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Productivity effects of higher education human capital in selected countries of Sub-Saharan Africa*

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Abstract

This study aimed to analyse the productivity effects of higher education enrolment (HEE), higher education output (HEO) and the associated productivity gap (GP) on selected countries in Sub-Saharan Africa (SSA) over the period between 1981 and 2014. It was hypothesized in the study that HEE and HEO had statistically significant positive impact on productivity in the selected sub-Saharan Africa countries over the stated period. Fixed effect Least Square Dummy Variable (LSDV) and a robust version of System Generalized Methods of Moment (SYSGMM) were adopted as model estimating techniques. Results from the LSDV model indicated that HEE had no statistically significant positive impact on productivity growth in the twenty-one SSA countries. This non-significance was corrected in the dynamic model, but with negative effects on the growth rate of total factor productivity (TFP). The study further compared the worldwide technological frontier with those of the SSA countries under investigation and discovered that countries like Gabon, Mauritius and Swaziland ranked high, while Burundi needs to improve on its productivity determinants. The major conclusion of this study is therefore that higher education human capital should be supported with strong policy implementation, as this can have a positive impact on productivity growth.

Key words: *total factor productivity, Sub-Saharan Africa, human capital, higher education output, higher education enrolment*

JEL classification: *C50, I23, I29*

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1. Introduction

There are quite a few debates as to whether higher education human capital engenders productivity in an economy. Between 1980 and 2000, SSA countries generally witnessed low productivity and low higher education. A trend that has persisted until the present date. Low productivity of the mentioned economies are hypothesized to be a result of low higher education among the SSA countries (Glewwe, Maiga and Zhend, 2007).

De la Fuente (2011) argues that models of human capital and productivity are built around the hypothesis that the knowledge and skills embodied in human capital directly raises productivity and increase an economy's ability to develop and to adopt new technologies. This argument was based on the existing human capital theory that views higher education as an investment good whose evaluation depends on the perceived productivity over and above alternative investment. The acknowledgement of this assumption makes employer of labour to reward higher education with higher income. However, the link between higher education and productivity remain contestable in literature. In the screening hypothesis, it is argued that higher education has mainly a screening role and enhancement of productivity effects is not attached. It is believed according to this version that, higher education helps to identify individual with specific qualities and once identified, higher education has no impact whatsoever on these potentials during the schooling period (Devadas, 2015; Menon, 2016).

A country's literacy level in general and higher education achievement in particular reveals and reflects the knowledge, skills, and the level of economic growth and freedom it enjoys (Bloom et al., 2014). This calls for urgent higher education policy intervention aimed at boosting its enrolment rates with the expectation that it will improve productivity in the region, and consequently reverse the trend of failing economic performance (Glewwe, Maiga, and Zhend, 2007; Olamosu and Wynne, 2015). SSA lags behind all other regions of the world when it comes to productivity. Output per worker in developed regions was \$64,319 in 2011, while it was \$13,077 in developing countries. This means that the average worker in an SSA country produces one-fifth the output of a worker in a developed country (United Nations, 2012).

Many studies have been conducted across the regions of the world on the contribution of higher education to productivity and the findings are mixed. However, to the best of our knowledge, no study has considered the combination of Higher education enrolment (HEE) and higher education output (HEO) to study the impact of higher education and productivity. In this study, higher education human capital is considered from two perspectives. Higher education enrolment (HEE) and higher education output (HEO) and their contributing effects on total factor productivity (TFP). It is believed that the consideration of higher education human capital from these two perspectives would enable us to offer explanation for dropout rates in higher education among the countries in the SSA region.

The region of SSA should not expect to significantly benefit from the 21st century's economy with a less-educated workforce. Without a more educated workforce and higher productivity in the region, there can be no long-term sustained economic growth translating to a higher GDP per capita. Higher productivity can be achieved in the SSA region through improvement in higher education (World Economic Forum, 2011). Premised on this, any attempt to examine and quantify poor economic performance and low productivity in the region and reverse them through a higher educated workforce is highly relevant because these are issues related to policy-making in the region.

The specific objective of this study is to estimate the effects of HEE and (HEO) on productivity in the selected SSA countries and analyse the possible productivity gap (PG) among them. HEO, as used in this study, represents all graduates from higher education institutions in the countries under investigation.

The hypothesis of this study is that HEE and HEO had significant positive impact on productivity in the selected SSA countries. To test this hypothesis, a systematic procedure involving fixed effect Least Square Dummy Variable (LSDV) and system Generalized Methods of Moment (GMM) LSDV were adopted to ensure the robustness of the estimation techniques.

Our study contributes to the literature in 3 important ways. One, we integrated HEE and HEO into the productivity effects model which before now have been used individually. This has enabled us to highlight drop-out rate as a possible factor influencing the divergent results in literature on the individual relationships between HEE on productivity and HEO on productivity. To the best of our knowledge, this is the first study integrating these two concepts. Secondly, we provide evidence to support a negative relationship between HEE and productivity, and a positive relationship between HEO and productivity. Finally, we measured the productivity gap of countries in the SSA region with a simple model adopted from De la Fuente (2011) which was applied to the worldwide frontier. This has not been previously done for the SSA region.

Section one of this paper presents a general overview of the study, highlighting the problem addressed. Section two traces existing literature to identify a link between the theoretical framework and empirical arguments concerning the nexus between HEE and TFP as well as HEO and TFP. Section three addresses methodological issues, with Cobb Douglas production function adopted to build the study's model. The fourth section is concerned mainly with the analysis and interpretation of results. The fifth section presents the discussion, summary, and inferences from past studies. The sixth section is the conclusive part where recommendations based on the findings from the study are given.

