Workers Health Status and Economic Productivity

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This study analyzes the economic impact of Nigerian labour force health status, proxy by malaria prevalence and HIV/AIDS, on economic productivity. It adopts the Ordinary Least Squares (OLS) regression method on data from 1988 to 2012 to explain the relationship between economic productivity of labour and their health status. HIV/AIDS was found to have a negative and significant relationship with economic productivity implying that the more people suffer from this disease, the less their economic productivity and this will impact the economic growth of the nation. Malaria prevalence as a measure of morbidity was discovered to be positively related to economic productivity. This may not be unconnected with the fact that Nigerians are becoming increasingly aware of the role mosquitoes play in the transmission of the disease and have therefore devised various ways of preventing the scourge. We recommend from these that more attention be paid to the health of the population especially the labour force since they are the economically active population that could contribute to economic growth.

Introduction
Health has been defined as the state of complete physical, social, mental and spiritual well-being and not merely the absence of diseases or infirmities in the body. The absence of health could impair the normal functioning and performance of an individual at work or home. Productivity on the other hand is an important driver of standard of living and it can be defined as an index that measures output (goods and services) relative to the input (labour, materials, energy, etc.) used to produce the output. Arising from this is the issue of whether the health status of workers affects their productivity.

Health is an important possession of every human being and it is very vital for both cognitive and physical development. Thus, the state of health of an individual or a group of people is very crucial to their personal development as well as the economic growth of the nation. A nation devoid of good health status of her labour force could find it difficult to attain its desired level of economic growth and development. Every
living person at one point or the other has a health status which can be described as either perfect or imperfect condition. A perfect condition of health enhances economic productivity while an imperfect health status can impair the economic productivity of an individual.

Health status plays an important role in economic development and poverty reduction. A healthier workforce is likely to be physically and mentally more energetic, which could be an asset to the nation. Good health impacts on output by boosting people’s capacity for work and thus increasing productivity. This consequently enhances their ability to take risks, invest and participate in production processes. On the other hand, unhealthy workers are unable to produce enough goods and services to earn a decent livelihood hence poverty and consequently malnutrition which further worsens their health status.

Productivity is an important driver of the standard of living of the population, because real income can only be increased in the long run if real output produced also increases. Measures of productivity growth constitute core indicators for the analysis of economic growth. Productivity is often associated with higher wages, increased output among other things, which brings to life a new world of possibilities for the workers. However, increase in workers’ earnings lead to higher purchasing power, which in turn leads to better standard of living of the labour force. With high productivity, a country is able to meet the fiscal pressures of aging population implying that there is possibility for increased health care funding. This in turn means workers can benefit from increased leisure, which could be vital for the cognitive and physical development of the labour force.

Productivity growth is very vital for economic growth and development of a nation. Economic productivity of workers deals with how much output can be generated from a given level of inputs by the labour force at a given period of time. The importance of productivity measurement in an economy cannot be overemphasized. It helps to trace technical change, to determine the efficiency of the adopted inputs in the production process, to identify the real cost of savings in production, serves as benchmarks in production processes and also a key element towards accessing standards of living. Labour productivity affects growth in output and therefore, there is a need to understand the determinants of labour productivity. Some of the traditional determinants of labour productivity are education, training, quantity and quality of complementary inputs of labour, health human capital, physical capital, technology, etc.

While it is intuitively obvious to establish the relationship between individual’s health status and labour supply and also the decision by individual to participate in the labour force, it is however difficult to categorically ascertain the relationship between health status and productivity. Comparatively, there are considerable researches in the developed countries to show that poor health status may have adverse impact on a country’s productivity level, growth and ultimately its economic development. However, same cannot be said of most developing countries, especially in sub-Saharan Africa, where such studies are either missing or have received very little attention.

Given the labour-intensive nature of Nigeria’s production technology, identifying the importance of having a healthier workforce and maximizing the productive benefits of good health is essential in the process of economic growth and development. Human well-being is unarguably an end in itself, but an understanding of the complex relationships between health status and economic productivity is important for proper priority setting and policy implementation. This study will not only estimate the country’s total factor productivity but will further explore the link between health status indicators as determinants of economic productivity in Nigeria.
Literature Review

The earliest studies on the relationship between health status and labor market outcomes were based on the efficiency wages hypothesis pioneered by Leibenstein (1957) and modified over the years by other researchers. However, this approach has some weaknesses which led to the development of human capital theory that conceptualizes health as an element of human capital in the process of economic and human development. Ghatak (2010) revealed that the human capital theory shows that health has pervasive effects on wage earnings, participation, hours worked, retirement, job turnover, benefits packages and productivity. He argued further that the economic value of health lies in the effect it has on the individual workers' level of productivity.

