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EFFECTS OF HEALTH ON PRODUCTIVITY OUTCOMES IN SUB-SAHARAN AFRICAN COUNTRIES

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ABSTRACT

This study examined the effects of population poor health status proxied by malnutrition rate and access to safe drinking water on productivity outcomes disaggregated into total factor productivity, labour productivity and economic performance in thirty-three Sub-Saharan African countries. The decline in overall productivity level and human capital accumulation in the sub-region unlike in many other developed regions of the world as a result of incidence of non-fatal undernourishment and water borne diseases which have impaired the productivity of the labour force necessitated the study. The Generalized Method of Moments estimation technique was employed in obtaining the numerical coefficients due to the endogeneity nature of the health variables, after analyzing the descriptive statistics, panel Granger causality tests, the Levin, Lin and Breitung panel unit root tests at levels and differences, the Pedroni and Kao residual cointegration tests were applied to test for the existence of long run relationship among the variables. Data for the study covered the period, 2000-2017 were extracted from the World Development Indicators database of 2018 and Food and Agricultural Organization database of 2018.The empirical results revealed that the health variables were insignificant in determining the sub-region's overall productivity level, positively correlated with Gross Domestic Product growth rate and significantly influences the labour productivity level of the sub-region. The study therefore recommended that Government in the sub-region should implement food policy programmes to ameliorate the high incidence of malnutrition in addition to provision of clean pipe-borne water in areas and communities where water sources are contaminated or potable water is inaccessible due to the direct impact of these health variables on human labour.

Key words: Health, productivity outcome, Generalized Method of Moments, Sub-Saharan Africa

INTRODUCTION

Improving the living standards of a people is one of the core objectives of policy makers around the world. A global benchmark of living standards is the ability of a citizen to earn income and profits from work or economic activity in order to use same to meet his day to day needs. These income and profits earned from employment or other economic activities when aggregated, represent the cumulative worth of the goods and services produced within a country as well as production capacity of the factors of production used in producing them.

As Harris (1999) puts it, although income, level of productivity and living standards are distinct concepts, all three concepts are severely correlated as taken together, they represent the level of productivity or growth rate which translate to the improvement or decline in the living standards of individuals in a country. While most economists agree that human capital is an important factor that significantly impacts economic productivity, the concept (human capital) has mostly been attributed to cover primarily education and skills. However, a body of literature has more recently developed and started paying increased attention to health as an equally important component of human capital (Elsa and Sala-i-Martin, 2003). Improvements in health which improves the quantum of human capital has been identified as a critical catalyst to economic growth and development in macroeconomic literature. Specifically, the neoclassical endogenous growth model posits that, growth in human capital (knowledge) impacts positively on output per worker in the long run (Romer, 1996).

Similarly, Grossman's human capital model suggests that quality health significantly influences human capital development through the additional working time and utility derived good health (Grossman, 1972). Good health does not only improve an individual's consumption and productive capacity in the short run, but it also improves returns from investment in productive activities in the long run Somi et al , 2009). Novignon et al (2012) provided evidence to show that poor health status has significant negative influence on both current and future welfare of households.

The populations of many of the poorest countries in the world suffer from the greatest degree of poor health. Murray and Lopez (2006) estimate the per capita disability adjusted life years (DALYs) lost in various regions of the world due to premature mortality and years lived in disability adjusted for severity. Their study revealed that the estimated figures are lowest in developed countries at about 0.17 DALYs per capita, they range from 0.2 to 0.4 DALYs per capita in various regions of the developing world and reach close to 0.6 DALYs per capita in Sub-Saharan Africa. Some of the world's lowest life expectancies in many cases less than 50 years, are experienced in those Sub-Saharan African countries that typically also suffer from extreme low levels of per capita income, poor health and often negative economic growth rates (Lvovsky, 2001). There have been robust empirical work of the impact of health on economic growth and productivity in developed countries in the literature, however only a few studies like Cole and Neumayer (2004) who used morbidity measures of health have been carried out on developing countries. This paper fills the gap in the literature by examining the morbidity measures of health using access to safe portable water and malnutrition as proxies of health and other control variables on productivity outcome disaggregated into total Factor productivity, labour productivity and growth rate of GDP in thirty three Sub-Saharan African Countries for the period 2000-2017.

The Generalized Method of Moments (GMM) was employed as the estimation technique because it conforms to the estimation techniques used in the literature, it controls for autocorrelation and it solves the problem of endogeneity usually associated with health variables. The rest of this paper is organized as follows: section two addresses the review of empirical literature, section three deals with the theoretical frame work, model specification and methodology employed. Section four focuses on the empirical analysis of the results obtained while section five concludes the paper.

Review of Empirical Literature

In the literature, several studies abound on the relationship between health and economic growth particularly in the developed countries. Few studies on developing economies and country specific cases with positive relationship between health variables and economic growth exist in the literature.

The empirical literature on the impact of health on productivity outcome draws largely from the experience of developed countries. The rich economic history of these countries that have experienced different phases of economic growth provides substantive evidence concerning the productivity impact of increased life expectancy and reduced morbidity over the last few centuries in Europe and the United States (Costa & Steckel 1995).

However, Costa and Steckel (1995) also stresses the importance of long-run dynamics and demonstrated that improvements in health in developed countries which began about two centuries ago in what is now developed countries of Europe and America is still evolving. An understanding of the key drivers of this long-run dynamics would no doubt be relevant for our study on Sub Saharan Africa. To this end, we therefore review some studies from the historical economic literature of these regions in earlier periods as well as a quick review of the empirical evidence from more recent periods.

