

Effect of health outcome on economic growth in sub-Saharan Africa: a system generalized method of moment approach

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Abstract

Purpose – Some progress have been made over time in improving health conditions in Sub-Saharan Africa (SSA). There are, however, contradicting reports on the relationship between health outcomes and economic growth in the region. The paper aimed at assessing the effect of health outcome on economic growth in SSA.

Design/methodology/approach – Data for 41 countries from 2000 to 2018 were obtained from WDI and WGI and analyzed using system generalized method of moment (sGMM) which is appropriate for the present scenario. AR(1) and AR(2) tests were used to assess the validity of the model while Sargan and Hansen tests were adopted to examine the validity of the instrumental variables. The robustness of the estimation was confirmed using the pooled OLS and fixed effect regression.

Findings – Health outcome (proxied by life expectancy), lagged GDP per capita, capital formation, labor force (LF), health expenditure (HE), foreign direct investment (FDI) and trade openness (TOP) significantly affected economic growth emphasizing the importance of health in the process of economic growth in the region. AR(1) and AR(2) tests for serial correlation and Sargan/Hansen tests confirmed the validity of the estimated model and the instrumental variables respectively. Robustness of the GMM results was established from the pooled OLS and the fixed effect model results.

Social implications – Improvement in the national health system possibly through the widespread adoption of National Health Insurance, increase government spending on healthcare alongside increased beneficial trade and ease of doing business to facilitate investment were recommended to enhance.

Originality/value – The study used up-to-date data with appropriate methodology.

Keywords Life expectancy, Economic growth, System generalized method of moment, Sub-Saharan Africa

Paper type Research paper

1. Introduction

The state of health of the people living in a society can serve as a microcosm to assess its poverty status and its potential for prosperity. Health is believed to be very important to

JEL Classification — B22, C23, I12

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economic growth and development and is seen as a key determinant of economic performance because it is a major component of human capital. One of the major roles of health in an economy is that healthy people are likely to be more productive, while healthy infants and children tend to develop faster, have better ability to learn and become more creative and productive adults thereby contributing to a country's economic growth. WHO (2014) asserted that increased investment in health could result into huge additional income, which could be available to improve social infrastructure and living condition in poorer countries.

The global objective to minimize all forms of health casualties can be traced back to 2000 when the Millennium Development Goals (MDGs) were adopted. Among the eight goals, three were related to health. Following the expiration of the MDGs in 2015, and building on existing achievements, the United Nation General Assembly adopted the Sustainable Development Goals (SDGs) which is an ambitious sustainable development agenda with 2030 as target date. The SDG has 17 goals with Goal number 3 called "the health goal" having 13 targets which have direct links to individual health. The health status of people in sub-Saharan Africa (SSA) is visibly lower than average for most other developing regions. It is known that the rates of infant and maternal deaths are very high while life expectancy at birth is low. This situation is compounded by high prevalence of diseases, e.g. HIV/AIDS, malaria and tuberculosis alongside conflicts, inter-tribal and civil wars in a number of countries in the region.

Figure 1 shows that life expectancy in SSA has remained abysmally low compared to most other regions in the world and the implication of this on the economies of the countries in the region may be grievous. Life expectancy in SSA remained between 50 and 61 years from 2000 to 2018 while it was as high as 76 and 81 in East Asia and the Pacific (EAP) and in the European Union (EU) respectively in 2018. Life expectancy in SSA in 2010 was 50.45 years while it was 66.8 and 73.8 years in South Asia and in Latin America and the Caribbean (LAC) respectively. In 2018, life expectancy was 61.3, 69.4 and 75.2 years in SSA, South Asia and LAC respectively (World Bank, 2019). Correspondingly, the average economic growth rate in SSA in 2010 was 2.73% while it was 6.17% in South Asia and 4.83% in LAC. As at 2018, the growth rate in these regions were 3.22%, 5.39% and 2.68% respectively.

