Prevalence of HIV/AIDS as a Health Indicator on Productivity in Nigeria

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ABSTRACT

This paper analyzed empirically the impact of public health expenditure on productivity in Nigeria. The study employs econometric techniques to verify the time series properties and the relationship among HIV/AIDS prevalence rate, life expectancy rate and productivity in Nigeria. The findings revealed that maternal mortality rate and HIV/AIDS prevalence rate have a negative significant impact on productivity in the long run. Again, the life expectancy rate was found to have a positive significant effect on productivity. In the short run, the multiple regression results showed that public health expenditure has a positive insignificant impact on productivity in Nigeria. Also, the findings revealed that the maternal mortality rate has a negative insignificant effect on productivity in the short run. The study consequently proposes that more research be conducted to determine the root reason of the negative link between public health spending and productivity in Nigeria. To boost Nigerian productivity, the government should enhance public health spending and strengthen maternity healthcare facilities.

Keywords: *Health, life expectancy, HIV/AIDS, Productivity*

Background to the Study

Health gains have a lot of economic rewards with prevalent economic growth and this help to prevent poverty which is caused by ill health (World Health Organization, 1999). An average percentage of economic growth differentials between advanced economies and emerging economies is attributable to morbidity and low life expectancy. The recommendation by the United Nation (U.N) to a country is that an average of 8 to 10 percent of its GDP should be the average expenditure on health. Developed countries devote a significant proportion of their budget to health care because they are persuaded that their resident's health can be a propeller

for productivity. Therefore, no amount spent on health by a nation is considered extravagant because a healthy nation is a wealthy nation.

A quick look generally at the Human Development Index (HDI) of Nigeria shows a poor image of its worth of human capital. In 2012 Nigeria ranked 153rd position among 187 countries with human development index value of 0.47. Although there was a step up on the Human Development Index ranking compared to the previous year when it was ranked at 155. Even with this, Nigeria cannot make the first 10 countries with the highest human development index value in Africa following Ghana, Kenya and Cameroon (UNDP, 2013). In 2016, it ranked 152nd position among 188 countries with an HDI value of 0.527. Yaqub (2010), observed that in 2000, World Health Organisation (WHO) ranked Nigeria's overall health performance 187th among the 191 member states, while in 2016 our position remains unchanged suggesting an inertia in our health system. The average Life expectancy in Nigeria is currently 52.8 years which is below Sub-Saharan Africa, and other developing countries (World Bank 2016). To this end, there is a need for critical re- appraisal of HIV/AIDS prevalence as a health indicator and productivity in Nigeria.

Statement of Problem

In 2001, all African leaders declared to commit a minimum of 15% of their total spending to improve their respective health sectors. Despite the 15% declaration, Nigeria has hardly committed more than 4% of her budget on average to the advancement of the health sector. This is a pathetic situation in the sense that countries like Zambia, Kenya and Ghana which are relatively poorer than Nigeria allocate 6.1%, 7% and 7% respectively of their incomes to health (Lucas, 2000). This suggests that successive governments in Nigeria have neglected the people's health. Inadequate healthcare facilities, poor sanitation and unavailability of clean water amongst others that characterize the Nigerian economy today attest to this.

Moreover, in Nigeria, an estimated average of over fifty million naira was expended in the health sector annually in a couple of years back (Federal Ministry of Health, 2005). However, the health status of Nigerians is consistently ranked low amongst other nations of the world. For example, in 1980, Nigeria's life expectancy rate, which is one of the most common indicators of health conditions in a country, was 45.5 years (World Bank, 2003). This was among the smallest in the world. In 2003, Nigeria's life expectancy rate was estimated to be 47.9 years and it fell to 47 years in 2011. Also, the National Bureau of Statistics (NBS) reports show that health indicators for infant mortality, maternal mortality and life expectancy over the past decades in Nigeria have worsened. One million Nigerian children die annually before the age of five and the main causes of death are attributed to neonatal causes, communicable diseases, malaria, and pneumonia (NBS, 2006).

Research Questions

The research work will examine the following questions:

i. What is the effect of the HIV/AIDS prevalence rate on productivity in Nigeria?
ii. What is the effect of the life expectancy rate on productivity in Nigeria?

Objectives of the Study

The broad objective of the study is to examine the impact of public health expenditure on labour productivity in Nigeria. The specific objectives of this work include to:

i. Determine the effect of HIV/AIDS prevalence rate on productivity in Nigeria.

ii. Evaluate the effect of the life expectancy rate on productivity in Nigeria.

Productivity

One of the universal definitions of productivity is that it is a quantitative relationship between output and input (Iyaniwura & Osoba, 1983; Antle & Capalbo, 1988). According to Prokopenko (1987), despite the category of trade and industry, production and economic system, this explanation is generally acknowledged because it suggests what productivity is, and it remains the same as long as the basic idea is the connection linking the quantity and quality of goods and services created and the number of resources used during their production.

Olaoye (1985) observed that the concept of productivity can be viewed from two dimensions: namely total factor productivity (TFP) and partial productivity. Total Factor Productivity is defined as the correlation between output created and the combination of inputs: which implies the total of basic resources which are capital, labour, and natural resources. Total Factor Productivity is also known as Multi-Factor Productivity (Eatwell & Newman, 1991).

