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Inter-Dependency and Inter-relationship Among Tax Revenue, Infrastructure and Human Capital Development in Nigeria: Small Scale Macroeconometric Model

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Abstract
Recently, there has been increased calls for human capital development across the African economics. The role of human capital to economic growth and development cannot be overemphasized. Infrastructural development and efficient tax system are veritable tools for promoting human development. When human development is stunted, infrastructural development and tax revenue also shrink. This paper examined the inter-relationship and interdependency among tax revenue, infrastructure and human development in Nigeria for the period 1980- 2021. This paper adopted the simultaneous equation modeling approach and a system of equations where tax revenue, infrastructure and human development are taken to be exogenous. From the result, temporary 10 percent increase in value added tax revenue has higher effect on human capital development , real GDP and broad money supply. In contrast, permanent increase in value added tax revenue has higher effect on government spending on social and community services(including health and education) and inflation rate than the temporary 10 percent increase in value added tax revenue. Hence, to increase human capital development in Nigeria, temporary tax revenue shock is sufficient. The government should diversify its revenue base and expend more on health and education in addition to building a strong institutional framework to ensure the efficacy of government spending on both health and education.
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1. Introduction

Human capital development encompasses multiple elements of a people's wellbeing, from their health status to their economic and political wellness. Human capital development literature have reiterates that human capital development- by promoting health, knowledge, skills and awareness- enlarges human capital and improves opportunities and choices. It breeds a better qualified workforce with better technical and managerial capacity in usage of time; creates a favourable economic atmosphere for promoting new businesses; more promising jobs; rids population of poverty; supports human rights through greater democracy at different levels(UNDP, 2015). On of the measures of humanc capital development is the Human Development Index (HDI), which measures human capital development , a composite index of three core indicators: health index; education index and per capita income index.

Infrastructure is important for human capital development. Measures of infrastructure cuts across a broad spectrum of social and economic indicators of basic facilities, systems and structures needed by the populace and the society such as transportation, communication, water, electricity, energy, and others. Access to the aforementioned is considered fundamental and drivers for human capital development. Without infrastructures, there will be poor outcomes in education; wellness will be reduced as a result of the incidence of disease and poverty. Thus, prioritizing basic infrastructure is one certain means of catalyzing progress in human capital development. Todaro and Smith (2011) reaffirmed this important enabler of economic activity and a prerequisite for inward investment, trade and productive activities and an important instrument for accelerating human capital development. Moreso, the role of infrastructural development in human capital development lies in the amount of revenue generated for economic and social overheads as well as the amount of government expenditure actually spent on the needed infrastructure. One means of generating the amount of revenue for providing the needed infrastructure is through a well-structured tax system. In addition, a country's tax system is a major determinant of other macroeconomic indexes, hence, Chaudhry and Muni (2010) buttresses that taxation is usually by far the most important source of government revenue for financing infrastructure. The amount of generated revenue is in turn dependent on the level of infrastructural development which directly impacts on the gross domestic product and the level of human capital development. Therefore, fiscal policies aimed at adjusting the tax rate tends to influence the level of economic development. Evidences abound on developed economies that channeled its tax revenue to the provision of necessary infrastructures, which has translated to their improved livelihood. The two major questions of this paper are:

- What are the effects of tax revenue and infrastructure on education development in Nigeria? and
- What are the simulation scenarios of forecasting tax revenue and infrastructure on education in Nigeria?

Majority of the previous studies on human capital development involving health and education has not considered the inter-dependency and inter-relationship of tax revenue and infrastructure in promoting human capital development. The investigation of the role of tax revenue and infrastructure bearing in mind the linkages of these exogenous variables on human capital development is a major contribution to the extant literature.(See Appleton & Teal, 1998; Dae-Bong, 2009; Omojimite, 2011; Asaju et al, 2013; Shuaibu & Oladayo, 2014; Eigbiremolen & Anaduaka, 2014; World Bank, 2010; Ndulu, 2010; Odia & Omofonmwa, 2010; Kern, 2009). The next section presents the methodological approach used to achieve the objective of our study.

2 Methodology

2.1 Theoretical Framework

The role of human capital development and physical capital in the growth process has been widely acknowledged from a theoretical foundation. Different growth theories have been explored to capture the extent to which investment in human and physical capital translates to productivity expansion in an economy. In this regard, one prominent growth theory is endogenous growth theory which clearly demonstrates the essence of this capital in the growth process. Human capital captures the abilities, skills, and knowledge of particular. Like other economic goods, human capital can be rivalry and excludable. Thus, the endogenous growth model explored in this study resemble the Solow model, the Ramsey and Diamond models which assumed constant returns to scale. The model differs from other models in suggesting that moderate adjustment in the resources directed to physical and human capital accumulation may result in large changes in output per worker. Thus, huge investment in physical capital (e.g. infrastructure) and human capital is essential for the development of the economy. A simple theoretical model follows Mankiw, Romer and Weil (1992). Given a Cobb-Douglas production function as presented below:

$$Y(t) = K(t)^{\alpha} H(t)^{\beta} \left[A(t) L(t) \right]^{1-\alpha-\beta} \tag{2.1}$$

Given that $\alpha \succ 0$, $\beta \succ 0$, $\alpha + \beta \prec 1$

Where Y is the output or productivity, K is the physical capital (in our case infrastructure), H is the stock of human capital, L captures the number of labour and A is the technological progress, therefore a skilled labour supplies both 1 unit of L and some amount of H and the production function exhibits constant returns to K, H, and L together. The assumptions about the dynamics of K and L are presented below:

$$\dot{K}(t) = s_K Y(t) \tag{2.2}$$

$$\dot{L}(t) = nL(t) \tag{2.3}$$

The share of output (in terms of resources) channelled to physical capital accumulation (that is infrastructure) is represented by s_K and labour grows at rate n. in addition, there is no depreciation in the model for simplicity. The dynamics of technological progress is

$$\dot{A}(t) = gA(t) \tag{2.4}$$

The modelling of human capital follows the approach of physical capital accumulation which gives

$$\dot{H}(t) = s_H Y(t) \tag{2.5}$$

Where s_H is the share of resources devoted to human capital accumulation. This model shows that human capital is also endogenous as it is determined by amount resources direct towards its improvement. In essence, the equation (5) can be viewed as the technology necessary for producing new human capital requires physical capital (that is infrastructure development), existing human capital, and raw labour, in the same manner, the technology used in the production of goods.

Specifically, the model of human capital accumulation can be presented in endogenous form as follows:

$$\dot{H}(t) = K_F^{\alpha} H_F^{\beta} \left[A L_F \right]^{1-\alpha-\beta} \tag{2.6}$$

Where K_F, H_F, and L_F represent the amount of physical capital (infrastructure), human capital and raw labour used for education. Suppose that physical capital (infrastructure), human capital and raw labour grow at the same

rate s_H, this then means that equation (6) can be rewritten as follow:

$$\dot{H}(t) = s_H \left[K_F^{\alpha} H_F^{\beta} (AL_F)^{1-\alpha-\beta} \right] \tag{2.7}$$

Therefore, our production function still satisfies Inada conditions as in a Solow growth model. However, the assumption of exogenous technological progress can be substituted with a model of endogenous growth of knowledge. In essence, the assumption that the technology for producing new human capital is the same as the technology for producing output is relaxed.

Furthermore, the dynamics of the economy in the endogenous growth model is different from the Solow model. Unlike the Solow model that focuses on the dynamics of an economy from physical capital perspective, endogenous growth model analysis the dynamics of an economy by considering the dynamics of physical and human capital. Following the intensive approach, the variables are redefined as $k = K/AL$, $h = H/AL$, and $y = Y/AL$. Hence, equation (1) can now be expressed in intensive form:

$$y(t) = k(t)^{\alpha} h(t)^{\beta} \tag{2.8}$$

By considering k, the definition of k and the equations of motion for K, L, and A suggest that

$$\dot{k} = \frac{\dot{K}(t)}{A(t)L(t)} - \frac{K(t)}{\left[A(t)L(t)\right]^2}\left[A(t)\dot{L}(t) + L(t)\dot{A}(t)\right] \tag{2.9}$$

$$= \frac{s_K Y(t)}{A(t)L(t)} - \frac{K(t)}{A(t)L(t)}\left[\frac{\dot{L}(t)}{L(t)} + \frac{\dot{A}(t)}{A(t)}\right] \tag{2.10}$$

$$= s_K y(t) - (n+g)k(t) \tag{2.11}$$

$$= s_K k(t)^{\alpha} h(t)^{\beta} - (n+g)k(t) \tag{2.12}$$

Similarly, the dynamics of human capital follows the same reasoning in the dynamics of physical capital which yields

$$\dot{h}(t) = s_H k(t)^{\alpha} h(t)^{\beta} - (n+g)h(t) \tag{2.13}$$

At the steady-state where $\dot{h}$ is zero, human capital and physical capital can be presented in endogenous form as follows:

$$h(t) = \left[\frac{s_H k(t)^{\alpha}}{(n+g)}\right]^{1/1-\beta} \tag{2.14}$$

$$k(t) = \left[\frac{(n+g)k(t)}{s_H}\right]^{1/\alpha} h^{(1-\beta)/\alpha} \tag{2.15}$$

