The Impact of Health on Labour Productivity in Nigeria from 1970 to 2012, Applying the Standard Neo-Classical Growth Framework

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Abstract
This study estimates the impact of health on labour productivity in Nigeria from 1970 to 2012, applying the standard neo-classical growth framework. Using ordinary Least Square (OLS) technique, Cointegration and Granger Causality test procedures, the Unit root test result shows that five of the variables, PERCAPITA, LABFORCE, EDUCATIO, AGRICULT and HEALTH are not stationary at level (order zero)except INVEST, indicating no propensity for the variables to move together towards equilibrium. The cointegration test procedures conducted indicates at most three cointegrating equations. The causality test result conducted indicates a unilateral causality from LABFORCE to PERCAPITA, PERCAPITA to HEALTH, PERCAPITA to EDUCATIO and PERCAPITA to AGRICULT. The result table also shows no direction of causality between PERCAPITA and INVEST. The OLS test result shows that the empirical evidence strongly indicates that healthy labour force is one factor that determines productivity. Statistically, the R^2 result shows that the independent variables explain the dependent variable to the tune of 90%. The t-value of the variables, LABFORCE, EDUCATIO and AGRICULT are statistically significant while others are not. The stability and residual diagnostic tests results indicates that the CUSUM and CUSUMQ test results reveal satisfactory plot of the recursive residuals at 95 percent significance level. The study therefore recommends that the Federal Government as well as the authorities in every state of the country must focus on the improvement of labour productivity in order to raise the standard of living of the people in Nigeria

JEL CLASSIFICATION: C12, C51, J24.I12, N3, N37

Keywords: Health, Labour Productivity, Granger Causality, Cointegration, OLS, Nigeria

Introduction

The importance of health as a form of human capital cannot be overemphasised. A healthy workforce is one of the most importance asset a nation could possess. Lilliard and Weiss(1997) were of the view that health is one of the most importance asset a person has as it permits to fully develop our capacities. Ajani and Ugwu(2008)assert that good health and productive workforce are important in any economy especially in the fight against poverty. Health is importance for economic agents as it directly contributes to the wellbeing of individuals, besides constituting part of the human capital stock which determines the productivity and income levels reached (Alves and Andrade, 2002). A country's capability to improve its national output growth over time depends almost entirely on the size of its labour force. This in turn propels the country's productive capacity and hence raises productivity (Qaiser and Foreman-Peck, 2007).

The link between health and both income and labour productivity has been long studied by economists and development experts. The significance and positive correlation that observers clearly see between measures of health status and of income and work performance has motivated much of the research (McNamara, Ulinwengu and Leonard, 2010). The authors were of the view that the strong association between good health and economic prosperity is easily appreciated and appears in the context of agricultural productivity as well as in context such as income, wages and other wealth measures. Strauss and Thomas (1998) stated that there is a positive relationship between health and productivity of skilled and unskilled labour. Good health according to the authors, as related to labour output or better production organisation can enhance farmers/household income and economic growth. Healthier worker are physically and mentally more energetic and robust, so they are less likely to miss work due to illness, either of themselves or their families (The World Health Organisation, 2002).

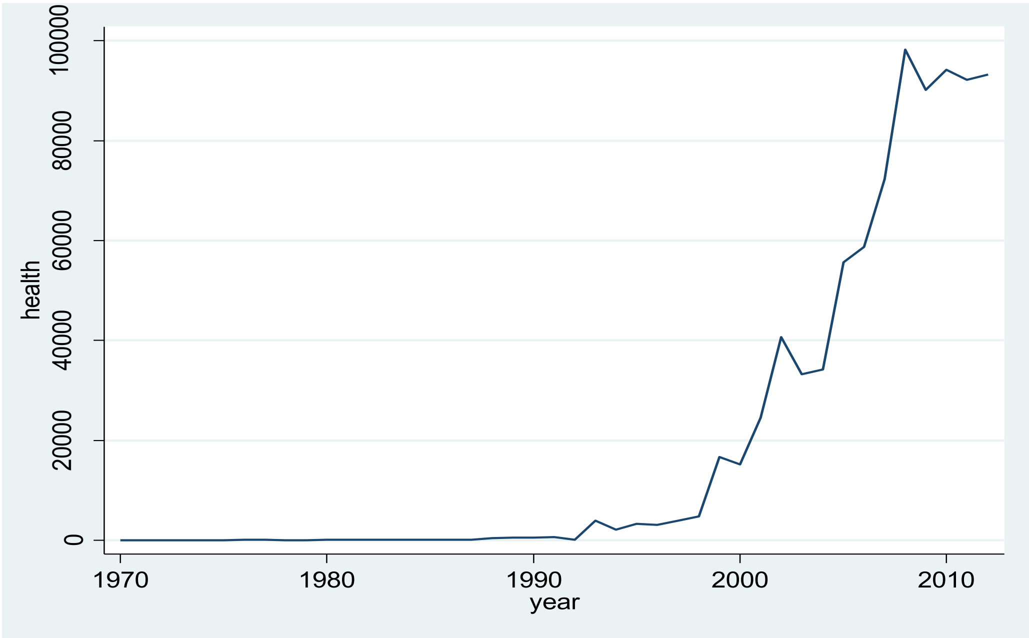
The economic effect of health related problems like malaria, musculoskeletal disorders, HIV/AIDS , farm injuries, yellow fever, typhoid fever, schistosomiasis, onchocerciasis, diarrhoea will be felt first by individuals and their families, then ripple outwards to firms and business and the macroeconomy (Nwaorgu,Bollinger and Stover,1999). According to the authors, the household impacts impacts begin as soon as a member of the household starts to suffer from these related illness which include,

(a) Loss of income of the patients (who as bread winner)
(b) Household expenditures for medical expenses may increase substantially
(c) Other members of the household usually daughters and wives may miss school or work less in order to care for the sick person
(d) Death results in: a permanent loss of income from the less labour on the farm or from lower remittances; funeral and mourning cost and the removal of children from school in order save on educational and increase household labour resulting in a server loss of future earning potentials.

