,W. & Jingjuan, Z. (2015). The impact of aging agricultural labor population onfarmland output: from the perspective of farmer preferences. Mathematical Problems in Engineering, 1-7.

Isaac, N., Dela-Dem, D.F. & Jonathan, O.N. (2016). Effect of human capital on maize productivity in Ghana: a quantile regression approach.  *International Journal of Food and Agricultural Economics,* 4:(2): 125-135.

Keji S. A. (2018). An Empirical Investigation into the Nexus between Agricultural Financing and Economic Growth in Nigeria. *Saudi Journal of Economics and Finance (SJEF),* 2:(2): 57-64

Keji, S.A. & Efuntade, O.O. (2020). Agricultural output and government expenditure in Nigeria. *Jurnal Perspektif Pembiayaan dan Pembangunan Daerah*, 8:(2): 101-110.

Kubalu, A.I., Aminu, M.M. & Zainab, S.S. (2017). A dynamic analysis of the relationship between human development and economic growth in Nigeria. *International journal of advanced studies in economics and public sector management,* 5:(1): 968-989

Malakar, Indra Mali, and Bhaba Datta Sapkota. (2021). Human development index: A comparative study between NEPAL and other SAARC Member Countries. *South Asian Journal of Social Studies and Economics* 12 (1):27-35

Mohsen, A. S., & Chua, S. Y. (2015). Effects of Trade Openness, Investment and Population on the Economic Growth: A Case Study of Syria. *Hyperion Economic Journal*, 3:(2): 14-23.

National Population Commission. (2006) Census Figures for Nigeria.

Obasanmi, J.O. & Idogun, H.I. (2020). Impacts of Human Capital Development on Real Sectors Growth in Nigeria. *Journal of Finance and Accounting.* Special Issue: *Financial Inclusion, Accounting Perspectives and Development,* 8:(1): 24-33.

Omolara, C.A (2017). Inclusive growth and sustainable human development in Nigeria. *Advances in social sciences research journal*, 4:(7): 345-353

Osmani, S.R (2016). The capability approach and Human development : Some reflections. *UNDP Human Development report; think piece,* pp 1-24.

Pesaran, M. H, Shin, Y. & Smith, R. (2001) Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometric*, 16:(3): 289 - 326

Tartiyus, E.H., Dauda, M.I. & Peter, A. (2015). Impact of Population Growth on Economic Growth in Nigeria (1980-2010). *IOSR Journal of Humanities and Social Science (IOSR-JHSS)*, 20(4), 115-123

Tuaneh, G. L. 2018). [Vector autoregressive modelling of the interaction among macroeconomic stability indicators in Nigeria (1981-2016)](https://scholar.google.com/citations?view_op=view_citation&hl=en&user=7svd4NAAAAAJ&citation_for_view=7svd4NAAAAAJ:qjMakFHDy7sC). *Asian Journal of Economics, Business and Accounting* 9 (4), 1-17

# Tuaneh G. L. & Dododei, W. (2025), Innovative statistical modelling of exchange rates and agricultural sector performance in Nigeria: The Markov-switching vector autoregressive modelling. *Asian Journal of Probability and Statistics* (in Press)

Tuaneh and Ewubare (2017). [Financial deepening: Implications on agricultural performance (1981-2014)](https://scholar.google.com/citations?view_op=view_citation&hl=en&user=7svd4NAAAAAJ&citation_for_view=7svd4NAAAAAJ:Zph67rFs4hoC). *International Journal of Applied Research and Technology 5 (2), 38-46*

Tuaneh and Okidim (2019). [On agricultural performance amidst macroeconomic instability in Nigeria; Autoregressive distributed lagged modelling (2010Q1-2017Q4)](https://scholar.google.com/citations?view_op=view_citation&hl=en&user=7svd4NAAAAAJ&citation_for_view=7svd4NAAAAAJ:ufrVoPGSRksC). *Asian Journal of Economics, Business and Accounting* 10 (2), 1-13

Tuaneh, G. L. & Nmegbu (2021). The nexus between stabilization policies and real sector output in Nigeria (1981-2020). *Economics and Social Sciences Academic Journal*, 3(11), 1-22

Tuaneh, G. L., Essi, I. D., & Ozigbu, J. (2021). Dynamic linear interdependence between international trade and macroeconomic stability in Nigeria: A vector error correction modelling. *Archives of Business Research*.

UNDP (2018). *Human development index trends, 1990-2017.* Human Development Report Office (HDRO), United Nations Development Programme. Retrieved from http://hdr.undp.org/ on January 10, 2022.

World Bank (2017). World development indicators. Available: https://data.worldbank.org/indicator

World Bank (2018). *The world bank annual report 2018.* World Bank: Washington.

**APPENDIX**

**Table A1: Time series data spanning 23 years, covering the period from 1999 to 2022**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Year** | **AO (% GDP)** | **BR (%)** | **LE (Years)** | **DR (%)** | **GEE (%)** |
| 1999 | 26.3 | 43.211 | 46.614 | 17.66 | 11.12 |
| 2000 | 21.58 | 44.34 | 47.193 | 17.842 | 8.36 |
| 2001 | 24.73 | 44.38 | 47.619 | 17.66 | 7 |
| 2002 | 37.35 | 44.38 | 47.928 | 17.479 | 5.9 |
| 2003 | 34.18 | 44.36 | 48.441 | 17.298 | 1.83 |
| 2004 | 27.51 | 44.36 | 48.767 | 16.863 | 10.5 |
| 2005 | 26.36 | 42.96 | 49.297 | 16.428 | 9.3 |
| 2006 | 24.99 | 42.96 | 49.73 | 15.993 | 11 |
| 2007 | 24.92 | 41.53 | 50.033 | 15.558 | 8.09 |
| 2008 | 25.54 | 40.82 | 50.225 | 15.123 | 13 |
| 2009 | 27.03 | 40.82 | 50.712 | 14.8 | 6.54 |
| 2010 | 23.89 | 39.44 | 50.945 | 14.478 | 6.4 |
| 2011 | 22.29 | 38.77 | 51.357 | 14.115 | 1.69 |
| 2012 | 22.05 | 38.13 | 51.497 | 13.833 | 10 |
| 2013 | 21 | 37.52 | 51.707 | 13.51 | 8.7 |
| 2014 | 20.24 | 36.93 | 51.791 | 13.201 | 10.6 |
| 2015 | 20.86 | 36.36 | 51.841 | 12.892 | 9.5 |
| 2016 | 21.21 | 35.93 | 52.043 | 12.583 | 6.1 |
| 2017 | 21.06 | 35.54 | 52.305 | 12.274 | 7.38 |
| 2018 | 21.43 | 35.21 | 52.554 | 11.965 | 7.03 |
| 2019 | 22.12 | 37.684 | 52.91 | 11.771 | 7.2 |
| 2020 | 24.45 | 37.269 | 52.887 | 11.577 | 6.7 |
| 2021 | 23.7 | 36.855 | 52.676 | 11.382 | 5.6 |
| 2022 | 24.04 | 36.44 | 53.633 | 11.188 | 5.4 |

***Sources; (1) MacroTrends (2022) (***[***www.matrotrends.net***](http://www.matrotrends.net)***). (2) National Bureau of***

***statistics, various issue. (3)Index mundi. (4) World Bank data***