There have been limited and contradicting knowledge on the impact of the health on the economies of SSA. Some studies reported positive relationships (e.g. Ogundari and Awokuse, 2018), some reported negative relationship (e.g. Kunze, 2014) while some found no relationship (e.g. Ogunleye, 2014). Meanwhile, the Kunze's study was a theoretical exposition rather than empirics while Ogunleye (2014) study employed five-year interval

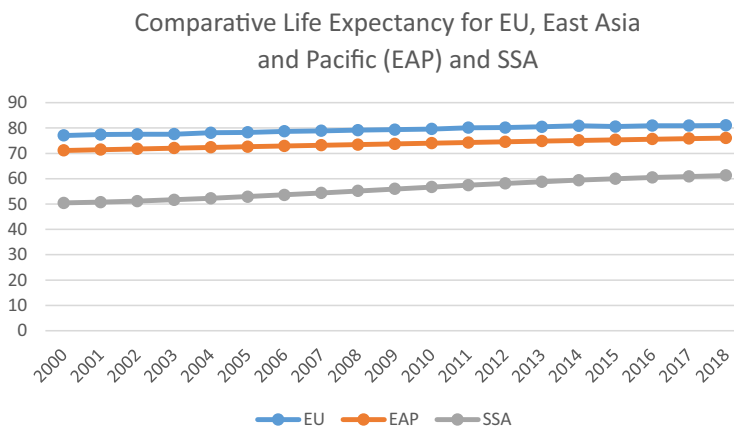


Figure 1. Comparative graphical illustration of life expectancy in SSA, East Asia and Pacific and the EU

data which ended in 2005. The interval leaves room for masking of effects and more over there might have been background changes between 2005 and 2014 when the paper was published. In addition, the [Ogundari and Awokuse \(2018\)](#) study utilized data which terminated in 2008. A lot of things would have changed within the ten years period between the end of the data and the publication of the paper. For instance, the impact of MDGs and efforts from different fronts might have changed the narratives.

The present study aimed at bridging the obvious knowledge gap occasioned by the inconsistent and outdated findings. Specifically, the study assessed the effect of health outcome on economic growth for a panel of 41 countries in the region using currently up-to-date available data. This is expected to chat policy direction to governments and development partners in the region. The rest of this paper consists of [Section 2](#) which reviewed past literature, [Section 3](#) described the study methodology and [Section 4](#) presented and discussed the results while [Section 5](#) summarized the study and concluded based on findings.

2. Empirical review of literature

There seems to be a link between health status of the people and economic performance of a society as wealthier countries tend to have healthier populations. Many research works have been carried out on the relationships between health and economic growth and results have been diverse.

[Acemoglu and Johnson \(2007\)](#) in an extensive research investigated the effect of health proxied by life expectancy at birth, on economic growth. The study exploited the large improvements in life expectancy driven by international health interventions, more effective public health measures and the introduction of new chemicals and drugs from the 1940s. The situation was referred to as the *international epidemiological transition*, which was asserted to have led to improvement in life expectancy in many countries and regions. The study reported that there were large declines in disease-specific mortality following the earlier listed global interventions. The estimation did not find any significant effect of life expectancy on total GDP. Worthy of note was that GDP per capita and GDP per working age population relatively declined in countries experiencing large increases in life expectancy. There was no convergence in income per capita between initially poor, middle-income and rich countries. The study result found support in the neoclassical growth theory as it was conceived that improvement in life expectancy raised population, which at first reduced capital-to-labor and land-to-labor ratios, thus reducing per capita income. This was latter believed to be compensated by higher output as more people entered the LF and as more capital were acquired. Meanwhile, the compensation may not be complete if the gains from improved life expectancy are not enough and if some factors of production, for instance, land, are supplied inelastically.