Fogel (1991) showed that historical trends in countries in Western Europe on two measures related to nutrition, i.e., the height and weight of adults (BMI – Body mass index). These (height and weight) two variables taken together, provide different information about the health of citizens. While adult height reflects the sufficiency of child nutrition at an early age, the weight reflects adequacy in the nutrition of adults. Drawing on evidence from Norway, Fogel (1991) examined records to establish a relationship between the height, weight and risk of mortality among citizens in Norway. Fogel successfully predicted that the decline in the rate of mortality estimates the proportion of the decline in mortality in the country which he attributed to changes in these selected measures since the 18th century.

Umoru and Omolara (2013) also chronicled their findings on the subject. According to the researchers, health capital is both a result and a determinant of labour and hence income level. The study examined the impact of health capital on labour productivity in Nigeria using the generalized method of moment technique and found that health capital has a significant positive relationship with labour productivity. The mechanism is that richer nations have on average healthier workforce. The healthiness of the country's labour force determines importantly, her level of productivity and hence economic growth (Weil, 2004). Labour productivity being the ratio of a volume measure of output to a volume measure of input, uses hours worked, labour force jobs and number of individual employment as measures of inputs.

By intuition, labour productivity will vary as a function of the health capital of the economy amongst other factors of production and the efficiency with which these inputs are utilized. This provides the basis for diversity in labour productivity growth across regions, with production levels showing life-size split between advanced and developing countries. For example, GDP per capita grew fastest in East Europe, followed by Asia, then North America, and Western Europe but lowest in Latin America and Africa (Iverson, 2006). Cole and Neumayer (2006) in their work to determine the impact of poor health on total factor productivity, argued that the link through which health affects growth is via total factor productivity- which is the total usage of capital and labour in the production process.

They identified three indicators of health that are inimical to the growth and development of developing countries as malnutrition, malaria and water borne diseases. However, they found the impact of poor health on total factor productivity to be negative and significant. These three indicators of health have to a large extent, been the bane of development in the African sub region with about 90% of all malaria related deaths in the world occurring in the African Sub region.

A large body of empirical literature on the interactions between health and productivity of the labour force exist. These studies can be divided into those with a micro or individual focus and those with a macro or national focus. The key findings from the micro/individual level research are documented as follows: healthy workers are more productive; healthy workers and family members contribute to output by reducing absenteeism; ill health reduces hourly wages; lower expenditure on health care by households frees up resources for other productive activities like food and education and contributes to development; lower infant and child mortality in households lowers the family size and deepens investment on each child; ill-health generates poverty; income and education are key determinants of health (Gupta, 2006).

The micro links logically translates into macro links between health and productivity and growth. At the aggregate level, Bloom and Canning (2000) identified four pathways by which health can affect productivity namely; a healthy labour force may be more productive because workers have more physical and mental energy and are absent from work less often; individuals with a longer life expectancy may choose to invest more in education and receive greater returns form their investments; with longer life expectancy, individuals may be motivated to save more for retirement, resulting in a greater accumulation of physical capital; and improvement in the survival and health of young children which may in turn provide incentives for reduced fertility and result in an increase in labour force participation leading to increase in per capita income if these individuals are accommodated by the labour market.

With regards empirical evidence on the link between worker health and productivity, Barro and Sala-i-Martin (1995) documented that elasticity of productivity growth with respect to the log of life expectancy range between 0.046-0.082 for 134 countries. Using the log of GDP growth rate per capita as a productivity measure, Bhargava et al. (2001), studied the empirical link between labour productivity and health capital for 125 countries from pen World Tables and 107 countries from World Development Indicators (1965-90); and found that 1 percent change in adult survival rate is associated with a 0.05 percent increase in GDP growth rate. Measuring health capital by log of life expectancy, Bloom, Canning and Sevilla (2001) observed that 0.04 each extra year of life expectancy leads to an increase of 4 percent in productivity growth.

On their part, Knowles and Owen (1995) provide empirical evidence on the correlation between health capital (log of 80 years less life expectancy at birth) and labour productivity for 84 countries. According to these authors, elasticity of productivity growth with respect to log difference of GDP per working age person is respectively 0.381, 0.382, and 0.03.

Bound (1991) used labour force participation as a productivity measure and self-reported health status relative to those of same age with date of death as instrument for health limits. Bound's empirical evidence indicated that ill-health affected labour market participation of workers and that of caring Household members.

Theoretical Framework and Model Specifications

The endogenous growth model explains that balanced growth is positively influenced by knowledge spillover, human capital (in the form of health and education), research and development (R&D), through their influence on the technical progress. Technological progress in this model is therefore endogenised and can be explained by some factors. Based on this model Lucas (1988) put forward an endogenous growth model where human capital is a major driver of output growth. Lucas theorized that economic growth Y is a function of capital stock (K), labour productivity (A) and labour units (L). The production function may be of the form:

$Y_{(t)} = K_{(t)}^{\alpha}(A_{(t)}L_{(t)}^{1-\alpha}$ - - - - - - - - - - 3.1

Where A(t)L is effective labour with α and (1-α) as relative shares of K and AL respectively in output. Now with the technical progress or labour productivity (A) being entirely explained by the stock of human capital, say H, that is, human capital increases labour productivity

$A=H$ - - - -- - - - - - - - 3.2

Consider an economy where population does not grow, i.e. n = 0 [where n is the growth rate of the population], there are constant returns to scale to the produced inputs in both goods and research sectors. Furthermore, Research and Development (R&D) uses labour and the existing stock of human capital, but not physical capital, whereas goods production uses labor, human and physical capital. The production function for labour productivity is given by:

$\acute{A}_{(t)} = Ba_lLA_{(t)}$ - - - - - - - - - 3.3

and since all physical capital is used to produce goods, goods production is

$Y_{(t)} = K_{(t)}^{a}[(1-a_1)LA_{(t)}]^{1-a}$ - - - - - - - - 3.4

Where $\acute{A}_{(t)}$ denotes a derivative of labour productivity with respect to time [that is, $\acute{A}_{(t)}$ is a shorthand for $\frac{dA(t)}{dt}$; B is a shift parameter [which accounts for all other factors affecting rate of change of labour productivity other than labour and labour productivity]; a_1 and 1- a_1 denote the fraction of labour used in labour productivity and goods production, respectively; and a represents the elasticity of output with respect to capital stock, while 'L, A, K and Y are labour force, labour productivity, capital stock and output, respectively. Notice that time (t) enters the 'model continuously in line with [the prescriptions of] the endogenous growth theory. The savings rate is assumed to be constant, so that:

$k_{(t)} = sY_{(t)}$ - - - - - - - - - - 3.5

Equation (4.4) is important to this study because it introduced capital stock, labour and labour productivity as (macroeconomic) determinants of output. Since model (3.4) is a mathematical model, we need to change it to an econometric model by exponentially introducing the error term as thus:

$Y_{(t)} = K_{(t)}{}^{a} [(1 — a_1)LA_{(t)}]^{1-a} e^{\mu(t)}$ - - - - - - - 3.6

where $\mu_{(t)}$ is error term, which entered the model exponentially for two main reasons: First, for the model's error term after transformation to follow normal distribution with zero mean and homoscedastic variance, that is $\mu \sim (0,\delta)$, as it is required for valid statistical inference.

If $\mu_{(t)}$ had entered model (3.6) multiplicatively such as in $Y_{(t)} = K_{(t)}{}^{a} [(l - a_l)LA_{(t)}]^{1-a} \mu_{(t)}$, it is then the model's log-error that will follow normal distribution, that is $\ln \mu \sim N(0,\delta^2)$, in which case μ must follow the log-normal distribution with mean $\mathbf{e^{\delta 2/2}}$ and variance $\mathbf{e^{\delta 2}}$ $(\mathbf{e^{\delta 2}} - 1)$ which has implications to the statistical inference of the model's findings. Second, $\boldsymbol{\mu_{(t)}}$ entered model (3.6) exponentially for it to be intrinsically linear (in parameter) regression model because if it had entered additively such as in $Y_{(t)} = K_{(t)}{}^{a} [(l - a_l)LA_{(t)}]^{1-a} + \mu_{(t)}$, there is no way to transform the model so that the transformed model becomes linear in the parameters (Gujarati & Porter, 2009). Thus, to show that model (3.6) is actually a suitable growth model for this study and to enable the use of linear regression estimation technique such as Generalized Method of Moments (GMM) rather than "trial-and-error" or 'iterative' methods of nonlinear regressions, we log-transform model (3.6) as thus:

$\ln Y_{(t)} = \ln[K_{(t)}{}^{\alpha}[(1-a_l)LA_{(t)}]^{1-\alpha} e^{\mu}{}_{(t)}$ - - - - - - - 3.7

So,

$\ln Y_{(t)} = \alpha \ln K_{(t)} + (1-\alpha) \ln (1-\alpha_l) + (1-\alpha)\ln L + (1-\alpha)\ln A_{(t)} + \mu \ln e$ - - - 3.8

Then,

$\ln Y_{(t)} = \alpha_0 + (1-\alpha) \ln A_{(t)} + \alpha \ln K_{(t)} + (1-\alpha) \ln L_{(t)} + \mu_{(t)}$ - - - - 3.9

Where $\alpha_0 = (1-\alpha)\ln(1- \alpha_l)$ = a constant, and $\ln e = 1$

Then again, to measure output per man, a measure of labour productivity, we will use per capita income derived in growth model by dividing model (3.4) by the labour, L, as thus:

$$\frac{Y(t)}{L(t)} = \frac{k(t)^{\alpha}\left[(1-\alpha_l)LA(t)\right]^{1-\alpha}}{L(t)} \equiv \frac{Y(t)}{L(t)} = K(t)^{\alpha}\left[(1-\alpha_l)LA(t)\right]^{1-\alpha}\left[L(t)\right]^{-1} \quad \text{-- - -- } 3.10$$

$$Then, \frac{Y(t)}{L(t)} = K(t)^{\alpha}(1-\alpha_l)^{1-\alpha} A(t)^{1-\alpha} L(t)^{1-\alpha-1} \quad \text{-- - - - } 3.11$$

$$i.e \frac{Y(t)}{L(t)} = K(t)^{\alpha}(1-\alpha_l)^{1-\alpha} A(t)^{1-\alpha} L(t)^{-\alpha} \quad \text{-----} \ 3.12$$

$$y(t) = K(t)^{\alpha}(1-\alpha_l)^{1-\alpha} A(t)^{1-\alpha} L(t)^{-\alpha} \ \ell^{\omega(t)} \quad \text{------} \ 3.13$$

Where: *y(t)* denotes output per man [a proxy for productivity of labour], and where $\omega_{(t)}$ is the error term introduced exponentially into the model for the same reason as in model (3.6).

We divided output by labour as our measure of productivity because output per man or per capita means output per head/population. The population of interest here is population of the working age and precisely the labour force because Blanchard (1997) opines that people who are not working and are not looking for employment are not regarded as unemployed and so are not in the labour force. According to Blanchard, macroeconomists call these people Discouraged Workers. Thus, our derivative of the per capita output as a measure of labour productivity in model (3.13) is quite a reasonable approximation.

Log-transformation of model (3.13) yields:

$$\ln y(t) = \ln\left[K(t)^{\alpha}(1-\alpha_l)^{1-\alpha} A(t)^{1-\alpha} L(t)^{-\alpha} \ell^{\omega(t)}\right] \quad \text{---------} \quad 3.14$$

$$\ln y(t) = \alpha \ln K(t) + (1-\alpha)\ln(1-\alpha_l) + (-\alpha)\ln L(t) + (1-\alpha)\ln A(t) + \omega \ln \ell \quad \text{--------} \quad 3.15$$

$$Thus,\ \ln y(t) = \alpha_1 + (1-\alpha)\ln A(t) + \alpha \ln K(t) + (-\alpha)\ln L(t) + \omega(t) \quad \text{-------} \quad 3.16$$

Where α_1 = (1-α) ln(1-α_l) = a constant, and where ln ℓ = 1.