2. Literature review

2.1. Higher education human capital and productivity: theoretical foundation

Theories on the impact of human capital on productivity have been adequately provided in the literature. Lucas (1988) for instance, argues that the level of (TFP) in an economy is determined by the average level of human capital that produces it. Romer (1990) developed a similar model and noted that improvement in productivity depends on the number of people devoting their time to the accumulation of new ideas and the existing stock of ideas. However, the human capital theory originated by Becker (1962) argues that education enhancing productivity is due to the correlation between education and improving wages.

Spence (1973) adds his voice to the debate by propounding the signalling theory which says that income earnings could increase in response to higher education not due to any impact on productivity, but just as a result of higher education acting as a signal of productivity. That is, employers of labour who believe that there is a correlation between higher education and productivity would subject workers to screening based on their acquisition of higher education, and be prepared to pay higher wages to those who are more educated. Their belief would be verified in their real life experiences if preferring individuals with higher levels of higher education eventually produces individuals with higher productivity. An optimal situation would be where individuals with higher education live up to this expectation, provided the acquisition cost for higher education is lower for high productivity individuals than it is for lesser productivity employees. In that case, all things being equal, the true market situation would be reflected by an equilibrium separation where an individual having higher productivity capacity is more likely to have higher education than an individual with lower productivity, and is therefore more likely to receive more wages.

Mankiw et al. (1992) posited that the stock of human capital generates innovation. Thus, a nation with a higher stock of human capital tends to experience faster productivity. Nelson and Phelps (1966) also argued that the ability to adopt new technology is determined and facilitated by the stock of human capital that produces it. De la Fuente (2011) predicted that models of human capital and productivity are built around the hypothesis that the knowledge and skills embodied in human capital directly raise productivity and increase an economy's ability to develop and to adopt new technologies. The further a state is from the frontier, the greater the benefits of this catch-up. Benhabib and Spiegel (1994) noted that a more educated labour-force would also innovate faster. However, in the contrary, Carderelli and Lusinyan (2015) postulates that marginality and negative signs of total factor productivity are indications of inefficiency, poor economic performance, underutilisation of allocated resources, weaker innovation and technological process. In summary, human capital theoretical models are premised on the postulation that the embodiment of skills and knowledge in human capital directly raises productivity, leading to the adoption of new technologies and improved economic performance. However, it appears that the empirical evidence has not always been consistent with this theoretical model. Moreover, there is insufficient empirical evidence to test this assumption in SSA countries. The negative results reported in some studies have led scholars to question the functional role of higher education in the productivity process.

2.2. Higher education human capital and productivity: empirical studies

Some empirical studies on the relationship between higher education and human capital development, as well as its impact on productivity, have been done in the literature and are herein discussed. De la Feunte (2011) employed average years of schooling as a proxy for human capital and biennial data for a period of 1965-1995 to examine the effects of human capital on productivity among some OECD countries. Linking the Cobb Douglas production function with the technical progress function, the study found that human capital has a large and positive coefficient value, with the coefficient for Spain being higher than those of the other OECD countries under investigation. The productivity share of human capital for Spain accounted for a 40% productivity gap, while a 30% gap was reported for other OECD countries.

Hua (2005) adopted a production function to investigate the impact of three levels of education on productivity in the provinces of China. He measured productivity based on the ratio between production and a weighted sum of production factors. The Malmquist Index was used to calculate TFP while putting distance function into consideration in order to measure the production or efficiency frontier. The results suggest that public employment is one transmission channel of education to productivity such that, while individuals with higher education tend to shy away from the public sector, those with primary education attempt to stay within the sector. Among secondary school graduates, insignificant movement was reported. With weighted signs, most coefficients were found to be significant and technical efficiency was reduced by the diminution of total demand related to business cycle.

Dahal (2015) empirically investigated the impact of higher education on TFP in the Nepali economy. The study used the ARDL method of co-integration on time series data for the period between 1975 and 2011. Higher education was found not to be statistically significant, although the coefficient was positive. However, the speed of adjustment showed an adjustment process of about 28%, since the value was significant and the coefficient negative. Soto and Flores (2015) accessed average schooling years, education expenditure and inventive coefficient and their increasing effects on productivity in Mexico. The problem of serial correlation endogeneity were controlled through the adoption of system GMM. Result conforms to the theory. The lags significance is established and the significant and positive effects on productivity changes with the level of income.

Danquah and Ouattara (2014) adopted panel data methods on the Malmquist productivity index to analyse the contribution of composite total human capital to productivity growth and the technological "catch-up" process. This was done through the channels of innovation and adoption of technology in nineteen SSA countries between 1960 and 2003. Their results revealed various contributions of human capital composition to growth in TFP. The unskilled labour proxies for secondary and primary school attainment (which are major suppliers of growth in productivity) had a significant impact on technology adoption in SSA countries, whilst skilled labour in form of higher education school attainment performed some fundamental role in domestic innovation. The findings focussed on circuitous depictions of the symbiotic relationship between the composition of human capital and productivity growth in sub-Saharan Africa, suggesting that efforts in scaling-up investments in human capital by governments, development partners etc. should not be too concentrated on one composition of human capital (Pritchett, 2001).

3. Methodology and methods of analysis

3.1. Model specification

The central concern of this study is to view human capital from the perspective of higher education enrolment and higher education output, and decipher how these independent variables affect the growth of the economy via TFP.