[Bloom et al. \(2010\)](#) investigated the possibility of using cross-country growth model alongside socioeconomic factors to explain the growth India and China have witnessed and to compare the experience with the rest of the world. It was reported that the increased growth was due to the sharp rise in life expectancy thereby underscored the importance of health in economic growth process. [Gong et al. \(2012\)](#) examined how economic growth and physical capital accumulation were affected by investment in health and physical capital in China and a positive effect was reported. This was hinged on the effects of health on productivity outweighing the crowding out effect of health investment on physical capital.

[Barro \(2013\)](#) applied the apparatus of advances in growth theory to examine the interaction existing between health and growth. The study used data from 1960 to 1990 and also reported a two-way causation between health and the economy. [Kunze \(2014\)](#) carried out a theoretical exposition on the relationship between life expectancy and economic growth in

an overlapping generation model with family altruism where private and public investments in human capital of children are the engine of endogenous growth. It concluded that the relationship between life expectancy and growth may be non-linear. It was deduced that increasing life expectancy may be good for growth when growth started from a low level and bad for growth when it started from a high level and shows that its emergence critically depends on the existence of intergenerational transfers in form of bequests.

Ogunleye (2014) investigated the effect of infant mortality and life expectancy on economic growth in SSA countries using panel data observed every five years from 1980 to 2005. The study applied the GMM estimation and reported that health indicators were very poor and unable to significantly affect growth of the economies of the region. Ogundari and Awokuse (2018) assessed the relationship between health and economic growth and further examined which of health and education contributed more to economic growth in SSA and reported that both health and education had significant positive effect on economic growth in the region with health exerting more. The empirical literatures reviewed so far showed that there has not been concordance in findings and there is need for further research especially using most recently available data alongside appropriate method of data analysis.

3. Methodology

3.1 Model specification

This present study is built on the augmented Solow growth model of Mankiw *et al.* (1992) and adopted from Bloom *et al.* (2004). The empirical model is stated as:

$$\% \text{ change in GDPPC} = f(\text{GDPPC}_{it-1}, \text{LF}, \text{LE}, \text{SSE}, \text{GFCF}, \text{HE}, \text{TOP}, \text{FDI}, \text{COR}) \quad (1)$$

where GDPPC represents GDP per capita which was used as a proxy for economic growth, LE represents life expectancy, SSE represents gross secondary school enrollment, GFCF represents gross fixed capital formation as proxy for physical capital stock, HE represents health expenditure, LF represents labor force, TOP represents trade openness, FDI represents foreign direct investment and COR represents Corruption (control of corruption index).

The model is specified as an aggregate production function following Bloom *et al.* (2004) as;

$$\text{GDPPC} = \text{AGFCF}^\alpha \text{LF}^\beta e^{\phi_1 \text{SSE} + \phi_2 \text{LE} + \phi_3 \text{HE} + \phi_4 \text{TOP} + \phi_5 \text{FDI} + \phi_6 \text{COR}} \quad (2)$$

If Eqn (2) is linearized by taking the logarithms to obtain Eqn (3) whose regress and is the percentage change in GDPPC for country i at time t ,

$$\begin{aligned} \text{Percent Change in GDPPC}_{it} &= a_{it} + \varphi_1 \log \text{GDPPC}_{it-1} + \varphi_2 \log \text{GFCF}_{it} + \varphi_3 \log \text{LF}_{it} \\ &+ \varphi_4 \log \text{SSE}_{it} + \varphi_5 \log \text{LE}_{it} + \varphi_6 \log \text{HE}_{it} + \varphi_7 \text{TOP}_{it} \\ &+ \varphi_8 \text{FDI}_{it} + \varphi_9 \log \text{COR}_{it} + \eta_i + \mu_t + \varepsilon_{it} \end{aligned} \quad (3)$$

where $i = 1, 2, \dots, 41$ which stands for countries, $t = 1, 2, \dots, 19$ which is the years covered by the study, a , is the intercept, η is the country specific effects, μ represents the time effects and ε represents error term.

