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Human Capital Formation and Economic Growth in Sub-Saharan African Countries: An Empirical Investigation

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Abstract

This study explored human capital–economic growth nexus and determine if the relationship is influenced by the level of economic development in 36 sub-Saharan African countries during the period from 1986–2018. The study used dynamic generalised method of moments (GMM) and static estimations to achieve the objective of the study. The study used alternative indicators of human capital to provide strong evidence and robust results. The study also considered the income groups within the region. The study found that human capital contributed to economic growth, as its indicators are positive and significant. The study also found that the connection that exists between human capital and economic growth also depends on the level of economic development. Generally, our finding emphasised that both education and health measures of human capital are important, and that policymakers must consider the level of economic development while formulating policies that can enhance the impact of human capital on economic growth in the Sub-Saharan Africa region.

JEL Classification: O15, O4, C10, O55

Keywords

Human capital, economic growth, GMM, Sub-Saharan Africa

I. Introduction

Both theoretical growth models (e.g., Becker et al., 1990; Lucas, 1988; Mulligan & Sala-i-Martin, 1992; Rebelo, 1991) and empirical studies (e.g., Benhabib & Spiegel, 1994; Freire-Serén, 2010; Nonneman & Vanhoudt, 1996; Uwatt, 2002) have identified human capital as one of the major determinants of economic growth. Human capital serves as a vital input in the research sector in Romer (1990), as it is the engine behind the generation of new ideas that underlie technological progress. Nelson and Phelps

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(1966) stated that the transfer, introduction and integration of new technology are facilitated by the large accumulation of human capital.

Several studies have examined the relationship between human capital and economic growth in both developed and developing countries. However, Ogundari and Awokuse (2018) raised an observation that the majority of the previous studies that examined the link between human capital and economic growth across the globe either focused on the nexus between education and growth or nexus between health and economic growth. They stated that most of the studies in the literature failed to use both education and health as indicators of human capital in the same study. The consequence is that their results might suffer from the bias of omitted variables as both health and education as measures of human capital cannot be perfectly substituted for each other.

In Sub-Saharan Africa, studies that examined the connection between human capital and economic growth fail to investigate if the level of economic development influences the relationship in the region. The level of economic development might be playing a crucial role in human capital–economic growth nexus. For instance, countries with high gross national income (GNI) per capita income have the potential to produce efficient human manpower that can contribute to economic growth because they have more resources to invest in human capital. UNESCO Institutes of Statistics (2008) stated that illiteracy is very high in low-income countries than other income groups. The high illiteracy rates in low-income countries might connect with the inability of those countries to make education available and affordable for the people. The level of economic development is central to the availability of trained teachers, instructional materials and infrastructure development needed to keep pace with the heavy demand for education. Countries that lack sufficient investment in those areas might experience slow economic growth due to a lack of competent human capital.

Due to insufficient evidence on the nexus between human capital and economic growth in Sub-Saharan Africa coupled with the fact that the few past studies might suffer from the omission of critical variables, this study intends to offer additional evidence by investigating the impact of human capital on economic growth in Sub-Saharan Africa and also among the income groups within the region. This is to ascertain whether the impact of human capital on economic growth depends on the level of economic development in the region. This study is different from former studies in the following ways. First, this study uses different measures of human capital, which include health human capital indicator that is not common among previous studies. Second, this study will investigate if the effect of human capital on growth depends on the level of economic development within the region. This will enable the study to provide robust results on which sound policies can be based. Three, this study uses a larger data set from 36 sub-Saharan African countries and covers a wider period from 1986 to 2018 compared to previous studies. For instance, Gyimah-Brempong and Wilson (2004) used a sample of 21 sub-Saharan African countries and 22 Organisation for Economic Co-operation and Development (OECD) countries. Gyimah-Brempong et al. (2006) used a sample from 34 African countries, while Ogundari and Awokuse (2018) used samples from 33 African countries.

The rest of the study is organised into six sections. Section II contains the literature review. Section III presents the model specification. Section IV deals with data and variables. Section V focuses on the results and discussions. Section VI presents the implication of findings, while Section VII concludes the study.

II. Review of Literature

Studies have considered the effect of human capital development on economic growth, covering the different periods, economies and using varieties of methods, a development that produced varying results.

Gupta et al. (1999) investigated the effect of human capital on the economic growth of 50 developing countries using ordinary least squares (OLS) and two-stage least squares (2SLS) regressions. The results showed that the primary healthcare spending and adult literacy rate have a positive influence on the economic growth of those economies.

Gyimah-Brempong and Wilson (2004) used panel data consisting of 21 sub-Saharan African countries and 22 OECD countries to explore the effect of health human capital on growth. After controlling for some variables, the study found that the stock of investment and investment in health human capital significantly impacted economic growth in both regions. The study also found that health human capital accounted for 22 per cent of per capita income growth rate in Sub-Saharan Africa and 30 per cent for the growth rate in per capita income of OECD countries.

Gyimah-Brempong et al. (2006) examined the relationship between higher education and economic growth in Africa using panel data, covering the period from1960 to 2000. The study used a dynamic panel estimator for the estimation. The study found that all levels of education significantly impacted economic growth in contrast to previous studies' findings. The study further estimated 0.09 value as the growth elasticity of higher education human capital. The estimate (0.09) value is twice the growth impact of physical capital investment, which means that education human capital is more beneficial to economic growth.