As the economy relied heavily on the dynamics of physical (infrastructure) and human capital, human capital also benefits from infrastructural development. More so, on the balanced growth path, k, h, and y are constant. Thus, output, physical capital (in this case infrastructure), and human capital are all growing at rate $(n+g)$ while in terms of per labour, the three variables will be growing at a rate g. Therefore, the long-run growth rate of output per labour is determined by the exogenous rate of technological progress. A simple manipulation and taking the

logs of the equations (14 and 15) yield

$$\ln s_K + \alpha \ln k^* + \beta \ln h^* = \ln(n+g) + \ln k^* \tag{2.16}$$

$$\ln s_H + \alpha \ln k^* + \beta \ln h^* = \ln(n+g) + \ln h^* \tag{2.17}$$

Equations (2.16 and 2.17) can be solved for $\ln k^*$ and $\ln h^*$, this gives

$$\frac{1-\beta}{1-\alpha-\beta}\ln s_K + \frac{\beta}{1-\alpha-\beta}\ln s_H - \frac{1}{1-\alpha-\beta}\ln(n+g) \tag{2.18}$$

$$\ln h^* = \frac{\alpha}{1-\alpha-\beta}\ln s_K + \frac{1-\alpha}{1-\alpha-\beta}\ln s_H - \frac{1}{1-\alpha-\beta}\ln(n+g) \tag{2.19}$$

Taking the log of equation 1 yields

$$\ln\ y^* = \alpha\ \ln\ k^* + \beta\ \ln\ h^* \tag{2.20}$$

Substituting equations (18 and 19) for k^* and h^* in equation 20

$$\ln y^* = \frac{\alpha}{1-\alpha-\beta}\ln s_K + \frac{\beta}{1-\alpha-\beta}\ln s_H - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g) \tag{2.21}$$

The above equations clearly show the importance of physical (infrastructure) and human capital are essential in one hand and investment in infrastructure and human capital are very critical to improve the growth process. The importance of investing in infrastructure and human capital development is essential for the overall growth of any country. Equation 2. 19 emphasized on the importance of infrastructure for human capital development. In the literature, resource mobilization through tax for the development of infrastructures and human capital is vital for the achievement of high and stable growth. It is also important to know that huge allocation of resources and efficient utilization of such resources in financing infrastructures that are beneficial to human capital will lead to a tremendous increase in productivity. According to Funke and Strulik (2000), physical capital enhances growth significantly at the early stage of development and human capital accumulation through an accumulation of knowledge (education and training) move the economy to a higher stage of development. Many studies such Bundell et al. (1999), De la Fuente and Cicoone (2002), Raheem et al. (2018), and Oyinlola et al. (2020), have emphasized the importance of huge investment in the human capital development. Thus, productivity can only expand significantly if the huge resources directed towards infrastructural and human capital development. This clearly shows the linkages among resources, infrastructure, human capital and growth.

2.2 Empirical Model Specification

This paper employed a macro-econometric model for a small but dynamic open-economy with a linear representation of the Nigerian economy. The model is specifically designed to allow us to examine the relationship among tax revenue, infrastructure and human capital development. The model is built on the IS-LM framework as explored by Olubusoye *et al.* (2016) and Olofin *et al.* (2014). However, this study extends the existing model by introducing an additional equation of human capital development. Expectedly, this additional model is greatly influenced by changes in government revenue directly and through infrastructure. Thus, the structure of our model consists of six important equations which have 13 variables (6 endogenous and 7 predetermined variables). The macro-model designed allows us to determine the following:

- The relevance of tax revenue and infrastructure in predicting/forecasting human capital development(education) in Nigeria.
- The effect of tax revenue through human capital development(education) on the Nigerian economy.
- The effect of infrastructure through human capital development(education) on the Nigerian economy.

There are six equations in the system which are:

- An IS equation which captures the effect of real interest rate, education, government revenue and real exchange rate on the real output.
- Human capital equation analyses the effect of government revenue, infrastructure and inflation on

education.

- Government revenue equation captures the effect of oil price and value-added tax on government revenue.
- LM equation analyses the effect of real output, interest rate, and nominal exchange rate on real money balance.
- Aggregate supply equation examines the effect of previous inflation, real output, change in real exchange rate expectation on inflation.
- Interest rate equation shows the effect of monetary policy rate, inflation, real output, nominal exchange rate expectation on interest rate.

2.2.1 The IS equation

The aggregate demand equation shows the real output as a function of the real interest rate and the real exchange rate for Nigeria (a small open economy):

$$y_t^g = \beta_1 y_{t-1}^g + \beta_2 (i_{t-1} - \pi_t^e) + \beta_3 s_{t-1} + \beta_4 r_{t-1} + \beta_5 h_t + \eta_t^y \quad (2.22)$$

Where y_t^g measures the real output gap which is the percentage difference between the actual and potential real GDP (y_t^g is computed as $100 \log\left(\frac{Y_t}{Y_t^*}\right)$ where Y_t represents the level of real GDP and Y_t^* represents potential output which is captured the trend level of GDP (Berg et al., 2006), i_t is the nominal interest rate, π_t^e is the expected inflation rate, $(i_{t-1} - \pi_t^e)$ is the real interest rate, s_t is the real exchange rate, r_t is the government revenue and h_t is the human capital development. According to the economic theory, the relationship between output and lagged output is expected to be positive. The restriction $1 \prec \beta_1 \geq 0$ is analyzed to ascertain if output depends on its lagged value, y_{t-1}^g. The real interest rate influences the level of real economic activity negatively as it discourages the investment and productive activities in the economy then $\beta_2 \prec 0$. The long-run coefficient of the real interest rate can be recovered using the formula $\beta_2 / (1 - \beta_1)$. In addition, a decline in s_t (suggesting an appreciation of the real exchange rate) will lead to a reduction in the level of real output and thus $\beta_3 \succ 0$. In essence, an appreciation of real exchange rate does not attract foreigners to export while import becomes cheaper to domestic consumers. The long-run effect can be computed as $\beta_3 / (1 - \beta_1)$. An increase in r_t is expected to increase the level of real output and thus, $\beta_4 \succ 0$. The long-run effect of government revenue can be obtained from this computation: $\beta_4 / (1 - \beta_1)$. The positive relationship is expected since the economy is largely funded by government. Hence, a high level of government revenue will enhance output expansion whereas a low level of government revenue will inhibit output expansion. h_t captures the role of human capital in the growth process. According to Mankiw et al. (1992), human capital accumulation amplifies growth through education and training. Accumulation of knowledge and new skills enable a worker to contribute meaningfully to the production process. Thus, as human capital accumulation continues to increase, real output also increase as there will be an increase in productivity through new skills acquired by the worker and hence $\beta_5 \succ 0$. High level of human capital accumulation is expected to lead to an increase in output while a low level of human capital accumulation is expected to reduce it. The long-run effect of human capital development is computed by $\beta_5 / (1 - \beta_1)$. The inclusion of human capital development in the IS equation differentiates our model from Olofin et al. (2014) and Olubusoye et al. (2016).

2.2.2 Human Capital Equation

This equation is the key equation introduced into the structural equations by Olubusoye *et al.* (2016) and it is specified as follows:

$$h_t = \alpha_1 h_{t-1} + \alpha_2 r_t + \alpha_3 f_t + \alpha_4 \pi_t + \eta_t^h \quad (2.23)$$

Where h_t represents human capital development, r_t is the government revenue, f_t is the infrastructure and π_t is the inflation rate. The predetermined level of human capital (h_{t-1}) plays a significant role in determining the increase in the current level of human capital. Government revenue is positively related to human capital development. As more resources are channelled towards knowledge, training and health of workers, the level of human capital accumulation increases. Thus, we expect $\alpha_2 \succ 0$. The long-run effect of government on human capital development is computed as $\alpha_2 / (1-\alpha_1)$. The level of infrastructure also enhances human capital development. Availability of huge infrastructure determines to a large extent the efficiency of human capital. This also allows workers to contribute to meaningfully to the overall economy since there is a conducive environment for workers to efficiently utilize their skills and training in the production process. Thus, an increase in the level of infrastructure will lead to an increase in human capital development which implies that $\alpha_3 \succ 0$. The long-run effect of infrastructure is computed by $\alpha_3 / (1-\alpha_1)$. In addition, a high level of inflation is expected to dampen human capital development. This can be pass through the cost of new skills and training which in turn will discourage human capital development. Since knowledge is also economic good which has features of rivalry and excludability. High cost of training and knowledge accumulation will prevent many workers from pursuing beneficial knowledge thus human capital declines. Human capital will respond negatively to a high price level, thus, $\alpha_4 \prec 0$. The long-run effect of inflation is also computed as $\alpha_4 / (1-\alpha_1)$.

2.2.3 Government Revenue Equation

This equation was introduced by Olubusoye et al. (2016) and it is specified as follows:

$$r_t = \delta_1 op_t + \delta_2 v_t + \eta_t^r \tag{2.24}$$

Where r_t is the government revenue, op_t is the crude oil price in the current year t and v_t is the value-added tax revenue at year t. The coefficients of the op_t and v_t are expected to be positive since an increase in the crude oil price and value-added tax revenue are expected to increase the level of government revenue. Any negative shocks to crude oil price and value-added tax will lead to a decline in government revenue.