Now, assumes the growth rate of labour to be equal to zero, that is, $\frac{d \ln L(t)}{dt} = \frac{dL(t)}{dt} \Big/ L(t) = n = 0$, then the two most interesting models for this study — models (3.9) and (3.16) — will reduce, respectively to:

$$\ln y(t) = \alpha_0 + (1-\alpha)\ln A(t) + \alpha \ln K + \mu(t) \quad \text{------} \quad 3.17$$

and,

$$\ln y(t) = \alpha_1 + (1-\alpha)\ln A(t) + \alpha \ln K(t) + \omega(t) \quad \text{------} \quad 3.18$$

Note that transformations that yielded equations (3.17) and (3.18) were done also to justify the rationale behind the logging of some variables in this study. Finally, substituting equation 3.2 or 3.3 into either 3.17 or 3.18, so that human capital H and by consequence, health enters the model, we have

$$\ln y(t) = \alpha_0 + (1-\alpha)\ln H(t) + \alpha \ln K + \mu(t) \quad \text{--------} \quad 3.19$$

and,

$$\ln y(t) = \alpha_1 + (1-\alpha)\ln H(t) + \alpha \ln K(t) + \omega(t) \quad \text{------} \quad 3.20$$

Thus the equations 3.19 or 3.20 will serve as the fundamental equation adopted for this study. It simply shows that human capital in the form of health is an important determinant of productivity.

Empirical Model Specification

Drawing from Lucas (1988) model in the theoretical framework above, this study will investigate the impact of health on productivity in sub-Saharan Africa countries, adopting the model specified by Cole and Neumayer (2006) with a slight modification we have:

Y = f (X; LAB, GFCF, AGR, TRAD, INF) -- - - - - 3.21

Where:

Y = is the dependent variable which will represent Total Factor Productivity (TFP), Labour Productivity (LP) and Economic Performance (GDPGR)

X = An indicator of health which would be malnutrition (MNU) and access to safe water (ASW) which will be used in separate estimation.

LAB= Labour Growth in the Sub-region

GFCF =Growth of Gross Fixed Capital formation

AGR =Share of Agriculture in GNP

TRAD = Trade Openness

INF= Rate of inflation

Empirical Analysis

In this section we present the Panel unit root tests both at levels and first differences using the Im, Pesaran & Shin (IPS) and Fisher Augmented Dickey-Fuller (ADF) methods; the Panel Cointegration tests using the popular Pedroni residual tests to test for the long run relationship between the dependent and independent variables and finally an analysis of the relationship between our health variables and productivity outcomes using the Generalized Method of Moments (GMM) estimation technique.

Table 1: Im, Pesaran & Shin and Fisher Augmented Dickey-Fuller Panel Unit Root Tests at Levels

Variable	Im, Pesaran & Shin			Fisher Augmented Dickey-Fuller		
	Null Hypothesis: Unit root (assumes individual unit root process)					
	W-Statistic	**Probability**	**Remarks**	**Chi-Square Statistic**	**Probability**	**Remarks**
TFP	-1.32155	0.0932	Stationary	89.4606	0.0289	Stationary
LP	5.47391	1.0000	Non-stationary	32.5072	0.9998	Non-stationary
GDPGR	-6.34458	0.0000	Stationary	154.395	0.0000	Stationary
MNU	-5.23932	0.0000	Stationary	139.034	0.0000	Stationary
ASW	-1.57311	0.0578	Stationary	66.4773	0.4604	Non-stationary
LLAB	4.39750	1.0000	Non-stationary	40.0642	0.9952	Non-stationary
LGFCF	-0.65797	0.2553	Non-stationary	69.4981	0.3605	Non-stationary
AGR	-1.57068	0.0581	Stationary	84.5828	0.0614	Stationary
TRAD	-0.67350	0.2503	Non-stationary	74.9252	0.2113	Non-stationary
INF	-8.29484	0.0000	Stationary	193.948	0.0000	Stationary

Source: Results Extract from EViews 8.0

As shown in Table 1, the Im, Pesaran & Shin unit root tests revealed that total factor productivity, gross domestic product growth rate, prevalence of malnutrition rate, access to safe drinking water, agricultural output share of GDP and inflation rate are stationary at levels but labour productivity, log of labour growth, log of gross fixed capital formation and trade openness are non-stationary at level. Based on the Fisher Augmented Dickey-Fuller tests, it was discovered that total factor productivity, gross domestic product growth rate, prevalence of malnutrition rate, agricultural output share of GDP and inflation rate are stationary at levels while labour productivity, access to safe drinking water, log of labour growth, log of gross fixed capital formation and trade openness are non-stationary at level.

Table 2: Im, Pesaran & Shin and Fisher Augmented Dickey-Fuller Panel Unit Root Tests at Differences

Variable	Im, Pesaran & Shin			Fisher Augmented Dickey-Fuller		
	Null Hypothesis: Unit root (assumes individual unit root process)					
	W-Statistic	**Probability**	**Remarks**	**Chi-Square Statistic**	**Probability**	**Remarks**
D(TFP)	-	-	-	-	-	-
D(LP)	-3.04153	0.0012	Stationary	111.935	0.0004	Stationary
D(GDPGR)	-	-		-	-	-
D(MNU)	-	-	-	-	-	-
D(ASW)	-	-	-	91.8731	0.0194	Stationary
D(LLAB)	-3.04153	0.0012	Stationary	88.0719	0.0361	Stationary
D(LGFCF)	-6.71355	0.0000	Stationary	158.824	0.0000	Stationary
D(AGR)	-11.1030	0.0000	Stationary	243.187	0.0000	Stationary
D(TRAD)	-12.2289	0.0000	Stationary	247.693	0.0000	Stationary

D(INF)	-	-	-	-	-	-

Source: Results Extract from EViews 8.0

From Table 2. it can be observed that based on the Im, Pesaran & Shin unit root tests labour productivity, log of labour growth, log of gross fixed capital formation, agricultural output share of GDP and trade openness are difference stationary. By means of the Fisher Augmented Dickey-Fuller tests, the results showed that labour productivity, access to safe drinking water, log of labour growth, log of GFCF, agricultural output share of GDP and trade openness are difference stationary.