3.2 Data sources and measurement of variable

The study utilized data on 41 SSA countries from 2000 to 2018 sourced from World Bank (2019) World Development Indicators webpage and World Governance Indicator (WGI). GDP per capita was measured in constant 2010 US dollars. Life expectancy was measured by number of years a new born is expected to live given the circumstances (health facilities and

other pre-disposing factors) prevailing in the country alongside other statistics. Secondary school enrollment was measured as percentage of the number of children who enrolled relative to the total number of children within the enrollment age group in the population. Gross Fixed Capital Formation was measured in constant 2010 US dollars. HE was measured as a percentage of GDP; LF was measured by number of people; FDI was measured as percentage of GDP; TOP is the ratio or percentage of the sum of import and export relative to GDP. Corruption is measured using annual control of corruption index (sourced from the World Governance Indicator – WGI) which ranks countries on a scale from –2.5 (high corruption) to 2.5 (low corruption). This index was rescaled by subtracting countries' scores from 2.5 so that higher values correspond to higher corruption levels. This attempt is in line with [Ackay \(2006\)](#).

3.3 Estimation procedure

Pre-estimation: This includes descriptive analyses and correlation analyses.

Estimation - The system-generalized method of moment (sGMM) regression technique was the appropriate method of analysis for the present study. In literature, it has been established that economic growth and health outcome have bi-causal relationship which cause endogeneity problem. An appropriate technique to handle such phenomenon is the GMM methodology. It combines in a system the important regressors expressed in their level forms and their differences. There are differenced and system GMM. The latter is preferred here because it has been proven to correct biases due to omission of variables, unobserved country heterogeneity, error due to measurement and tendency for endogeneity that commonly affect growth estimation ([Arellano and Bover, 1995](#); [Blundell and Bond, 1998](#)).

There are further compelling justifications for the choice of GMM estimation approach and these are carefully enumerated. The modeling strategy which is dynamic enables for the control of persistence in the levels of economic growth since it has behavioral effects which persist. Persistence can be checked by correlation between GDPPC and its corresponding first lag. The GMM estimation technique enables accounting for likely endogeneity by controlling for unobserved heterogeneity with time invariant omitted variables. Cross-country variations are controlled in the regressions, and furthermore, [Blundell and Bond \(1998\)](#) posited that the system GMM estimator corrects for biases associated with differenced estimator. The GMM approach is specifically most suitable for panel data scenario where the number of cross-sections (e.g. countries) N is large while the number of periods (e.g. years) T is small as in this case; there are independent variables which are not strictly exogenous (endogenous regressors) and there are fixed effects. It is also useful when there are heteroskedasticity and autocorrelation within each country's data but not across the countries.

The orthogonal deviations which is an alternative to differencing which was the original transformation used in the traditional GMM approach and was proposed by [Arellano and Bover \(1995\)](#) was adopted in this study. This orthogonal deviation subtracts the average of all future available observations of a variable from the existing data. "Not minding the number of gaps, the computation is done for all observations except the last for each individual, thereby minimizing data loss" ([Roodman, 2009](#)). Also included in all estimations are the time dummies that capture time specific effect. The time dummies reflects the assumption of no autocorrelation across countries and it helps to reduce the extent of serial correlation among countries and the error idiosyncratic term, thereby improving the robustness of the estimation ([Roodman, 2009](#)).

However, to avoid proliferation or over-identification of instruments which causes biasedness of GMM estimator, over-fitting of endogenous variables, weakening of Sargan/Hansen test, the rule of thumb is that the number of instruments should not be higher than the number of periods in cross sections ([Asongu and Nwachukwu, 2017](#)). However, [Roodman \(2009\)](#) suggested that in order to avoid proliferation of instruments, the number of

instruments should not exceed the number of groups (cross-section). The two-step system GMM estimates that is robust to heteroskedasticity and panel-specific autocorrelation with Windmeijer correction for finite samples which helps to remove standard error biases was also preferred to the one-step estimation. To make result more robust, instrument was collapsed and also instrument was set to a lag limit of 2 and longer lags for transformed equation and limit of 2 for level equation. Finally, variables considered to be endogenous were life expectancy, secondary school enrollment and HE. As each of the three variables may affect growth of GDPPC, GDPPC is also capable of causing changes in each of the variables thereby introducing endogeneity problem into the estimation.