Both Cai and Kalb (2004) and Weil (2007) adopted the human capital theory to study economic growth and also explain economic productivity. They estimated the relationship between health and economic growth and considered health as a peculiar form of human capital. Thus, health has since become a regular factor of production where output is now assumed to be correlated with improvements in health status. It can be argued that higher stock of health enhances economic growth by facilitating technological innovation and/or adoption. Hence, productivity growth is expected to be positively correlated with the level of health, particularly with the initial or average level of life expectancy in a given country.

Gouveia (1997) had earlier reported that human factors such as health, education and training embodied in the labor force now accounts for much of economic growth that was formerly attributed to physical capital. Expenditure on health and education were identified as not only consumption expenditure but more as investment expenditure that contributes to the productive capacity of the economy. In providing useful insight into modeling the two key aspects of human capital (health and education), and their relationships to labor supply, earnings and productivity; Tompa (2002) adopted human capital theory to relate health status to labor based on the idea that increase in the stock of knowledge and health of the working population increases the level of productivity both in market and non-market activities. This suggests a relationship between the health status of workers and their economic productivity.

However, Aghion, Howitt and Murtin (2010) in their study opined that there are at least three channels to establish that workers' health status is important to economic growth. First, higher life expectancy is likely to translate to higher domestic and national savings which in turn implies higher capital accumulation which again feeds back to higher economic growth. Second, higher life expectancy could imply higher investment in education (individually or by the parents) which implies higher human capital formation which is also expected to translate to growth. Thus, improvements in health raise the incentive to acquire schooling since investments in schooling can be amortized over a longer working life. Third is that, better health could imply higher productivity, more creativity and better adaptation to technologies. Healthier people are better workers. They can work harder and longer, and also think more clearly.

To estimate the impact of workers' health status on productivity, various methods of estimation like ordinary least squares (OLS) estimation technique, two-stage least square (2SLS) regression, Granger causality test and co-integration analysis have been used by various researchers.

Sachs and Warner (1997a) adopted OLS estimation technique and concluded that health human capital (proxy life expectancy for health status) increases economic growth at a decreasing rate. McCarthy, Wolf and Wu (2000) used descriptive statistics and OLS to investigate the prevalence of malaria as one of the most infectious and challenging diseases affecting the developing countries. Gallup and Sachs (2001) however investigated the quantitative impact of incidence of one disease—malaria on cross-
country macroeconomic growth by adopting the OLS estimation technique and controlling for variables such as tropical location, location in Africa, life expectancy at birth, trade policy, geographical accessibility to international trade and initial income. Finally, Malik (2006) adopted the same OLS technique to estimate the relationship between health status and economic growth.

In a study by Arora (2001), both OLS and two-stage least square regression were employed to investigate the significant effect of health indicators on gross national income and economic growth. Bloom and Canning (2000, 2003) adopted the OLS and non-linear two stage techniques of estimation and proxy life expectancy as health status, using a cross country growth data to determine how significant health status can impact the rate of economic growth in the countries under study. To analyze the cost of poor health and the economic benefits of improving health status on the economic growth of Estonia, Tallium (2006) adopted both OLS and fixed effect specifications in carrying out the estimates on the labour supply and labour productivity at the individual level.

To examine the impact of health status on economic growth in Latin America generally, and specifically in Brazil and Mexico, Mayer (2001) adopted the Granger causality test. Bloom, Canning and Sevilla (2004) on their own used the two-stage Least Square technique and co-integration analysis to estimate the relationship between human capital and income. In the same spirit, to analyze the long term impact of health on economic growth in Pakistan; Akram, Haq Padd and Khan (2006) also used the Granger causality test and co-integration analysis. Their study also used life expectancy, population per bed and mortality rate as proxies for health status.