Panel Co-integration Tests

We present the analysis of the panel cointegration tests using the Pedroni cointegration techniques.

Table 3: Pedroni Residual Co-integration Test for Total Factor Productivity Model Augmented with Prevalence of Malnutrition Rate

Series: TFP, MNU, LLAB, LGFCF, AGR, TRAD, INF				
Alternative hypothesis: Common AR coefficients (within-dimension)				
	Statistic	**Probability**	**Weighted Statistic**	**Probability**
Panel v-Statistic	-0.743146	0.7713	-2.459329	0.9930
Panel rho-Statistic	4.877932	1.0000	4.451438	1.0000
Panel PP-Statistic	-3.438823	0.0003	-5.431147	0.0000
Panel ADF-Statistic	0.134687	0.5536	0.165404	0.5657
Alternative hypothesis: Individual AR coefficients (between-dimension)				
	Statistic	**Probability**		
Group rho-Statistic	6.483261	1.0000		
Group PP-Statistic	-5.294095	0.0000		
Group ADF-Statistic	2.523923	0.9942		

Source: Results Extract from EViews 8.0

As Table 3 shows, the Pedroni residual cointegration test for total factor productivity model augmented with malnutrition prevalence rate indicates that the null hypothesis of no cointegration cannot be rejected at the 5 percent level of significance. This is because eight out of the eleven test statistics as revealed in the table are not significant at the 5 percent level.

Table 4: Pedroni Residual Co-integration Test for Total Factor Productivity Model Augmented with Access to Safe Drinking Water

Series: TFP, ASW, LLAB, LGFCF, AGR, TRAD, INF				
Alternative hypothesis: Common AR coefficients (within-dimension)				
	Statistic	**Probability**	**Weighted Statistic**	**Probability**
Panel v-Statistic	-1.373599	0.9152	-3.027532	0.9988
Panel rho-Statistic	4.684531	1.0000	4.359340	1.0000
Panel PP-Statistic	-4.409860	0.0000	-7.482422	0.0000
Panel ADF-Statistic	0.605201	0.7275	-0.648448	0.2583
Alternative hypothesis: Individual AR coefficients (between-dimension)				
	Statistic	**Probability**		

Group rho-Statistic	6.721469	1.0000
Group PP-Statistic	-8.418277	0.0000
Group ADF-Statistic	1.871714	0.9694

Source: Results Extract from EViews 8.0

As shown in Table 4, the Pedroni residual cointegration test for total factor productivity model augmented with access to safe drinking water shows that the null hypothesis of no cointegration cannot be rejected at the 5 percent level of significance. This is because eight out of the eleven test statistics as revealed in the table are not significant at the 5 percent level.

Table 5: Pedroni Residual Co-integration Test for Labour Productivity Model Augmented with Prevalence of Malnutrition Rate

Series: LP, MNU, LLAB, LGFCF, AGR, TRAD, INF				
Alternative hypothesis: Common AR coefficients (within-dimension)				
	Statistic	**Probability**	**Weighted Statistic**	**Probability**
Panel v-Statistic	-0.654101	0.7435	-1.153407	0.8756
Panel rho-Statistic	5.709040	1.0000	5.346370	1.0000
Panel PP-Statistic	1.578722	0.9428	-0.025532	0.4898
Panel ADF-Statistic	1.662841	0.9518	2.095596	0.9819
Alternative hypothesis: Individual AR coefficients (between-dimension)				
	Statistic	**Probability**		
Group rho-Statistic	7.598596	1.0000		
Group PP-Statistic	-0.130222	0.4482		
Group ADF-Statistic	3.202022	0.9993		

Source: Results Extract from EViews 8.0

From Table 5, using Pedroni residual cointegration test for labour productivity model modified with prevalence of malnutrition rate shows that the null hypothesis of no cointegration cannot be rejected at the 5 percent level of significance. This is because none of the eleven test statistics, as shown in the table, is significant at the 5 percent level.

Table 6: Pedroni Residual Co-integration Test for Labour Productivity Model Augmented with Access to Safe Drinking Water

Series: LP, ASW, LLAB, LGFCF, AGR, TRAD, INF				
Alternative hypothesis: Common AR coefficients (within-dimension)				
	Statistic	**Probability**	**Weighted Statistic**	**Probability**
Panel v-Statistic	0.649159	0.2581	-1.497196	0.9328
Panel rho-Statistic	3.247448	0.9994	4.976264	1.0000
Panel PP-Statistic	-7.210066	0.0000	-2.903534	0.0018
Panel ADF-Statistic	2.042770	0.9795	1.291794	0.9018
Alternative hypothesis: Individual AR coefficients (between-dimension)				
	Statistic	**Probability**		
Group rho-Statistic	7.034185	1.0000		
Group PP-Statistic	-5.931143	0.0000		

Group ADF-Statistic	3.235332	0.9994

Source: Results Extract from EViews 8.0

As Table 6 shows, the results of Pedroni residual cointegration test for labour productivity model modified with access to safe drinking water show that the null hypothesis of no cointegration cannot be rejected at the 5 percent level of significance. This is because eight out of the eleven test statistics, as revealed in the table, are insignificant at the 5 percent level.