Post-estimation diagnoses: The diagnoses after estimation in the GMM framework demands testing for serial correlation, ascertaining the overall validity of instrumental variables and examining the accuracy of the GMM estimate especially with the coefficient of the lagged regressor and relative to pooled OLS and the fixed effect model.

Serial correlation test: The reason for carrying out tests for serial correlation in GMM estimation was emphasized by [Arellano and Bover \(1995\)](#) and [Blundell and Bond \(1998\)](#). [Arellano and Bond \(1991\)](#) developed a test for autocorrelation in the idiosyncratic disturbance term v_{it} that may render some of the lags invalid as instruments. According to [Roodman \(2009\)](#), this test is usually conducted on the differences of the residuals. Due to the fact that Δv_{it} is mathematically related to $\Delta v_{i,t-1}$ via $v_{i,t-1}$ term, negative first-order autocorrelation is expected and its presence is inconsequential and does not convey much information. The null hypothesis of “no autocorrelation” of AR(2) which tests for second order serial correlation is expected to be accepted for validity of the estimated model results.

Validity of instruments: The validity of the instrumental variables were assessed using Sargan and Hansen tests. Note that for GMM estimator to be considered as consistent the instruments must be valid. The null hypotheses of both Sargan and Hansen tests is that all instruments as a group are exogenous. Therefore, higher p -values are desirable.

OLS and within-group (fixed effects) estimates: According to [Bond \(2002\)](#), the good estimate of the lagged dependent regressor should lie between its OLS and Within-group estimates. These estimates provide a useful check on result. Therefore, pooled OLS and fixed effect model were also estimated.

3.4 Rationales for inclusion of variables

Percentage change in gross domestic product Per capita (GDPPC): as a proxy for economic growth is used because output (y) is expressed in per capita terms, i.e. Y/L in the Solow growth model and the modification in [Mankiw et al. \(1992\)](#) which were the bases for the study. It is also based on previous literature as seen in the work of [Bloom et al. \(2004\)](#) and it reflects welfare.

Lagged GDPPC: Lagged GDPPC was included for two main reasons. First, it is part of the routine in the adopted GMM estimation procedure. Second, it captures convergence effect as used by [Yamarik \(2011\)](#).

Life expectancy (LE): as a proxy for health outcome because it is the most important and most popular proxy of the health status as higher life expectancy can be generally associated with higher health status as in [Bloom et al. \(2004\)](#), [Barro \(1996\)](#) etc.

Labor force (LF): LF was used in this study because it is a major factor in the production process. Most empirical growth models included LF or a close variable – population, e.g. [Bloom et al. \(1998\)](#).

Trade openness (TOP): This measures the extent to which an economy gets involved in the global trading system. It is usually measured by the ratio between the sum of exports and imports to GDP. It may also be expressed in percentage and usually included in growth models as found in [Saibu \(2004\)](#), [Mathew \(2014\)](#), [Mputu \(2016\)](#) etc.

Secondary school enrollment (SSE): as a proxy for education was used in the present study because the rate of secondary education enrollment is an important determinant of the level of education in a country. Furthermore, with secondary school education, one should possess the required skill to be able to adapt to existing technology required for production. [Yamarik \(2011\)](#) also assessed the effect of schooling on regional growth. The importance of human capital stock (which consists mainly of health and education) was also emphasized in the work of [Benhabib and Spiegel \(1994\)](#).

Gross fixed capital formation (GFCF): as proxy for capital stock was included in the estimated model to capture the physical aspect of capital which is one of the determinants of growth through investment and this has its roots in most growth models and a number of previous literature, e.g. [Gill \(1976\)](#), [Ongo and Vukenkeng \(2014\)](#) and [Nweke et al. \(2017\)](#).