Taking the augmented type of Cobb-Douglas production function from Fuente (2011) in which

$$Y_{it} = A_{it} K_{it}^{\alpha k} H_{it}^{\alpha h} L_{it}^{\alpha l} \quad (1)$$

Where Y_{it} = Total output in a given country *i* at time *t*.

L_{it} = Employment level, K_{it}= Physical stock. H_{it}, which is the stock of human capital, is disaggregated such that $H_{it}= (HEE_{it} + HEO_{it})$. *HEE* is enrolment in higher education and *HEO* is the higher education output. Elasticity with respect to the stock of the various factors is measured through the coefficient α_i, (with $I =k,h,l$).

First, we provide for labour productivity as follows: Per capita production function relates average labour productivity to average schooling and to the stock of capital per worker such that output per worker, *Q=Y/L,* and stock of capital per worker, *Z=K/L,* stock of human capital per worker, *W= H/L*. Dividing eq.1 through by total employment L, yields:

$$Q_{it} = AZ_{it}^{\alpha z} W_{it}^{\alpha w} \quad (2)$$

To provide for TFP, the new Cobb Douglas function is in the form:

$$Y_{it} = A_{it} K_{it}^{\alpha k} HEE_{it}^{\alpha hee} HEO_{it}^{\alpha heo} L_{it}^{\alpha l} \quad (3)$$

With constant return to scale (*αk + αhee + αheo + αl =1*), linear equation level is produced by taking logarithms. We can assume a growth rate of *y= dln (Y/L) dt,* which relates the annual percentage growth of output per worker to the growth of physical capital per worker and educational capital per worker. We introduce $\mu_{it,}$ to capture the unexplained phenomenon (random shock) which was not captured in the adjustment process.

This leads to:

$$y_{it} = \alpha_{it} + ak(k_{it}) + ahee(hee)_{it} + aheo(heo)_{it} + \mu_t \quad (4)$$

Since a_{it} is the accounting residual growth known as total factor productivity,

$$a_{it} = y_{it} - ak(k_{it}) - ahee(hee)_{it} - aheo(heo)_{it} + \mu_t \quad (5)$$

In order to build a dynamic model into the system for TFP, we introduce the lag of dependent variable to the right-hand side:

$$a_{it} = y_{it} - a_{it-1} - ak(k_t) - ahee(hee_{it}) - aheo(heo_{it}) + \mu_t \quad (6)$$

3.2. Productivity Gap (PG) in SSA Countries

De la Feunte (2011) and Pritchett (2001) employed the technical progress function to express what determines the growth rate of TFP, which can be written thus:

$$A_{it} = \beta_t G_{it} \quad (7)$$

Where, β_t is world-wide technological frontier, $PG_{it} = A_{it}/\beta_t$ is an inverse indicator of the technological gap between country *i* and the world-wide technological frontier. β_t is expected to grow at constant and exogenous rate, *r.* Taking the TFP of the US as β_t since it is the most industrialised country in the world, $PG_{it} = 1 - A_{it}/\beta_t$ helps us to study the PG for each of the SSA countries. Most countries of the world have PG between 0 and 1. Those whose TFP exceed that of the USA are expected to have negative signs, while those with lower TFP gaps are expected be closer to the technological frontier. The relative TFP will tend to stabilise over time and the steady state value will be partly determined by the level of HEE_{it} and HEO_{it} through equation (6).

3.3. Estimating technique and summary procedures (GMM)

To account for the dynamic nature of our model and in order to control for endogeneity, GMM is incorporated within the method of estimation. Dynamic panel models have been identified as a technique to improve the performance of the estimators in a panel model. This approach has been popularized by (Arellano and Bond 1991). When a static specification of the fixed effects model is joined with autoregressive coefficients which is the lagged value of the dependent variable, it allows feedback from past or current shocks to the current value of the dependent variable. This method of specification is known as GMM. The dynamic specification removes the temporal autocorrelation in the residuals and prevents a spurious regression which may lead to inconsistent estimators from being run. The GMM model that describes the relationship among education enrolment, education output and productivity in SSA countries is specified thus:

$$a_{it} = \beta_{it} + \rho a_{it-1} - \beta_2 k_{2it} - \beta_3 hee_{3it} - \beta_4 heo_{4it} - \mu_{it} \quad (8)$$

Equation (8) is the modified form of Equation 6 represented in dynamic panel data form with the addition of the lagged value of the dependent variable. Consequently, by taking the first difference of Equation (8), we obtain Equation (9) as follows:

$$\Delta a_{it} = \beta_1 + \rho \Delta a_{t-1} - \beta_2 \Delta k_{2it} - \beta_3 \Delta hee_{3it} - \beta_4 \Delta heo_{4it} - \Delta \psi_{it} \quad (9)$$

In order to avoid possible correlation between α_{it-1} and ψ_{it}, an instrumental variable $Z\Delta$ that will not be correlated with both is obtained through a matrix transposition of the explanatory variable. Equation (10) is multiplied in vector form by $Z\Delta$, leading to:

$$Z\Delta y_{it} Z'\Delta a_{it} = \beta_1 + Z'(\Delta a_{it-1})\rho - Z'(x_{it})\beta - Z'\Delta\psi_{it} \quad (10)$$

Estimating Equation (10) using the generalized least square (GLS) method yields one-step consistent GMM estimators. However, an additional input to the approach used by Arellano and Bond (1991) which evolved over the years was developed by Blundell and Bond (1998). It is referred to as system-GMM (SYS-GMM). The difference between this approach and GMM is that SYS-GMM exercises more precaution in the usage of the instrumental variables. It was developed to tackle the problem of possible weak instrumental variables which may occur in GMM. Therefore, SYS-GMM is expected to yield more consistent and efficient parameter estimates, especially in the event of larger time periods. This necessitated the preference for SYS-GMM in this study.