2.2.4 The LM Equation

The LM equation can also be called real money balance. Conventionally, the real money balance is assumed to be affected by the level of income, interest rate and nominal exchange rate. The level of income and interest rate captures the transactionary, precautionary and speculative motives of money demand. The exchange rate was included to capture the peculiarity of the small open economy such as Nigeria (Salisu et al. 2013).

$$m_t - p_t = \varphi_1 y_t^g + \varphi_2 i_t + \varphi_3 e_t + \eta_t^m \tag{2.25}$$

Where m_t represents the nominal money, p_t is the price level in the economy, y_t^g captures real output gap, i_t is the nominal interest rate and e_t is the nominal exchange rate. The real income captures the transactionary motive of demand for money which influenced real money balance positively. As real income increases, people tend to increase the level of their spending while a decline in real income suggests a decline in the spending level of people. Also, the nominal interest rate and exchange rate captures the opportunity cost of holding money and they affect real money balance negatively. As interest rate and exchange rate (depreciation) increase, the motivation to hold money reduces which will lead to a reduction in the real money balance in the economy. Hence, $\varphi_2, \varphi_3 \prec 0$.

2.2.5. The Aggregate Supply Equation

The reduced-form Philip curve used in this study is derived from a combination of wage-contracting and consumption price index equations. This combination gives an aggregate supply curve or price-setting equation which captures the effect of output gap on the inflation. The specification represents a small open-economy aggregate supply equation which expresses inflation as a function of its next period expected value and lagged values, output gap (the mark-up of firms prices over marginal costs), and expected real exchange rate. The equation is presented as follows:

$$\pi_t = \gamma_1 \pi_{t+1}^e + (1-\gamma_1)\pi_{t-1} + \gamma_2 y_t^g + \gamma_3 S_{t+1}^e + \eta_t^\pi \tag{2.26}$$

Where π_t is the inflation rate, π^e_{t+1} is the inflation expectation at period $t+1$ relying on information at a time t, π_{t-1} is the inflation rate at the previous period, y^g_t is the current value of output gap and S^e_{t+1} is the real exchange rate expectation at period $t+1$ based on the information at period t. Theoretically, the summation of coefficients of the expected inflation and lagged inflation must fall between 0 and 1. The value of the coefficient will now determine if the inflation rate is forward-looking or backwards-looking. Inflation rate is expected to respond negatively to output gap which suggests a low level of real GDP in the economy. In addition, the expected exchange rate will be positively related to inflation since depreciation of exchange rate in countries (e.g. Nigeria) with low elasticity of import demand will likely increase inflation rate (Olubusoye et al., 2016).

2.2.6. The Interest Rate Equation

In this case, there is an assumption that monetary policy instrument is determined by the short-term nominal interest rate (that is MPR for Nigeria). Also, the monetary authority (Central Bank) sets this policy instrument to pursue the objective of inflation-targeting. The nominal interest rate can also respond to deviation output from steady-state. Thus, interest rate equation is expressed as a function of inflation rate, monetary policy rate, real output gap, and nominal exchange rate expectation. This equation is simply Taylor's monetary policy rule. The model is expressed as flows:

$$i_t = \theta_1 e^e_{t+1} + \theta_2 \pi_t + \theta_3 y^g_t + \theta_4 mpr + \eta^i_t \quad (2.27)$$

Where $_t$ is the nominal interest rate, e^e_{t+1} is the expected nominal interest rate at period $t+1$, π_t is the inflation rate, y^g_t is the output gap, and mpr is the monetary policy rate. Expectedly, the monetary policy variable is should be positively related to nominal interest rate in the economy. In addition, nominal exchange rate expectation and inflation rate are expected to influence nominal interest rate positively since loanable funds may become expensive when anticipated nominal exchange rate depreciates coupled with high inflation rate in the economy. Since exchange volatility is carefully observed by the policymaker and exchange rate expectation is linked with adaptive expectation, then, monetary policy may respond directly to the exchange rate. In line with Woodford (2003), the CBN is expected to smoothen interest rates by adjusting them slowly to the required level given the deviations of inflation and output from steady-state.

The definition and measurement of the stochastic equations are in the appendix.

2.3 Estimation Techniques and Procedure

This section focuses on the estimation technique explored to address the objectives of the study. Since the models are specified in structural form, the Ordinary Least Squares (OLS) approach was employed to estimate the structural equations following Olofin *et al.* (2014). It is important to note that the choice of a suitable estimation approach in macroeconomic modelling can be rigorous and complex as there are several methods with their associate advantages and shortcomings. Also, the appropriateness, sample size, simplicity, estimate consistency and reliability and efficiency of the estimates are critical to the choice of estimation under macro-model.

Also, determination of the goodness of fit of the macro-models and estimated coefficients of individual variables is very vital for modelling macro-econometric models, however, the good statistical features of individual equations may not be sufficient for the good performance of the models in the system. Predictability and forecasting power of the model relies on the quality properties of the data, the interlinkages among the behavioural equations and economic intuition behind the estimated coefficients. Given the common challenge of endogeneity in the structural models, the study also explores Two-Stage Least Squares (2SLS). This method is employed to address the endogeneity issues and for robustness purpose. The approach allows for the inclusion of instrumental variables. Instead of having exogenous and endogenous variables like OLS, the 2SLS accounts for the instrumental variables. In the process of estimating 2SLS, each endogenous variable will be introduced as dependent variable in the first stage regression equation. Then, each endogenous variable is regressed on all the exogenous and instrumental variables. The estimated values from the regressions substitute for the original estimates of the endogenous variables in the second stage regression equation.

The study went further to utilize Three-Stage Least Squares (3SLS) for robustness checking. The estimated coefficients from this approach are determined by estimating a set of nonlinear equations with different blocks as demonstrated in our macroeconomic modelling. The approach imposes a constraint with a diagonal covariance matrix of the error terms across equations. The estimated coefficients are used to form a consistent estimate of the covariance matrix of the error terms. This is applied as a weighting matrix when the model is estimated again to determine the new estimates.

2.3.1 Validation of the Estimated Model

This section focuses on the summary statistics of the variables used in the study. Summary statistics capture the measure of location, the measure of variation and measure of symmetric or asymmetric (skewness and kurtosis)

characteristics of the series which give information about the nature of the distribution.

The measures of location involve the mean (simple average of the distribution). This is captured by the summation of all series divided by the number of the series. Also, the median is the middle value of the series given that the values are arranged in ascending or descending order. The mode is dropped due to issues of bi-modal or multi-modal problem that are common with time-series data. Thus, the closer the mean and the median, the better the symmetry of the series and the closer it is to the normal distribution.

Furthermore, the measures of variation include the range and standard deviation. The range is then captured by the gap between maximum and the minimum value of the series while the standard deviation shows the standardized value of the deviation of the series from their means. In addition, low standard deviation implies a more evenly distributed series and hence it is closer to the normal distribution. The standard deviation is a preliminary measure of the degree of volatility, this higher the standard deviation, the higher the degree of volatility.

The measures of symmetric give information about the shape of the distribution relative to the normal distribution. These include the skewness and kurtosis statistics. Also, a normally distributed series should skewness statistic of zero value, this is a specific characteristic of symmetric series. Also, a series is positively skewed when its skewness statistic is positive (when it is extreme to the right). Similarly, a series is negatively skewed if its skewness statistic is negative (when it is extreme to the left). The second measure of symmetric feature is the kurtosis statistic which captures the peakedness and tailedness of the series compared to the normally distributed series. Kurtosis can be measured by kurtosis statistic or excess kurtosis statistic. The Kurtosis statistic implies that a normally distributed series will have a kurtosis statistic equal or approximated to 3 (mesokurtic). Hence, when the kurtosis statistic of a series is greater than 3, it is termed leptokurtic (peak top and fat tail). However, when the kurtosis statistic of a series is less than 3, it is termed platykurtic (flat top and light tail). But when kurtosis is captured by excess kurtosis statistic, the interpretation is similar except that the excess kurtosis statistic for a normally distributed series will be zero. Any series with excess kurtosis that is greater than zero (positive) is then termed leptokurtic while any series with excess kurtosis that is less than zero (negative) is platykurtic.

The combinations of skewness and kurtosis statistics are very relevant in analyzing the normality of the series. This study relies on Jarque – Bera statistic to measure normality of series that combine both skewness and kurtosis statistics. The test of normality is a test of the joint hypothesis that skewness and Kurtosis coefficients are 0 and 3 respectively where JB statistic is expected to be 0. Thus, when the value of the JB statistic is significantly different from zero (if the p-value of the statistic in an application is sufficiently low), the null hypothesis that the residuals are normally distributed will be rejected. In the case where the p-value is reasonably high (if the value of the statistic is close to zero), the null hypothesis does not reject the normality assumption.