Health expenditure (HE): HE was included because it indicates the level of investment that is put into the production of health. HE has been included in economic growth studies as seen in [Yang \(2020\)](#), [Wang \(2015\)](#) etc.

Foreign direct investment (FDI): These are the net inflows of investment to acquire a lasting management interest (10% or more of voting stock) in an enterprise operating in an economy which is not that of the investor. It is the total addition of equity capital, reinvestment of earnings, other long-term capital and short-term capital as shown in the balance of payments. Due to its fundamental importance in production of good and services it is usually included in economic growth models as in [Ayanwale \(2007\)](#), [Giwa et al. \(2020\)](#) etc.

Corruption (COR): Control of corruption which was used as proxy for corruption reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as “capture” of the state by elites and private interests. It is important to include corruption in the model of economic growth because abuse of power and mismanagement of resources will lead to poor output in the economy and income distribution is likely to skew. It has been included a number of empirical economic growth model such as [Nwakwo \(2014\)](#), [Alfada \(2019\)](#), etc.

4. Results and discussion

4.1 Pre-estimation analyses – descriptive statistics and correlation analyses

[Table 1](#) presents the descriptive statistics of the observations of the data sets of the study variables. Among the statistics presented are measures of central tendency and dispersion among others.

4.1.1 *Correlation matrix.* [Table 2](#) represents the correlation analyses of the study series. The result showed that no high degree of correlation existed between any pair of explanatory variables to cause multicollinearity in the model.

4.2 System GMM estimation to determine the effect of health on economic growth

In a bid to determining the effects of health on economic growth in SSA, the sGMM estimation technique was adopted due to its uniqueness and suitability to the present study earlier enumerated. The results obtained are represented in [Table 3](#). Lagged GDPPC was positive and significant and this implied divergence in the growth of the economies of the countries in the region. The coefficient value of 0.8911 implied that it was inelastic. Furthermore, there is still potential for expansion or growth in the economies of the region as convergence has not been reached. More of the income realized in the previous year could still be reinvested into the economy. This result is consistent with [Apanisile and Akinlo \(2014\)](#) who reported that previous year’s economic growth plays a significant role in determining the current growth level. This is more plausible because if the bulk of production in the previous year consisted of producer goods, they are likely to boost production in the present year. LE (life expectancy at

	GDPPC	LE	LF	GFCF	SSE	HE	FDI	TOP	COR
Mean	2009.157	56.778	6632076	5.60E + 09	39.829	5.725	2.501	57.040	3.18
Median	781.214	56.765	3996038	1.97E + 09	36.210	5.133	2.576	57.765	3.25
Maximum	20,333.94	74.395	57352456	8.74E + 10	102.754	19.727	4.094	63.311	4.27
Minimum	218.284	38.702	128029	32468304	6.112	0.839	1.692	49.660	1.34
Std. Dev	3042.984	6.411	866910	1.31E + 06	22.237	2.720	0.604	5.398	0.57
Skewness	2.969	0.289	2.927015	4.425097	0.963	1.590	0.745	0.007	-0.95
Kurtosis	13.166	3.167	13.78105	23.04199	3.283	6.674	3.671	1.761	3.64
Jarque-Bera	396.602	10.503	439.436	126.19	67.413	623.524	2.116	0.640	13.92
Probability	0.000	0.005	0.000	0.000	0.000	0.000	0.347	0.726	0.034

Source(s): Authors' computation 2019

Table 1.
Descriptive statistics of
variables

Table 2.
Correlation coefficient
matrix

	GDPPC	LE	LF	GFCF	SSE	HE	FDI	TOP	COR
GDPPC	1								
LE	0.282	1							
LF	-0.014	-0.207	1						
GFCF	0.413	-0.088	0.644	1					
SSE	0.699	0.457	0.034	0.416	1				
HE	-0.092	-0.080	-0.175	-0.013	0.078	1			
FDI	0.128	0.092	0.610	0.651	0.291	0.395	1		
TOP	0.425	0.408	0.515	0.509	0.095	0.079	0.527	1	
COR	-0.518	0.034	0.317	0.194	0.171	0.081	0.035	0.027	1