Some of the misconceptions about productivity are as follows:

Productivity can be mistaken for a raise in output; this is because people mistake productivity for production. (Sumanth l984). It is possible for output to increase and yet productivity is not increasing, this can be due to an increase in input cost. To manage this misconception, it is important to take note of the movement of input cost by linking output increase to increase in price and inflation. To differentiate between productivity and increase in output the expression 'productivity growth' is used to explain the level of productivity growth. Another misconception about productivity is the idea that productivity is only labour efficient, although labour productivity data are very important in empirical analysis and in the making of policies. Even with the above statement, there is more to productivity than labour productivity, there is a need to consider other inputs involved in the process of production.

The third misreading about productivity is the belief that always finding a way to reduce cost will increase productivity. If cost is cut down inappropriately it can lead to a setback in productivity. Productivity does not only apply to production it is also very relevant to other aspects of the economy like services and information technology. Furthermore, another misunderstanding of productivity is when it is taken for profitability. The concepts are different because even when productivity is effective but the demand for goods and services is low, profitability will be poor. Again, effectiveness or efficiency can also be mistaken for productivity. Scott (1983) observed that efficiency and effectiveness are measures of performance likewise productivity is also a measure for performance. Efficiency denotes producing durable goods within a short period while effectiveness refers to the result of production.

2.2.2 Public Expenditure on Health

Healthcare expenditures are defined based on their prime purpose of health improvement, irrespective of the main function or activity of the body which provides or pays for the related health services. World Bank (2016) describes health expenditure as the provision of preventive and curative health services, nutrition activities, family planning services and health emergency aids. However, it does not include the provision of sanitation and water. According to World Health Organisation (2015) healthcare spending can be defined as the amount of ultimate consumption of health goods and services as well as capital investment expenditure in healthcare infrastructure. Thus, consumption of healthcare involves investment spending in

health goods and services by individuals, provision of personnel and infrastructure for healthcare and improvement in healthcare infrastructure by the government. Thus, the government makes provisions for healthcare personnel and facilities while the individuals make use of these healthcare facilities to enhance their health status.

Public expenditure on health involves overheads on health care services which are solely financed by public funds. Public funds are finances provided by the state, local government schemes as well as community security schemes. Public capital formation on health consists of investment in health care facilities that are financed publicly as well as capital transfers to the private sector for the construction of hospitals and healthcare equipment. World Health Organization (WHO, 2010), states that the following comprises public health expenditure recurrent and capital expenditure from government budgets, external borrowings and grants which include donations from non-government organizations and international agencies as well as compulsory health insurance finances.

2.3 Theoretical Review

2.3.1 Endogenous Growth Theory

The endogenous growth model was developed by Romer (1990) and Lucas (1988) to explain the income divergence between poor and rich nations. As noted by Barro (1990), this model did not assume that physical capital accumulation was the dominant factor in determining growth. Instead, they rejected the neoclassical position of diminishing returns to capital and the prediction of the steady-state income divergence. Practically, the endogenous growth model did not only predict that higher levels of investment in physical capital and labour can sustain higher levels of growth, but also investment in knowledge and human capital, research, and development and also in public infrastructure. Human capital according to this school of thought is considered in the form of skilled labour, which could be augmented by education, training, and investment in health.

With the extended concept of capital, education and health, the endogenous growth model hypothesizes constraints to the factors that can be accumulated, while the long-run growth is determined by parameters of the model and not by technological innovation or population growth. From this viewpoint, the model supports that any temporary change in the economic environment can generate permanent effects which opens up the possibility of fiscal policy to have a long-run effect on growth. In other words, in the endogenous growth model, labour cannot be regarded as a single input but decomposed into skilled and unskilled labour. By breaking the linked between economic growth, physical capital accumulation and diminishing returns, the endogenous growth model has been able to account for the income divergence between the rich and the poor nations. To this extent, Romer (1990) emphasized that economic growth depends on the stock of human capital, which in turn is determined by growth. The human capital stock is endogenized and so, its effects on growth are more dynamic than thought by the neoclassical school.

Since the endogenous growth model holds human capital as the most influential factor of production, it suggests that human capital can be obtained through education, training, and health investments. They, therefore, advocated that government policies are immensely important in affecting the rate of accumulation through research and development as well as appropriate investment in health and education to ensure an abundant supply of high-quality human capital.

2.2.3 Keynesian Theory of Public Expenditure

The Keynesian school of thought is of the opinion that public expenditure contributes positively to the growth of an economy. Consequently, a rise in government spending will result in an increase in investment, profits and employment via the multiplier effect on aggregate demand. Hence, government spending influences the aggregate demand which aggravates a rise in output based on the expenditure multiplier. Therefore, Keynes's postulations are that:

i. The expansion of the functions of government activities brings about an increase in government spending on its regulatory and administrative activities in the economy.
ii. The expansion of the industrialized society will heighten political pressure for social development and engineer the need for social consideration allowances on the conduct of the industry.

The increase in government spending will be greater than the proportionate rise in national income and hence, the size of the public sector will expand relatively.

2.4 Empirical review

Some research work and past studies have shown the correlation between public health expenditure and economic productivity. Some of the work reviewed show that there is a positive significance between public health expenditure and productivity while some other studies showed that there is a positive insignificance relationship between health expenditure and economic growth. Gallup et al (1998) examine the effect of health on economic growth using the life expectancy rate to determine in general the health of the population. They observed a positive significant relationship between health and economic growth. They recommended that good health would increase productivity. Similarly, Lustig (2006) in his research on the relationship between health and economic growth in Mexico, used the variables life expectancy, infant mortality rate, maternal mortality rate and under-five mortality rate as health indicators. The annual series data used was from 1970 to 1995. He observed that in the long run, one-third of economic growth is due to good health.