The coefficients of the stochastic equations of a macroeconometric model are estimated before performing dynamic simulation experiments to determine the dynamic effects of exogenous variables. Some right-side variables are however normally correlated with the disturbance terms of the equations in which they appear. This is because these right- side variables appear in other equations as dependent variables. To this end, the application of the Ordinary Least Square(OLS) technique to estimate the equations of a macro-model gives biased and inconsistent estimates of parameters. To overcome this problem in our model, simulataneous equation estimation techniques were used. The Three Stage Least Square(3SLS) wer used in the estimation.

Historical simulation, which is the conventional approach to evaluation of the forcasting performance of the estimated model. This includes an examination of the graphs of actual and simulated values and the use of summary statistics such as; the Theil's inequality coefficient and its decomposition, root mean squared error(RMSE) and the correlation coefficient between the actual and simulated values of the endogenous variables.

The study explored two methods for model forecasting evaluation which are Root Mean Square Error (RMSE) statistic and Theil's U statistic. The satisfaction of the a priori values of estimated coefficients and plotting and evaluation of the actual against the stimulated values of the endogenous variables. The evaluation performance is computed as follows:Theil inequality:

$$U = \frac{\sqrt{1/T \sum_{t=1}^{T} \left(Y_t^s - Y_t^a\right)^2}}{\sqrt{1/T \sum_{t=1}^{T} (Y_t^s)^2} + \sqrt{1/T \sum_{t=1}^{T} (Y_t^a)^2}}$$

RMSE:

$$RMSE = \sqrt{1/T \sum_{t=1}^{T} \left(\frac{Y_t^s - Y_t^a}{Y_t^a} \right)^2}$$

Where Y_t^s and Y_t^a are the simulated and observed values, respectively, for the endogenous variable at time t, and T is the length of the simulation period. The value of U ranges between 0 and 1. If U=1, it implies that the simulated values are worst and if U=0, this suggests that the simulated values are better forecast performance of the model. This case is reversed in the case of RMSE.

The data are secondary in nature following the objectives of the study. The various data, the measurements and the various sources are presented at the appendix

3 Empirical Results and Analysis

3.1 Prelimnary Results

3.1.1 Descriptive Statistics

Table 3.1 presents the descriptive statistics for the variables employed for empirical analysis in this study. The main dependent variable in this study is human capital development (HCD). This was proxied by six measures based on different indicators of health and education. The first and second measures are indicators of level of education. These are, specifically, education index and secondary school enrolment. The third and fourth measures are indicators of level of health; life expectancy index and life expectancy at birth. The fifth and sixth measures are composite indexes computed using principal component approach. While the fifth measure consists of education and life expectancy index, the sixth measure consists of secondary school enrolment and life expectancy at birth. Education index shows that human capital development has been falling, secondary school enrolment suggests that human capital development is not falling but hardly increase after 2013Q4. Meanwhile, indicators of health (life expectancy and life expectancy at birth) revealed that human capital development increased consistently between 2010 and 2018. Our computed HCD index, which is a composite education and health indices revealed that human capital development is increasing, although a break in trend was noticeable in 2013Q4.

From the descriptive for human capital development indicators (in the first panel), the average education index (EI) between 2010Q1 and 2018Q4 is 0.46 index point. According to the 2018 Human Development Indicators (HDI) by United Nations Development Programme (UNDP)

[1], Nigeria was ranked 158 among 189 countries; some less economically competitive countries such as Gabon, Namibia, Congo, Equatorial Guinea, Kenya, Angola and Cameroon. The average level of secondary school enrolment (SSE) over this period was found to be 46.19 percent; indicating that less than 50 percent of the population is educated up to secondary school level on the average. The highest SSE obtained during this period is 56.21 percent, which was observed in 2013Q3.The standard deviation coefficient for SSE is larger than that of the EI, which indicates that SSE is more volatile than EI as a measure of human capital development. The skewness, kurtosis and the Jarque-Bera statistics however show that both indicators are not normally distributed.

[1] See: http://hdr.undp.org/en/data#

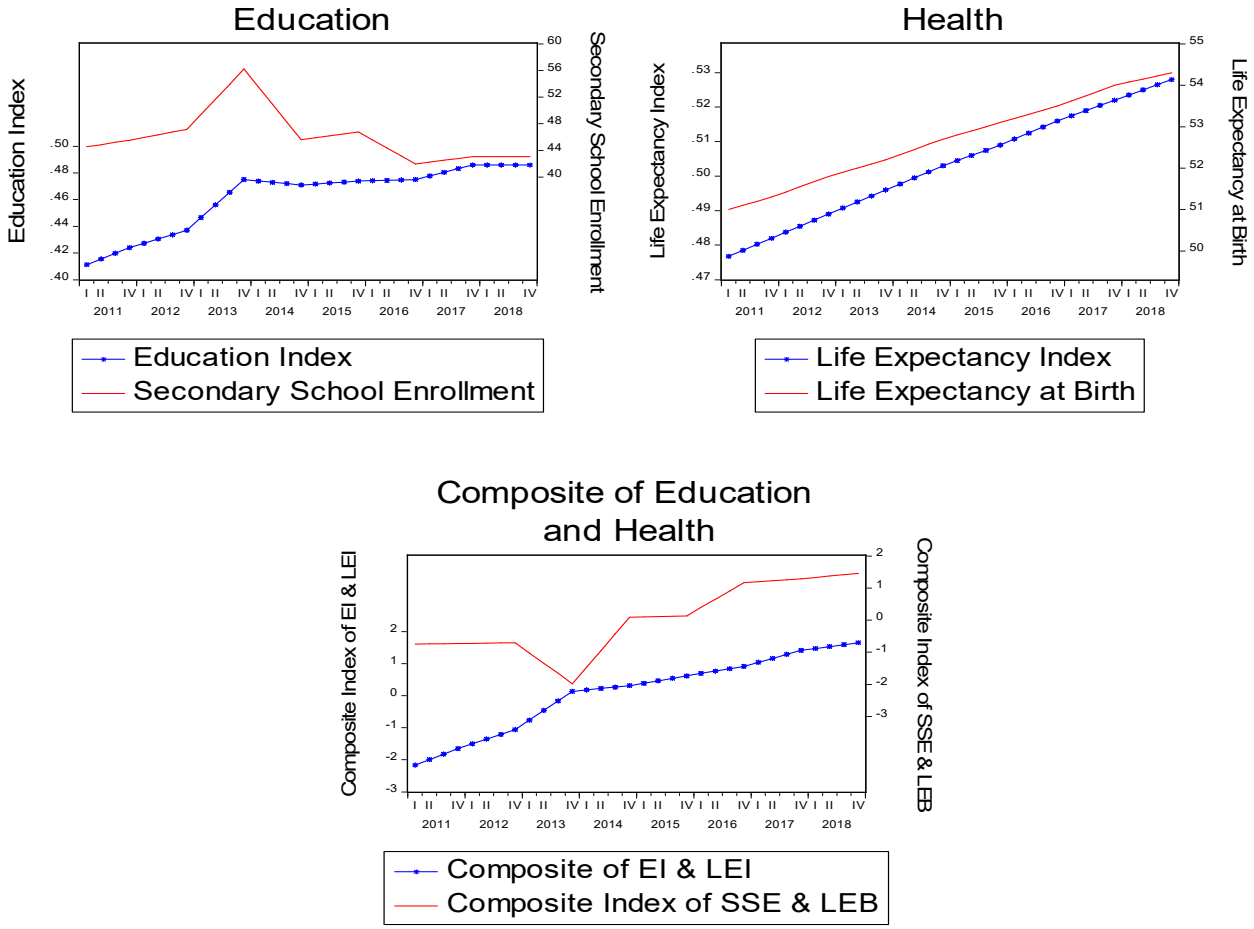

Figure 3.1: Trends in Human Capital Development

Table 3.1: Summary Statistics

	Mean	Std. Dev.	Min.	Max.	Skew.	Kurt.	J.-Bera
Human Capital Development (HCD) Indicators							
Education Index - (1)	0.46	0.03	0.41	0.49	-0.88	2.27	5.00*
Sec. Sch. Enrolment - (2)	46.19	3.59	42.00	56.21	1.22	3.82	9.16**
Life exp. Index - (3)	0.50	0.02	0.48	0.53	-0.07	1.79	2.03
Life exp. at birth - (4)	52.65	1.05	50.90	54.30	-0.05	1.78	2.07
Composite HCD (1 & 3) - (5)	0.03	1.22	-2.33	1.65	-0.52	2.02	2.80
Composite HCD (2 & 4) - (6)	-0.03	1.04	-1.98	1.47	0.05	1.76	2.12
Infrastructure and Tax revenue indicators							
Infrastructure (Compos. Index)	54.111	22.492	18.935	91.815	-0.002	1.776	1.998
VAT Receipt (Billion)	65.964	10.968	47.172	89.501	0.706	2.715	2.766
Control variables and Macroeconomic indicators							
Soc. & Comm. Exp. (Billion)	944.10	125.19	746.577	1287.15	1.30	4.11	10.59***
RGDP growth (%)	3.15	2.681	-2.341	6.892	-0.416	2.206	1.763
CPI (Index)	177.57	52.68	103.58	278.40	0.42	1.92	3.10
Inflation (%)	11.81	2.76	8.00	17.60	0.45	2.44	1.81
Broad Money (₦' Billion)	3,748.00	2,859.00	8,378.80	10,311.00	0.99	2.57	6.67**
Max. Lending rate (%)	26.63	3.25	21.85	31.45	0.17	1.67	3.04
Monet. Pol. Rate (MPR) (%)	12.320	1.744	6.833	14.000	-1.534	5.499	20.88***
Nom. Exch. Rate (₦/US$)	212.468	65.488	153.513	306.713	0.661	1.595	4.960*
Bonny Oil price (US$/Barrel)	82.511	29.605	33.373	121.227	-0.083	1.330	3.756

Source: Reserachers' Computation Using Stata 11.0

Furthermore, Table 3.1 corroborates the observation from Figure 3.1 that the two indicators of health as measure of human capital development follow a similar pattern. This is evident from the skewness, kurtosis and the Jarque-Bera statistics, which are very similar. The standard deviation for life expectancy at birth is however higher than that of the life expectancy index, indicating that life expectancy at birth is more volatile than life expectancy index as a measure of human capital development. Our composite index combines the education and health indicators based on their level of volatility. Thus, the composite health and education based on life expectancy at birth and secondary school enrolment is more volatile as a measure of human capital development compared to the composite health and education based on life expectancy index and education index.