Source(s): Authors' computation 2019

Table 3.
Estimation results
(dependent
variable = percentage
change in GDPPC)

Variables	Main results		Robustness check results			
	System-GMM results		Fixed effect model results		Pooled OLS results	
	Coefficients	t-value	Coefficients	t-values	Coefficients	t-values
Lagged lnGDPPC	0.8911***	9.07	0.7103***	3.45	0.9512***	8.65
lnLE	0.3904**	2.05	0.1710*	1.92	0.0191	0.93
lnLF	-0.1093**	-2.07	-0.1927***	-3.71	-0.0213***	-2.94
ln GFCF	0.0721*	1.89	0.0617***	5.73	0.0203***	3.32
SSE	0.0109	0.37	-0.0007	-0.49	-0.0011**	-2.07
HE	0.0312**	2.08	-0.0075**	-2.21	-0.0108	-1.05
FDI	0.0561*	1.93	0.0346	1.54	0.0231*	1.79
TOP	0.1711**	2.39	0.1972*	1.85	0.1930*	1.90
COR	0.0863	1.03	0.1036	0.09	0.0923	1.07
AR(1) p-value	0.009	-	-	-	-	-
AR(2) p-value	0.319	-	-	-	-	-
Hansen test p-value	0.693	-	-	-	-	-
Sargan test p-value	0.625	-	-	-	-	-
R-squared	-	-	0.9208	-	0.9993	-
F-stat (Prob)	398.41 (0.000)	-	247.52 (0.000)	-	9045.71 (0.0000)	-
No. of instruments	26	-	-	-	-	-

Note(s): *, ** and *** indicate that the coefficients are significant at the 10%, 5% and 1% level of significance, respectively

Source(s): Authors' computation 2019

birth) had significant and positive effect on economic growth. A percentage increase in life expectancy caused 0.39% increase in economic growth. This is consistent with economic theory and the exposition of the augmented Solow model of [Mankiw et al. \(1992\)](#). Positive and significant relationship between health outcome and economic growth reported in the present study corroborated [Ogundari and Awokuse \(2018\)](#). It however contradicted [Ogunleye \(2014\)](#) who reported no significant relationship. It should however be noted that the former covered 1980–2008 while the latter covered 1980–2005 using countries in SSA. Events in the last 12 years might have changed the narrative. The results may find further explanation in the theoretical exposition of [Kunze \(2014\)](#) who proved and posited that life expectancy may be good for economic growth when growth started from a low level as in the case SSA. The result also contradicted [Acemoglu and Johnson \(2007\)](#) who found no significant effect of life expectancy on economic growth.

HE had a positive and significant effect on changes in GDPPC. A percent increase in HE increased growth by 0.031%. This also corroborate the report of [Piabuo and Tieguhong \(2017\)](#)

for countries in central Africa and that of [Aboubacar and Xu \(2017\)](#) in SSA. Aside HE improving health and translating into improvement in the economy through improved labor productivity, HE may raise aggregate demand, provide jobs for construction workers for hospital buildings, equipment suppliers, computer programmers for automations, etc. thereby directly contributing to economic growth.

LF had a negative effect on economic growth in SSA. This may be due to low productivity of labor occasioned by low skills and low level of mechanization which are likely to reduce labor effectiveness and results in low output per labor. A percent increase in LF reduced economic growth by 0.109% in SSA. Gross Fixed Capital formation (GFCF) was positive and significant at 10% risk level. A percent increase in GFCF resulted in 0.0721% increase in economic growth in the region. The positive effect of GFCF corroborated [Uneze \(2013\)](#) also in SSA. Although, education was positive it was not significant. This was contrary to studies in other places such as those of [Benhabib and Soiegel \(1994\)](#), [Yamarik \(2011\)](#), [Chanda and Panda \(2016\)](#) and [Panda \(2017\)](#) all of which emphasized the importance of human capital (education and health) to economic growth.