In the same vein, Philips (2005) did a study with several countries over 50 years on the impact of health on economic growth. Using life expectancy and infant mortality rate as health indicators, he observed that there is an increase in life expectancy and a decrease in infant mortality rate in most countries expects Sub-Saharan Africa in the 1990s. He also noted that good health can increase economic productivity because healthy people are more productive, particularly in countries where corruption is not an issue. On the other hand, poor health can hinder economic growth because it can affect labour negatively. As well, in a study done in India, World Bank (2004) evaluated the effect of Gross Domestic Product GDP and Health Expenditure on Infant Mortality rate. They used state rank data over the period 1980 to 1999. The research showed that both per capital public expenditure on health and per capital GDP is negatively significant to infant mortality rate, although the outcome was observed not to be generally accepted because of the alternative specification of the model.

Maduka et al (2016) observed that government health spending, health outcomes, and the growth of the economy in Nigeria follow a causality approach and examined the relationship which exists among government health expenditure, health outcomes, and the growth of the economy in Nigeria. The period considered for this research is between 1970 and 2013. Toda and Yamamoto (1995) used the modified WALD statistic (χ2distribution) test for causality

while ADF and KPSS were used for the unit root test. The Johansen technique was used to carry out the cointegration test. The outcome of the test showed that there is a long-run relationship among the variables. From the causality test, they observed that public health spending has an indirect relationship with economic growth, but this is through health outcomes which are life expectancy and mortality rate. From the study, it was suggested that government should always look out for health outcomes that will help increase economic growth through health care spending.

Ilori and Ajiboye (2015) examined the relationship between healthcare spending and economic growth in Nigeria using the Error Correction Mechanism, Ordinary Least Square techniques and the Auto-regressive Distributed Lag (ARDL) Model. The time duration of the data used is between 1981 and 2013. It was observed that there is a long-run relationship among the variables. Furthermore, it was noted that gross capital formation and total health expenditure have a direct relationship with economic growth in Nigeria, on the other hand, Life Expectancy has an inverse relationship with growth in the economy, which is different from the a priori expectation. Some of the recommendation made from the study is that government should increase spending on health, encourage saving and investment, and increase security to enable adequate growth in the Nigerian economy.

Edeme et al (2017), examine the impact of Public Health Expenditure on Health outcomes in Nigeria. The variables used for the research are public health expenditure, life expectancy and infant mortality rates, urban population and HIV prevalence rate. Using the co-integration test, it shows that there is a long-run relationship between the variables. It was also observed that an increase in public health expenditure leads to an increase in life expectancy and a decline in infant mortality rates. Furthermore, HIV prevalence rate and urban population have an impact on health outcomes, while there is no relationship between per capita income and health outcomes in Nigeria. The result shows that public health expenditure is a basic factor that determines the improvement of health outcomes in Nigeria.

Riman and Akpan (2010) examined the impact of public health expenditure, poverty and health status, in Nigeria. To carry out their empirical analysis, they used the Vector Error Correction Model (VECM) and Granger causality test. From their study they discovered a bi-directional relationship between life expectancy rate and poverty rate in Nigeria. Furthermore, the research shows an insignificant relationship between health status and government health spending in the long run. On the other hand, there exist a significant long run relationship between health status and poverty. In their recommendations, they suggested that to improve health status, poverty level must be reduced to make increase in healthcare spending significant and they also mention the need to encourage adult literacy.

Yaqub et al (2013) examined the effects of public health expenditure on infant and under-5 mortality rates and life expectancy. They adopted the two-stage-least squares regression technique as well as the ordinary least squares method. Their findings should that public health spending is positively related to infant mortality and under-5 mortality rates. However, when they introduced governance indicators into the model, public health expenditure was found to have a negative impact on infant mortality and under-5 mortality rates. They affirmed that when corruption level declines and that the value of corruption perception index improves, health status would improve provided infant mortality and under-5 mortality rates decline and life expectancy rate improves. They advocated that mere increases in public health spending would not improve health status, but the issue of corruption should be dealt with.

Wilhelmson and Gerdtham (2006) reviewed the impact of investment in maternal newborn health on economic growth. They suggested the use of more all-encompassing maternal

newborn health measures that incorporate the health of both the newborns and mothers; and other aspects of ill-health apart from death which include measures of sickness absenteeism, mental health, quality of life and functional limitations. Mizushima (2008) analysed the impact of public health funding and aging population on savings and economic growth rate. He used a growth model to demonstrate that an increase in the rate of life expectancy will result in an increase in economic growth.

Lucian et al (2010) examined the relationship between economic growth and health. They used the findings of some existing works and applied them on the recent data. Their objective was to discover whether the economic growth rates of members of European Union is linked to the growth rates of various diseases. Their findings revealed that there is a positive relationship between the health of population and economic growth. They also found out that causality runs from economic growth to growth rates of diseases. Bloom et al (2004) examined the effects of public health spending on economic growth. Their results showed that health has a positive and statistically significant effect on economic growth. Their findings pointed out that when the life expectancy of the population increases by one year output will grow by 4%. This implies that increases in public health expenditure can only be justified by its effect on labour productivity apart from its effect on improved health welfare.