Finally, recent contribution by Umoru and Yaqub (2013) towards finding the effect of health capital on labour productivity in Nigeria adopted the generalized method of moment’s (GMM) estimation technique. Findings from their study aligned with several findings that health capital investment is a significant determinant of labour productivity.

We submit therefore that higher life expectancies and low levels of disease both tends to stimulate economic growth through accelerating the demographic transition, promoting investments in human capital, increasing household savings, and thus augmenting domestic and foreign investment and greater social and macroeconomic stability.

Empirically, using life expectancy at birth, at ages five, ten, fifteen, or twenty, and structure of adulthood as proxy for health status, Arora (2001) concluded that improvement in health status has increased the pace of long-term economic growth by 30-40% and that high rate of disease prevalence and deaths are among the main reasons for poor long-term growth in developing countries. In the same spirit, Alleyne and Cohen (2002) in their study found that a 5-year increase in life expectancy, if translated into 5 additional years in the workforce, could raise labour productivity by 15%, which is about half the value predicted by the macro studies. They submitted that good health, proxy by life expectancy, has a direct bearing on workers’ productivity. Also, Guillem, Rivera and Currais (2004) found out that improvement in health status accounted for about 11% of countries’ economic growth during the period 1960-2000 while Barro (1997), holding other variables constant, concluded that a 10% increase in life expectancy could raise economic growth by 0.4% yearly for the subsequent decades.

According to the World Bank (1993), diseases may permit individuals to work but it reduces their productivity, shorten their working lives, and increase the numbers of working days lost due to illness. In the light of this, Hempel and Najera (1996) summarized that the bout of non-fatal malaria infection, which can be experienced for about one or two bouts a year, will last for about 10 to 14 days, including 4 to 6 days of total incapacitation with other days being characterized by headaches, fatigue and nausea leads to loss of labour
time, reduced economic productivity and reduction in economic output. They concluded that workers with bouts of malaria in Indonesia are 20% less productive than those who were not infected, and treated of malaria.

Two separate studies by Gallup and Sachs (2001) and McCarthy, Wolf and Wu (2000) have similar conclusions on the impact of prevalence of malaria on economic growth. These studies found significantly negative relationship between malaria morbidity and economic growth rates. Gallup and Sachs (2001) estimated that the effect of a country having intensive malaria was to lower its economic growth and that a 10% reduction in malaria incidence would result in 0.3% increase in the growth rate of per capita GDP. McCarthy, Wolf and Wu (2000) on their part concluded that malaria prevalence have an impact on economic growth of about 0.25% per year for around one quarter of the sample used.

In an agreement with the fact that burden of diseases makes workers weak, unable to work or study (to acquire more knowledge and education) and negatively impacts economic productivity, Cole and Neumayer (2005) estimated that a 1% increase in malaria incidence will reduce total factor productivity by between 0.58% and 0.75% and reducing the amount of labour supplied. Alleyne and Cohen (2002) conducted their study using malaria as a proxy for health status reported that between 1965 and 1990, countries with high transmission of malaria experienced an average loss of 0.4% per capita GDP growth in a year, while an average growth rate of 2.3% per year will be experienced in countries with low malaria transmission. Asante and Asenso-Okyere (2003), adopting a production function approach revealed that the impact of malaria on the growth in real GDP is negative and decreases (-0.41%) for every increase in the malaria morbidity rate.

Bjargava, Jamison, Lau and Murray (2001) and Weil (2001), in their different studies to find out the relationship between health status and economic growth, used adult survival rate as an indicator of health status, found out similar results. While, Bjargava, et.al (2001) found out a significant relationship between health status and economic growth even when adult survival rate is replaced by life expectancy, Weil (2001) submitted that a one percentage point increase in adult survival rates translates into a 1.68 percent increase in labor productivity. The study of the analysis of productivity effects of health human capital conducted by Umoru and Yaqub (2013) indicated that a 10% point increase in the size of the healthy-labour force is associated with 0.6 percent rise in the productivity of labour for a given disequilibrium in the aggregate production function.

In sum, a number of studies on the importance of health status to labour productivity and economic growth have used different health indicators as well as various estimation techniques to reach different conclusions. However, this study will focus on two major health issues threatening the developing countries especially the Sub-Saharan Africa, which are prevalence of malaria as a measure of morbidity and HIV/AIDS. We shall also extend the estimation technique by adopting the Error Correction Model (ECM) as an improvement to further establish the health-productivity linkage in Nigeria.