The Cobb-Douglas production function was first estimated in order to identify the objectives of the study. The variable adopted for the production function are real GDP per worker, higher education enrolment and output, real capital stock per worker, and labour force. The importance of the variables as regards the TFP model is as follows:

(i) Real output per worker: The conventional dependent variable in the Cobb-Douglas production function is the real output per worker. The study applied real GDP in US dollars at constant prices (2000) which was divided by labour force to get real output per worker.

(ii) Capital enters the production process with labour to produce units of input. It is the tangible object that aids production performance. In the Cobb-Douglas production function, capital stock per worker is an independent variable. Capital stock data is readily available for most of the countries in the SSA region, and was used to calculate the capital stock for the time-period covering 1981-2014.

(iii) TFP in the context of this study is the dependent variable. It is of great importance in accounting for economic growth, economic fluctuations and differences in cross-country per capita income. When considering frequencies in the business cycle, TFP always correlates with output and hours worked. In the new growth theory, human capital levels affect productivity growth, a measurement of which is needed when we attempt to trace technical change in an economy.

(iv) HEE and HEO are two independent variables that proxy human capital. In the context of this study, it is believed that higher education output is an important determinant of human capital. Since not all that enrol for higher education eventually graduate – even though the process of human capital has begun, – this study aims to find out whether the two human capital variables can independently impact on TFP. As is a common practice in the literature, the study interpolates the five-year averages to align with the annual data for other variables in the Penn World Table.

4. Data and empirical analysis

4.1. Data

This study adopts panel data of 21 countries for the time period between 1981 and 2014 to estimate the study's models. The data for the Higher Education Output (HEO) and Higher Education Enrolment (HEE)" are available in Baro and Lee (1950-2010) data sets to cover the period 1980-2010 while the data to cover the period 2015 are available in the new version Baro and Lee (2015-2040) data sets. The two columns referred to as "tertiary total" and "tertiary completed" under tertiary in Baro and Lee data sets are referred to as HEE and HEO, respectively, in this study.

Data on real GDP**,** capital stock, and employment rates are adopted from the Penn World Table 9.0 for the 1981-2014 period. The study adopts a similar approach to data selection as that developed by Tang et al. (2008). Data from Penn World

Tables are annual data while those from the Barro and Lee dataset (1950-2010 and 2015-2040) are in five-year averages. To gain the degree of freedom required for the data, data on HEE and HEO from the Barro and Lee dataset were interpolated from e-view 9.5.

4.2. Data analysis

The paper adopts the robust version of Levin, Lin and Chu (LLC), Im, Pesaran and Shin (IPS) and Augmented Dickey-Fuller Test (ADF) to test for the presence of unit root (stationarity) in our data. Various approaches were adopted to ensure consistency and in order to compare and validate the results (Moon and Perron, 2004; Frimpong and Adu, 2012; Demetriades and Fielding, 2012). The result from Table 1 indicates that log of capital stock, employment rates, higher education enrolment, higher education output and log of real GDP growth are not stationary at levels, i.e. I(0) but when converted became stationary at I(1). While only TFP is stationary at level, i.e. I(0), as shown from the result of the various tests. None of the variables is I(2). Therefore, the result has shown that the data is stable.

Table 1: Tests for unit root in the model variables

Variables	Levin, Lin and Shu (Individual intercept)		Im Pesaran and Shin (individual intercept)		ADF- Fisher Chi- square (Ind. Intercept)	
	Order of Integration	P-value	Order of Integration	P-value	Order of Integration	P-value
Logck	I(1)	0.031**	I(1)	0.005***	I(1)	0.011**
Ctfp	I(0)	0.002***	I(0)	0.081*	I(0)	0.003***
Emp	I(1)	0.008***	I(1)	0.000***	I(1)	0.000***
DHee	I(1)	0.000***	I(1)	0.000***	I(1)	0.000***
DHeo	I(1)	0.000***	I(1)	0.000***	I(1)	0.000***
logrgdpna	I(1)	0,000***	I(1)	0,000***	I(1)	0.000***

Note: ***, ** and * represent statistical significance at 1%, 5%, and 10% respectively

Source: Authors' calculation

The results from the summary descriptive statistics show that data distribution of all the variables under investigation are positive. While some are closer to the maximum, others are closer to the minimum. For instance, the mean distribution of total factor productivity is 0.5355437, which is closer to the maximum than the minimum. This implies that total factor productivity growth is fairly high during this reviewed period. Again, the value 10.81182 of capita per labour also shares a closer mean distribution to the maximum, giving a clear indication that its growth during the period under investigation was relatively high among the SSA countries. A similar result was obtained for output per worker among the SSA countries under investigation.

However, the reverse is the case for higher education enrolment and higher education output, as the values 0.0602017 and 0.0316629 respectively are seen to be closer to the minimum than the maximum. This implies that these two variables did not behave well among the SSA countries during the period under review.