Methodology

Theoretical Framework

The hypothetical structure of this work is patterned after the augmented growth model by Mankiw, Romer & Weil (1992). Their model is same as the Solow (1956) growth model but augmented with human capital. The idea was to augment the Solow growth model to include the accumulation of human capital. The model assumes that countries have the same rate of efficiency growth. The initial level of growth efficiency is assumed to differ randomly from one country to another. This is as result of local factors such climatic conditions, and this can be used to justify the error term. Their work avoids the presumption of the Solow model that cross country variation in labour productivity is largely by appealing to variations in technologies. The model expressed output (Y) as a function of physical stock of capital (K), human capital (H), quantity of labour (L) and the coefficient of technical progress (A). This is expressed in functional as:

$$Y_t = f(K, H, AL) \quad \text{.....(1)}$$

Using the Cobb Douglas production model and a world consisting of i = 1,…n countries, equation (1) can be represented as:

$$Y_{it} = K_{it}^{\alpha} H_{it}^{\beta} (AL)_{it}^{1-\alpha-\beta} \quad \text{.....(2)}$$

Where: $0< \alpha < 1$; $0< \beta < 1$ and $\alpha + \beta < 1$.

Mankiw, Romer and Weil (1992) assumed that households save a fraction s_k of their income to invest in physical capital and a fraction s_h to invest in human capital. And that human capital also depreciates in the same way as physical capital. The depreciation rates for physical capital is given by δ_k and human capital, δ_h, where $\delta_k = \delta_h = \delta$. Population growth rate is n

and technology growth rate is g. When equation (2) is transformed into output per capita and solved, we have the steady state of output per labour (productivity) as follows:

$$y_{it} = A_{it} k_{it}^{\alpha} h_{it}^{\beta} \quad \ldots\ldots(3)$$

Where:

$$k_{it} = \left(\frac{s_k^{1-\beta} s_h^{\beta}}{n+g+\delta} \right)^{\frac{1}{1-\alpha-\beta}} \quad \ldots\ldots(4)$$

$$h_{it} = \left(\frac{s_k^{\alpha} s_h^{1-\alpha}}{n+g+\delta} \right)^{\frac{1}{1-\alpha-\beta}} \quad \ldots\ldots(5)$$

By substituting expression (4) and (5) into (3), output per labour in steady state becomes:

$$y_{it} = A_{it} \left(\frac{s_k}{n+g+\delta} \right)^{\frac{\beta}{1-\alpha-\beta}} \left(\frac{s_h}{n+g+\delta} \right)^{\frac{\alpha}{1-\alpha-\beta}} \quad \ldots\ldots(6)$$

Mankiw, Romer and Weil (1992) assumed that $A_{it} = \bar{A} e^{g}$ and that countries differ according to technology level (initial level, $\bar{A}$) but they share the same common technology growth rate, g. Taking the log of both sides in equation (6) yields the following expression:

$$\ln y_{it} = \ln \bar{A}_{it} + g_{it} + \frac{\beta}{1-\alpha-\beta} \ln \left(\frac{s_k}{n+g+\delta} \right)_{it} + \frac{\alpha}{1-\alpha-\beta} \ln \left(\frac{s_h}{n+g+\delta} \right)_{it} \quad \ldots\ldots(7)$$

Since $\bar{A}$ is unobserved it can be captured by the error term. Hence, equation (7) can be rewritten in econometric form as:

$$\ln y_{it} = g_{it} + \frac{\beta}{1-\alpha-\beta} \ln \left(\frac{s_k}{n+g+\delta} \right)_{it} + \frac{\alpha}{1-\alpha-\beta} \ln \left(\frac{s_h}{n+g+\delta} \right)_{it} + \varepsilon_t \quad \ldots\ldots(8)$$

Equation (8) represents output per labour (productivity) in logarithm form. The coefficients of the physical capital and human capital inputs are elasticity parameters. The model shows that investment in physical and human capital results in increased productivity. Thus, the augmented Solow model gives output per labour as depending on the rate of technical change, capital stock and human capital (Mankiw, Romer & Weil, 1992). In empirical applications, the basic Solow model has been modified to obtain the augmented Solow growth model where the rate of growth of output for a given country depends not only on technical change, capital and labour but also on policy variables like trade, fiscal policy and monetary policy (see, Ologun, 2003; Easterly & Levine, 2001).

3.3 Model Specification and Methodology

Based on the theoretical framework, we specify the functional model for productivity as follows:

$$GDPL = f(PHE, MMR, HPR, LER) \quad \ldots\ldots(9)$$

Where: GDPL = Gross Domestic Product per labour (Productivity). PHE = Public health expenditure, MMR = Maternal mortality rate, HPR = HIV/AIDs prevalence rate and LER = Life expectancy rate

For empirical analysis, the functional model can be expressed in econometric form as:

$$GDPL_t = \alpha_0 + \alpha_1 PHE_t + \alpha_2 MMR_t + \alpha_3 HPR_t + \alpha_4 LER_t + \mu_t \ldots\ldots\ldots\ldots\ldots (10)$$

Where: $\alpha_1, \alpha_2, \alpha_3, \alpha_4 \; and \; \alpha_5$ are the long-run parameter elasticity estimates.

μ_t= Error term

The a priori signs of public health expenditure and life expectancy rate are expected to be positive while infant mortality rate, maternal mortality rate and HIV/AIDs prevalence rate are expected to be negative. Symbolically, the a priori expectations are: $\alpha_1, \alpha_5, \alpha_4 > 0$; $\alpha_2, \alpha_3 < 0$.