Freire-Serén (2010) investigated the association between human capital formation and economic growth as well as the influence of income level on human capital formation in the Spanish economy from 1964 to 1991. The study used a two-stage non-linear least square technique for the analysis. The results from the study indicated that human capital accumulation had a positive and significant impact on the growth of the Spanish economy, and that income level exerted a positive effect on human capital formation in Spain.

Kanayo (2013) explored the nexus between human capital formation and economic growth in Nigeria from 1970 to 2010. The study employed an error correction model for the analysis. The outcomes revealed that investment in human capital formation in the way of capacity building and education in both primary and secondary education in Nigeria positively and significantly influenced changes in economic growth during the period covered by the study. However, capital investment in education did not produce significant results on the growth of economic activities in Nigeria during the same period.

Siddiqui and Rehman (2016) considered the association between human capital and growth of economic activities in nine selected Asian economies. The study employed the Bayesian methodology, which addressed both the heterogeneity problem and common structure that yielded 'informationally' efficient results. With concerns to produce robust results that better explained the growth of economies in Asian regions, varieties of human capital measures were used. Findings showed that investments in primary and secondary education explained the variations to the growth of economic activities in East Asia better than the expenditures on tertiary and vocational education in South Asia.

Altiner and Toktas (2017) examined the impact of human capital development on the economic growth of selected 32 developing countries with a panel data analytical method. The study had two issues in focus: examining the direction of causality and the magnitude of the impact of the rise in the educational level on economic growth. The empirical evidence supported the fact that human capital development positively influenced the GDP in those economies. Again, it was found that the development of physical capital had a positive effect on economic growth in the selected countries.

Ali et al. (2018) used data that covered a period of 15 years for 132 countries to investigate the effect of human capital development on economic growth. The results showed that human capital development positively determined per capita GDP growth under the condition of better economic prospects and quality institutions. The study, therefore, concluded that economic prospects strengthened the effect of human capital on GDP, especially when social capabilities as a variable were included.

Ogundari and Awokuse (2018) combined both education measures and health human capital indicators to investigate the contribution of human capital to economic growth in Sub-Saharan Africa. The system generalised method of moments (SGMM) was applied on panel data, which included 35 countries from 1980 to 2008. The study found that human capital promotes economic growth. However, health contributed to growth more than education measures.

Saileja and Narayan (2019) investigated the influence of foreign direct investment (FDI) moving out of countries such as Brazil, Russia, India, China and South Africa (BRICS) to the rest of the world on human capital and the economic growth of BRICS countries from 1985 to 2017. Using the panel vector error correction model (VECM) method capable of determining both long- and short-run impact, the study discovered a positive influence of outward FDI on human capital in the short run, while, in the long run, the effect was not significant. However, outward FDI significantly elevated the GDP of BRICS countries, both in the short run and in the long run, and bidirectional causality between outward FDI and human capital was discovered.

Almost all the studies reviewed found a positive relationship between human capital and economic growth though the studies used different proxies for human capital, employed different methodologies and the scope covered different periods. It is also obvious that while some studies used education measures, only some used both education and health measures. However, we observed that these studies failed to consider the influence of economic development levels in the relationship by investigating the impact of human capital on economic growth among the income groups. Our study complements the literature on human capital and growth by providing new cross-country empirical evidence by considering the growth effect of both education and health measures of human capital in Sub-Saharan Africa. Moreover, this study goes further and explores the relationship among the income groups within region.

III. Model Specification

This study adopts the augmented growth model proposed by Mankiw et al. (1992) to estimate the impact of human capital on economic growth in Sub-Saharan Africa. One main reason that underlies the specification of the model is that it considers human capital, which enhances labour productivity, boosting growth as well as physical capital. Taking heterogeneity of the coefficients into consideration and control variables, the model is specified as follows:

$$\Delta y_{it} = \alpha_1 + y_{it-1} + \gamma_1 \Delta \text{hum}_{it} + \gamma_2 \Delta \text{phy}_{it} + \sum_{p=1}^{k} \beta_{pi} \Delta X_{it}^{p} + u_{it} \quad (1)$$

where subscripts i indicate the country, while subscript t represents the time period, y_{it} signifies GDP per capita, y_{it-1} is the lagged GDP per capita, 'hum' is the human capital variable, 'phy' represents physical capital, u_{it} is an error term and α_1 is the country-specific effect. X indicates all the control variables included in the study. The control variables include trade openness, population and democracy accountability, which serve as an institutional quality variable. These control variables are included to account for structural differences across countries. According to previous studies such as Li and Liang (2010), Siddiqui and Rehman (2016), and Sala and Trivin (2014), these control variables are the major determinants of economic growth. Equation (1) will be estimated by the system generalised method of moments (GMM). According to Teixeira and Queirós (2016), human capital and economic growth can stimulate each other. That is, a bidirectional causal relationship might exist between the two variables, and this will make endogeneity inevitable in the model. To minimise the problem of endogeneity, Arellano and Bond (1991) suggested a difference GMM that uses instrumental variables to deduce the GMM of corresponding moment conditions. The idea of this method is to eliminate the individual fixed effect by proceeding with the first difference of the regression equation in the first place. Thereafter, the lagged variable will be regarded as the corresponding instrumental variable of endogenous variables in the difference equation. However, this method produces poor estimates according to Bond et al., (2001), because it suffers severe weak instruments problem particularly in a finite sample. To solve this problem, Arellano and Bover (1995) and Blundell and Bond (1998) introduced a system GMM estimator in which GMM is applied to a system of two equations: an equation in differences instrumented by lagged levels and an equation in levels instrumented by lagged differences. According to Bond et al. (2001), system GMM has the ability to solve heterogeneity problems, taking care of omitted variable bias, measurement error and potential endogeneity issues that frequently affect growth models when using static models. Aali-Bujari et al. (2017) stated that the system GMM estimator also has an advantage over other estimators, as it produces unbiased results in a small sample.