3.2 Model Estimation Results

Tables 3.2 presents the empirical results of of the small scale macroeconometric model of tax revenue and infrastructure development in Nigeria

Table 3.2a: Estimated Results for the Small Scale Macroeconometric model of the Nigerian economy (with education index as proxy for Human Capital Development)

Variables	Coefficient	Std. Error	t-Statistic	Prob.
Real Output Growth				
Intercept	-22.998***	7.627	-3.015	0.003
Real Output Growth (-2)	0.295*	0.170	1.742	0.084
Human Capital Development	63.353***	16.369	3.870	0.000
Real Interest Rate	-0.062	0.137	-0.449	0.654
Real Oil Price	4.298***	0.744	5.775	0.000
Real Exchange Rate	-3.342	3.357	-0.995	0.321
Human Capital Development				
Intercept	0.411	0.281	1.463	0.145
Government Expenditure on Education and Health	-0.125**	0.052	-2.409	0.017
Government Expenditure on Education and Health (-1)	0.126**	0.057	2.215	0.028
Index of Infrastructure	0.001***	0.000	9.008	0.000
Inflation Rate	-0.287*	0.146	-1.973	0.050
Government Expenditure on Education and Health				
Intercept	10.088***	0.308	32.714	0.000
Oil Price	0.099***	0.023	4.258	0.000
Value Added Tax	0.774***	0.062	12.492	0.000
Broad Money				
Intercept	0.046	0.820	0.056	0.955
Real Output Growth	0.011	0.013	0.842	0.401
Maximum Lending Rate	1.996***	0.568	3.513	0.001
Nominal Exchange Rate	0.578**	0.254	2.278	0.024
Inflation Rate				
Intercept	2.435***	0.586	4.155	0.000
Inflation Rate	0.864***	0.043	19.911	0.000
Real Output Growth	-0.291***	0.052	-5.574	0.000
Real Exchange Rate Expectation	4.418	9.715	0.455	0.650
Maximum Lending Rate				
Intercept	0.714***	0.093	7.713	0.000
Monetary Policy Rate	0.096**	0.045	2.133	0.035
Inflation Rate	0.004***	0.001	3.768	0.000
Real Output Growth	0.008***	0.002	5.560	0.000
Nominal Exchange Rate Expectation	0.421***	0.022	19.331	0.000

Source: Researchers' Computaion using Stata 11.0

Note: ***, ** and * indicate 1%, 5% and 10% level of statistical significance

Table 3.2b: Estimated Results for the Small Scale Macroeconometric model of the Nigerian economy (with Secondary School Enrollment as proxy for Human Capital Development)

Variables	Coefficient	Std. Error	t-Statistic	Prob.
Real Output Growth				
Intercept	-4.932	6.717	-0.734	0.464
Real Output Growth (-2)	0.423*	0.231	1.830	0.069
Human Capital Development	0.211*	0.125	1.690	0.093
Real Prime Le nding Rate	-0.248	0.185	-1.337	0.183
Real Oil Price	1.367	0.866	1.578	0.117
Real Exchange Rate	-4.992	4.269	-1.169	0.244
Human Capital Development				
Intercept	-128.923	88.411	-1.458	0.147
Government Expenditure on Education and Health	-24.812	16.364	-1.516	0.132
Government Expenditure on Education and Health (-1)	38.255**	17.926	2.134	0.034
Index of Infrastructure	-0.130***	0.032	-4.032	0.000
Inflation Rate	-70.126	45.847	-1.530	0.128
Government Expenditure on Education and Health				
Intercept	10.088***	0.308	32.714	0.000
Oil Price	0.099***	0.023	4.258	0.000
Value Added Tax	0.774***	0.062	12.492	0.000
Broad Money				
Intercept	0.046	0.820	0.056	0.955
Real Output Growth	0.011	0.013	0.842	0.401
Maximum Lending Rate	1.996***	0.568	3.513	0.001
Nominal Exchange Rate	0.578**	0.254	2.278	0.024
Inflation Rate				
Intercept	2.435***	0.586	4.155	0.000
Inflation Rate	0.864***	0.043	19.911	0.000
Real Output Growth	-0.291***	0.052	-5.574	0.000
Real Exchange Rate Expectation	4.418	9.715	0.455	0.650
Maximum Lending Rate				
Intercept	0.714***	0.093	7.713	0.000
Monetary Policy Rate	0.096**	0.045	2.133	0.035
Inflation Rate	0.004***	0.001	3.768	0.000
Real Output Growth	0.008***	0.002	5.560	0.000
Nominal Exchange Rate Expectation	0.421***	0.022	19.331	0.000

Source: Researcher's Computation using Stata 11.0
Note: ***, ** and * indicate 1%, 5% and 10% level of statistical significance.

Table 3.2a revealed that infrastructure has positive and statistically significant impact on human capital development, which implies that higher infrastructure causes higher human capital development. Also, with positive effect of human capital development on economic growth, it implies that infrastructure is also a good mean to facilitate economic growth as Wang and Lee (2020) also found through human capital development. The result from Table 3.2b, where secondary school enrolment was used as proxy for education, however, counters this argument. This implies that the analysis is sensitive to the choice of proxy for education. In other words, education index is more appropriate as the indicator of education when modeling human capital development.

Furthermore, our results reveal that real oil price have positive and significant effect on Nigeria's economic growth which is in tandem with the findings of Mohammed et al. (2020), implying that higher (lower) real oil price will cause increase (decrease) in Nigeria's economic growth. The LM equation shows that higher lending rate and exchange rate depreciation causes significance increase in real money balances. This indicates that monetary authority could use interest rate and exchange rate policy to influence money supply in the economy. More so, the interest rate equation shows that interest rate in Nigeria is significantly influenced by the Central Bank's monetary policy rate, inflation rate, economic growth and real exchange rate expectation. By implication, the result suggests that an expansionary and contractionary monetary policy by the Central Bank of Nigeria (CBN), through changes in MPR, have significant impact on interest rates in Nigeria.

The effect of tax revenue and infrastructure through human capital development (using health as indicator) on the Nigerian economy is examined as the second objective of this study. With two proxies for health, the results

for the analysis of this objective are presented in Tables 3.3a and 3.3b, with life expectancy index and life expectancy at birth as proxy for health, respectively. Like in the previous sub-section, we compare the results from the two models for robustness purposes. As evident from the two models, human capital development (with health as indicator) has positive and significant effect on economic growth of Nigeria. This is consistent with the results obtained when education was used as indicator of human capital development, and supports the argument of the endogenous growth model. The result also conforms with the findings of Usman & Adeyinka (2019).

As evident from Table 3.3a, value added tax receipts (tax revenue) has positive and statistically significant effect on government's spending on education and health, which is consistent with the result obtained when education was used indicator of human capital development. However, government spending on education and health does not have significant impact on human capital development. This result was also supported by the alternative health-based model. This suggests that health (as indicator of human capital development)does not have a good transmission link between tax revenue and economic growth. In other words, health is not a good channel though which tax revenue can be used to influence economic growth.Relative to the results on education. Education is a better link than health as indicator of human capital development, when modeling the effect of tax revenue on economic growth though human capital development.