Health expenditure outcomes in Nigeria

In Nigeria, the Federal Government's percentage growth in health expenditure lagged behind their normal counterpart all through from 1978 till 2003. For example while the sum of N452.6 million in nominal terms was spent in 1989; this amount was only worth N62.69 million in real terms during the same year. In 2003, approximately N396.86 million was the nominal amount spent by the Federal Government in Nigeria, this amount in 2000 real terms is worth N272.96 million. This is not significantly different from the N257. 01 million spent in 1977 in real terms. However, in recent times, the Federal Government expenditure has been on the increase. The figure 1 below shows the total of Federal Government expenditures on health in Nigeria from 1970 -2012:

Figure 1: The health expenditures of Nigeria from 1970 -2012.



Source: author's computation

From the graph, it could be seen that the health expenditure of the Nigeria government took a positive dive. For example, in the year 1991 a total amount of N755million was spent; this rose nominally to N63171.2 million in 2002. Considering changes in price level, this amount spent in 2002 reduced to a mere N495.42 million in 2009 (CBN,2009). In 2013, the Federal Government allocated a total of N279.23 billion to health care and N81.41 billion to agricultural sector. The top three expenditures for the country in 2013 were education, defence and police formations and commands. The increase in the education allocation of N493.5 billion is commendable when compared to the 2012 but still it is considered insufficient considering the level of deterioration in public education at all levels in the country.
The labour force population based on the 2011 estimate indicates that the country has a total of 51.53 active labour force (CIA World fackbook, 2014). Based on the 2011 report, the population of the country's labour force by occupation that agriculture dominates the population of labour force participation with 70 %, industry 10 % and services 20%. The CIA World fact book report (2014) noted that 23.9 % of the country's active population are unemployed. The figure indicates an astronomical increase in unemployment rate from 4.9% estimate in 2007. Among the sub-Saharan African countries, Nigeria ranked first with the highest number of labour with a total of 52.64 million based on the 2011 estimate (CIA World fackbook, 2014).

Statement of the problem

In recognising health as a fundamental basic need for development purpose, Yesufu(2000) affirms that development comes through the abilities and work of those members of the population who are fit, healthy and capable of productivity. Dauda(2007)stated that attaining high level of economic development by a nation with a population crippled by pervasive illness of its workforce, high infant and material mortality and low life expectancy will be an illusion. Alaba and Alaba (2002) in a study of health situation in the Nigerian economy noted that sickness at the household level affects productivity and income level. Equally, the prevention and treatment of illness consume scarce household resources including productive time. Karen, Sara, Michelle, Alice and Alyssa (2005) stated that when people are unable to worker drop out of workforce because of serious health problems or disability, they do not generate economic output, pay taxes on earning or help raise the nation's standard of living. The United Nation's (2008) report on AIDS epidemic in Nigeria noted that around 3.1% of adults between ages of 15-49 are living with HIV and AIDS. According to the report, although the HIV prevalence is much lower in Nigeria than in other African countries, the size of the population (around 148 million) meant that by the end of 2007, there were an estimated 2,600,000 people infected with HIV. Despite various declarations by African governments in the 1990s and complementary effort promised in the main content of the Roll back malaria declaration in Abuja in 2000, malaria remains a major health challenge facing Nigeria and entire continent. About 107 countries and territories involving about 3.2 billion people are still at risk of malaria attack as at 2004(The World Health Organisation (WHO), 2005).

These has presented a serious implication for labour productivity and household welfare. Prevalence of redundant labour, low income growth, lack of training, low level of technology, low capacity utilisation, low investment expenditures and poor performing infrastructure are critical factors, amongst others that are responsible for low productivity of labour in Africa (Mordi and Mmieh, 2008). A dramatic reduction in life expectancy has equally affected the Nigerian labour force and hence productivity in addition to allied potential lasting adverse effect on growth within the economy (Umoru and Yaqub,2013). This study therefore seeks to answer the following question: Do health status affect labour productivity in Nigeria? What is the direction of causality between health and labour productivity in Nigeria?

Objective of the study

The broad objective of this study is to estimate the impact of health on labour productivity in Nigeria. The specific objectives are:

(1) To ascertain the direction of causality between health and labour productivity in Nigeria .
(2) To proffer policy measures that would enhance labour productivity in Nigeria

Research hypothesis

The research hypotheses employed in this study are stated as follows:
H_0 : Health does not affect labour productivity in Nigeria

H_0 : There is no direction of causality between health and Labour productivity in Nigeria

Scope of the study

The study covers the period from 1970-2012. The period was chosen as it gives a chance for a comprehensive and accurate data estimate.

Significance of the study

An examination of the impact of health on labour productivity in Nigeria would reveal that among the traditional factor inputs, land, labour and capital (human and materials), labour are to a large extent most affected by health. This study would therefore bring to knowledge of governments at all levels , the economic need to invest in the health of workers by providing them with adequate health facilities at reduced or subsidised cost; since adverse health reduces productivity of the nation's workforce. Given that poverty, food security and economic growth continues to maintain priorities in government policies in most African countries, the efficiency of health capital as indispensable production input cannot be over emphasized.