**Theoretical Framework**

The economic theory that serves as basis for this study can be formulated from production theory through the concept of human capital theory and linked with the analysis of economic productivity and growth. Under some simplifying assumptions (producers behave efficiently, i.e. they minimize costs and/or maximize revenues, markets are competitive, and market participants are price-takers who can only adjust quantities but not individually act on market prices), production theory states that outputs are generated from the transformation of inputs in the process of production.
In the main therefore, the Cob-Douglas aggregate production function can be explicitly expressed as:

\[ Y_t = K_t^\alpha H_t^\delta A_t^\lambda L_t^{\beta} \]

where, \( 0 < \alpha < 1, 0 < \delta < 1 \) and \( 0 < \lambda < 1 \) (1)

where \( Y \) represents real gross domestic product (RGDP), \( A \) an index of productivity, \( K \) represents physical capital stock, \( H \) represents human capital (proxy by education) and \( L \) is the labour force. The addition of the share of the inputs in the production process \( (\alpha + \delta + \lambda) \) is not restricted to be equal to one and this is to allow for the possibility of increasing or decreasing returns to scale.

In an attempt to properly capture total factor productivity, the aggregate production function is divided by the total labour force and this yields:

\[ y_t = A_t k_{t}^{\alpha} h_{t}^{\delta} l_{t}^{\lambda} \]

(2)

From equation (2) above, \( y, k \) and \( h \) represent the real output, physical capital and human capital per worker respectively, and \( A \) can be assumed as the measure of total factor productivity, which is measured by the technological index of the country. By expressing equation (2) in natural logarithm form, it explicitly leads to a linear aggregate production function which is thus depicted as follows:

\[ \ln y_t = \ln A_t + \alpha \ln k_t + \delta \ln h_t + (\alpha + \delta + \beta - 1) \ln l_t \]

(3)

The returns to scale of the production function can be determined by the coefficient on \( \ln l_t \). The subscript \( t \) denotes the year. Expressing equation (3) in an econometric model directly leads to the following estimable equation:

\[ \ln y_t = \theta_t + \alpha \ln k_t + \delta \ln h_t + (\alpha + \delta + \beta - 1) \ln l_t + \varepsilon_t \]

(4)

The measure of total factor productivity is the summation of the constant and stochastic terms \( (\theta_t + \varepsilon_t) \) in equation (4), which is assumed to be equivalent to \( \ln A_t \) in equation (3).

Having determined the total factor productivity (TFP) index from equation (4) above, we are left with identifying the determinants of TFP in the country by relating it to the selected health status variables. Existing theory on productivity has not provided a particular specification in determining the drivers of total factor productivity for an economy (Akinlo, 2006). However, some determinants of total factor productivity have been suggested in various productivity/growth studies. For instance, Senhadji (1999) defines five types of determinants: (a) the endowments in labour, capital and human capital; (b) the terms of trade; (c) the macroeconomic environment; (d) the trade regime; and (e) the political stability. Miller and Upadhyay (2000) suggested trade openness and inflation rate as determinants of total factor productivity. Based on the availability of data and the important roles some of these variables play in the Nigerian economy, the study adopts health status; trade openness; inflation rate and agriculture value added as the main determinants of total factor productivity in the country. Thus, the total factor productivity function for Nigeria follows the equation below:

\[ TFP = f(HLTH, TRAD, INFLR, AGRC) \]

(5)

Where, TFP is total factor productivity, HLTH is health status, TRAD is trade openness, INFLR is inflation rate and AGRC is agricultural sector value added. The explicit natural logarithm equation to estimate the determinants of total factor productivity is as follows:

\[ \ln TFP_t = \theta_t + \theta_1 \ln X_t + \theta_2 \ln TRAD_t + \theta_3 \ln INFLR_t + \theta_4 \ln AGRC_t + \varepsilon_t \]

(6)
where $\theta$ is the constant term, $X$ denotes indicators of health status (proxy by prevalence of malaria and incidence of HIV/AIDS) and $\varepsilon$ is the error term.