The Error Correction Model (ECM) associated with the long-run estimates is specified as:

$$\Delta GDPL_t = \rho + \partial \Delta PHE_t + \emptyset \Delta MMR_t + \tau \Delta HPR_t + \pi \Delta LER_t + \sigma ecm(-1) + \varepsilon_t \ldots (11)$$

Here, $\partial, \emptyset, \tau, \pi \; and \; \theta$ are the short-run dynamic coefficients of the convergence of the model to equilibrium; Δ denotes differencing, σ is the coefficient of adjustment expected to be negative.

3.4 Methods of Data Analysis

The study adopts the co-integration analysis. This involves unit root tests, co-integration test and error correction modeling. The initial co-integration analysis test done is to carry out a unit root test for every variable in the model. The unit root test determines whether the variables are stationary at levels or first differences. Most economic time series are difference stationary. In general, a regression involving the levels of these non-stationary series will produce misleading results, with conventional Wald tests for coefficient significance spuriously showing a significant relationship between unrelated series (Phillips, 1986). According to Eagel and Granger (1987), the regression of two non-stationary variables on each other produced spurious and inconsistent parameter estimates.

Elliott et al. (1996) projected a simple adjustment of the ADF tests in which the data are detrended so that independent variables are taken out of the data prior to running the test analysis. They define a quasi-difference of Y_t that depends on the value a representing the specific point alternative against which we wish to test the null hypothesis:

$$d(Y_t|a) = \begin{cases} Y_t & if \; t = 1 \\ Y_t - aY_{t-1} & if \; t > 1 \end{cases} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (12)$$

Next, consider an OLS regression of the quasi-differenced data $d(Y_t|a)$on the quasi-differenced $(X_t|a)$:

$$d(Y_t|a) = d(X_t|a)'\delta(a) + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (13)$$

Where: $X_t$contains either a constant, or a constant and trend, and let $\hat{\delta}(a)$ be the OLS estimates from this regression.

All that we need now is a value for a. Elliott et al (1996) recommend the use of $a = \bar{a}$ where:

$$\bar{a} = \begin{cases} 1 - \frac{7}{T} & if\ X_t = \{1\} \\ 1 - \frac{13.5}{T} & if\ X_t = \{1, t\} \end{cases} \quad \text{.....(14)}$$

We now define the *GLS detrended data,* Y_t^d using the estimates associated with the $\bar{a}$ as:

$$Y_t^d = Y_t - X_t'\hat{\delta}(a) \quad \text{.....(15)}$$

The Augmented Dickey-Fuller (ADF) test constructs a parametric correction for higher-order correlation by assuming that the Yseries follows an $AR(p)$ process and adding p lagged difference terms of the dependent variable $Y$to the right-hand side of the test regression given as:

$$\Delta Y_t = \alpha Y_{t-1} + X_t'\delta + \beta_1 \Delta Y_{t-1} + \beta_2 \Delta Y_{t-2} + \ldots + \beta_p \Delta Y_{t-p} + V_t \quad \text{.....(16)}$$

Then the DF-GLS test involves estimating the standard ADF test equation (16) after substituting the GLS de-trended $Y_t^d$for the original $Y_t$and we have:

$$\Delta Y_t^d = \alpha Y_{t-1}^d + \beta_1 \Delta Y_{t-1}^d + \beta_2 \Delta Y_{t-2}^d + \ldots + \beta_p \Delta Y_{t-p}^d + V_t \quad \text{.....(17)}$$

Note that since the $Y_t^d$are detrended, we do not include the $X_t$in the DF-GLS test equation. As with the ADF test, we consider the t-ratio for $\hat{\alpha}$ from this test equation. While the DF-GLS t-ratio follows a Dickey-Fuller distribution in the constant only case, the asymptotic distribution differs when you include both a constant and trend. Elliott et al. (1996) simulated the critical values of the test statistic in this latter setting for $T = \{50, 100, 200, \infty\}$. Thus, the null hypothesis is rejected for values that fall below these critical values.

This study employs both the residual based test – the Engel-Granger approach and the Johansen multivariate co-integration test. The Engel-Granger approach tests the residual for stationarity test. If the residual is stationary, then co-integration is established. Also, the multivariate Johansen co-integration test is carried out to ascertain whether long run relationship exists among the variables in a model. Johansen (1991, 1995) developed a Vector Autoregressive (VAR) based cointegration tests to determine the long run relationship.

Consider a VAR of order p: $Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots + A_p Y_{t-p} + BX_t + \varepsilon_t$ .....(18)

Where: Y_t is a k-vector of non-stationary I(1) variables, $X_t$is a d-vector of deterministic variables, and $\varepsilon_t$is a vector of innovations. We may rewrite this VAR as:

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + BX_t + \varepsilon_t \quad \text{.....(19)}$$

Where: $\Pi = \sum_{i=1}^{p} A_i - I$ and $\Gamma_i = -\sum_{j=i+1}^{p} A_j$

From the foregoing, the Granger representation theorem asserts that if the coefficient matrix Π has reduced rank r < k, then there exist k x r matrices α and β each with rank r such that $\Pi = \alpha\beta' and\ \beta' Y_t$ is integrated of order zero, I(0). Here, r indicates the number of cointegrating relations also referred to as the *cointegrating rank* and where each column of β represents the cointegrating vector. The elements of α indicate the adjustment parameters in the Vector Error Correction (VEC) model to the long run equilibrium. Thus, the Johansen co-integration test is to estimate the Π matrix from an unrestricted VAR model and to test whether the restrictions implied by the reduced rank of Π can be rejected or not. Thus, the variables must be integrated of the same order and co-integrated before they can be used for error correction modeling.