Literature review

The literature relating health to labour market outcomes according to Campolieti and Krashinsky(2006), originates with Becker's (1964) discussion of human capital and health capital , in which he argues that motivation for investment in general human capital, such as education is similar to the rational for investing in health capital. According to the authors, Grossman (1972) formalised this idea with a model in which health directly affects consumption and labour market outcome. Mankiw, Romer and Weil(1992) extended the Solow growth model by adding human capital, specifying that this variable has significant impact on economic growth. According to Galleg(2000), following a Ramsey scheme, Baro (1996) develops a growth model including physical capital and quantity of hours worked. The author noted that by obtaining first order conditions, Baro finds that increase in health indicators raises the incentives to invest in education and a raise health capital lowers the rate of depreciation of health; adding that there are diminishing marginal return to investment in health.

Aguayo-Rico,Guera,Iris and Ricardo(2005) in their study noted that Grossman (1972) developed a model that allow health capital formation seen as capital good, to be able to work ,to earn money and to produce domestic goods. He showed that an increase in the quantity of health capital reduces the time loss of being sick. The assumes people are born with initial endowment of health which depreciate with age and grow with investment in health (Aguayo-Rico et.al, 2005). In their study, Bloom and Canning (2000) described how healthy population tends to have higher productivity due to their greatest physical energy and mental clearness. Also Strauss and Thomas (1998) reviewed the empirical evidence of the relationship between health and productivity, establishing correlations between physical productivity and some health indicators especially those related to nutrition or specific disease.

In health economics, the endogenous causality between health and income has been the topic of several studies whose purpose is to establish the direction of the causality. Luft(1978) gives an informal explanation of this causality, according to the author, a lot of people who otherwise wouldn't be poor are, simply because they are sick; few people who otherwise would be healthy are sick because they are poor. In explanation of the direction of causality of the impact of health over income, Smith (1999) uses life cycle models which links health condition with future income, consumption and welfare. Bloom and Canning (2000) noted that healthy people live more and higher incentives to invest in their abilities since the present value of the human capital formation is higher.

Empirical literature

Umoru and Yaqub(2013) analyse the labour productivity effects of health capital in Nigeria using Generalised Method of Moment (GMM) methodology. The result indicate that health capital investment enhances productivity of the labour force.
Chansarn (2010) calculates the growth rates of labour productivity of 30 countries categorised into four groups ,including G7 countries, Western developed countries; Eastern developed countries and eastern developing countries during 1981-2005. The result reveals that growth rates of labour productivity of every country, except the Philippines were greater than four percent per annum during 1981-2005.he notes that eastern developed countries had the highest average annual growth rate of labour productivity.
Ugwu(2009) examines the impact of HIV/AIDS on farm women in Nigeria with particular reference to Enugu State using Multi-Stage and purposeful sampling methodologies in the selection of farm families /households including (women) persons living with HIV/AIDS for the study. The result shows that the impact HIV/AIDS on the farm women and their households were significance
Ajani and Ugwu(2008) examine the impact of adverse health on productivity of famers in Kainji Labke Basinin the North central Nigeria. The study use Stochastic Frontier Production model. The result indicate that technical efficiency of farmers fall in the range of 0.28-0.99 with mean of 0.85.

Research Methodology

Under the Standard Neo-Classical growth framework conditional convergence studies assumes that a country with higher initial human capital among others, performs better. The growth implication of health which is another component of capital to education have not been investigated thoroughly within the optimum growth framework (Muysken, Yetkiner and Ziesmer, 1999). The aim of this study is to show rigorously the positive association between labour productivity proxies with percapita income and health status of an economy; and thereby provide a theoretical background for using health variables in conditional convergence analysis. The positive relationship between health and percapita output is first shown in the standard neo-classical growth framework where the health status is exogenously given.

In the human capital development theory, the more educated and healthy are more productive. This imply that productivity of country's labour force is driven by her status of health capital and education (Kalemli-Ozcan,Harl and Weil,2009).

According to the authors, a healthy and educated workforce is expected to contribute positively to the effectiveness and hence productivity of a nation.
Based on these assertion, we can express percapita equation as:

$$PERCAPITA_t = K_t^{\varsigma} H_t^{\eta} E_t^{\lambda} L_t^{1-\xi-\eta-\lambda} A_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

where (H) health and education (E) are two components of human capital and assumption of constant returns to scale (CRTS), the augmented aggregate productivity function could express as:

$$(PERCAPITA) = \left(\frac{K_t}{L_{\varsigma}}\right)^{\frac{\varsigma}{1-\varsigma-\eta-\lambda}} \left(\frac{H_t}{L_t}\right)^{\frac{\eta}{1-\varsigma-\eta-\lambda}} \left(\frac{E_t}{L_t}\right)^{\frac{\lambda}{1-\varsigma-\eta-\lambda}} A_{it}^{T} \ldots\ldots\ldots..(2)$$

The expression of relation in equation (2) ,labour productivity measured by worker's output is a function of physical, health and education capitals per unit of labour services. For example:

$(K/L) = k^{\frac{\varsigma}{1-\varsigma-\eta-\lambda}}, (H/L) = h^{\frac{\eta}{1-\varsigma-\eta-\lambda}} and\,(E/L) = e^{\frac{\lambda}{1-\varsigma-\eta-\lambda}}$,respectively

A total factor productivity is measured by the technological index of the country A_{it}^{T} therefore taking the log of equation (2) yields:

$$Ln(PERCAPITA) = \frac{\varsigma}{1-\varsigma-\eta-\lambda} Lnk + \frac{\eta}{1-\varsigma-\eta-\lambda} Lnh + \frac{\lambda}{1-\varsigma-\eta-\lambda} Lne + LnA_{it}^{T} \ldots\ldots,,,,,,,\ldots(3)$$