This study is also aimed at exploring if human capital–economic growth nexus depends on the level of economic development. As a result, we include the income groups within the region in the study. Based on the income classification by the World Bank, all 48 Sub-Sahara African countries are organised into four groups. The first group consists of low-income countries, the second group consists of lower-middle-income countries, the third group consists of the upper-middle-income countries and the fourth group comprises high-income countries. By implication, it means each of the countries in Sub-Saharan Africa must fall within one of these groups. The low-income group comprises 27 countries; the lower-middle-income group consists of 14 countries, the upper-middle-income group consists of 6 countries and the high-income group consists of a single country. Therefore, investigating the relationship between human capital and economic growth for the income groups using dynamic GMM is not appropriate. The condition for using GMM is that the number of countries must be greater than the period of the study or fixed effect if preferable (Roodman, 2009). Estimating Equation (1) by OLS will lead to the wrong conclusion as the result will be biased. Therefore, to solve this problem, we choose alternative models, which deal with pooled regression that nests data by integrating fixed effects and random effects (RE). The fixed-effects model has few assumptions about the behaviour of residuals, and the equation that will be estimated is specified as follows:

$$\Delta y_{it} = \alpha_1 + y_{it-1} + \gamma_1 \Delta \text{hum}_{it} + \gamma_2 \Delta \text{phy}_{it} + \sum_{p=1}^{k} \beta_{pi} \Delta X_{it}^{p} + \varepsilon_{it} \tag{2}$$

In Equation (2), $\varepsilon_{it} = v_i + u_{it}$, hence

$$\Delta y_{it} = \alpha_1 + y_{it-1} + \gamma_1 \Delta \text{hum}_{it} + \gamma_2 \Delta \text{phy}_{it} + \sum_{p=1}^{k} \beta_{pi} \Delta X_{it}^{p} + v_i + u_{it} \tag{3}$$

The error ϵ_{it} can be separated into two separate parts: the first part (v_i) is the fixed part that remains constant for each country and the second (u_{it}), which is the random part, satisfies the conditions of OLS ($\epsilon_{it} = v_i + u_{it}$), which is the same as carrying out a general regression and giving each individual a different point source (ordinate). The specification of the RE model is similar to the fixed effects, except for the term v_i; instead, of being fixed for each country and constant over time, it is a random variable with mean $E(v_i)$ and variance $\text{Var}(v_i) \neq 0$. Thus, the model is expressed as follows:

$$\Delta y_{it} = \alpha_1 + y_{it-1} + \gamma_1 \Delta \text{hum}_{it} + \gamma_2 \Delta \text{phy}_{it} + \sum_{p=1}^{k} \beta_{pi} \Delta X_{it}^{p} + v_i + u_{it} \quad (4)$$

According to Aali-Bujari et al. (2017), the RE model is more efficient than the fixed-effect model, but it is less consistent than the fixed-effect model. The fixed-effect model is capable of controlling for the omitted variables in addition to the unbalanced data used. In using the static model to estimate cross-country regressions, there is always a challenge of the choice of the model to be used. That is choosing between the fixed-effect model and the RE model. We, however, addressed this problem by using the Hausman (1978) specification test. Before proceeding with the estimation, there is a need to test for the existence of heteroscedasticity, autocorrelation and cross-sectional dependence in the model. We use the xtest3 Stata module proposed by Baum (2000) to compute the modified Wald statistic for group-wise heteroskedasticity. The test result shows that the *p*-value is less than 5 per cent. We use Baltagi-Wu (1999) LBI, Bhargava, Franzini and Narendranathan (1982) DW-d and Adjusted Lagrange Multiplier (ALM) to test for autocorrelation. The null hypothesis cannot be rejected when the Baltagi-Wu's (1999) LBI test statistic is greater than 2—this is our expectation concerning the regression model. However, if Baltagi-Wu's (1999) LBI test statistic is less than 2, we reject the null hypothesis. The *p*-value for ALM test is (0.0000), which is less than 0.05; we, therefore, reject the null hypothesis. This implies that the autocorrelation tests confirm the presence of autocorrelation in the model. Pesaran's (2004) cross sectionally dependency lagrange multiplier (CDLM test) is used to test cross-sectional dependence. The *p*-value of Pesaran's (2004) CDLM test is lower than 0.05, and we reject the null hypothesis. We conclude that there is a cross-sectional dependence problem in the model. To solve these problems, we employ Driscoll-Kraay's (1998) robust standard errors. Driscoll-Kraay's (1998) standard error model can be used in the case of existence of heteroscedasticity, autocorrelation and cross-sectional dependence as it corrects for cross-section correlation, period arbitrary serial correlation, time-varying variances in the disturbances and observation-specific heteroskedasticity.