The Error Correction Model (ECM) is used to establish the short-run dynamics of a regression model. It is a means of reconciling the short-run behaviour of an economic variable with its long-run behaviour. The Granger representation theorem (Granger, 1981 and 1986) establishes formally the theoretical basis of error correction modeling. According to the theorem, if Y_t and X_t' are cointegrated, then there is a long run relationship between them. Let's consider the following regression model:

$$Y_t = \beta X_t' + \mu_t \quad \text{.....(20)}$$

Where: Y_t is the dependent variable; X_t' is a set of explanatory variables and μ_t is the residual.

The Error Correction Model involves using the lagged residual to correct for deviations of actual values from the long-run equilibrium values. Thus, the residual from equation (20) is given as:

$$\widehat{\mu_t} = Y_t - \beta X_t' \quad \text{.....(21)}$$

Where: $\widehat{\mu_t}$ is integrated of order zero, i.e. I(0).

Assume that Y_t is integrated of order one, i.e. $Y_t \sim I(1)$ and $X_t' \sim I(1)$. If there exist a scalar β such that $(Y_t - \beta X_t') \sim I(0)$ then Y_t and X_t' are said to be cointegrated. Since, Y_t and X_t' are assumed to be cointegrated, the error correction model can be specified as follows:

$$\Delta Y_t = \beta \Delta X_t' + \alpha \hat{\mu}_{t-1} \quad \text{.....(22)}$$

Using the ECM symbol, equation (22) may be rewritten as:

$$\Delta Y_t = \beta \Delta X_t' + \alpha ECM(-1) \quad \text{.....(23)}$$

This results from differencing the non-stationary series Y_t and X_t' before using them for the regression but adding an error correction term – a period lagged residual, $\hat{\mu}_{t-1}$. α is the error correction coefficient. This is expected to be negative and significant to rightly correct for any deviations of actual values from the long-run equilibrium values.

3.5 Sources of Data - Descriptive Statistics

The data sources include the publication of the Central Bank of Nigeria annual reports, annual publications of National Bureau of Statistics (NBS) and World Bank Development

Indicators. Descriptive statistics show the summary of data and other basic characteristics within the series. The descriptive statistics for variables of the study are reported in fig.1.

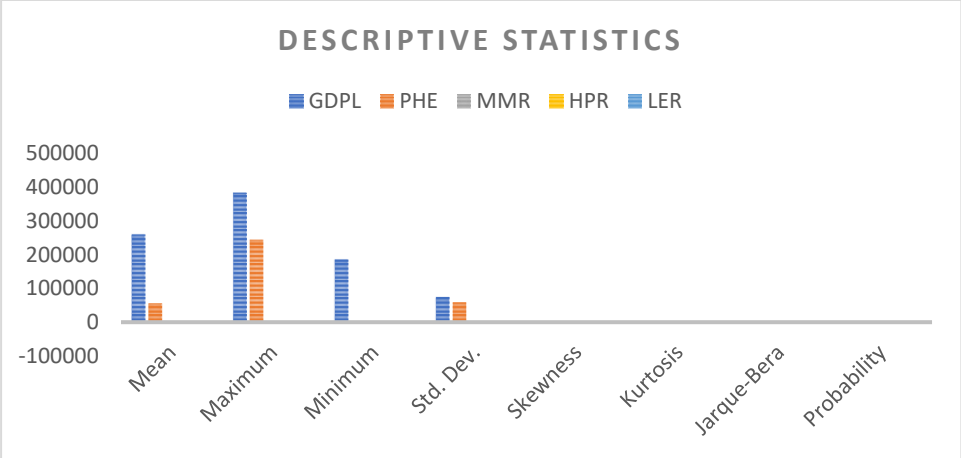

Fig.1: Descriptive Statistics - *Source: Author's Computation (2022)*

4.6 Presentation and Interpretation of Regression Results

Since long-run co-integration relationships have been established among the variables, the Error Correction Model (ECM) was estimated using the Ordinary Least Squares regression method. The results of the Error Correction model are presented in Table 4.8 below.

Table 4.8: Estimated Coefficients of the Short Run Dynamic Error Correction Model

Dependent Variable: DLOG(GDPL)				
Regressor	Coefficient	Standard Error	T-Ratio	Probability
DLOG(MMR)	-0.597286	0.329150	-1.814631	0.0896
DLOG(HIV)	-0.056909	0.047458	-1.199151	0.2491
DLOG(LER)	5.742168	1.919207	2.991948	0.0091
DLOG(PHE)	0.007598	0.008552	0.888426	0.3883
ECM (-1)	-3.30E-06	9.89E-07	-3.337465	0.0045
C	-0.019617	0.013620	-1.440313	0.1703
R-Squared-0.7381				R-Bar-Squared-0.6334
F-Statistic-7.0468-(0.0010)				DW-Statistic-1.9103

(Source: Author's computation using Eview 8.0)

The coefficient of determination of the Error Correction Model, R-squared (R^2) is about 0.74 and the adjusted R-squared ($\bar{R}^2$) is 0.63. The R-squared implies that about 74 percent of the systematic variations in first difference of the log of gross domestic product per labour are explained by the regressors in the short run equation. The adjusted R-squared indicates that about 63 percent of the systematic changes in the dependent variable are attributable to the explanatory variables. Hence, the explanatory power of the model is high. The F-statistic has a value of 7.05 with an associated probability value less than 0.01. This implies that the overall

goodness of fit of the model is significant at the 1 percent level. Thus, all the independent variables do collectively account for variations in the dependent variable in the short run.