In line with the technological diffusion of Bloom,Canning and Sevilla(2001)in a model of a country's aggregate productivity index A_{it}^{T} ,we have that:

$$\Delta Ln(A_{it}^{T}) = \phi Ln(A^{*}_{it} - A_{it}^{T}) + \varepsilon_{\varsigma t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..\ldots\ldots\ldots(4)$$

where $\varepsilon_{\varsigma t}$ represents a random shock; Nigeria has a ceiling level of TFP given by A^{*}_{it} ,the country's TFP adjusts towards this ceiling at a rate ϕ
the ceiling specific level of a country's productivity is determined by worldwide technological frontier ,proxy by GDP ratio and sets of country specific variables that affects productivity. We therefore specify as follows:

$$Ln(A^{*}_{it}) = \theta Ln(W_{it}^{T}) + Ln(WWT) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

It noted that technology gaps are not observed directly,we utilised the fact that lagged productivity level can be derived from equation(4) so we specify the equation as:

$$Ln(A_{it}^{T}) = \omega Ln\{s(k)\}_{t-1} + \xi Ln\{s(h)\}_{t-1} + \xi Ln\{s(e)\}_{t-1} - \gamma Ln[n+g+\delta]_{t-1} - (LnPERCAPITA)t-1$$
$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.\ldots..(6)$$

Differencing the equation (6) yields

$$\Delta Ln(PERCAPITA) = \omega\Delta Ln\{s(k)\} + \xi Ln\{s(e)\} - \gamma Ln[n+g+\delta]\Delta LnA_{it}^{T} \quad \ldots\ldots\ldots$$
$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..\ldots\ldots\ldots...(7)$$

Substituting $\Delta Ln(A_{it}^{T})$ using equation (4) and (5) gives the following labour productivity function:

$$\Delta Ln(PERCAPITA) = \omega\Delta Ln\{s(k)\} + \xi Ln\{s(h)\} + \xi Ln\{s(e)\}$$
$$-\gamma\Delta Ln[n+g+\delta] + \phi \begin{bmatrix} Ln(WWT) + \theta Ln(W_{it}^{T}) + \omega Ln\,\omega Ln\{s(k)\}_{t-1} \\ +\xi Ln\{s(h)\}_{t-1} + [\xi Ln\{s(e)\}]_{t-1} \\ -\gamma Ln[n+g+\delta]_{t-1} - Ln(PERCAPITA)_{t-1} \end{bmatrix} + \varepsilon_{\varsigma} \ldots\ldots\ldots(8)$$

We envisage in this study that healthy-labour force (LABFORCE), government's expenditure in agriculture (AGRICULT), government's investment in health (HEALTH) and in education ($EDUCATIO^{E}_{t}$), influence labour productivity. Thus, our labour function becomes:

$$\Delta Ln(PERCAPITA) = \omega \Delta Ln\left\{s(k)\right\} + \xi Ln\left\{HEALTH\right\} + \xi Ln\left\{EDUCATIO_t^{\,E}\right\}$$

$$-\gamma \Delta Ln\left[n+g+\delta\right] + \lambda Ln\left[LABFORCE\right] + \varpi Ln\left[AGRICULT\right] \quad \text{.....(9)}$$

$$+\phi \begin{bmatrix} Ln(WWT) + \theta Ln(W_{it}^{\ T}) + \omega Ln\, \omega Ln\left\{s(k)\right\}_{t-1} \\ +\xi Ln\left\{s(h)\right\}_{t-1} + \left[\xi Ln\left\{s(e)\right\}\right]_{t-1} \\ -\gamma Ln\left[n+g+\delta\right]_{t-1} - Ln(PERCAPITA)_{t-1} \end{bmatrix} + \varepsilon_{\varsigma}$$

However, this modelling approach encompasses the estimation of the labour productivity function in first differences as advocated by Lee, (1982) and Umoru and Yaqub (2013).

Model Specification:

Assuming a linear relationship between our dependent variable and independent variables, our equation using the multiple regression analysis can be shown as follows:

$$PERCAPITA = F\left(LABFORCE, HEALTH, EDUCATIO, AGRICULT, INVEST\right) \text{.....;...........(10)}$$

We introduced INVEST (Private investment) variable in the linear equation to ascertain impact of private investment on labour productivity. Econometrically, the equation could be stated as follows:

$$PERCAPITA = \beta_0 + \beta_1 LABFORCE + \beta_2 HEALTH + \beta_3 EDUCATIO + \beta_4 \text{AGRICULT} + \beta_5 \text{ INVEST } + \mu_t \quad \text{...............(11)}$$

Given that the estimation is a time series analysis, we incorporate the time factor thus;

$$PERCAPITA_t = \beta_0 + \beta_1 LABFORCE_t + \beta_2 HEALTH_t + \beta_3 EDUCATIO_t + \beta_4 \text{AGRICULT}_t + \beta_5 \text{ INVEST}_t + \mu_t \quad \text{.............(12)}$$

where PERCAPITA is the output proxied with labour productivity, LABFORCE is the Labour force, HEALTH government expenditures on health, and EDUCATIO is the expenditures of government on education, AGRICULT for government expenditure on agriculture and INVEST for private investment.

Estimation Procedure

Unit root test

To test for stationarity or the absence of unit roots, this test is done using the Augmented Dickey Fuller test (ADF) with the hypothesis which states as follows: If the absolute value of the Augmented Dickey Fuller (ADF) test is greater than the critical value either at the 1% , 5% ,or 10% level of significance , then the variables are stationary either at order zero, one ,or two. The Augmented Dicky Fuller test equation is specified below as follows:

$$\Delta u_t = \beta u_{t-1} + \sum_{i=1}^{k} \Delta u_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (13)$$

Cointegration test procedure

In time series analysis, we often encounter situations where we wish to model one non-stationary time series (Y_t) as a linear combination of other non-stationary time series $(X_{1,t}, X_{2,t}, \ldots\ldots\ldots\ldots X_{k,t})$. In other words:

$$Y_t = \beta_0 + \beta_1 X_{1,t} + \beta_2 X_{2,t} + \ldots\ldots\ldots\ldots \beta_k X_{k,t} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (14)$$

In general, a regression model for non-stationary time series variables gives spurious (nonsense) results. The only exception is if the linear combination of the (dependent and explanatory) variables eliminates the stochastic trend and produces stationary residuals.

$$Y_t + \gamma_1 X_{1,t} + \gamma_2 X_{2,t} + \ldots\ldots\ldots\ldots + \gamma_{k,t}\ 1(0) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (15)$$

In this case, we refer to the set of variables as cointegrated. It is only in this case that we can look at regression as a reasonable and reliable model. Cointegration means that, while many developments can cause permanent changes in the individual variable $(i.e X_{i,t})$, there is some long-run equilibrium relation tying the individual variables together, represented by some linear combination of them.