Table 2: Summary descriptive statistics

Variable	Mean	Stand. Dev	Minimum	Maximum
Ctfp	0.535	0.315	0.105	2.078
Cl	10.811	12.825	0.738	65.658
Yl	10.212	12.247	0.691	66.357
dHee	0.060	0.182	-0.788	2.600
dHeo	0.031	0.091	-0.504	1.330

Source: Authors' calculation

Table 3 shows the correlation matrix which summarizes the statistic shown in Table 2, and appears to corroborate its results. For instance, both capital per labour and output per worker have strong relationships with total factor productivity. On the other hand, there is weak relationship between the composite of HEE and HEO on TFP. A very strong relationship however exists between output per worker and capita per worker, and between HEE and HEO. The implication of this weak relationship between HEE and HEO will be a subject of intense examination as the analysis proceeds. This is because the respective expected relationships with the growth of enrolment appears to be arbitrary.

Table 3: Pair-wise correlation matrix

Variables	ctfp	cl	Yl	Dter	Dtou
ctfp	1.000				
Cl	0.613	1.000			
	(0.00) ***				
Yl	0.640	0.997	1.000		
	(0.00) ***	(0.00)***			
dHee	0.113	0.042	0.053	1.000	
	(0.003)***	(0.268)	(0.161)		
dHeo	0.101	0.065	0.077	0.919	1.000
	(0.007)***	(0.081)*	(0.039)**	(0.00)***	

Note: *Statistical significance at 10%, **Statistical significance at 5%. ***statistical significance at 1%. P-value in parenthesis

Source: Authors' calculation

Having done the descriptive analysis, econometric analysis can now be done to either confirm or refute the sketchy conclusions made under the descriptive analysis. Consequently, panel data analysis was carried out beginning with the fixed effects least square dummy variable (LSDV), and the findings are as shown in Table 4.

Table 4: Result of Fixed Effects (LSDV) analysed

Variables	Coefficients	Std. Err.	T	P-Value
Y1	0.078***	0.008	9.630	0.000
Cl	-0.067***	0.009	-7.430	0.000
dHee	0.094	0.076	1.240	0.217
DHeo	-0.292***	0.153	-1.910	0.057
Countries				
Benin	0.128***	0.034	3.820	0.000
Botswana	0.523***	0.046	11.340	0.000
Central A	0.212***	0.034	6.190	0.000
Cote d'lvoire	0.349***	0.034	10.350	0.000
Cameroon	0.298***	0.034	8.840	0.000
Gabon	0.757***	0.059	12.720	0.000
Kenya	0.315***	0.034	9.190	0.000
Lesotho	0.117***	0.045	2.620	0.009
Mozambique	0.20***	0.034	5.94	0.000
Mauritania	0.295***	0.049	6.00	0.000
Mauritius	0.622** *	.0522	11.900	0.000
Namibia	0.397** *	.054	7.360	0.000
Niger	0.043	.033	1.280	0.201
Rwanda	0.041	0.034	1.220	0.224
Senegal	0.347** *	0.034	10.370	0.000
Serial Lo	0.288** *	0.034	8.520	0.000
Swaziland	0.471** *	0.103	4.580	0.000
Togo	-0.004	0.034	-0.120	0.902
South Africa	0.559** *	0.035	16.150	0.000
Zimbabwe	0.468** *	0.034	13.880	0.000
Cons	0.163** *	0.025	6.600	0.000

Note: ** Statistical significance at 5%. *** statistical significance at 1%.

Source: Authors' calculation

The LSDV result is an extension of the fixed effects results. The test computes coefficients for dummy variables as intercept or constant for all the twenty-one countries. It also tests their individual statistical significance. It should be noted that the first aspect is the summary result of the fixed effects within regression. The remaining coefficients are the constants which represent dummy variables for each country.

The LSDV result shows that out of the twenty-one countries used in the study, only three have their constants to be statistically not significant. These countries are Niger, Rwanda and Togo. The reason for such results bears further investigation. The remaining seventeen countries exhibit common significant features, with Burundi as the reference point. The cross-sectional dependence noticed from this result seems to show that the variables are behaving in the right direction and could be enough to influence our findings and conclusions from the analysis, especially when supported by a more robust estimating technique. It is evident that almost all the countries under investigation share the same pattern of behaviour in terms of the relationship between total factor productivity and the identified explanatory variables used.

4.3. Dynamic panel data analysis

Various researchers in the past have emphasized that estimates from static panel data analyses, though consistent, may not be efficient. In order to make adequate checks for robustness and as a follow up to results obtained from static panel data analyses, dynamic panel data analysis was developed by both Arellano and Bond (1991) and Blundell and Bond (1998). This method of approach is popularly known as System Generalized Methods of Moment (SYS-GMM). Consequently, this study applies the dynamic panel model for the effects of HEE and HEO on TFP to serve as a robust check for the results obtained under the static panel models (Blundell and Bond, 1998). The results from the dynamic panel data are presented in Table 5.

The dynamic panel results as presented in Table 5 exhibit a slight variation from the initial result obtained from the static panel model of fixed effects least square dummy variables. They indicate some variations in terms of the nature of the relationship existing between HEE and HEO on TFP, as well as the significance of each determinant. Notwithstanding, the dynamic panel, SYSGMM, further offers consistent and robust results obtained so far to corroborate other results in the study. Efforts are made to explain those areas with slight differences from what was obtained under the static panel models.

Firstly, the signs of the variables' coefficients indicate some variations. For instance, output per labour and capital per labour in both static and dynamic models share similarity in coefficient sign – while output per labour is positively signed, capital per labour is not. However, the reverse holds in the case of HEE and HEO. While enrolment is positively signed in static model, it is negatively signed in the dynamic model, and while HEO is negatively signed in the static model, it is positively signed in the SYSGMM model. However, all variables except HEE under the static model are statistically significant. All other variables are significant in both models. Enrolment, which is not significant in static model, is significant in the dynamic model.