**Methodology**

Measures of productivity growth constitute core indicators for the analysis of economic growth. However, there are many different approaches to productivity measurement and their calculation and interpretation requires careful consideration. While different authors have adopted different means, this study will adopt the Ordinary Least Square (OLS) Multiple Regression Analysis method to estimate the total factor productivity and Error Correction Model to analyze the relationships existing between workers’ health status and economic productivity. The estimation technique follows a three-step modeling procedure and error correction model to determine the long run dynamics of the model.

**Unit Root Test:** Since time series data are assumed to be non-stationary, we carry out the unit root and stationarity of the series using the Augmented Dickey Fuller (ADF) and Phillips-Perron tests.

**Regression:** A least square linear regression model will be estimated to determine the total factor productivity and also for impact estimation. This will investigate the impacts of the selected health indicators as well as other identified determinants of total factor productivity within the economy.

**Co-integration:** The co-integration technique will be conducted to ascertain if the variables adopted in this study have common stochastic trend and to determine the relationships that exist between the variables. The basic assumption of the technique is that the co-integrating vector is unique, bounding to a model that is a linear combination of independent co-integrating vectors.

**Error Correction Model:** This is the final specification, which involves a short run dynamic process, consistent with data and converging to the long run equilibrium. The Error Correction Model (ECM) attempts to integrate economic theory useful in characterizing long run equilibrium with observed disequilibrium by building a model that explicitly incorporates behaviour that would restore equilibrium. Error Correction Mechanism has the co-integrated relations built into the specification so that it restricts the long-run behaviour of the endogenous variables to converge to their co-integrating relationships while allowing for short-run adjustment dynamics. The Error Correction Model (ECM) is the one-period lagged value of the residual from a static model.

Having established the co-integration relationships among variables, an over-parameterized error correction model will be estimated which consist of lag length for each variable. The over-parameterized error correction model estimated is given in the equation below:

$$\Delta Y_t = \alpha_0 + \alpha_1 X_t + \alpha_2 (Y - \beta_1 X)_{t-1}$$

In equation (7) above; the dependent variable, $Y$, is total factor productivity; $X$ is a vector of independent variables including health status indicators (prevalence of malaria and incidence of HIV/AIDS), trade openness, inflation and agriculture value added. All these were found to be co-integrated with the dependent variable, while $(Y - \beta_1 X)_{t-1}$ are stationary residuals from that co-integration static model. Following the “general to specific” modeling methodology, the over-parameterized model was continually simplified and re-parameterized by removing variables with low explanation until a parsimonious and encompassing representation of the data generation process was obtained with the choice of optimum lag length guided by the *Akaike and Schwarz Information Criteria*. 

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Data and Data Sources
Time series secondary data on Nigeria from 1988 to 2012 was employed for this study and were obtained from the World Bank data bank, African Development Indicators (ADI), National Bureau of Statistics and the Central Bank of Nigeria Statistical Bulletin. The variables used for the study are described in Table 1 below:

Table 1: Description of variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Description</th>
<th>Variable Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real GDP</td>
<td>GDP at 1990 constant prices</td>
<td>Dependent</td>
</tr>
<tr>
<td>Physical Capital</td>
<td>Gross fixed capital formation</td>
<td>Explanatory</td>
</tr>
<tr>
<td>Labour Force</td>
<td>Working population, economically active population</td>
<td>Explanatory</td>
</tr>
<tr>
<td>Human Capital</td>
<td>Senior Secondary School Certificate Completion</td>
<td>Explanatory</td>
</tr>
<tr>
<td>Prevalence of Malaria</td>
<td>Malaria infections clinical reported cases</td>
<td>Explanatory</td>
</tr>
<tr>
<td>Incidence of HIV/AIDS</td>
<td>Prevalence of HIV/AIDS, percentage of population ages 15-49 years</td>
<td>Explanatory</td>
</tr>
<tr>
<td>Trade Openness</td>
<td>Ratio of export and import to the GDP</td>
<td>Explanatory</td>
</tr>
<tr>
<td>Inflation Rates</td>
<td>Consumer Price Index (CPI)</td>
<td>Explanatory</td>
</tr>
<tr>
<td>Agriculture value added</td>
<td>Share of agriculture value added in the GDP</td>
<td>Explanatory</td>
</tr>
</tbody>
</table>