The signs of all the estimated coefficients (public health expenditure, maternal mortality rate, HIV/AIDs prevalence rate, life expectancy rate and investment) in the ECM conform to their theoretical expectations. The coefficient of the first difference of the log of public health expenditure DLOG(PHE) is positive but insignificant even with 10 percent level of significance. Its coefficient is 0.008 with a t-value of 0.89. The t-statistic failed the significance test at the 10 percent level. Therefore, public health expenditure has a positive insignificant impact on productivity in the short run. The coefficient of the first difference of the log of maternal mortality rate DLOG(MMR) is negative and significant at 10 percent level of significance. It has a coefficient of -0.60 and t-statistic of -1.81. Its p-value is 0.09. The coefficient passed the statistical test of significance at the 10 percent level. Hence, if the maternal mortality rate increases by 1 percent, labour productivity will fall by about 0.6 percent in the short run. The implication is that maternal mortality rate has a significant adverse impact on labour productivity in the short run in Nigeria.

The first difference of log of HIV/AIDs prevalence rate DLOG(HPR) is negatively signed which conforms to its a priori expectation. Its elasticity coefficient is -0.06 with a t-value of -1.20. It failed the test of statistical significance at the 10 percent level. Thus, HIV/AIDs prevalence rate has no significant adverse effect on productivity in the short run. The elasticity of labour productivity with respect to life expectancy rate is positive and significant. Its coefficient is 5.74 and it has a t-value of 2.99 with a p-value of 0.01. This magnitude of t-statistic passed the significance test at the 1 percent level of significance. Hence, should life expectancy rate fall by 1 percent labour productivity will also fall by 5.74 percent in the short run. It follows that life expectancy rate has a significant positive impact on productivity in the short run in Nigeria.

The coefficient of adjustment of the ECM is correctly signed. That is, it is negative and significant at the 1 percent level. Thus, it will rightly act to correct any deviation of real gross domestic product per capita from its long-run equilibrium value. Its coefficient is –3.3E-06. This implies that the coefficient of adjustment will correct the previous disequilibrium of gross domestic product per capita at the rate of 3.3E-04 percent annually. This however shows a rather slow adjustment process to the long run equilibrium. A cursory look at the Durbin Watson statistic of approximately 1.91 depicts absence of autocorrelation in the error correction model. Having analyzed the short-run dynamics of the Error Correction Model, we estimated its associated long run model using the Ordinary Least Squares regression technique. The results of the estimated long run model are presented in Table 7 below.

Table 4.9: Estimated Coefficients of the Long Run Model

Dependent Variable: GDPL				
Regressor	Coefficient	Standard Error	T-Ratio	Probability
LOG(PHE)	-0.023461	0.011384	-2.060832	0.0550
LOG(MMR)	-0.747623	0.272026	-2.748353	0.0137
LOG(HIV)	-0.082326	0.047158	-1.745747	0.0989
LOG(LER)	3.377329	1.002668	3.368344	0.0036
LOG(INV)	0.050152	0.022756	2.203864	0.0416
C	-20.35695	5.544095	-3.671826	0.0019

R-Squared 0.9779	*R-Bar-Squared* 0.9714
F-Statistic 150.56(0.000)	*DW-Statistic* 1.7927

Source: Author's computation using Eview 8.0

The overall goodness of fit for the long run model is quite impressive compared to its short run model. The R-squared (R^2) and the adjusted R-squared ($\bar{R}^2$) are approximately 0.98.and 0.97 respectively. The R^2 indicates that about 98 percent of the systematic variations in gross domestic product per labour are accounted for by the independent variables in the long run equation. While the $\bar{R}^2$ shows about 97 percent of the systematic variations in the dependent variable are attributable to the independent variables. The unexplained variations in the dependant variable are about 3 percent based on the adjusted R-squared coefficient. The F-statistic is 150.6 with a p-value less than 0.0001. It indicates that the model is highly significant passing the test of significance at the 1 percent level. This indicates that there is a log-linear relationship between the dependent and each independent variable in the model. The Durbin Watson statistic of approximately 1.79 indicates absence of serial correction in the long run model.

The signs of all the estimated coefficients of the explanatory variables in the long-run model conformed to their a priori expectations except for public health expenditure whose sign turned out negative. The elasticity of productivity concerning public health expenditure (PHE) is negative and significant. Its elasticity coefficient is -0.023 with a t-value of -2.06. The t-statistic passed the significance test at the 10 percent level. This indicates that 1 percent rise in public health expenditure will lead to a fall in productivity by about 0.02 percent annually in the long run. Contrary to expectation, public health expenditure does have a significant adverse effect on productivity in the long run in Nigeria. The coefficient of log of maternal mortality rate LOG(MMR) is negative. It is significant at 1 percent level of significance. It has a coefficient of -0.75 and a t-statistic of -2.75. Its p-value is 0.01. The coefficient passed the statistical test of significance at the 1 percent level. The implication is that the maternal mortality rate has a negative significant impact on productivity in the long run. That is, a fall in maternal mortality rate by 1 percent will raise labour productivity by 0.75 percent in the long run in Nigeria.