Table 3.3a: Estimated Results for the Small Scale Macroeconometric model of the Nigerian economy (with Life Expectancy Index as proxy for Human Capital Development)

	Coefficient	Std. Error	t-Statistic	Prob.
Real Output Growth				
Intercept	-46.570**	18.337	-2.540	0.012
Real Output Growth (-2)	0.196	0.186	1.050	0.295
Human Capital Development	105.407***	36.565	2.883	0.005
Real Prime Lending Rate	0.108	0.168	0.642	0.522
Real Oil Price	4.790***	1.042	4.598	0.000
Real Exchange Rate	-5.045	3.591	-1.405	0.162
Human Capital Development				
Intercept	0.498***	0.031	15.896	0.000
Government Expenditure on Education and Health	0.003	0.006	0.462	0.644
Government Expenditure on Education and Health (-1)	-0.005	0.006	-0.784	0.435
Index of Infrastructure	0.001***	0.000	60.252	0.000
Inflation Rate	-0.006	0.016	-0.398	0.691
Government Expenditure on Education and Health				
Intercept	10.088***	0.308	32.714	0.000
Oil Price	0.099***	0.023	4.258	0.000
Value Added Tax	0.774***	0.062	12.492	0.000
Broad Money				
Intercept	0.046	0.820	0.056	0.955
Real Output Growth	0.011	0.013	0.842	0.401
Maximum Lending Rate	1.996***	0.568	3.513	0.001
Nominal Exchange Rate	0.578**	0.254	2.278	0.024
Inflation Rate				
Intercept	2.435***	0.586	4.155	0.000
Inflation Rate	0.864***	0.043	19.911	0.000
Real Output Growth	-0.291***	0.052	-5.574	0.000
Real Exchange Rate Expectation	4.418	9.715	0.455	0.650
Maximum Lending Rate				
Intercept	0.714***	0.093	7.713	0.000
Monetary Policy Rate	0.096**	0.045	2.133	0.035
Inflation Rate	0.004***	0.001	3.768	0.000
Real Output Growth	0.008***	0.002	5.560	0.000
Nominal Exchange Rate Expectation	0.421***	0.022	19.331	0.000

Source: Computed by the Researcher
Note: ***, ** and * indicate 1%, 5% and 10% level of statistical significance.

Table 3.3b: Estimated Results for the Small Scale Macroeconometric model of the Nigerian economy (with Life Expectance at Birth as proxy for Human Capital Development)

	Coefficient	Std. Error	t-Statistic	Prob.
Real Output Growth				
Intercept	-82.217***	29.291	-2.807	0.006
Real Output Growth (-2)	0.180	0.184	0.979	0.329
Human Capital Development	1.682***	0.557	3.020	0.003
Real Prime Lending Rate	0.133	0.168	0.789	0.431
Real Oil Price	4.942***	1.047	4.720	0.000
Real Exchange Rate	-4.732	3.568	-1.326	0.187
Human Capital Development				
Intercept	52.428***	2.025	25.891	0.000
Government Expenditure on Education and Health	0.367	0.375	0.980	0.329
Government Expenditure on Education and Health (-1)	-0.524	0.411	-1.276	0.204
Index of Infrastructure	0.045***	0.001	61.228	0.000
Inflation Rate	-0.700	1.050	-0.667	0.506
Government Expenditure on Education and Health				
Intercept	10.088***	0.308	32.714	0.000
Oil Price	0.099***	0.023	4.258	0.000
Value Added Tax	0.774***	0.062	12.492	0.000
Broad Money				
Intercept	0.046	0.820	0.056	0.955
Real Output Growth	0.011	0.013	0.842	0.401
Maximum Lending Rate	1.996***	0.568	3.513	0.001
Nominal Exchange Rate	0.578**	0.254	2.278	0.024
Inflation Rate				
Intercept	2.435***	0.586	4.155	0.000
Inflation Rate	0.864***	0.043	19.911	0.000
Real Output Growth	-0.291***	0.052	-5.574	0.000
Real Exchange Rate Expectation	4.418	9.715	0.455	0.650
Maximum Lending Rate				
Intercept	0.714***	0.093	7.713	0.000
Monetary Policy Rate	0.096**	0.045	2.133	0.035
Inflation Rate	0.004***	0.001	3.768	0.000
Real Output Growth	0.008***	0.002	5.560	0.000
Nominal Exchange Rate Expectation	0.421***	0.022	19.331	0.000

Source: Computed by the Researcher

Note: ***, ** and * indicate 1%, 5% and 10% level of statistical significance.

More so, the result in Table 3.3a revealed that infrastructure has positive and statistically significant impact on human capital development. This result is consistent with what is obtained from the alternative model, where life expectancy at birth was used as indicator for health. Apparently, the result implies that higher infrastructure causes higher human capital development. As positive and significant effect of human capital development on economic growth was established consistently under the two health-based models (in Tables 3.3a & 3.3b), it implies that infrastructure is a good mean to facilitate economic growth though human capital development. In other words, higher investment ininfrastructure or higher infrastructural development will increases human capital development, and increase in human capital development will cause increase in economic growth. This result is robust to the choice of proxy for health, as using life expectancy index and life expectancy at birth yield similar result. Education and health could serve as good indicator of human capital development though with infrastructure can influence the Nigerian economy.

In addition, we find consistent results as regards the effect of real oil price on Nigeria's economic growth, which positive and statistically significant. The result of the LM equation that higher lending rate and exchange rate depreciation causes significance increase in real money balances was also confirmed. More so, the interest rate equation shows that interest rate can be influenced by the Central Bank's monetary policy rate, inflation rate, economic growth and real exchange rate expectation, which is consistent with our findings when education is used as indicator for human capital development.

We combine education and health variables to form a more informative indicator of human capital development. The first composite HCD index for education and health was based on less volatile series, that is,

education index and life expectancy index, while the second composite HCD index was based on relatively more volatile series, that is, secondary school enrolment and life expectancy at birth. Models with these two indicators of human capital development are presented in Tables 3.4a and 3.4b. The result from the small scale macroeconometric model of Nigeria using composite HCD index for education and health indexes (in Table 3.4a) reveals that human capital development has positive and statistically significant effect on economic growth in Nigeria. This is consistent with the earlier results and the postulation of the endogenous growth model. The result is however sensitive to the choice of human capital development proxy, as the alternative model (consisting of composite HCD index with secondary school enrolment and life expectancy at birth) shows contrary result. Meanwhile, the two models (in Table 3.4a & 3.4b) show evidence of positive and significant relationship between (Value Added) tax revenue and government expenditure on education and health. This implies that increase in tax revenue causes increase in government spending on social and community services including education and health.

Meanwhile, the models (in Table 3.4a & 3.4b) show negative relationship between government expenditure on education and health and human capital development. This is suggesting that increase in government expenditure on education and health will cause reduction in human capital development. This contradicts the theoretical expectation and the relationship between government spending on socialand community services and human capital development. The problem may be associated with the recent increase in the private sector expenditure on education and health, while government spending, particularly on capital social expenditure, has remained fairly constant. Thus, subsequent studies in this area may need to consider the effect of private sector spending on human capital development.

More so, this result indicates that human capital development channel does not constitute a good transmission link between tax revenue and the Nigerian economy. The problem may also be as a result of corruption in the government-led health sector, which is not making government spending on the health to translate into increase in human capital development with health as indicator. While education index exhibits significant positive impact on human capital development, the negative impact exhibited by the composite HCD index (for education index and life expectancy index) may be influenced by the performance of health indicator. Thus, we may conclude thataggregation of education and health as indicator of HCD may yield inconsistent results. This conclusion isconsistent with evidence from the alternative model with composite HCD index based on secondary school enrolment for education and life expectancy at birth for health. This is apparent as secondary school enrolment for education has positive and significant impact on human capital development, while life expectancy at birth for health has negative insignificant effect.

Table 3.4a: Estimated Results for the Small Scale Macroeconometric model of the Nigerian economy (with Composite of Education and Life Expectancy Index as proxy for Human Capital Development)

Variables	Coefficient	Std. Error	t-Statistic	Prob.
Real Output Growth				
Intercept	6.243***	1.230	5.074	0.000
Real Output Growth (-2)	0.247	0.174	1.424	0.157
Human Capital Development	1.444***	0.402	3.594	0.000
Real Prime Lending Rate	0.032	0.146	0.220	0.826
Real Oil Price	4.730***	0.871	5.433	0.000
Real Exchange Rate	-3.794	3.426	-1.107	0.270
Human Capital Development				
Intercept	-1.358	7.401	-0.184	0.855
Government Expenditure on Education and Health	-2.944**	1.370	-2.149	0.033
Government Expenditure on Education and Health (-1)	2.876*	1.501	1.917	0.057
Index of Infrastructure	0.049***	0.003	18.210	0.000
Inflation Rate	-7.243*	3.838	-1.887	0.061
Government Expenditure on Education and Health				
Intercept	10.088***	0.308	32.714	0.000
Oil Price	0.099***	0.023	4.258	0.000
Value Added Tax	0.774***	0.062	12.492	0.000
Broad Money				
Intercept	0.046	0.820	0.056	0.955
Real Output Growth	0.011	0.013	0.842	0.401
Maximum Lending Rate	1.996***	0.568	3.513	0.001
Nominal Exchange Rate	0.578**	0.254	2.278	0.024

Variables	Coefficient	Std. Error	t-Statistic	Prob.
Inflation Rate				
Intercept	2.435***	0.586	4.155	0.000
Inflation Rate	0.864***	0.043	19.911	0.000
Real Output Growth	-0.291***	0.052	-5.574	0.000
Real Exchange Rate Expectation	4.418	9.715	0.455	0.650
Maximum Lending Rate				
Intercept	0.714***	0.093	7.713	0.000
Monetary Policy Rate	0.096**	0.045	2.133	0.035
Inflation Rate	0.004***	0.001	3.768	0.000
Real Output Growth	0.008***	0.002	5.560	0.000
Nominal Exchange Rate Expectation	0.421***	0.022	19.331	0.000

Source: Computed by the Researcher
Note: ***, ** and * indicate 1%, 5% and 10% level of statistical significance.