Table 5: Results from System GMM series analysed

Variable	Coefficients	Corrected Std. Err	Z	P-Value
Cons	0.015	0.009	1.570	0.117
Cl	-0.014***	0.005	-2.920	0.004
Yl	0.015***	0.005	3.150	0.002
DHee	-0.571***	0.216	-2.650	0.008
DHeo	1.122**	0.448	2.500	0.012
Ctp (L1)	0.941***	0.032	28.660	0.000

Note: ** Statistical significance at 5%. *** statistical significance at 1%. Number of instruments = 11; Wald chi2 (5) = 6557.63; Prob> chi2 = 0.000; Number of groups = 21

Source: Authors' calculation

These findings show that HEE has not been having significant positive impact on the productivity growth in the twenty-one SSA countries investigated. However, since this non-significance is corrected in the dynamic model though resulting to a negative coefficient, we can infer that HEE has been adversely affecting the growth rate of total TFP among these SSA countries.

Also, output per labour, which measures the labour productivity ratio, has a significant positive impact on TFP from both fixed effect and SYSGMM analyses. This shows that output per labour exhibits the expected positive relationship with TFP in the countries under investigation. Similarly, capital per labour, which measures capital output ratio, has a significant positive impact on TFP from both analyses.

HEO is expected to have a positive relationship with TFP. The coefficient is significant in both the fixed effect LSDV and SYSGMM, and the negative coefficient exhibited in the static is corrected in the dynamic model, thus indicating that HEO has a significant positive impact on TFP. For instance, the coefficient under systemic GMM is 1.12247. This simply implies that a unit rise in HEO will lead to about 11.22% rise in TFP. This result agrees with findings from other researchers such as Appiah and McMahon (2002), McMahon (1987), Agiomirgianaskis, Asteriou and Monasitiriotis (2002) and Voon (2001), who found a positive relationship between education and productivity growth.

Of importance is the HEE because it is an input to HEO. Results show that it is significant but with a negative coefficient. Although this negated the apriori expectation, it is an evidence of its negative effect in the SSA and further establishes the claim from literature that the SSA region has the lowest HEE of all regions of the world.

Table 6: Sargan test of over-identifying restrictions

H_0: over-identifying restrictions are valid	
chi2(5)	1.480
Prob> chi2	0.920

Source: Authors' calculation

The result from the Sargan test as indicated in Table 6 clearly revealed that the null hypothesis is rejected, therefore, over-identifying restrictions are invalid. This implies that the number of instruments used in the SYSGMM estimation does not have any negative effect on the estimators of the SYSGMM, and that the result, apart from not being significant, establishing the rejection of the null hypothesis. Again, the closer the probability to the value of one, the better. Thus, the Sargan test result strongly rejected the null hypothesis.

Table 7: Hansen test of over-identifying restrictions

H_0: over-identifying restrictions are valid	
chi2(5)	4.180
Prob> chi2	0.520

Source: Authors' calculation

Table 7 reports the result from the Hansen test of over-identification to corroborate the earlier result shown in Table 6 of the Sargan test of over-identification restriction. The result of the test exhibits consistency, and clearly shows that the null hypothesis is rejected at the probability value of 0.524. Therefore, over-identifying restrictions are invalid. This implies that the number of instruments used in the SYSGMM estimation does not have any negative effect on the estimators of the SYSGMM, and that the result, "the number of instruments is well specified", establishes the rejection of the null hypothesis.

Table 8: Arellano-Bond test for serial correlation

Arellano-Bond test for AR(1)	z = -1.970	Pr> z = 0.049
Arellano-Bond test for AR(2)	z = -1.020	Pr> z = 0.308

Source: Authors' calculation

Table 8 reports the result of serial correlation. The null hypothesis is that there is the presence of serial correlation in the model. Based on the model diagnostics of Arellano and Bond, the SYSGMM estimator produces the best estimates as AR (1) is rejected at 1% significance level, while AR (2) is accepted. This indicates the presence of serial correlation at AR (1), which is corrected at AR (2). Thus, the null hypothesis is rejected.

Thus, the results of the study passed all the diagnostic tests from extant literature, as the number of instruments does not exceed the number of countries, and the overall probability value is strongly significant.

4.4. Productivity gap analysis

This study follows the approach of Feenstra, Robert and Marcel (2015), where the US TFP (β) is benchmarked as 1. (β): $TFP \geq 1$, or $TFP \leq 0$: $0 \geq TFP \geq 1$ measures the productivity gap. $PG = 1 - TFP_{it}/\beta_t$. The standard USA productivity gap = 1 – 1/1 = 0. It therefore follows that the closer the productivity gap of country X to 0, the better. It is evident from the foregoing that countries having a TFP higher than one should have a negative productivity gap. This represents technical efficiency progress, and countries with lower productivity gap are known to have productivity decline.

This study attempts to compute the productivity gap of the twenty-one countries under investigation. These results are presented in Table A1 of Appendix 1. The justification for computing the productivity gap is premised on the fact that, although policy makers will want to know the difference in productivity across levels of education, this might not be sufficient to argue for the need for higher education. Since higher education is costly, policy makers might want to look at its costs and benefits. For policy makers to be convinced about the need for higher education, there needs to be proof that it contributes significantly to overall productivity. The first task is to prove that higher education has an impact on productivity, and the results presented earlier have established this. Policy makers may be interested in the productivity gap between those countries whose economies have benefited from higher education and those who have not before they can be interested in providing greater support to higher education. From the literature, the USA has been identified as one of the most advanced countries, making remarkable progress in terms of higher education development (Bloom et al., 2014). This study therefore submits that if SSA countries were to tread the same path as USA for instance, they would enjoy the similar benefits from higher education. From the productivity gap computations, Gabon ranked best, having the lowest productivity gap.