FDI was positive and significant at 10% level. A percent rise in FDI increased the economic growth by 0.056%. FDI is naturally expected to improve the economy as it is will boost production and services. The positive relationship corroborates [Ajide and Eregba \(2015\)](#) who reported a positive effect of FDI on economic performance in the sub-region after controlling for economic freedom. The study attributed the small (though significant) effect to the fact that bulk of FDI are directed to the extractive industry in the region. The positive effect reported in this paper also corroborates the findings of [Jugurnath et al. \(2016\)](#). However, [Nketiah-Amponsah and Sarpong \(2019\)](#) reported a positive relationship only when FDI was interacted with infrastructure in the region. The study explained that improved infrastructure reduces the cost of production of multinational companies thereby improving economic growth.

TOP came up with positive and significant coefficient in line with expectation. The result implied that the more the countries in the region get involved in international trade the more they experienced growth. Specifically, a percent increase in trade increased growth by 0.17%. This aligns with the finding of [Keho \(2017\)](#) for Cote d'Ivoire. It is worthy of note that corruption did not significantly affect economic growth in the region contrary to perception and expectation. This however does not constitute an incentive for corruption in the region as [Nwankwo \(2014\)](#) reported a negative effect of corruption on economic growth in Nigeria.

4.3 Post estimation results

Serial correlation test: [Table 3](#) included the results of the Arellano and Bond test for autocorrelation. The p -value of AR(1) was less than 5%, therefore, the null hypothesis of “no first order autocorrelation in the idiosyncratic error term” was rejected while the null hypothesis of AR(2) was accepted as the probability value of 0.319 was higher than 5% risk level. These should actually be theoretically so. Hence, the validity of the estimated model was confirmed.

Sargan and Hansen tests: Consistency is a desirable property of econometric estimates. In order to establish the consistency of the estimates of GMM, the instrumental variables must have overall validity. The Sargan and Hansen tests are both tests of over-identifying restrictions, which test the validity of the instrumental variables. Here, the null hypothesis was that “all instruments as a group were exogenous or were valid”. The probability value of the Sargan and Hansen tests were 0.693 and 0.625 respectively ([Table 3](#)). Hence, it was concluded that the instrumental variables were valid.

4.3.1 Robustness check (pooled OLS and fixed effect model results). In order to establish the robustness of the system GMM estimates, it is imperative to report the Pooled OLS and the

Fixed Effect Model estimates. The parameter estimate of the lagged dependent variable must fall between the values of the Pooled OLS and the Fixed Effect Model. Table 3 present the Pooled OLS estimates and the Fixed Effect Model estimates. The coefficient of the lagged GDPPC of two step system GMM lies between its values in Fixed effect and pooled OLS estimates, i.e. $0.7103 < 0.8911 < 0.9512$. Therefore, the estimated model was robust.

5. Summary and conclusion

The study assessed the effect of health outcome proxied by life expectancy on economic growth in SSA. Data on GDPPC, LE, LF, GFCF, SSE, HE, FDI and TOP for 41 SSA countries from 2000 to 2018 were obtained from WDI while data on COR were sourced from the World Governance Indicator (WGI). The system-GMM results revealed that health outcome (life expectancy), lagged GDP per capita, gross fixed capital formation, HE, FDI and TOP had positive and significant effects on the growth of the economies of SSA countries. LF had significant negative effect while education was found to be insignificant at all acceptable risk levels except in the Pooled OLS model adopted for robustness check. It was concluded that health outcome is an important determinant of economic growth in the region. Based on the findings of this paper, improved health for the people through effective national health policies such as widespread adoption of the National Health Insurance Scheme, increased government healthcare spending, improvement in beneficial international trade which should include strengthening of the concerned agencies and more conducive investment environment alongside improved "Ease of doing business" were recommended in order to achieve significant economic growth in the region.

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