Table 2: ADF and PP unit test results for stationarity of variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Level</th>
<th>ADF</th>
<th>PP</th>
<th>First Difference</th>
<th>ADF</th>
<th>PP</th>
<th>I(d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RGDP</td>
<td>I(1)</td>
<td>-2.95**</td>
<td>-2.99**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical Capital</td>
<td>I(1)</td>
<td>8.95**</td>
<td>-5.49*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human Capital</td>
<td>I(0)</td>
<td>-3.03**</td>
<td>-8.88*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour Force</td>
<td>I(1)</td>
<td>-3.20**</td>
<td>-3.29**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malaria</td>
<td>I(1)</td>
<td>-6.13*</td>
<td>-6.16*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIV/AIDS</td>
<td>I(0)</td>
<td>-2.69**</td>
<td>-3.05**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trade Openness</td>
<td>I(0)</td>
<td>-3.53**</td>
<td>-5.73*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inflation Rate</td>
<td>I(1)</td>
<td>-5.97*</td>
<td>-4.53*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agriculture Value added</td>
<td>I(0)</td>
<td>-4.85*</td>
<td>-3.80*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTE: * and ** imply significant at 1% and 5% respectively.

Empirical Analysis
The results of the unit root test conducted on the variables, as shown in Table 2 below, revealed that the model is with constant but without deterministic trend. The null hypothesis for ADF and PP is that an observable time series is not stationary (i.e. has unit root). As shown in Table 2, both the Augmented Dickey Fuller (ADF) and the Phillips-Perron (PP) tests of unit root suggest that all the variables included in the model are stationary at either level (human capital, trade openness, agriculture value added and HIV/AIDS) or after the first difference (RGDP, physical capital, labour force, malaria and inflation rate), at different levels of significance.
Total Factor Productivity Regression Analysis
Adopting the estimation method of Cole and Neumayer (2005) in deriving the total factor productivity value, we estimated our total factor productivity through the summation of the constant and stochastic terms in the regression analysis of Cobb-Douglas aggregate production function. The regression estimate is presented in Table 3 below:

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>3.33(0.000)</td>
<td>0.428</td>
</tr>
<tr>
<td>Ln(k)</td>
<td>0.21(0.021)</td>
<td>0.083</td>
</tr>
<tr>
<td>Ln(h)</td>
<td>-0.08(0.537)</td>
<td>0.126</td>
</tr>
<tr>
<td>ln(L)</td>
<td>1.42(0.005)</td>
<td>0.456</td>
</tr>
<tr>
<td>R^2</td>
<td>0.901424</td>
<td>Adjusted R^2 = 0.887342</td>
</tr>
</tbody>
</table>

Note: P-value in parentheses

From Table 3, the coefficient of physical capital was 0.21, which shows the elasticity of output with respect to the stock of capital, while human capital with coefficient -0.08 is equivalent to the inelasticity for human capital to output. As indicated earlier, the coefficient 1.42 of ln(L), which indicates the returns to scale of the production function, shows that the production function exhibits an increasing returns to scale type of production process.

Co-integration Test
In order to further establish if the non-stationary variables in the model are co-integrated, since we have the variables to be I(0) and I(1) from the unit root test, the Johansen test was conducted.

Table 4 below shows the co-integration test. From the result, it was discovered that there are at least two co-integration equations at 5% significance level in the model. This suggests a long-run equilibrium among the variables included in the model. That is, the variables, natural logarithm of total factor productivity, HIV/AIDS, malaria, inflation, agriculture value added and trade openness can move together into the long-run. Since long-run equilibrium condition serves as the precondition for short-run analysis through the Error Correction Model, we thereby turn to the next section in the consideration of the latter.

Error Correction Model
The model short-run dynamics exhibits co-integration, which could lead to spurious regression, in order to correct for this, an Error Correction Model (ECM) is adopted. ECM incorporates one period lagged residual from the static regression; the autoregressive distributed lag technique was used to obtain an over-parameterized equation. The parsimonious result, shown in Table 5, was obtained through the process of sequential reduction.

All the variables considered in determining the impact of workers health status and other determinants of total factor productivity are significant and have hypothesized signed except for lagged value of HIV/AIDS, malaria, inflation and trade openness, which have different signs from the a priori expectation.

