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Does Research Output Matter for Economic Growth in Sub Saharan African Countries? Quantity and Quality Analysis

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Does Research Output Matter for Economic Growth in Sub Saharan African Countries? Quantity and Quality Analysis

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Abstract

We study the link between university rankings and economic growth in Sub Saharan African Countries (SSA) by applying the panel data analysis method and the system GMM technique used on a sample of 43 SSA countries during the period 1996-2015. Our results indicate that academic research exerts a positive and significant effect on the level of economic growth for both fixed and random effect. However, this relation seems to be insignificant when we run GMM in system regression. Also, findings show that domestic investment (INVES) and gross domestic savings (GDSAV) are considered as key factors for boosting economic growth in the SSA region. Contrary, the effect of foreign direct investment (FDI) is positive but not significant for fixed and random effect regressions.

Keywords: research output, quantity and quality, economic growth, SSA countries panel data, GMM in system

¿Tienen Importancia los Resultados de la Investigación para el Crecimiento Económico de los Países del África Subsahariana? Análisis Cuantitativo y Cualitativo

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Resumen

Estudiamos la relación entre rankings universitarios y el crecimiento económico en países del África Subsahariana aplicando el método de análisis panel y la técnica sistema GMM sobre una muestra de 43 países del África Subsahariana durante el periodo 1996-2015. Nuestros resultados indican que la investigación académica ejerce un efecto significativo y positivo sobre el nivel de crecimiento económico tanto para los efectos fijos como para los aleatorios. Sin embargo, esta relación parece insignificante cuando ejecutamos una regresión GMM. Así mismo, los resultados muestran que la inversión doméstica (INVES) y los ahorros domésticos brutos (GDSAV) se consideran factores clave para el crecimiento económico en la región. Contrariamente, el efecto de la inversión extranjera directa es positivo pero no significativo para regresiones de efectos fijos y aleatorios.

Palabras clave: resultados de la investigación, cuantitativo y cualitativo, crecimiento económico, datos de panel de países de SSA, GMM en sistema

Compared to worldwide economies, the African economies are considered as the most unstable and least affluent. The African region, especially SSA countries, records a lower level of growth and faces several challenges to solve weaknesses which limit development. Consequently, the need to search and propose how to boost economic growth in this region is obvious. An increased number of studies have emphasized the role of human capital to facilitate a faster level of economic growth. The role of human capital is discussed in Nelson and Phelps (1966), and further confirmed in the model of endogenous growth found in Romer (1986, 1990), Lucas (1988), and Becker et al. (1990).

Recently, an increasing number of researchers have been investigating the relationship between economic growth and its research output, measured in scientometric indicators (Lundberg, 2015; Ntuli et al., 2015; Inglesi-Lotz & Pouris, 2013). On the one hand, governments have dedicated an importance for expenditure on education and on the other hand, the research output of universities and researchers is growing. Here we should raise the following question: Why does academic research not solve economic problems in many countries?

The research/growth relation is multidimensional and it has been discussed differently in many studies. The first part of the studies has investigated the linkage between the effects of the quantity of research measured by the number of publications on the level of economic growth (Price, 1978; Pouris & Pouris, 2009). The second part of the studies has analyzed the effect of the quality of research measured by the number of citations on the level of growth (Haiqi & Yuha, 1997; De Moya-Anego & Herrero-Solana, 1999; Butler, 2003; Pouris, 2003; King, 2004; Inglesi-Lotz & Pouris, 2013). The causal relationship between research output and growth has been given in the third part of the studies. Finally, the research/growth relation may differ depending on the country's classification. It is recognized that highly developed countries normally have the most active and productive research universities, which positively affects the level of growth.

Motivated by the necessity to increase the level of growth in the African continent and to benefit from the results of academic research, this paper aims to test the linkage between academic research and economic growth in

Sub Saharan African Countries (SSA). To this end, we used a sample of 43 SSA countries during the period 1996-2015. The econometric approaches used in this study are based on the panel data analysis method and the system GMM technique. The empirical findings of this paper indicate that academic research measured by the Naperian logarithm of the number of publication per year (PUB) exerts a positive and significant effect on the level of economic growth for both fixed and random effects. Also, results indicate that growth in SSA countries can be derived by domestic investment (INVES) and gross domestic savings (GDSAV).