The presence of unit root econometrically promotes the investigation for a long run relationship among the variables. Co-integration tests are therefore meant to ascertain the existence of co-integration between the dependent and explanatory variables. The co-integration specification is given as:

$$\left[\eta_m \log Y_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \eta_m Z_i - \left[\eta_m \log Y_t - \sum_{i=1}^{p} \beta X_{i-1} + \nu_{1t}\right]\right] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (16)$$

where [$\eta_m \log Y_t - \sum_{i-1} \beta X_{t-i}$] is the linear combination of the co-integrated vectors,

X is a vector of the co-integrated variables.

This is necessary as the Granger Representation theorem notes that cointegrated variables are related through an error correction mechanism.

The equation is specified as follows"

$$\Delta y_t = Lagged(\Delta y_t, \Delta x_t) - \lambda u_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (17)$$

where

u_{t-1} = the disequilibrium error

$y_t = \beta_0 + \beta_1 x_1 + u_t$

λ = the short adjustment parameter

The Johansen maximum likelihood procedure begins by expressing a process of N I (1) variables in an Nx1 vector x as an unrestricted auto regression:

$$X_t = \lambda_1 + X_{t-1} + \lambda_2 X_{t-2} + \ldots\ldots + \lambda_k X_{t-k} + \mu_t$$

with t = 1, 2, …, T and μ_t being the random error term. The long-run static equilibrium is given by $\prod_x = 0$, where the long run coefficient matrix Π is defined as:

$$\prod = 1 - \prod_1 - \prod_2 - \ldots\ldots - \prod_k$$

where I is the identity matrix and Π is an nxn matrix whose rank determines the number of distinct cointegrating vectors which exist between the variables in x. Define two nxr matrices α and β, such that:

$$\prod = \alpha\beta'$$

with the rows of β′ to form the r distinct cointegrating vectors. The likelihood ratio statistic (LR) or trace test for the hypothesis that there are at most r cointegrating vectors is: LR or TRACE= $-T\sum_{i=r+1}^{n} \ln(1-\lambda i)$

where λr + 1, … λn are n-r the smallest squared canonical correlations between the residuals of xt–k and Δxt series, corrected for the effect of the lagged differences of the x process. Additionally, the likelihood ratio statistic for testing at most r cointegrating vectors against the alternative of r + 1 cointegrating vectors, namely, the maximum eigenvalue statistic, is given as: $\lambda MAX = T \ln(1-\lambda r+1)$

Both statistics have non-standard distributions under the null hypothesis, although approximate critical values have been generated by Monte Carlo methods and tabulated by Johansen and Juselius (1990) procedure.

Granger causality test procedure

In order to ascertain the significance of the second objective which is to determine the direction of causality between the health and labour productivity in Nigeria, a granger causality test is carried out. The procedure adopted in this study for testing statistical causality is the "Granger-causality" test developed by C.W.J. Granger in 1969. The Granger causality tests determine the predictive content of one variable beyond that inherent in the explanatory variable itself.

The study uses two most common choices of information criteria: Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC) to ascertain significance of the results estimates.

Granger causality test rely on two basic equations:

$$X_t = \Upsilon_0 + \sum_{i=1}^{k_3} \Upsilon_i H_{t=1} + \sum_{i=1}^{k_4} \lambda_i X_{t=1} + \omega_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(18)$$

$$H_t = \alpha_0 + \sum_{i=1}^{k_1} \alpha_i H_{t-1} + \sum_{i=1}^{k_2} \beta_i X_{t=1} + \sum\nolimits_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(19)$$

where:

X = an indicator of PERCAPITA,

H = an indicator of HEALTH

t = current values

t-1 lagged values

Source of data

Data for this study were from secondary sources. The estimation period is from 1970-2012. The data used in this study are from the statistical bulletin of the CBN (2012), CBN Annual Report and Statement of Account for various years.

Econometrics software

The E-view econometrics packages was utilized in analyzing the data while excel worksheet was used in imputing the data.

Results

Unit root test

The Unit root test result shows that five of the variables, PERCAPITA, LABFORCE EDUCATIO, AGRICULT and HEALTH are not stationary at level (order zero) as they all drift far apart from equilibrium in the short-run. Only one variable, INVEST is stationary at level. In effect, it shows that there is no propensity for the variables to move together towards equilibrium. However, on application of the tests to the first differences of the series, the tests indicate that the variables under consideration, PERCAPITA, HEALTH, EDUCATIO, AGRICULT and INVEST are stationary and integrated of order one I(1) at 5% level of significance in the ADF statistic; only the LABFORCE variable is not stationary. Having established the order of integration of the series, we employed both the Johansen‟s and Juselius‟ Maximum Likelihood (LM) co-integrating techniques under the trace and maximum Eigen value test statistics to explore the possibility of long-run equilibrium between the variables under study.