5. Results and discussion

Findings from the investigation provide a very strong indication that both higher education enrolment and higher education output impact significantly on TFP among the twenty-one SSA countries under review. Specifically, higher education output had a positive impact on TFP, while higher education enrolment inversely impacted on TFP between 1981 and 2014. The consistent results obtained from the static and dynamic analyses of our methodology indicate that the results are quite robust.

The region of SSA, whose productivity was at the same pace with South-Asia in the 60s, has unfortunately suffered from chronic productivity decline since the 1980s. Studies conducted have indicated that the low enrolment rates and low human capital in the region could be among the factors causing low productivity growth. This study adopts both static and dynamic models to examine the effects of higher education enrolment and higher education output on productivity. For instance, the mean distributions of total factor productivity, capita per labour and output per worker among the SSA countries under investigation are closer to the maximum than the minimum under in summary statistics. However, this closeness to the maximum value did not drive productivity growth in the region, as this growth is driven by primary products which continue to suffer from weaker commodity prices. The growth of capital and output per labour, which appears fairly high in the summary statistic, is also reflected in the productivity graph presented in Appendix 1. Comparably, the sluggish growth of higher education and output is also reflected in the graph.

The analyses from both summary statistics, correlation matrix and LSDV fixed effects all indicated that higher education enrolment and higher education output, though closer to the minimum than the maximum, have the tendency of driving productivity growth since they are both statistically significant. Capital per labour has a negative relationship with TFP in the results of both system GMM and LSDV analyses. This simply implies that there is capital labour imbalance among the countries under investigation, and suggests that a highly educated workforce is needed to correct this imbalance.

The results also suggests that there is a high level of unskilled labour in the system, whose activities does not have much impact on the region's TFP. LSDV results show that there is an inverse relationship between higher education output and TFP, but this is corrected in the robust system GMM which is a more advance methodology. If higher education output increases, it is expected that this increase will have an impact on TFP. Again, the figure in the Appendix 1 shows that both higher education enrolment and higher education output contribute only marginally to TFP, and by implication, the economy in the SSA region. This result supports the findings of Danquah and Ouattara (2014) who found education to be positively related to TFP.

6. Conclusion

The findings from these analyses have indicated that both HEE and HEO have significant impacts on TFP. While HEO has a positive effect on TFP, an inverse relationship is the case with HEE. Given the diagnostic checks conducted in this study, the robustness of our result has been established. The hypothesis of this study that HEE and HEO had significant positive impact on productivity in the selected Sub-Saharan Africa countries has been proved. The result which indicates that HEO has a positive relationship with TFP is supported both theoretically and empirically from studies conducted by other researchers in countries across other regions of the world. In addition, the inverse effect of HEE on TFP, which appears unexpected, is a true reflection of the state of enrolment in the region. Its low level negatively affects the marginal increase in TFP. The effects of education on productivity have been extensively explored in the literature. Our study however contributes to the literature in 3 important ways. One, we integrated HEE and HEO into the productivity effects model which before now have been used individually. This has enabled us to highlight drop-out rate as a possible factor influencing the divergent results in literature on the individual relationships between HEE on productivity and HEO on productivity. To the best of our knowledge, this is the first study integrating these two concepts. Secondly, we provide evidence to support a negative relationship between HEE and productivity, and a positive relationship between HEO and productivity. Finally, we measured the productivity gap of countries in the SSA region with a simple model adopted from De la Fuente (2011) which was applied to the worldwide frontier. This has not been previously done for the SSA region. The major constraint in the study was the limited availability of TFP data. From our research, we were only able to find TFP data made available for twenty-one countries in the SSA region. Using the results of a study conducted on twenty-one out of the forty-six countries available in the world bank development indicator to give generalized conclusions about the entire SSA region is contestable and opens the study to criticism. This is an unavoidable limitation to the study. Further efforts to compute TFP for the SSA region from the estimation of residuals in the Cob Douglas production function were again constrained by the higher education output variable. There is room for further research on this subject, since the study was not able to identify the determinants of TFP in the SSA region. Furthermore, a comparative study across regions should expose how the productivity level in the SSA region compares to other regions in the world. The study could also be extended to other levels of education apart from higher (tertiary) education. With regards to implications of the study for the SSA region in economic policy making, the results indicate that if HEO is put into productive use, it has the potential of improving productivity, as a highly-educated workforce has the tendency of adopting foreign technology. Even though there is negative relationship between HEE and TFP, informed policies can revert this trend substantially. The productivity gaps between SSA countries and the developed world which have been computed indicate the potential for productivity in the SSA region. This potential can only be realised if its countries develop a sufficiently educated workforce.