Table 7: Pedroni Residual Co-integration Test for GDP Growth Rate Model Augmented with Prevalence of Malnutrition Rate

Series: GDPGR, MNU, LLAB, LGFCF, AGR, TRAD, INF				
Alternative hypothesis: Common AR coefficients (within-dimension)				
	Statistic	**Probability**	**Weighted Statistic**	**Probability**
Panel v-Statistic	-3.586651	0.9998	-5.285005	1.0000
Panel rho-Statistic	2.762088	0.9971	3.934111	1.0000
Panel PP-Statistic	-14.52057	0.0000	-17.10234	0.0000
Panel ADF-Statistic	-1.824741	0.0340	-4.642598	0.0000
Alternative hypothesis: Individual AR coefficients (between-dimension)				
	Statistic	**Probability**		
Group rho-Statistic	5.672797	1.0000		
Group PP-Statistic	-28.21058	0.0000		
Group ADF-Statistic	-2.891715	0.0019		

Source: Results Extract from EViews 8.0

As depicted in Table 7, the Pedroni residual cointegration test for GDP growth rate model adjusted with prevalence of malnutrition rate indicates that the null hypothesis of no cointegration cannot be accepted at the 5 percent level of significance. This is because six out of the eleven test statistics, as shown in the table, are significant at the 5 percent level.

Table 8: Pedroni Residual Co-integration Test for GDP Growth Rate Model Augmented with Access to Safe Drinking Water

Series: GDPGR, ASW, LLAB, LGFCF, AGR, TRAD, INF				
Alternative hypothesis: Common AR coefficients (within-dimension)				
	Statistic	**Probability**	**Weighted Statistic**	**Probability**
Panel v-Statistic	-2.672560	0.9962	-5.734162	1.0000
Panel rho-Statistic	3.345910	0.9996	4.262920	1.0000
Panel PP-Statistic	-15.39816	0.0000	-13.09770	0.0000
Panel ADF-Statistic	-2.427490	0.0076	-3.964100	0.0000
Alternative hypothesis: Individual AR coefficients (between-dimension)				
	Statistic	**Probability**		
Group rho-Statistic	6.001526	1.0000		
Group PP-Statistic	-23.04239	0.0000		
Group ADF-Statistic	-1.709803	0.0437		

Source: Results Extract from EViews 8.0

The Pedroni residual cointegration test for GDP growth rate model adjusted with access to safe drinking water, as shown in Table 8, reveals that the null hypothesis of no cointegration cannot be accepted at the 5 percent level of significance. This is because six out of the eleven test statistics, as revealed in the table, are significant at the 5 percent level.

Analysis of the Estimated Generalized Method of Moments (GMM) Models

We present the results of the three estimated models for the study. The analyses of the total factor productivity model, labour productivity model and GDP growth rate model using the GMM estimation method

Table 9 Analysis of the Relationship between TFP and Health Variables

Dependent Variable: Total Factor Productivity		
Independent Variable	**Estimated Coefficient**	
Constant	0.062179 (1.037)	0.003276 (0.048)
One year lagged value of total factor productivity	-0.390632*** (-4.870)	-0.374208*** (-4.728)
Prevalence of malnutrition rate	4.91E-05 (0.212)	-
Access to safe drinking water	-	0.000415 (1.726)
Log of labour growth	-0.000766 (-0.108)	0.006938 (0.861)
Log of gross fixed capital formation	-0.004178 (-0.725)	-0.008387 (-1.456)
Agricultural output share of GDP	-3.28E-05 (-0.375)	3.22E-05 (0.343)
Trade openness	-0.000199** (-1.988)	-0.000196** (-1.982)
Inflation rate	-1.95E-05*** (-9.057)	-1.99E-05*** (-9.261)
Summary Statistics		
R-squared	0.944	0.872
Adjusted R-squared	0.930	0.870
Instrument rank	14	14
J-statistic	3.931	2.599
Probability (J-statistic)	0.137	0.273

Note: t-statistics are in parentheses; *, ** & *** indicate significance at 10%, 5% & 1% respectively.

Source: Results Extract from EViews 8.0

The coefficient of determination of the total factor productivity model augmented with prevalence of malnutrition rate, R-squared (R^2) is about 0.94 and the adjusted R-squared ($\overline{R}^2$) is 0.93. The R-squared implies that about 94 percent of the systematic variations in total factor productivity are explained by the regressors in the model. The adjusted R-squared indicates that about 93 percent of the systematic changes in the dependent variable are attributable to the explanatory variables. The J-statistic has a value of 3.93 with an associated probability value of 0.14. This implies that the instruments used are not correlated with the disturbance terms. Thus, the over-identifying restrictions of the model are valid and the model is adequate.

On the other hand, the R-squared (R^2) and adjusted R-squared ($\overline{R}^2$) of the total factor productivity model augmented with access to safe drinking water are approximately 0.87. This shows that 87 percent of the systematic variations in total factor productivity are explained by the independent variables in the model. Hence, the explanatory power of the model is lower compared to when it is augmented with prevalence of malnutrition rate. The J-statistic is 2.60 with a probability of 0.27. This indicates that null hypothesis that over-identifying restrictions of the model are valid cannot be rejected. Hence, the model is adequate.

From the total factor productivity model augmented with prevalence of malnutrition rate, the signs of all the estimated coefficients but inflation rate did not conform to their theoretical expectations. Lagged total factor productivity has a negative significant effect on its current value. Malnutrition prevalence rate has no significant impact on total factor productivity. Labour growth does not have any significant effect on total factor productivity. GFCF has no significant impact on total factor productivity. The share of agriculture in GDP does not significantly affect total factor productivity. The coefficient of trade openness is negative and significant at the 5 percent level. It indicates that trade openness has an adverse effect on total factor productivity. Inflation rate has a negative coefficient and it is significant at the 1 percent level. It implies that lower inflation rates will enhance total factor productivity.