IV. Data and Variables

We use an unbalanced panel of annual data for the period from 1986 to 2018. The annual data are from 36 sub-Saharan African countries. The availability of data greatly determines the choice of the period and countries included in this study. The dependent variable in this study is the log difference of economic growth measured by real GDP per capita. In line with Siddiqui and Rehman (2016) and Ogndari and Awokuse (2018), human capital is measured by educational and health human indicators. In the literature, there is no agreement on the best measure of education human capital. We use gross primary school enrolment, gross secondary school enrolment and gross tertiary enrolment to measure education human capital. While some other studies used the average of education and government expenditure on education as proxies for education, these data are insufficient in terms of Sub-Saharan Africa. For further evidence, we also use total enrolment, which is the sum of all the levels (primary, secondary and tertiary) of education.

Regarding health human indicators, life expectancy is used as a proxy. Sachs and Warner (1997), Bhargava et al. (2001), Weil (2001) and Bloom et al. (2004) also use life expectancy to proxy health human capital. According to Murray and Lopez (1997), life expectancy is highly connected to sound health and low morbidity. Though some previous studies (e.g., Acemoglu & Johnson, 2007; Bloom et al., 2013) used infant mortality to measure health human capital, we use only life expectancy due to the absence of data on other measures of health human capital in the region. However, to provide a robust check, we also use the total labour force to proxy human capital. Labour force encompasses people who are of ages 15 and above, engaging in economic activities related to the production of goods and services during a specified period. It includes people who are presently employed and people who are unemployed but seeking work as well as first-time jobseekers. Based on the important role of human capital, we expect the indicators of human capital to significantly impact economic growth. Physical capital plays a major role in economic growth, as indicated by Solow (1956), a neoclassical growth model. Physical capital is measured by gross capital formation. Gross capital formation consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. We expect a positive relationship between physical capital and economic growth. For the control variables, we use trade openness, which is very important to economic growth. Both import and export can encourage economic growth through efficiency, adoption of modern technology and efficient utilisation of resources. As used in this study, trade openness is the sum of export and import as a percentage of GDP. We expect trade openness to stimulate economic growth.

The population growth rate is another control variable used in the study; the population is crucial to economic growth. Previous studies (e.g., Ogundari & Awokuse, 2018; Zahonogo, 2016) used population growth rate to proxy human capital. We include democracy accountability to capture the impact of political institutions on economic growth. We include institutional quality in the growth equation to capture the impact of political rights. It is argued that the lack of political rights generally limits the security of life and property, thus reducing the rate of accumulation and the efficiency of the factor of production. Acemoglu and Robinson (2012) emphasised the importance of institutional quality on economic growth. Democracy accountability is scaled between 0 and 6. The higher value means strong institutional quality. Chang et al. (2009) and Goff and Singh (2014), among many studies, included institutional quality in their studies. The institutional quality data are available online at www.icrgonline.com.

All the data are obtained from World Development Indicators (World Bank, 2020), except institutional quality variables. The institutional quality variable is obtained from the International Country Risk Guide (ICRG), which is made available by the Political Risk Services (PRS) Group. Table 1 displays the descriptive statistics of the variables, while the correlation matrix is presented in Table A1. The result of unit root test is presented in Table A2.

Table 1. Summary of Statistics of Variables

	Mean	Min	Max	Std. Dev.
GDP per capita	6.9126	5.1010	9.9288	0.9879
Physical capital	2.9153	1.2280	4.1185	0.4993
Primary school enrolment	4.4567	3.1495	5.0524	0.3479
Secondary school enrolment	3.2771	1.2852	4.6954	0.7362
Tertiary school enrolment	1.1883	1.5669	3.7037	1.0552
Labour force Total	14.9202	11.4355	17.9214	1.3871
Total enrolment	4.5709	0.8309	5.4868	5.4868
Life expectancy	3.9868	3.2647	4.3109	0.1321
Openness	4.0496	2.2122	5.1693	0.4552
Democracy accountability	2.9654	0	4.3109	0.1321
Population	0.8952	2.9086	2.0941	0.5135

Source: Authors' Computation.

V. Results and Discussion

The estimation results are presented in Table 2. Table 2 contains four models, and each of the models contains the result of the alternative measure of human capital. As indicated earlier, different education and health measures are used in the study. For instance, all the levels of education (primary, secondary, tertiary) and the sum of all the school enrolment are used as the educational measures to proxy human capital. For health measure, life expectancy is used to proxy health human capital. To further provide a robust check, the study equally uses the total labour force to proxy human capital. All these indicators are used for the study to provide reliable, valid and robust results for appropriate policy formulation. The results of the various diagnostic tests are provided in the lower part of Table 2. The first-order correlation (AR(1)) and second-order correlation (AR(2)) are important as they determine the consistency of the estimated results from the dynamic GMM. The existence of first-order correlation (AR(1)) and the absenteeism of second-order correlation (AR(2)) point to the consistency of the models. To ensure that the instruments employed are valid, the Sargan test is included to ensure that there is no error of model misspecification.