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Učinak produktivnosti ljudskog potencijala visokog obrazovanja u odabranim zemljama Sub-saharske Afrike

Koye Gerry Bokana[1], *Gbenga Wilfred Akinola*[2]

Sažetak

Ovaj rad usmjeren je na analizu učinaka produktivnosti upisa na visoka učilišta (HEE), rezultate visokog obrazovanja (HEO) i povezanog jaza produktivnosti (GP) u odabranim zemljama u sub-saharskoj Africi (SSA) u razdoblju od 1981. do 2014. godine. U istraživanju se polazi od hipoteze da HEE i HEO imaju statistički značajan pozitivan utjecaj na produktivnost u odabranim zemljama sub-saharske Afrike u navedenom razdoblju. LSDV model fiksnih učinaka (Least Square Dummy Variable) i robusna verzija sustava generalizirane metode momenata (SYS GMM) usvojene su kao tehnike procjene modela. Rezultati dobiveni primjenom LSDV modela pokazuju da upisi na visokoobrazovne ustanove nemaju statistički značajan utjecaj na rast produktivnosti u dvadeset i jednoj zemlji sub-saharske Afrike. Ovaj manjak statističke značajnosti ispravljen je u dinamičkom modelu, ali s negativnim učincima na stopu rasta ukupne faktorske produktivnosti (TFP). Istraživanje je nadalje uspoređivalo svjetsku tehnološku granicu s istraživanjima zemalja SSA i ustanovilo da su zemlje poput Gabona, Mauricijusa i Svazi visoko rangirane, dok Burundi treba poboljšati svoje determinante produktivnosti. Glavni zaključak ovog istraživanja je stoga da se ljudski kapital visokog obrazovanja treba podržati snažnom provedbom politike, jer to može imati pozitivan utjecaj na rast produktivnosti.

Ključne riječi: *ukupna faktorska produktivnost, Sub-saharska Afrika, ljudski potencijal, rezultati visokog obrazovanja, upisi na visokoobrazovne ustanove*

JEL klasifikacija: *C50, I23, I29*

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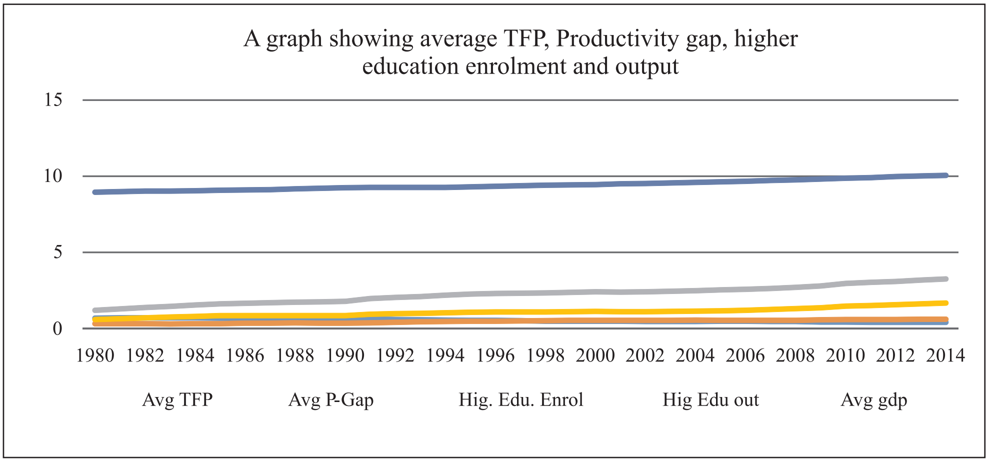
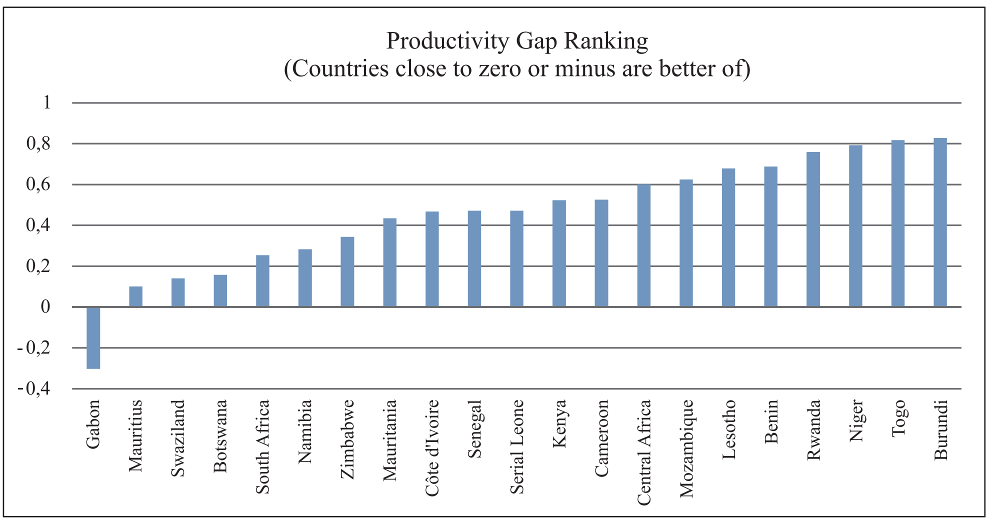
Appendices

Figure A1: A graph showing average TFP, productivity gap, HEE and output for 21 SSA countries under investigation



Source: Authors' calculation

Figure A2: Average productivity gap among selected twenty-one SSA countries



Source: Authors' calculation

Figure A3: Showing productivity gap ranking of countries in SSA Region

Rank	Country	PG
1	Gabon	-0.302
2	Mauritius	0.101
3	Swaziland	0.140
4	Botswana	0.158
5	South Africa	0.254
6	Namibia	0.284
7	Zimbabwe	0.344
8	Mauritania	0.434
9	Cotd'evoire	0.468
10	Senegal	0.472
11	Serial Leone	0.472
12	Kenya	0.523
13	Cameroon	0.526
14	Central Africa	0.601
15	Mozambique	0.625
16	Lesotho	0.680
17	Benin	0.688
18	Rwanda	0.760
19	Niger	0.792
20	Togo	0.817
21	Burundi	0.828

Source: Authors' calculation