Alternatively, as shown in the total factor productivity model augmented with access to safe drinking water, the coefficients of access to safe drinking water, labour growth, agricultural output share of GDP and inflation rate are properly signed. Lagged total factor productivity, gross fixed capital formation and trade openness do not conform to their a priori signs. The lagged value of total factor productivity has a negative significant impact on its current value. Access to safe drinking water has a positive but insignificant effect on total factor productivity. Labour growth is positive but insignificant. Thus, labour growth has no significant impact on total factor productivity. GFCF has no significant effect on total factor productivity. The share of agriculture in GDP is positive but does not significantly affect total factor productivity. The coefficient of trade openness is negative and significant at the 5 percent level. It shows that trade openness has an adverse effect on total factor productivity. Inflation rate is negative and significant at the 1 percent level. It reveals that higher inflation rates will reduce total factor productivity.

Table 10 Analysis of the Relationship between Labour Productivity and Health Variables

Dependent Variable: Labour Productivity		
Independent Variable	**Estimated Coefficient**	
Constant	201.9365*** (6.507)	122.4005*** (3.682)
One year lagged value of labour productivity	-0.001045 (-0.016)	0.011278 (0.175)
Prevalence of malnutrition rate	-0.455152*** (-4.165)	-
Access to safe drinking water	-	0.392794*** (3.514)
Log of labour growth	-90.38036*** (-13.930)	-85.25162*** (-12.932)
Log of gross fixed capital formation	70.25703*** (14.388)	69.70668*** (14.190)
Agricultural output share of GDP	-0.095132** (-2.359)	-0.061628 (-1.423)
Trade openness	-0.055113 (-1.232)	-0.055249 (-1.243)
Inflation rate	0.002099** (2.155)	0.001548 (1.584)
Summary Statistics		
R-squared	0.723	0.726

Adjusted R-squared	0.719	0.723
Instrument rank	14	14
J-statistic	1.994	3.861
Probability (J-statistic)	0.369	0.142

Note: t-statistics are in parentheses; *, ** & *** indicate significance at 10%, 5% & 1% respectively.

Source: Results Extract from EViews 8.0

As shown in the labour productivity model augmented with prevalence of malnutrition rate, the R-squared (R^2) and adjusted R-squared ($\overline{R}^2$) is about 0.72. This indicates that the explanatory variables account for about 72 percent of the systematic variations in labour productivity in the model. The J-statistic is 1.99 with a probability value of 0.37. This shows that the instruments used in the model are uncorrelated with the error terms. Thus, the over-identifying restrictions of the model are valid and the model is adequate.

Then again, the R-squared (R^2) of the labour productivity model modified with access to safe drinking water is approximately 0.73 and the adjusted R-squared ($\overline{R}^2$), 0.72. Based on the adjusted R-squared, 72 percent of the systematic variations in labour productivity are attributed to the independent variables in the model. The J-statistic is 3.86 with a probability of 0.14. This indicates that null hypothesis that over-identifying restrictions of the model are valid cannot be rejected. Hence, the model is valid.

As can be observed in the labour productivity model augmented with prevalence of malnutrition rate, only malnutrition prevalence rate and GFCF satisfy their economic criteria signs. All other variables in the model do not meet their a priori signs. Lagged labour productivity has an insignificant impact on its current value. Malnutrition prevalence rate has a negative significant impact on labour productivity. This suggests that high prevalence rates of malnutrition will retard labour productivity in the economy. Labour growth has a negative significant effect on labour productivity. GFCF has a positive significant impact on labour productivity. Surprisingly, agricultural output share of GDP has a negative significant effect labour productivity. Trade openness has no significant impact on labour productivity. Inflation rate has a positive significant impact on labour productivity. This result is somewhat counterintuitive.

On the other hand, as depicted in the total factor productivity model augmented with access to safe drinking water, the coefficients of lagged labour productivity, access to safe drinking water and gro+ss fixed capital formation conform to their expected theoretical signs. The other variables – labour growth, agricultural output share of GDP, trade openness and inflation rate do not meet to their a priori signs. The lagged value of labour productivity has an insignificant impact on its current value. Access to safe drinking water has a positive significant effect on labour productivity. This implies that more access to safe drinking water enhances labour productivity. Labour growth is significant and it negatively impacts on labour productivity. GFCF has a positive and significant effect on labour productivity. This finding denotes that increased GFCF boosts labour productivity. The share of agriculture in GDP and trade openness do not significantly affect labour productivity. Also, inflation rate has no significant effect on labour productivity.

Table 11 Analysis of the Relationship between GDP Growth Rate and Health Variables

Dependent Variable: GDP Growth Rate		
Independent Variable	**Estimated Coefficient**	
Constant	-34.30689*** (-4.596)	-15.84374* (-1.886)
One year lagged value of GDP growth rate	-0.928845*** (-9.314)	-0.919205*** (-9.375)
Prevalence of malnutrition rate	0.056218**	-

	(1.949)	
Access to safe drinking water	-	-0.110165*** (-3.640)
Log of labour growth	2.876141*** (3.265)	1.312016 (1.318)
Log of gross fixed capital formation	1.468362** (2.040)	1.972056*** (2.737)
Agricultural output share of GDP	0.002927 (0.270)	-0.010702 (-0.926)
Trade openness	0.038088*** (3.192)	0.038431*** (3.265)
Inflation rate	-0.001107*** (-4.098)	-0.000978*** (-3.650)
Summary Statistics		
R-squared	0.864	0.905
Adjusted R-squared	0.850	0.890
Instrument rank	14	14
J-statistic	2.794	1.549
Probability (J-statistic)	0.216	0.424

Note: t-statistics are in parentheses; *, ** & *** indicate significance at 10%, 5% & 1% respectively.
Source: Results Extract from EViews 8.0

From the GDP growth rate adjusted with prevalence of malnutrition rate, the R-squared (R^2) value is about 0.86 and the adjusted R-squared ($\bar{R}^2$) is 0.85. The $\bar{R}^2$ implies that about 85 percent of the systematic variations in GDP growth rate are explained by the independent variables in the model. The J-statistic has a value of 2.79 with an associated probability value of 0.22. This implies that the instruments used are uncorrelated with the error terms. Thus, the over-identifying restrictions of the model are valid.