The result from model 1, where we use school enrolments as education measures to proxy human capital, indicates that the lagged GDP per capita significantly enhances the current GDP per capita. From the model, it is evident that all educational measures contribute positively to economic growth. To be specific, primary school enrolment significantly promotes economic growth. The coefficient of primary enrolment is significant at 1 per cent. It implies that a percentage increase in the primary level of education will lead to a 1.79 per cent increase in economic growth. The coefficient of secondary school enrolment is positive as expected but not significant. Tertiary school enrolment promotes economic growth, as its coefficient is positive and statistically significant at 5 per cent. The primary level of education provides a robust and significant impact on economic growth than the secondary level of education and tertiary level of education. This result is in line with Artadi and Sala-i-Martin (2003), Sala-i-Martin et al. (2004) and Ogundari and Awokuse (2018), who found that primary school enrolment enhances economic growth better than other school enrolments. The positive coefficients of all the levels of education conform to Gyimah-Brempong et al. (2006).

From these results, we observe that gross primary school enrolment as a proxy for human capital has the most robust effect on economic growth than any other proxies for human capital. This is contrary to Ogundari and Awokuse (2018), who found that life expectancy has the most significant impact on economic growth, among other human capital indicators used in their study. The higher significant impact of gross primary school enrolment on economic growth might be linked to the increase in enrolment of primary level of education in Sub-Saharan Africa, since 2000, according to World Bank, 2012.

In model 2, the total labour force, which proxy human capital, stimulates economic growth. The coefficient of labour force is positive and statistically significant at the 5 per cent level. The result indicates that a percentage increase in labour force will stimulate economic growth by 0.2 per cent. Life expectancy in model 3, which is the proxy for health human capital, significantly contributes to economic growth in the region. The coefficient of life expectancy has a positive sign and significant at the 5 per cent level. This finding conforms with Gyimah-Brempong and Wilson (2004) and other earlier studies like Barro and Sala-I-Martin (1995) and Bhargava et al. (2001). The total enrolment in model 4, which is the last proxy for human capital, fails to significantly impact economic growth though it has a positive sign. There is overwhelming evidence in support of the growing impact of human capital from the various human capital indicators considered. This conforms with earlier studies (e.g., Lucas, 1988; Mauro, 1995) and current studies (e.g., Chen & Fang, 2018; Han & Lee, 2020; Teixeira & Queirós, 2016). This is not shocking because when human capital is efficient and sufficient, innovation and productivity will increase in the economy, thereby creating a direct impact on economic growth. Innovation results in the creation of new products and improved quality products, and hence, the output capacity will be enhanced. Human capital also plays a major role in technology adoption, which is one of the most important factors in modern-day productivity through the importation of equipment and fascination of ideas. This finding shows that even the quality of human capital in Sub-Saharan Africa is below the rest of the world; however, over the years, there has been an increase in skill and knowledge through improvement in the quality of education and health. However, the region can still experience the higher impact of human capital if it can provide solutions to the problem of huge idle and underutilisation of manpower by putting mechanisms in place to fully and effectively engage them into productive activities.

Physical capital promotes economic growth in all the models. The coefficient of physical capital is positive and significant at the 1 per cent level in all the models. This is not surprising as earlier studies (e.g., Barro, 1991; Caselli et al., 1996; Gyimah-Brempong & Traynor, 1999; Levine & Renelt, 1992) found a positive relationship between physical capital and economic growth. The availability of physical capital is germane to economic growth. Infrastructure facilities provide a conducive environment for the efficient operation of economic activities and boost productivity. The availability of infrastructure attracts FDI and allows business firms to operate at low costs.

On the other macroeconomic variables, the coefficient of trade openness is insignificant in all the models. A detailed study of the literature shows that there are mixed results on trade openness–economic growth nexus. For instance, studies (e.g., Adams & Opoku, 2015; Bonnal & Yaya, 2015; Hossain & Mitra, 2013; Ikpesu et al., 2019) found that trade openness promotes economic growth in the region. In contrast, studies carried out by Vamvakidis (2002), Ulaşan (2015) and Akpan and Atan (2016) found an inverse relationship between trade openness and growth. However, with appropriate policy and management, the region can take advantage of knowledge and technology diffusion through the importation of high-tech products for its benefit. Since trade openness increases the size of the market, the region can benefit from this by improving on its value added in agriculture and industry so that their products can compete with the rest of the world and thereby increase their export base.

During the study period, analysis has shown that population growth harms economic growth. This is based on the negative coefficient of the population in all the models and its significance level at 1 per cent. This is consistent with Bonnal and Yaya (2015) and Zahonogo (2016), who found population growth to be inversely proportional to economic growth. Population growth can benefit sub-Saharan African countries if they make effective use of their vast and diverse natural resources, heavy investment in population, adoption of appropriate policies and strike balance between labour-intensive and capital-intensive techniques in agriculture, industry and economic activities. The institutional variable has a positive sign in models 1,2 and 4 but negative in model 3. However, its coefficient is statistically insignificant in all the models. This signifies that the level of institutional quality is still very low in the region.

Concerning the diagnostic tests of the model, the first-order autocorrelation (AR(1)) is present, while the second-order autocorrelation (AR(2)) is absent. This is an indication that the models are valid. The *p*-value of the Sargan test is not significant, and this confirms the validity of the instrument used. The validity of the instrument indicates the correct specification of the models.