Table 3.4b: Estimated Results for the Small Scale Macroeconometric model of the Nigerian economy (with Composite of Secondary School Enrollment and Life Expectancy at Birth as proxy for Human Capital Development)

Variables	Coefficient	Std. Error	t-Statistic	Prob.
Real Output Growth				
Intercept	6.342***	1.734	3.657	0.000
Real Output Growth (-2)	0.211	0.246	0.858	0.393
Human Capital Development	0.163	0.717	0.227	0.820
Real Prime Lending Rate	-0.074	0.224	-0.329	0.743
Real Oil Price	2.602*	1.393	1.868	0.064
Real Exchange Rate	-8.831**	4.053	-2.179	0.031
Human Capital Development				
Intercept	29.180*	14.955	1.951	0.053
Government Expenditure on Education and Health	4.377	2.768	1.581	0.116
Government Expenditure on Education and Health (-1)	-6.723**	3.032	-2.217	0.028
Index of Infrastructure	0.049***	0.005	8.931	0.000
Inflation Rate	11.335	7.755	1.462	0.146
Government Expenditure on Education and Health				
Intercept	10.088***	0.308	32.714	0.000
Oil Price	0.099***	0.023	4.258	0.000
Value Added Tax	0.774***	0.062	12.492	0.000
Broad Money				
Intercept	0.046	0.820	0.056	0.955
Real Output Growth	0.011	0.013	0.842	0.401
Maximum Lending Rate	1.996***	0.568	3.513	0.001
Nominal Exchange Rate	0.578**	0.254	2.278	0.024
Inflation Rate				
Intercept	2.435***	0.586	4.155	0.000
Inflation Rate	0.864***	0.043	19.911	0.000
Real Output Growth	-0.291***	0.052	-5.574	0.000
Real Exchange Rate Expectation	4.418	9.715	0.455	0.650
Maximum Lending Rate				
Intercept	0.714***	0.093	7.713	0.000
Monetary Policy Rate	0.096**	0.045	2.133	0.035
Inflation Rate	0.004***	0.001	3.768	0.000
Real Output Growth	0.008***	0.002	5.560	0.000
Nominal Exchange Rate Expectation	0.421***	0.022	19.331	0.000

Source: Researchers' Computation using Stata 11.0
Note: ***, ** and * indicate 1%, 5% and 10% level of statistical significance.

Furthermore, we examine the effect of infrastructure through human capital development on the Nigerian

economy, while using the two composite indexes as proxy for human capital development. From the Tables 3.4a and 3.4b, infrastructure was found to have positive and statistically significant effect on human capital development, while human capital development has positive and statistically significant effect on economic growth. This suggests that while value added tax receipt does not serve a good link through human capital development to economic growth, infrastructure does. In other words, infrastructural development has the potential to cause increase in economic growth as it increased human capital development. This suggests that real effect (infrastructural development) has much impact than nominal effect (increase in government spending).

4 Discussion of Findings

This section deals with the analysis of the results for the specific objectives of this study. Specifically, it presents the analyses of the results on (i) the effect of tax revenue and infrastructure through human capital development (using education as indicator) on the Nigerian economy; (ii) the effect of tax revenue and infrastructure through human capital development (using health as indicator) on the Nigerian economy; and (iii) the effect of tax revenue and infrastructure through human capital development (using composite of education and health as indicator) on the Nigerian economy.

The effect of tax revenue and infrastructure through human capital development (using education as indicator) on the Nigerian economy is examined as the first objective of this study. With two proxies for education, the results for the analysis of this objective are presented in the preceeding tables, with education index and secondary school enrolment as proxy for education, respectively. Even, while the model performance evaluation result suggests that model with education index performs better; we compare the results from the two models for robustness purposes. As evident from the two models, human capital development has positive and significant effect on economic growth of Nigeria. Our result is consistent with the findings of Johnson (2011), Faria et al. (2016) and Usman & Adeyinka (2019).

This supports the argument of the endogenous growth model, and it is new evidence in the analysis of economic growth in Nigeria using macroeconometric model, as human capital development was not considered as a determinant of economic growth in earlier macroeconometric models of the Nigerian economy. As evident from the table presented, value added tax receipts (Tax revenue) has positive and statistically significant effect on government's spending on education and health. This implies that an increase in tax revenue causes increase in government's spending on education and health in Nigeria. The result also revealed that government's spending on education and health has positive (sum of the lag coefficients) and statistically significant effect on human capital development in line with the submission of Usman & Adeyinka (2019). This relationship is also confirmed by the results from the alternative model as presented above. This suggests that increase in government's spending on education and health will cause increase in human capital development. And, as it has been established earlier, an increase in human capital development causes higher economic growth. This suggests that education serves as a good transmission link between tax revenue and economic growth. In other words, education is a good channel though which tax revenue can be used to influence economic growth. More so, the result revealed that infrastructure has positive and statistically significant impact on human capital development. This result is consistent with what is obtained from the alternative model, where life expectancy at birth was used as indicator for health. Apparently, the result implies that higher infrastructure causes higher human capital development. As positive and significant effect of human capital development on economic growth was established consistently under the two health-based models, it implies that infrastructure is a good mean to facilitate economic growth though human capital development. In other words, higher investment ininfrastructure or higher infrastructural development will increases human capital development, and increase in human capital development will cause increase in economic growth. This result is robust to the choice of proxy for health, as using life expectancy index and life expectancy at birth yield similar result. Relative to the results obtained for education, education and health could serve as good indicator of human capital development though with infrastructure can influence the Nigerian economy.

In addition, we find consistent results as regards the effect of real oil price on Nigeria's economic growth, which positive and statistically significant. The result of the LM equation that higher lending rate and exchange rate depreciation causes significance increase in real money balances was also confirmed. More so, the interest rate equation shows that interest rate can be influenced by the Central Bank's monetary policy rate, inflation rate, economic growth and real exchange rate expectation, which is consistent with our findings when education is used as indicator for human capital development.

We combine education and health variables to form a more informative indicator of human capital development. The first composite HCD index for education and health was based on less volatile series, that is, education index and life expectancy index, while the second composite HCD index was based on relatively more volatile series, that is, secondary school enrolment and life expectancy at birth. Models with these two indicators of human capital development. The result from the small scale macroeconometric model of Nigeria using composite HCD index for education and health indexes reveals that human capital development has positive and

statistically significant effect on economic growth in Nigeria. This is consistent with the earlier results and the postulation of the endogenous growth model. The result is however sensitive to the choice of human capital development proxy, as the alternative model (consisting of composite HCD index with secondary school enrolment and life expectancy at birth) shows contrary result. Meanwhile, the two models show evidence of positive and significant relationship between (value added) tax revenue and government expenditure on education and health. This implies that increase in tax revenue causes increase in government spending on social and community services including education and health.

Meanwhile, the models show negative relationship between government expenditure on education and health and human capital development. This is suggesting that increase in government expenditure on education and health will cause reduction in human capital development. This contradicts the theoretical expectation and the relationship between government spending on socialand community services and human capital development. The problem may be associated with the recent increase in the private sector expenditure on education and health, while government spending, particularly on capital social expenditure, has remained fairly constant. Thus, subsequent studies in this area may need to consider the effect of private sector spending on human capital development.

More so, this result indicates that human capital development channel does not constitute a good transmission link between tax revenue and the Nigerian economy. The problem may also be as a result of corruption in the government-led health sector, which is not making government spending on the health to translate into increase in human capital development with health as indicator. While education index exhibits significant positive impact on human capital development, the negative impact exhibited by the composite HCD index (for education index and life expectancy index) may be influenced by the performance of health indicator. Thus, we may conclude thataggregation of education and health as indicator of HCD may yield inconsistent results. This conclusion isconsistent with evidence from the alternative model with composite HCD index based on secondary school enrolment for education and life expectancy at birth for health. This is apparent as secondary school enrolment for education has positive and significant impact on human capital development, while life expectancy at birth for health has negative insignificant effect. Specifically, human capital development (using education index)was found to outperform human capital development (using secondary school enrolment) in modeling the effect of tax revenue and infrastructure, through human capital development (with education as indicator), on the Nigeria economy. The forecast performance of human capital development (using life expectancy index) is not significantly different from that of human capital development (using life expectancy at birth) in modeling the effect of tax revenue and infrastructure, through human capital development (with health as indicator), on the Nigeria economy.Meanwhile, human capital development (using composite of education and life expectancy indexes) was found to outperform human capital development (using secondary school enrolment and life expectancyat birth) in modeling the effect of tax revenue and infrastructure, through human capital development (with education as indicator), on the Nigerian economy. Temporary 10 percent increase in value added tax revenue has higher effect on human capital development, real GDP growth, broad money supply and the maximum lending rate than the permanent 10 percent increase in value added tax revenue. Contrarily, permanent increase in value added tax revenue has higher effect on government spending on social and community services (including health and education) and inflation rate than the temporary 10 percent increase in value added tax revenue. Thus, to increase human capital development in Nigeria, temporary tax revenue shock is sufficient. This result appears to acknowledge the growth reducing effect of government tax by penalizing permanent increase in value added tax revenue with lower human capital development and real GDP growth enhancing capacity. The larger effect of permanent 10 percent increase value added tax revenue on government expenditure on social and community services (including health and education) indicates a direct relationship between government revenue and government expenditure. Moreover, a temporary 10 percent increase in the level of infrastructural development has higher effect only on inflation rate compared to the permanent 10 percent increase. Both temporary and permanent 10 percent increase in the level of infrastructural development has no significant effect on government spending on education and health. Whereas, a permanent 10 percent increase in the level of infrastructural development has higher effect human capital development, real GDP growth, real money balances and nominal interest rate. Thus, to increase human capital development in Nigeria, permanent infrastructural development in required. Summarily, the simulation results suggest that real growth (occasioned by increase in the level of infrastructural development) has stronger effect on human capital development than nominal growth (occasioned by increase in government tax revenue). The weak effect of tax revenue in boosting human capital development may not unconnected with corruption and growth constraining effect of taxes.