On the other hand, the R-squared (R^2) and adjusted R-squared ($\bar{R}^2$) of the GDP growth rate model augmented with access to safe drinking water are approximately 0.91 and 0.89 respectively. The adjusted R-squared shows that 89 percent of the systematic variations in GDP growth rate are accounted for by the explanatory variables in the model. The J-statistic is 1.55 with a probability of 0.42. This indicates that null hypothesis that over-identifying restrictions of the model are valid cannot be rejected. Hence, the model is adequate.

From the GDP growth rate model augmented with prevalence of malnutrition rate, the signs of all the estimated coefficients but lagged GDP growth rate and prevalence of malnutrition rate conform to their theoretical expectations. Lagged GDP growth rate has a negative significant effect on its current value. The most striking result to emerge is that malnutrition prevalence rate has a positive significant impact on GDP growth rate. This finding is counterintuitive. Labour growth has a positive significant effect on GDP growth rate. This shows that increased labour force enhances economic performance. Also, GFCF has a positive significant impact on GDP growth rate. However, the share of agriculture in GDP does not significantly affect GDP growth rate. The coefficient of trade openness has a positive significant effect on GDP growth rate. Inflation rate has a negative coefficient and it is significant at the 1 percent level. It implies that lower inflation rates will enhance GDP growth rate.

Alternatively, as shown in the GDP growth rate modified with access to safe drinking water, the coefficients of lagged GDP growth rate, access to safe drinking water and agricultural output share of GDP are not properly signed. But labour growth, gross fixed capital formation, trade openness and inflation rate conform to their a priori signs. The lagged value of GDP growth rate has a negative significant impact on its current value. Interestingly, access to safe drinking water has a negative significant effect on GDP growth rate. This finding is contrary to expectation. Labour growth is positive but insignificant. Thus, labour growth has no significant impact on GDP growth rate. GFCF has a positive significant effect on GDP growth rate. This indicates that an increase in gross capital formation will boost economic performance. The share of agriculture in GDP is negative but does not significantly affect GDP growth rate. The coefficient of trade openness is positive and significant at the 1 percent level. It shows that trade openness has a beneficial effect on GDP growth rate. Inflation rate is negative and significant at the 1 percent level. It reveals that lower inflation rates will enhance GDP growth rate.

Policy Implications

The co-integration results revealed that poor health has no clear co-integrating relations with total factor productivity. This implies that poor health does not have a meaningful long term relationship with overall economy’s productivity. Also, the study found out that there is no evidence of co-integration between poor health and labour productivity. The implication is that no long run equilibrium relationship exist between poor health and labour productivity. However, it was found that economic performance is co-integrated with poor health. This indicates that a long run relationship exists between economic performance and poor health.

It was found that poor health has no significant effect on total factor productivity. The evidence from this result suggests that prevalence rate of malnutrition and access to safe drinking water are no determinants of the overall economy’s productivity. However, it was ascertained that poor health status is significant and it negatively impacts on labour productivity in the sub-region. This finding indicates that labour productivity is determined by prevalence rate of malnutrition and access to safe drinking. Consequently, as revealed in the findings, 1 percent rise in prevalence of malnutrition rate will result in about 0.5 percent drop in labour productivity. Also, if the population with access to safe portable water is increased by 1 percent, labour productivity will rise by 0.4 percent. Nonetheless, it is somewhat surprising that the research found that poor health has a positive significant effect on economic performance. The implication is that the two measures for poor health (prevalence of malnutrition rate and access to safe portable water) do not support the economic notion that poor health retards economic performance. Instead, high prevalence rates of malnutrition are beneficial to economic growth and the smaller the proportion of the population with access to potable water, the better the performance of the economy. These findings are rather counterintuitive in that poor health status seems to enhance economic performance.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The main goal of this study was to determine the effect of poor health on productivity. One of the key findings of this investigation shows that malnutrition prevalence rate has an insignificant impact on overall economy’s productivity. This finding does not give credence to the fact that the overall productivity level of the economy is influenced by the population suffering from malnutrition. Again, the impact of access to potable water on total factor productivity was found to be insignificant at the 5 percent level. This suggests that the population with access to clean water does not influence the overall economy’s productivity. Thus, it may be the case that malnutrition rate and access to drinkable water are not determining factors of total factor productivity. However, it was revealed in this study that poor health status has a negative significant impact on labour productivity. To be precise, malnutrition prevalence rate constitutes a drag to labour productivity while access to safe drinking water enhances productivity of labour. Contrary to expectations, this study found out that the rate of malnourishment is positively correlated with economic growth rate and that the proportion of the populace with access to portable water is negatively related to economic growth rate. Notwithstanding these controversial findings, further studies need to be carried out in order to validate or refute these outcomes.

Recommendations

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

1. This study suggests that malnutrition prevalence rate and access to safe drinking water are no determinants of economy's productivity. There is, therefore, no intense need for governments and/or other relevant stakeholders to tackle the problem of overall economy's productivity considering prevalence rates of malnutrition and the population with access to safe drinking water as they do not pose any deleterious threat to overall productivity of the economy. However, concerted efforts should be geared towards alleviating the effects of other poor health variables that are capable of retarding the overall productivity of the economy.
2. Another important practical implication of the research finding is that labour productivity is affected by the proportions of the populace that are malnourished and have access to safe portable water. As a result, to enhance labour productivity there is need for governments to implement food policy programmes to ameliorate the high incidence of malnutrition among the populace.
3. In addition, another key policy priority for governments should be: to provide clean pipe-borne and/or bore-hole water in areas where their water sources are contaminated or potable water is inaccessible.

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