Table 2. Results of Human Capital on Economic Growth

Variable	Model 1	Model 2	Model 3	Model 4
Lagged GDP per capita	0.9847*** (0.0000)	0.9954*** (0.000)	0.9924*** (0.0000)	0.9953*** (0.0000)
Physical capital	0.0207*** (0.0000)	0.0174*** (0.000)	0.0166*** (0.000)	0.0206*** (0.0000)
Primary school enrolment	0.0179*** (0.0001)			
Secondary school enrolment	0.0007 (0.9140)			
Tertiary school enrolment	0.0083** (0.0350)			
Total labour force		0.0020** (0.0440)		
Life expectancy			0.0122** (0.0491)	
Total enrolment				0.0029 (0.1560)
Openness	−0.0055 (0.3470)	−0.0051 (0.3120)	−0.0037 (0.4400)	−0.0037 (0.4320)
Democracy accountability	0.0018 (0.2990)	0.0005 (0.7661)	−0.0001 (0.0122)	0.0001 (0.9541)
Population	−0.0209*** (0.0000)	−0.0175*** (0.0000)	−0.0197*** (0.0000)	−0.0149*** (0.0000)
AR(1) *p*-value	0.0000	0.0000	0.0000	0.0000
AR(2) *p*-value	0.6860	0.8590	0.5241	0.7932
Sargan test	0.3922	0.1801	0.1452	0.4334
Observation	332	416	435	467
No of countries	36	36	36	36

Source: Authors' Computation.

Notes: All the variables are in logs aside democracy accountability. The *p*-values for system GMM estimates are in brackets. ***, ** represent the significance of the individual coefficients at the 1 per cent, 5 per cent and 10 per cent levels, respectively. The Sargan test is for the over-identifying restrictions. AR(1) and AR(2) represent the Arellano-Bond test of first-order and second-order autocorrelation, respectively.

As stated earlier, we estimate the results of the income groups by the static model (fixed-effect and random models). However, we exclude the high-income group in the estimations because only one country falls into the group in Sub-Saharan Africa. Also, we combine lower-middle-income and upper-middle-income countries to become middle-income groups. The results of the low-income countries and middle-income countries are presented in Tables A3 and A4, respectively. Similar to Table 2, each table consists of four models. To avoid multicollinearity problems, we estimate separate models for education measures and health measures of human capital. The correlation matrix in Table A1 shows that some of the education measures of human capital are correlated with health measures of human capital. The presence of multicollinearity in the model undermines the estimations.

Starting with the low-income group, in model 1, the coefficients of primary and secondary levels of education are positive but insignificant. This means that both the primary level of education and the secondary level of education fail to significantly contribute to economic growth. The coefficient of tertiary enrolment is positive and statistically significant. It implies that only tertiary enrolment contributes to the economic growth of low-income countries in Sub-Saharan Africa. The insignificance of both primary and secondary levels of education implies that low-income countries invest more in higher education than lower education. This might be due to their desire to produce a fairly large stock of highly skilled graduates who can influence the economy better than lower school graduates. In the middle-income countries, both the primary school enrolment and tertiary enrolment contribute to economic growth, while secondary school-level education produces an insignificant effect on economic growth.

From the results, only tertiary school enrolment significantly contributes to economic growth in the low-income and middle-income groups. This conforms with Gyimah-Brempong et al. (2006) who stated that African countries spend a high proportion of their national income on higher education to make it accessible to citizens. The Africa–America Institute (2015) confirmed that Africa recorded the highest returns (21%) to investments in higher education, which is the highest in the world. This result shows that investment in higher education yields significant benefits to economic growth. The results from the education measures of human capital indicate that the level of economic development influences the relationship between human capital and economic growth. This means that policymakers need to formulate policies in line with the level of economic development. The insignificant effect of both primary and secondary levels of education in low-income countries suggests that more investment is required in lower education. Lack of sufficient investment in lower education can have great consequences on the quality of education in the region and hence slow down the speed of economic growth. Also, a lack of periodical review of the school curriculums in Sub-Saharan Africa to provide the quality education and training needed for economic development might affect the contributions of lower education to economic growth, particularly as the world moves towards better technology.

Regarding the health measure of human capital, life expectancy boosts economic growth in all the income groups. This is an indication that all the income groups are paying attention to health development and devoting a good proportion of their income to health sector development. The impact of health human capital is the strongest on economic growth in the low-income group. This is an indication that low-income countries might be spending more on health than middle-income groups. In low-income and middle-income groups, labour force promotes economic growth. The coefficient of the labour force is significant at the 1 per cent level in both income groups. This means that labour force is a determinant of economic growth in the two income groups. The total enrolment also exerts a significant positive impact on economic growth in all the income groups. The coefficient of total enrolment is significant at the 1 per cent level in both income groups.

On macroeconomic variables included in the study, trade openness produces an interesting result. In low-income group, trade openness impacts significantly on economic growth. In the middle-income group, the effect of trade on economic growth is insignificant. This finding is in line with Rassekh (2007) who found that low-income countries benefit from trade than high-income countries. The positive effect of trade openness on the economic growth of low-income countries might be due to the successful effort of the governments to manage trade openness efficiently. Population growth is detrimental to economic growth in all the income groups. The inverse connection between population growth and economic growth is in line with Akintunde, Olomola and Oladeji (2013), who found a similar result in Sub-Saharan

Africa. This finding supports the situation described by Weil (2013) as capital dilution, a situation where growth in population decreases the available per capita worker. Olomola (2007) explained that the rapid population growth rate decreases savings and thereby inhibits investment in productive sectors. Physical capital enhances economic growth among the income groups. However, the impact is more robust in low-income countries. This might suggest that low-income countries invest more in infrastructure than middle-income countries. Institutional quality produces an insignificant effect on economic growth among the income groups. The possible reason for this might be the low level of institutional quality. Generally, institutional quality is very low in Sub-Saharan Africa.