Cointegration Test

To establish whether long-run relationship exists among the variables or not, cointegration tests are conducted by using the multivariate procedure developed by Johansen (1988) and Johansen and Juselius (1990). The cointegration tests include: PERCAPITA, LABFORCE, HEALTH, EDUCATIO, AGRICULT, INVEST, which includes one lag in the VAR. The results of the conducted Johansen tests for cointegration among the variables are specified in table below: The results indicate that there are at most three cointegrating vectors
Using the trace likelihood ratio, the results point out that the null hypothesis of no cointegration among the variables is rejected in favour of the alternative hypothesis up to two cointegrating equations at 5% significant level because their values exceed the critical values. This means there are at most three cointegrating equations, which implies that a unique long-run relationship exists among the variables and the coefficients of estimated regression can be taken as equilibrium values.

Causality test

The result indicates a unilateral causality between LABFORCE to PERCAPITA expenditure. The result also shows that unilateral causality exist between PERCAPITA and HEALTH variable. The result also indicates a unilateral causality existing between PERCAPITA and EDUCATIO variable. There is unilateral causality existing between PERCAPITA and AGRICULT variable. The unidirectional causality means that the PERCAPITA has to grow first before the effect reflects on the Health, EDUCATIO, and AGRICULT variables. From the result table, no causality direction exists between PERCAPITA to INVEST.

Analysis of regression estimates

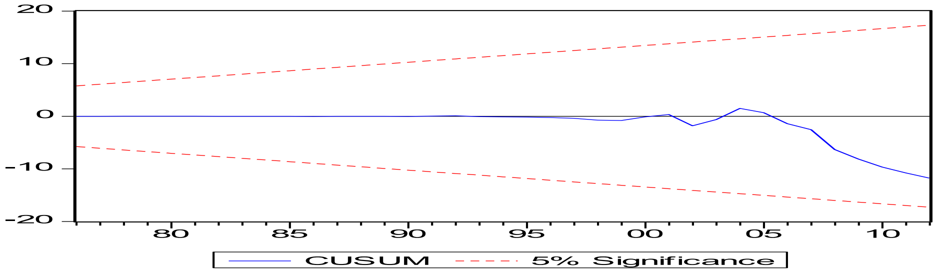
The regression estimates shows some robust significance of HEALTH, EDUCATIO AND LABFORCE interactive terms. Thus, the labour productivity effect of healthy-labour and educated labour is highly remarkable. The empirical evidence therefore strongly indicates that an educated, healthy-labour force is among the key determinants of labour productivity in Nigeria. Accordingly, the results indicate that healthy-labour force is one factor that determines productivity. The estimated coefficient of HEALTH is estimated with a negative and insignificant value even at the 5 % level of significance. The coefficient of EDUCATIO variable shows a positive sign indicating that during the period under review, the government expenditure on education improved upon labour productivity proxied by percapita income in Nigeria during the period under review. It also indicates that that a unit increase government expenditures in education increases productivity by 0.7percent. The result also shows that AGRICULT variable exhibit negative sign. It implies that a unit increase in expenditures on agriculture declines productivity by 3 percent. The result above equally indicates that private investment INVEST exerts negative influence on percapita income proxy as productivity growth in Nigeria between a decade after independence and 2012 fiscal year and this effects do not conform with the theoretical expectations. This implies that for a unit increase in private investment INVEST will elastically decline productivity by -2173.901 units.

Statistically, the R^2 (0.908222) =0.90 % shows that the independent variables explain the dependent variable to the tune of 90 %.From the regression results, the t-values of the variables under-consideration are as follows: From the result, it shows that the t-values of variables, LABFORCE, EDUCATIO and AGRICULT are statistically significant while others are not. The F-values obtained are as follows: F (5, 42) =71.25055 while tabulated value is given as follows F (5, 42) = 2.45 Decision: Since the F –calculated is greater than the F- tabulated, we reject H_O and conclude that the overall estimate of the regression is adequate statistically. The DW = 1.653179 which is greater than the adjusted R^2 = 0.90 % shows that the entire regression is statistically significant. So we accept the null hypothesis of no autocorrelation.

Stability and Residual Diagnostic Tests Results

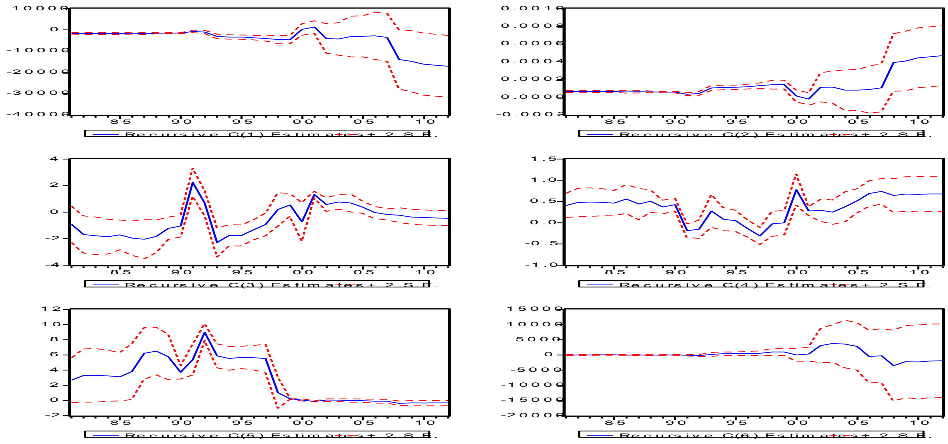
Further, a plot of the sample autocorrelation function (AC) against different lags yielded the correlogram of the regression residuals. The correlogram portrays an explicit representation of stationary residuals adjudged on the ground that the autocorrelations at various lags drift around zero, that is, the zero axis as indicated by the solid vertical line. The CUSUM and CUSUMSQ test results reveals satisfactory plot of the recursive residuals at the 95% significance level. Remarkably, cumulative sum of square residuals reveals that none of the parameters falls outside the critically dotted lines. This empirically dismisses any trace of inconsistent parameter estimates. The results of the CUSUM tests are provided in the graph below:

Figure2: CUSUM test result



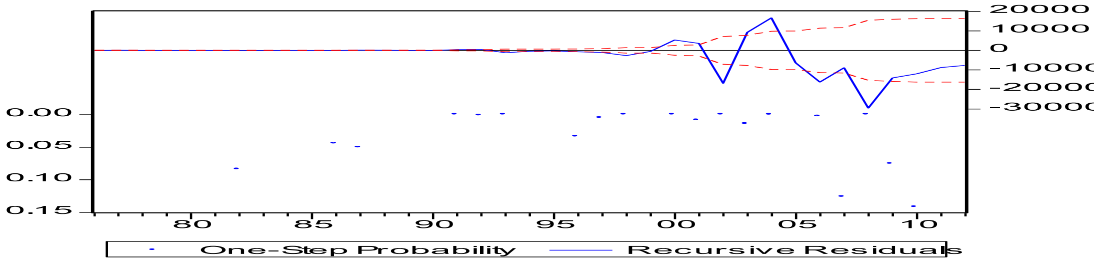
Evidently, stability hypothesis is validated for the period under analysis. The validity of stability of the regression relationships over time further enhances the standard significance of the conventional test statistic(s) without trace of nuisance parameters obtained in the study. Model stability is further established in this study given the empirical evidence that the recursive residuals in the regressions persistently drift within the error bounds [-2 and +2]. This facilitated the adaptive configuration of the cusum test parameters thereby correcting any trace of endogeneity and or simultaneity bias and serial correlation. Thus, the recursive residuals are the *expost* prediction error for all regressands in the study. This is because estimation utilized only the first $_{t-1}$ observations.the graph below depicts recursive estimates results:

Figure3:Recursive test result



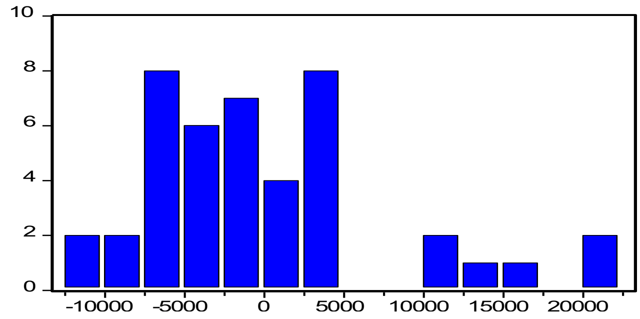
Given that the recursive estimation is computed for subsequent observations beyond the sample period, it therefore portrays the one-step prediction error graphically depicted as one-step probability recursive residuals as shown in the graph below:

Figure 4: One-step probability recursive test result



The adequacy of the specification was therefore established on the basis of the satisfactorily robust test statistic(s) obtained from the diagnostic tests conducted on the regression residuals. However, the empirical distribution test for model residuals also provides evidence of non-normality of the variables with a Jarque-Bera test statistic of 10.18416. The graph below depicts the non-normality of the distribution.

Figure5: Jarque-Bera test statistic



Series: Residuals	
Sample 1970 2012	
Observations 43	
Mean	6.56E-12
Median	-1853.561
Maximum	21113.68
Minimum	-11247.54
Std. Dev.	7618.305
Skewness	1.096234
Kurtosis	3.936626
Jarque-Bera	10.18416
Probability	0.006145

Conclusion

In this study, we estimated the impact of health on labour productivity in Nigeria applying the standard neo-classical growth framework. The data was estimated using annual time series data from 1970 to 2012. The OLS test result undertaken shows that the empirical evidence strongly indicates that the results indicate that healthy-labour force is one factor that determines productivity. Based on the findings of this study, the following recommendations are therefore made for policy considerations: The influence of health on labour productivity growth should be re-investigated to confirm the results obtained. The Federal Governments as well as the authorities in every states of the country must focus on the improvement of labour productivity if they wish to raise the standard of living of people in Nigeria

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Appendix

Augmented Dickey-Fuller Test Equation, for the model

ADF TEST				
VARIABLE	**ORDER ZERO**	**PROBABILITY**	**ORDER ONE**	**PROBABILITY**
PERCAPITA	0.649497	0.5198	-4.465192	0.0001
HEALTH	2.111422	0.0412	-3.596858	0.0009
EDUCATIO	2.364256	0.0231	-4.195933	0.0002
AGRICULT	-0.941206	0.3524	-7.298729	0.0000
INVEST	-2.777445	0.0084	-7.397786	0.0000
LABFORCE	1.727920	0.0919	-0.823451	0.4154

Cointegration test

Series: PERCAPITA LABFORCE HEALTH EDUCATIO AGRICULT INVEST
Lags interval: 1 to 1

Hypothesized No. of CE(s)	1 Percent Critical Value	5 Percent Critical Value	Likelihood Ratio	Eigenvalue
None **	90.45	82.49	200.4562	0.839750
At most 1 **	66.52	59.46	125.3845	0.828591
At most 2 **	45.58	39.89	53.07264	0.486381
At most 3 *	29.75	24.31	25.75539	0.296838
At most 4	16.31	12.53	11.31652	0.240846
At most 5	6.51	3.84	0.018926	0.000462

*(**) denotes rejection of the hypothesis at 5% (1%) significant levels

Granger Causality Tests

Pairwise Granger Causality Tests
Date: 09/10/14 Time: 06:29
Sample: 1970 2012
Lags: 2