The regression result of the ECM shows that the standard criteria of the coefficient of the ECM which should be negative and the P-value which should also be significant were met and these values support the fact that there is a co-integrating relationship between the variables. The coefficient indicates the speed of adjustment of about -0.44, which implies that in the short run disequilibrium, 44% of the adjustment to the long run takes place within one year period. The coefficient of determination relating to the goodness of fit, measured by both R^2 (0.889800) and the adjusted R^2 (0.755110) are good. These values mean that the explanatory variables in the model are powerful in explaining the dependent variable. The F-statistics and
Table 4: Johansen Co-integration Test for Total Factor Productivity Equation
Series: TFP HIV_AIDS MALA TRAD INFR AGRC
Lags interval (in first differences): 1 to 1
Unrestricted Co-integration Rank Test (Trace)

<table>
<thead>
<tr>
<th>Hypothesized No. of CE(s)</th>
<th>Eigenvalue</th>
<th>Trace Statistic</th>
<th>0.05 Critical Value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>None *</td>
<td>0.907136</td>
<td>145.4866</td>
<td>95.75366</td>
<td>0.0000</td>
</tr>
<tr>
<td>At most 1 *</td>
<td>0.885279</td>
<td>90.82432</td>
<td>69.81889</td>
<td>0.0004</td>
</tr>
<tr>
<td>At most 2</td>
<td>0.527025</td>
<td>41.02358</td>
<td>47.85613</td>
<td>0.1879</td>
</tr>
<tr>
<td>At most 3</td>
<td>0.499732</td>
<td>23.80320</td>
<td>29.79707</td>
<td>0.2089</td>
</tr>
<tr>
<td>At most 4</td>
<td>0.260208</td>
<td>7.873149</td>
<td>15.49471</td>
<td>0.4791</td>
</tr>
<tr>
<td>At most 5</td>
<td>0.040099</td>
<td>0.941281</td>
<td>3.841466</td>
<td>0.3319</td>
</tr>
</tbody>
</table>

Trace test indicates 2 co-integrating equation(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

Table 5: Parsimonious Result from Error Correction Model
Dependent Variable: D(TFP)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>D(INFR)</td>
<td>0.078091</td>
<td>0.033148</td>
<td>2.355820</td>
<td>0.0429</td>
</tr>
<tr>
<td>AGRC</td>
<td>0.003182</td>
<td>0.000788</td>
<td>4.039943</td>
<td>0.0029</td>
</tr>
<tr>
<td>C</td>
<td>-0.053352</td>
<td>0.054444</td>
<td>-0.979946</td>
<td>0.3527</td>
</tr>
<tr>
<td>ECM2(-1)</td>
<td>0.435708</td>
<td>0.140925</td>
<td>3.091768</td>
<td>0.0129</td>
</tr>
<tr>
<td>HIV_AIDS(-1)</td>
<td>-0.082248</td>
<td>0.030292</td>
<td>-2.715226</td>
<td>0.0238</td>
</tr>
<tr>
<td>D(TRAD(-1))</td>
<td>-0.011500</td>
<td>0.002556</td>
<td>-4.499150</td>
<td>0.0015</td>
</tr>
<tr>
<td>AGRC(-1)</td>
<td>-0.001668</td>
<td>0.000632</td>
<td>-2.640450</td>
<td>0.0269</td>
</tr>
<tr>
<td>HIV_AIDS(-2)</td>
<td>0.048147</td>
<td>0.021010</td>
<td>2.291586</td>
<td>0.0477</td>
</tr>
<tr>
<td>D(MALA(-2))</td>
<td>0.004711</td>
<td>0.012809</td>
<td>0.367757</td>
<td>0.7216</td>
</tr>
<tr>
<td>D(INFR(-2))</td>
<td>0.025948</td>
<td>0.026358</td>
<td>0.984468</td>
<td>0.3506</td>
</tr>
<tr>
<td>AGRC(-2)</td>
<td>0.003289</td>
<td>0.000907</td>
<td>3.626886</td>
<td>0.0055</td>
</tr>
<tr>
<td>D(TFP(-3))</td>
<td>0.022122</td>
<td>0.171246</td>
<td>0.129186</td>
<td>0.9001</td>
</tr>
<tr>
<td>R-squared</td>
<td></td>
<td>0.889800</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted R²</td>
<td></td>
<td>0.755110</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Standard Error of Regression 0.011142
F-Statistic 6.606304
Prob. (F-Statistic) 0.004250
Akaike info criterion -5.860706
Schwarz criterion -5.263836
Durbin-Watson stat 2.531698
its probability show that the model is well specified while the Durbin Watson value shows that there is negative correlation in the model specification.