VI. Implication of Findings

Based on the findings from this study, we can draw the following implications. First, the positive relationship between higher education and economic growth found in this study is a positive development for the region. However, the results of primary and secondary levels of education indicate that more investment is needed in the lower levels of education in the region. Therefore, more funding is needed to reposition the educational sector to be able to produce human resources needed to sustain the desired long-term growth of the region and to prepare the future human resources that can transform the economy of the region. Second, the study found that the development level influences the relationship between human capital and economic growth. This implies that the governments of various Sub-Saharan African countries need policies that will target both the development of human capital and economic growth in the region. Any policy targeting economic growth without capturing human capital might not achieve its potential as the efficiency and the effectiveness of the policies largely depend on human capital. In addition, policymakers must consider the level of development while introducing policies to improve the quality of human capital. Third, the harmful impact of trade openness on the economic growth of the middle-income group found in this study implies that the middle-income countries need to control trade openness. Middle-income countries need to reduce their import consumption as well as increase the production of consumption of commodities. They also need to improve the value added in agriculture and industry so that they can produce goods of high quality and thereby increase their export base. Fourth, the insignificant effect of institutional quality in both income groups call for an improvement in the level of institutional quality. Several studies have linked the current level of economic growth in the sub-Saharan African region to low institutional quality. Low institutional quality can slow economic transactions and limit FDI inflow into the region as investment requires protection, political stability and a sound legal system.

VII. Conclusion

Several countries have already taken significant steps towards enhancing the growth of their economies, and several factors such as FDI, institutional quality, financial development and others have been identified as determinants of economic growth. However, human capital has been highlighted as the engine of growth as the success of other determinants depend on human capital. Also, Sub-Saharan Africa has been identified as the most youthful region among the regions of the world. This demographic advantage makes the region a custodian of human resources needed for economic transformation.

To this end, this study analysed the impact of human capital on economic growth in Sub-Saharan Africa, using a dynamic GMM model for the full sample, consisting of 36 sub-Saharan African countries and static models for the income groups. First, the study considered how human capital impacts economic growth by using various human capital indicators. Primary, secondary and tertiary levels of education were used as education measures, and life expectancy was used as health human capital. To provide robust results, the study further used the sum of all the school enrolments and total labour force to measure human capital. Second, the study investigated whether the development level of an economy influences the effect of human capital on economic growth. To this end, based on the World Bank classification, the study considered the effect of human capital on economic growth among the income groups.

In the full sample, the study found that primary and tertiary school enrolments as educational measures of human capital significantly contributed to economic growth in Sub-Saharan Africa. Labour force and life expectancy, as other indicators of human capital, also significantly enhanced economic growth.

Based on the results of the income groups, the study established that the effect of human capital on economic growth depends on the level of economic development. This conclusion is based on the different impacts of the various measures of human capital on economic growth across the income groups in the region. The major constraint of this study is the inability to include all the countries in Sub-Saharan Africa in the study due to data limitation.

Appendix A

Table A1. Correlation Matrix for the GMM Model

	GDP	Open	Enr	Pop	Pry	Sec	Ter	Lab	Phy	Life	Dem
GDP	1.000										
Open	0.603	1.000									
Enr	0.614	0.428	1.000								
Pop	−0.721	−0.456	−0.456	1.000							
Pry	0.335	0.331	0.909	−0.178	1.000						
Sec	0.751	0.465	0.872	−0.491	0.618	1.000					
Tet	0.733	0.345	0.797	−0.498	0.525	0.912	1.000				
Lab	−0.566	−0.498	−0.173	0.512	−0.085	−0.243	−0.169	1.000			
Phy	0.161	0.341	0.105	0.065	0.093	0.088	0.131	0.084	1.000		
Life	0.579	0.369	0.635	−0.341	0.447	0.669	0.742	−0.184	0.350	1.000	
Dem	0.064	0.061	−0.165	0.117	−0.220	−0.071	0.018	0.009	0.167	0.087	1.000

Source: Authors' Computation.

Table A2. Unit Root Result

	Levine et al.		Im et al.		ADF		PP	
Variable	Level	1st Diff	Level	1st Diff	Level	1st Diff	Level	1st Diff
GDP per capita	−0.745	−7.436***	3.654	−12.116***	47.463	294.491***	52.469	590.619***
Physical capital	−3.405	−17.034***	−2.406	−20.496***	115.684	506.401***	126.712	695.413***
Primary school enrolment	−2.807***	1.028***	−1.027	−6.360***	72.218	156.685***	72.498	370.844***
Secondary school enrolment	−4.232***	−0.360***	1.523	−2.681***	58.260	78.358***	35.344	193.022***
Tertiary school enrolment	−3.357***	−3.357***	−6.720	2.962***	−5.741	124.670***	42.495	216.429***
Total labour force	1.456	−4.987***	9.517	−4.470***	17.259	138.411***	59.764	126.209***
Total enrolment	−14.159***	−46.156***	11.599***	−25.003***	670.874***	654.925***	289.275***	701.172***
Life expectancy	−20.897***	−37.131***	−26.897***	−36.238	566.333***	817.838***	24.925	60.252***
Openness	−1.365	−16.114***	1.257	−18.612***	83.552	461.579***	52.469	590.619***
Democracy accountability	−2.821***	−12.868***	−3.775***	−11.877	98.434***	262.070***	66.519***	382.011***
Population	−15.035***	−14.709***	−16.650***	−16.627	445.096***	502.559***	111.886***	153.595***

Source: The author.