5 Policy Implication of Findings

The foregoing analysis has thus revealed the effect oftax revenue and infrastructure on human capital development in Nigeria. From the results, the following were observed: First, value added tax has positive and statiscally significan effect on government expenditure on education and health. This implies that an increase in tax revenue causes increase in government's spending on education and health in Nigeria. Second, health is not a good channel

through which tax revenue can be used to influence economic growth, relative to education. Education impacts more on human capital in Nigeria than health. Three, higher investment in infrastructure or higher infrastructure will increase economic growth and human capital development. Four, positive and significant relationship exist between value added tax revenue and government expenditureon education and health. This implies that increase in tax revenue causes increase in government spending on social and community services including health and education. Five, to increase human capital development in Nigeria, temporary tax revenue shock is sufficient. This implies the growth reducing effect of government tax via permanent increase in value added tax revenue. Six, to increase human capital development in Nigeria, permanent infrastructure development and investment is required.

6 Conclusion and Policy Recommendations

6.1 Conclusion

The results of this study are mostly in tandem with the postulation of the endogenous growth model that human capital development induces economic growth. Specifically, the study concludes on the following:

i. Education is a good channel through which tax revenue and infrastructure can be used to influence the Nigerian economy.
ii. Education is a better link than health as indicator of human capital development, when modeling the effect of tax revenue on economic growth though human capital development.
iii. Aggregation of education and health as indicator of human capital development may yield inconsistent results.
iv. Tax revenue (value added tax receipt) does not serve a good link through human capital development to economic growth, but infrastructure does.
v. Real effect (infrastructural development) has much impact than nominal effect (increase in tax revenue and government spending on health and education) in promoting human capital development.
vi. To increase human capital development in Nigeria, temporary increase in tax revenue is sufficient.
vii. To increase human capital development in Nigeria, permanent infrastructural development is required.

6.2 Policy Recommendations

In line with the findings of this study enumerated in the preceding section, the study recommends that:i) The government should increase its investment on critical infrastructure to further bolster human capital development and by extension accelerate the rate of economic growth; ii) The government should diversify its revenue base and expend more on health and education in addition to building a strong institutional framework to ensure the efficacy of government spending on both health and education.

7 Contributions to Knowledge

The contributions of the study to existing knowledge are as follows:

i)Among the first empirical studies that examined the effect of tax revenue and infrastructure through human capital development using education index. An approach that supports the endogenous growth model.

ii) Among the first empirical studies that examined the effect of tax revenue and infrastructure through human capital development using life expectancy index and life expectancy at birth as proxy for health.

iii) Quite novel, as the study examined the effect of tax revenue and infrastructure through human capital development using composite of education and health as indicators of human capital development, first of its approach in the literature.

iv) Most importantly, its forcasting power using the root mean square error, mean absolute error, mean absolute prediction error and Theil inequality is contributory to the literature. As such, the effect of temporary and permanent increase in tax revenue through human capital development were examined as well as the effect of temporay and permanent increase in infrastructure through human capital development were investigated using deviations of the variables from the baseline scenario.A value addition to the literature.

8 Suggestion for Future Research

The paper focused on the effect of a component of government revenue, namely, tax revenue and infrastructure on economic growth through their impact on human capital development neglecting the role of the private sector on this nexus. With the expanding contribution of the private sector to the education and health sectors in Nigeria, accounting for its role in macroeconometric analysis of the effect of human capital development on economic growth in Nigeria may give a better and more holistic result. This is an area that can be explored in future research. Also, as pointed out earlier in our analysis, the unexpected negative effect of increased tax revenue on economic growth through its impact on life expectancy and life expectancy index as indicators of human capital development suggests a weak institutional support to guarantee the effectiveness of government health spending on improving health performance and human capital development to accelerate economic growth. This hypothesis has not been

tested in our analysis and investigating it in future research will be worthwhile.

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Data and Sources

Variables	Type	Proxy	Period covered	Unit of measurement	Source
Education index	Endo	Human Capital (Education)	2010 – 2018	Year	UNDP
Life expectancy index	Endo	Human Capital (Health)	2010 – 2018	index	UNDP
Access to clean fuels and technologies for cooking (% of population)	Endo	Human Development (Health)	2010-2016	% of population	WDI
People using at least basic drinking water services (% of population)	Endo	Human Development (Health)	2010- 2017	% of population	WDI
People using at least basic sanitation services (% of population)	Endo	Human Development (Health)	2010 – 2017	% of population	WDI
People using safely managed drinking water services (% of population)	Endo	Human Development (Health)	2010 – 2017	% of population	WDI
People using safely managed sanitation services (% of population)	Endo	Human Development (Health)	2010 – 2017	% of population	WDI
Access to electricity (% of population)	Exo	Infrastructure	2010 – 2018	% of population	WDI
Individuals using the Internet (% of population)	Exo	Infrastructure	2010 – 2018	% of population	WDI
Mobile cellular subscriptions (per 100 people)	Exo	Infrastructure	2010 – 2018	(per 100 people)	WDI
Inflation, consumer prices (annual %)	Exo	Macro	2010 – 2019	Percentage (%)	CBN Statistical Bulletin
Prime Lending rate (%)	Exo	Macro	2010 – 2019	Percentage (%)	CBN Statistical Bulletin
Real GDP (GDP at constant price)	Endo	Macro	2010Q1 – 2019Q1	N' Million	CBN Statistical Bulletin
Oil export revenue	Exo	Macro	2008M1 – 2019M3	N' Million	CBN Statistical Bulletin

Variables	Type	Proxy	Period covered	Unit of measurement	Source
VAT (Gross)	Exo	Macro	2010 – 2019	N' Billion	CBN Statistical Bulletin
Net VAT Receipts	Exo	Macro	2010 – 2019	N' Billion	CBN Statistical Bulletin
Oil Price (Bonny Light)	Exo	Macro	2010M1 – 2019M3	US dollar/barrel	CBN Statistical Bulletin
Exchange Rate	Exo	Macro	2010M1 – 2019M3	Naira/dollar	CBN Statistical Bulletin
Broad Money (M2)	Endo	Macro	2010M1 – 2019M3	Million Naira	CBN Statistical Bulletin
Monetary Policy rate	Exo	Macro	2010M1 – 2019M3	Percentage (%)	CBN Statistical Bulletin
Government Revenue	Endo	Macro	2010M1 – 2019M3	Million Naira	CBN Statistical Bulletin

Source: Reserachers' Compilation(2023)

Variable Descriptions

S/N	Variable Name	Acronym	Unit of measurement	Role in the model	Source
1.	Broad Money	M2	Billion Naira	Endo	CBN
2.	Consumer Price Index	CPI	Index (Basis points)	Exo	CBN
3.	Human capital development	HCD1a	Education Index (EI)	Endo	UNDP
		HCD1b	Sec. Sch. Enrolment (SSE)		WDI
		HCD2a	Life expectancy Index (LEI)		UNDP
		HCD2b	Life expectancy at birth (LEB)		WDI
		HCD3a	Composite (EI & LEI)		Computed
		HCD3b	Composite (SSE & LEB)		Computed
4.	Inflation	INF	Percentage (%)	Endo	CBN
5.	Infrastructure	INFRAST	Index(Basis points)	Exo	Computed
6.	Interest rate	MLR	Percentage (%)	Endo	CBN
7.	Monetary Policy Rate	MPR	Percentage (%)	Exo	CBN
8.	Nominal exchange rate	NER	Naira/US$	Exo	CBN
9.	Nominal exchange rate expectation	NERE	Naira/US$	Exo	CBN
10.	Bonny Light Crude oil price	OILP	US$/Barrel	Exo	CBN
11.	Real GDP growth	RGDP_GR	Percentage (%)	Endo	CBN
12.	Recurrent and Capital Social and Community Services Expenditure	SCST	Billion Naira	Endo	CBN
13.	Net Value Added Tax Receipt	VAT	Billion Naira	Exo	CBN

Source: Researcher's Compilation(2023)