Probability	F-Statistic	Obs	Null Hypothesis:
0.08763	2.60695	41	LABFORCE does not Granger Cause PERCAPITA
0.86424	0.14650		PERCAPITA does not Granger Cause LABFORCE
0.80192	0.22210	41	HEALTH does not Granger Cause PERCAPITA

0.00026	10.4772		PERCAPITA does not Granger Cause HEALTH
0.53721	0.63222	41	EDUCATIO does not Granger Cause PERCAPITA
0.01119	5.10272		PERCAPITA does not Granger Cause EDUCATIO
0.49323	0.72083	41	AGRICULT does not Granger Cause PERCAPITA
0.05385	3.17207		PERCAPITA does not Granger Cause AGRICULT
0.84467	0.16961	41	INVEST does not Granger Cause PERCAPITA
0.85778	0.15406		PERCAPITA does not Granger Cause INVEST

Regression result

Dependent Variable: PERCAPITA
Method: Least Squares
Date: 09/10/14 Time: 06:15
Sample(adjusted): 1971 2012
Included observations: 42 after adjusting endpoints

Prob.	t-Statistic	Std. Error	Coefficient	Variable
0.0956	-1.711669	2978.909	-5098.905	C
0.0026	3.234786	0.002080	0.006729	D(LABFORCE)
0.1219	-1.584199	0.274148	-0.434305	HEALTH
0.0001	4.363776	0.182180	0.794995	EDUCATIO
0.0285	-2.282458	0.150221	-0.342874	AGRICULT
0.7178	-0.364301	5967.312	-2173.901	INVEST

18713.78	Mean dependent var	0.908222	R-squared
24597.36	S.D. dependent var	0.895476	Adjusted R-squared
20.93189	Akaike info criterion	7952.385	S.E. of regression
21.18013	Schwarz criterion	2.28E+09	Sum squared resid
71.25055	F-statistic	-433.5698	Log likelihood
0.000000	Prob(F-statistic)	1.653179	Durbin-Watson stat

The t-statistics of the regression result

Variable	t-Statistic	Prob
LABFORCE	3.234786	0.0026
HEALTH	-1.584199	0.274148
EDUCATIO	4.363776	0.9243
AGRICULT	-2.282458	0.0001
INVEST	-0.364301	0.0285
		0.7178

Autocorrelation result

Date: 09/10/14 Time: 06:34
Sample: 1970 2012
Included observations: 43

<table>
<tr><th>Prob</th><th>Q-Stat</th><th>PAC</th><th>AC</th><th></th><th>Partial Correlation</th><th>Autocorrelation</th></tr>
<tr><td>0.000</td><td>40.270</td><td>0.935</td><td>0.935</td><td>1</td><td>. |*******|</td><td>. |*******|</td></tr>
<tr><td>0.000</td><td>75.566</td><td>-0.074</td><td>0.865</td><td>2</td><td>.*| . |</td><td>. |*******|</td></tr>
<tr><td>0.000</td><td>106.47</td><td>0.001</td><td>0.799</td><td>3</td><td>. | . |</td><td>. |****** |</td></tr>
<tr><td>0.000</td><td>132.33</td><td>-0.135</td><td>0.722</td><td>4</td><td>.*| . |</td><td>. |****** |</td></tr>
<tr><td>0.000</td><td>152.65</td><td>-0.139</td><td>0.632</td><td>5</td><td>.*| . |</td><td>. |***** |</td></tr>
<tr><td>0.000</td><td>167.21</td><td>-0.174</td><td>0.528</td><td>6</td><td>.*| . |</td><td>. |**** |</td></tr>
<tr><td>0.000</td><td>178.17</td><td>0.171</td><td>0.452</td><td>7</td><td>. |*. |</td><td>. |*** |</td></tr>
<tr><td>0.000</td><td>185.32</td><td>-0.201</td><td>0.360</td><td>8</td><td>**| . |</td><td>. |*** |</td></tr>
<tr><td>0.000</td><td>188.73</td><td>-0.210</td><td>0.245</td><td>9</td><td>**| . |</td><td>. |** |</td></tr>
<tr><td>0.000</td><td>190.20</td><td>0.146</td><td>0.158</td><td>10</td><td>. |*. |</td><td>. |*. |</td></tr>
<tr><td>0.000</td><td>190.66</td><td>0.034</td><td>0.087</td><td>11</td><td>. | . |</td><td>. |*. |</td></tr>
<tr><td>0.000</td><td>190.67</td><td>-0.118</td><td>0.013</td><td>12</td><td>.*| . |</td><td>. | . |</td></tr>
<tr><td>0.000</td><td>190.86</td><td>0.089</td><td>-0.055</td><td>13</td><td>. |*. |</td><td>. | . |</td></tr>
<tr><td>0.000</td><td>191.59</td><td>0.016</td><td>-0.105</td><td>14</td><td>. | . |</td><td>.*| . |</td></tr>
<tr><td>0.000</td><td>192.67</td><td>0.076</td><td>-0.125</td><td>15</td><td>. |*. |</td><td>.*| . |</td></tr>
<tr><td>0.000</td><td>194.18</td><td>0.049</td><td>-0.145</td><td>16</td><td>. | . |</td><td>.*| . |</td></tr>
<tr><td>0.000</td><td>196.22</td><td>-0.041</td><td>-0.166</td><td>17</td><td>. | . |</td><td>.*| . |</td></tr>
<tr><td>0.000</td><td>198.89</td><td>-0.240</td><td>-0.186</td><td>18</td><td>**| . |</td><td>.*| . |</td></tr>
<tr><td>0.000</td><td>202.28</td><td>-0.027</td><td>-0.205</td><td>19</td><td>. | . |</td><td>**| . |</td></tr>
<tr><td>0.000</td><td>206.54</td><td>-0.031</td><td>-0.225</td><td>20</td><td>. | . |</td><td>**| . |</td></tr>
</table>