HIV/AIDs prevalence rate (HPR) is negatively signed. Its elasticity coefficient is -0.08 with a t-value of -1.75. It passed the test of statistical significance at the 10 percent level. Thus, HIV/AIDs prevalence rate has a negative significant impact on labour productivity in the long run. This implies that a rise in HIV/AIDs prevalence will reduce productivity in the long run. The elasticity of labour productivity with respect to life expectancy rate (LER) is positive. Its coefficient is 3.38 with a t-value of 3.37. It passed the test of statistical significance at the 1 percent level. If life expectancy rate improves in Nigeria by 1 percent, labour productivity will rise by 3.38 percent in the long run. Thus, life expectancy rate has a positive significant impact on productivity in the long run. This implies that the higher the level of life expectancy the more productive the Nigerian economy will be in the long term.

4.7 Test of Hypotheses

Based on the regression results of the estimated long-run impacts of the explanatory variables, we can test the validity of the hypotheses presented in chapter one of this research. The estimated long-run coefficient of HIV/AIDs prevalence rate is negative. It is significant at the 1 percent level. Thus, we fail to accept the null hypothesis that HIV/AIDs prevalence rate does not have any significant impact on productivity in Nigeria. The estimated long-run coefficient of the

life expectancy rate is positive and significant at the 1 percent level. Therefore, we fail to accept the null hypothesis that the life expectancy rate has no significant impact on productivity in Nigeria.

Summary of Findings

This work analysed empirically the impact of public health expenditure on productivity in Nigeria. The study employed econometric techniques to verify the time series properties and the relationship among public health expenditure, maternal mortality rate, HIV/AIDs prevalence rate, life expectancy rate and productivity in Nigeria. The Dickey-Fuller Generalized Least Squares (DF-GLS) test was used to ascertain the order of integration of the time series. The Engel-Granger (residual-based) and multivariate Johansen co-integration tests were used to determine the long-run relationship between the dependent and the set of independent variables. The Error Correction Model (ECM) was used to model the short-run impact of the public health expenditure, health indicator variables and investment on productivity in Nigeria.

The empirical results showed that all the variables are integrated of order one, that is, they are all difference stationary. Also, there exists a long-run relationship among public health expenditure, maternal mortality rate, HIV/AIDs prevalence rate, life expectancy rate and productivity in Nigeria. In the short run, the multiple regression results showed that public health expenditure has a positive insignificant impact on productivity in Nigeria. Also, the findings revealed that the maternal mortality rate has a negative significant effect on productivity in the short run. Again, HIV/AIDs prevalence rate was found to have a negative insignificant effect on productivity in the short term in Nigeria. Life expectancy turned out to have a positive significant impact on productivity in the short run in Nigeria. Similarly, in the short run, the results revealed that investment has a positive significant impact on productivity.

In the long run model, the regression results showed that public health expenditure has a negative significant impact on productivity in Nigeria. However, the findings revealed that maternal mortality rate and HIV/AIDs prevalence rate have negative significant impact on productivity in the long run. Also, life expectancy rate was found to have a positive significant effect on productivity in the long run. Lastly, the results revealed that investment has a positive significant impact on productivity in the long run in Nigeria.

5.2 Recommendations

Based on the empirical findings of this research, the following recommendations have been proffered:

1. There should be more enlightenment and campaign on the effects of HIV/AIDs prevalence to stem the tides of the disease and encourage increased productivity in Nigeria. Government should use various media platforms to discourage the stigmatization of individuals living with the virus. Government should make adequate provisions for retroviral drugs and ensure that employers do not discriminate against those suffering from the disease. Individuals should avail themselves of the opportunity provided by government hospitals to check their status to reduce the spread of the virus if positive or mitigate possible contamination if tested negative.
2. Government should invest more in health care to provide quality healthcare services to its citizenry and improve the life expectancy rate which will in turn foster productivity and economic growth in Nigeria. Government should provide free health care services for the senior citizens in the country as obtainable in developed countries. The government should ensure a more accessible Health Insurance Scheme.

5.3 Conclusion

The findings of this study showed that public health expenditure has a positive and insignificant impact on productivity in the short term. However, the results revealed that public health expenditure has a long-run significant adverse impact on productivity in Nigeria. These findings suggest that public health expenditure in Nigeria has not yielded the desired results. Thus, there is a need for a proper review of public health expenditure to ensure a positive effect on labour productivity in Nigeria. HIV/AIDs prevalence rate was found to have a negative insignificant effect on productivity in the short run. However, the results revealed that in the long run, HIV/AIDs prevalence rate has a negative significant effect on productivity. The implication is that a high HIV/AIDs prevalence rate will inhibit productivity in the long run. Hence, there is a need to stem the scourge of HIV/AIDs prevalence in Nigeria to boost the country's productivity and economic growth. Furthermore, the life expectancy rate was found to have a positive significant impact on productivity both in the short and long run in Nigeria. This implies that an increased life expectancy rate will result in increased labour productivity in Nigeria. Finally, investment has a positive significant impact on productivity both in the short run and long run. These findings suggest that higher investment levels will increase the productivity level of the country both in the short term and in the long term. Thus, for the Nigerian economy to continually sustain increased productivity and economic growth, it should provide the needed environment for businesses and investment to strive effectively.

5.4 Contribution to Knowledge

This study has shown that public health expenditure has a negative significant effect on human productivity in the long term in Nigeria. Consequently, this finding provides an important opportunity to make further research into examining why public health expenditure plays a negative significant role in determining human productivity in the long term in Nigeria.

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