In line with the focus of this study, the ECM result indicated that malaria as an indicator of health status has a different sign from the hypothesized signs. This means that malaria has a positive relationship with total factor productivity. This result contrast the findings of Gallup and Sachs (2001) and Cole and Neumayer (2005) among others that malaria negatively influences economic productivity and economic growth. This could be because majority of the working population are in the informal sectors and who will not eat if they don’t go to work hence with malaria attack, most of them will still go to work. It might also not be unconnected with the various efforts both by the Federal Government and different international donors at eradicating the scourge of malaria endemic in the whole of African and Sub-Saharan African countries. It may also be due to the fact that Nigerians, especially rural dwellers where accessing medical care is difficult, have developed various traditional means of combating malaria infections.

HIV/AIDS has been of great concern to the whole world and most especially the Sub-Saharan African countries, where it is believed to be on the increase on a daily basis despite all efforts to curtail the spread of the virus. In line with the apriori expectation, we found out that HIV/AIDS is negatively related to total factor productivity in Nigeria in the present period but was positively related to the estimated lagged value. This we believe may be connected to the fact the most sexually active age group falls within the working population and unfortunately, this group of people are the most affected age brackets with this deadly disease. Also, it is our believe that the perception of people about HIV/AIDS in the country as a death sentence contributes a lot to the negative effect it has on the economic productivity of the labour force. The negative relationship between economic productivity and HIV/AIDS may as well be due to depression and stigmatization suffered by the people living with the disease in developing countries as compared with the developed countries, where people are more sensitized and enlightened, because a depressed individual will be less active emotionally and economically, thus leading to loss of output and productivity.

Other determinants included in the model specification, which we believe are of importance to the economic development of the country exhibit the following characteristics. Trade openness exhibited a negative relationship with TFP at level and a statistically significant negative value at the lagged period values. Corroborating the findings of Cole and Neumayer (2005) in a study of the determinants of total factor productivity for African countries, our result shows that the more open the Nigerian economy is, the less her economic productivity. Inflation was found to have a positive relationship at level and an inverse relationship when lagged. This means that the higher the price level in the previous year, the lower the total factor productivity in the following year. For value added by the agriculture sector, we found a negative relationship, though not statistically significant, with total factor productivity. This result agrees with the panel study on both developing and developed countries conducted by Cole and Neumayer (2005).

**Conclusion and Recommendation**

The health status of a country’s population, especially for labour abundant country like Nigeria, is highly essential for high economic productivity. Flowing from this study, we submit as follow:

There are no enough investment in education and even the investment so far are not being properly translated into human capital as obvious in the inelasticity of the coefficient on human capital in the regression of the total factor productivity. This means there is little investment in education in the country and the available educated are not adequately channeled into productive human capital for the economic development of the nation.
Considering the impact of HIV/AIDS on the economic productivity of the workers, we found a negative and significant relationship. This means the more people suffer from this disease, the less their economic productivity and this will impact the economic growth of the nation. Using the prevalence of malaria in the country as a measure of morbidity, we also discovered that malaria is positively related to economic productivity. This may not be unconnected with the fact that Nigerians are becoming increasingly aware of the role mosquitoes play in the transmission of the disease and have therefore devised various ways of preventing it.

From the estimated regression coefficients, we recommend that more attention be paid to the health of the population most especially the labour force since they are the economically active population that could contribute to the economic growth of the country. Government should increase her spending on health care facilities and the expansion of health care to the rural areas. Efforts at combating or eradicating malaria should be intensified through the various programmes such as the roll back malaria programme, encouraging the use of mosquito treated nets, etc.

Government should also devote more funds to orientation and sensitization of the public about HIV/AIDS. Laws should be enactment to protect the rights of people living with the virus to prevent them against stigmatization. Provision of anti-retroviral drugs for the people living with the virus at affordable rates should be a top policy priority.

References


West African Examination Council (WAEC).