Note: *** Indicate 1%, 5% and 10% levels of significance, respectively.

Table A3. Results of Low-income Countries

Variable	Model 1	Model 2	Model 3	Model 4
C	5.1262*** (0.0000)	0.0600 (0.785)	1.0498** (0.018)	4.9924*** (0.0000)
Physical capital	0.0983*** (0.008)	0.0583** (0.017)	0.0532** (0.048)	0.1308*** (0.0002)
Primary school enrolment	0.0346 (0.742)			
Secondary school enrolment	0.0030 (0.976)			
Tertiary school enrolment	0.1637*** (0.006)			
Total labour force		0.3573*** (0.0000)		
Life expectancy			1.1620*** (0.0000)	
Total enrolment				0.0284*** (0.0002
Openness	0.1594** (0.023)	0.2039*** (0.0000)	0.1230*** (0.0002)	0.2231*** (0.0001)
Democracy accountability	0.0103 (0.467)	0.0045 (0.676)	0.0157 (0.140)	−0.0077 (0.540)
Population	−0.1318* (0.087)	−0.0676* (0.078)	−0.0502 (0.146)	−0.0878 (0.111)
Adjusted R^2	0.59	0.46	0.49	0.10
F-statistics	69.73	109.64	76.13	
Prob > *F*	0.0000	0.0000	0.0000	
Wald chi^2				69.28
Prob > chi^2				0.0000
Hausman Test	0.0124	0.0000	0.0000	0.9170
Estimation method	Fixed effect	Fixed effect	Fixed effect	Random effect
Observation	207	435	475	431
No. of countries	21	21	21	21

Source: Authors' Computation.

Notes: All the variables are in logs aside democracy accountability. The *p*-values for fixed-effect and random-effect estimates are in brackets. ***, ** and * represent the significance of the individual coefficients at the 1%, 5%, and 10% levels, respectively.

Table A4. Results of Middle-income Countries

Variable	Model 1	Model 2	Model 3	Model 4
C	6.2687*** (0.0000)	3.6264*** (0.0000)	1.8493** (0.039)	7.5240*** (0.0000)
Physical capital	0.0383 (0.315)	0.1067* (0.097)	0.1205** (0.017)	0.0746 (0.230)
Primary school enrolment	0.2765** (0.038)			
Secondary school enrolment	−0.0208 (0.814)			
Tertiary school enrolment	0.2469*** (0.0000)			
Total labour force		0.2920*** (0.0000)		
Life expectancy			1.4721*** (0.0000)	
Total enrolment				0.0923*** (0.0000)
Openness	−0.0872 (0.108)	−0.0313 (0.732)	−0.0005 (0.993)	−0.0592 (0.474)
Democracy accountability	0.0075 (0.561)	−0.0055 (0.680)	−0.0049 (0.712)	−0.0155 (0.481)
Population	−0.1125*** (0.0000)	−0.2573*** (0.0000)	−0.4149*** (0.0000)	−0.2783*** (0.0000)
Adjusted R^2	0.83	35.01	0.16	0.46
F-statistics	260.00	11.04		76.61
Prob > *F*	0.0000	0.0000		0.0000
Wald chi^2			207.04	
Prob > chi^2			0.0000	
Hausman Test	0.0000	0.0000	0.4224	0.0000
Estimation method	Fixed effect	Fixed effect	Random effect	Random effect
Observation	137	275	305	262
No of countries	15	15	15	15

Source: Authors' Computation.

Notes: All the variables are in logs aside democracy accountability. The *p*-values for fixed effect and random effect estimates are in brackets. ***, ** and * represent the significance of the individual coefficients at the 1%, 5%, and 10% levels, respectively.

Appendix B. List of Countries

Full Countries	Middle-income Countries	Low-income Countries
Benin	Botswana	Benin
Botswana	Cameroon	Burkina Faso
Burkina Faso	Congo, Rep	Burundi
Burundi	Cote d'Ivoire	Central African. Rep
Cameroon	Equatorial Guinea	Chad
Central African. Rep	Estiwani	Comoros
Chad	Gabon	Congo, Dem. Rep
Comoros	Ghana	The Gambia
Congo, Rep	Kenya	Guinea-Bissau
Congo, Dem. Rep	Mauritania	Madagascar
Cote d'Ivoire	Mauritius	Malawi
Equatorial Guinea	Nigeria	Mali
Estiwani	South Africa	Mozambique
Gabon	Sudan	Niger
The Gambia	Zambia	Rwanda
Ghana		Senegal
Guinea-Bissau		Sierra Leone
Kenya		Tanzania
Madagascar		Togo
Malawi		Uganda
Mali		Zimbabwe
Mauritania		
Mauritius		
Mozambique		
Niger		
Nigeria		
Rwanda		
Senegal		
Sierra Leone		
South Africa		
Sudan		
Tanzania		
Togo		
Uganda		
Zambia		
Zimbabwe		

Source: Authors' Computation.

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