The remainder of this paper is presented as follows. The second section presents the literature review. An overview on the academic research and the level of growth in SSA countries is given in section three. The empirical analysis is made in section four. Finally, we conclude with section five.

Literature Review

It is widely acknowledged that the debate on the relationship between knowledge and economic growth is certainly not recent (Romer, 1986; Lucas, 1988). The importance of human capital is studied by Nelson and Phelps (1966), and further investigated by Romer (1986, 1990), Lucas (1988), and Becker et al. (1990). Studies have examined the linkage between economic growth and accumulated knowledge. They reported that the connection can imply causality running from any of the two indicators to the other (Price, 1978; Kealey, 1996; King, 2004; Fedderke & Schirmer, 2006; Lee et al., 2011; Inglesi-Lotz & Pouris, 2013).

An increasing number of researchers have interest in the relationship between a country's economic growth and its research output, mostly measured in scientometric indicators. There is some research that investigates the linkage between the effect of the quantity and/or quality of research on the level of economic growth. Quantity of research output is usually measured by the number of publications per year (Price, 1978; Pouris & Pouris, 2009). However, a country's research performance is measured by the number of citations for each paper in highly indexed journals (Haiqi & Yuha, 1997; De Moya-Anego & Herrero-Solana, 1999; Butler, 2003; Pouris, 2003; King, 2004; Inglesi-Lotz & Pouris, 2013).

Studies that explored the relationship between output research and economic growth can be divided into two groups. In the first group, some research has investigated the effect of research on growth (King, 2004; Vinkler, 2008; Lundberg, 2015). Literature on the causal relationship between these two indicators has been given in the second group (Lee et al., 2011; Inglesi-Lotz & Pouris, 2013; Inglesi-Lotz et al., 2014; Ntuli et al., 2015).

With reference to a dataset relative to Swedish municipalities during the period 1990–2010, Lundberg (2015) tested the effect of academic research on growth. Research output is measured by the number of dissertations and papers published in academic journals with peer review. Findings indicate that knowledge through research affects regional growth where the academic institution is located and the growth pattern of neighboring municipalities.

Based on the autoregressive distributed lag (ARDL) method, Inglesi-Lotz and Pouris (2013) studied the effect of academic research on the level of economic growth in South Africa. Results reveal that the affect differs from one scientific field to another. The relationship is confirmed for individual fields of science (biology and biochemistry, chemistry, material sciences, physics, psychiatry and psychology). Similar to the results of Vinkler (2008) and Lee et al. (2011), these findings confirm the positive effect of research output on economic growth in South Africa during the period 1980-2008. Vinkler (2008) and Lee et al. (2011) suggest that the nature of the link between research and economic growth varies according to the developmental stage of the country. The causal relation between research and economic growth in 34 OECD countries was studied by Ntuli et al. (2015). To this end, they used a sample observed over the period 1981–2011 and they performed the bootstrap panel causality analysis. The main results reveal unidirectional causality running from research output to economic growth for the US, Finland, Hungary, and Mexico; opposite causality from economic growth to research articles published for Canada, France, Italy, New Zealand, the UK, Austria, Israel, and Poland; and no causality for the rest of the countries.

Inglesi-Lotz et al. (2013) examined the causal relationship between economic growth and research output of the BRICS countries for the period 1981-2011. In this study, research output was measured by the number of

papers published. By performing panel causality analysis techniques, empirical results support no causality in any direction between research papers as a percentage share to the world and economic growth for all the BRICS except for India. For this country, the feedback hypothesis is confirmed.

Academics Research and Economic Growth: An Overview of SSA Countries

Academic research is recognized as the most influential indicator measuring how universities perform. The reputation and ranking of universities are heavily based on the number of papers published and/or cited in international and high impact journals. Those documents should provide solutions for the dysfunction and problems recognized by the nation. Findings should serve as recommendations for policy makers on how to enhance development and boost economic growth.

The African region, especially SSA countries, records a lower level of growth and faces several challenges to solve weaknesses which limit development for this region. Their priorities should be oriented to promote both research and education. Research output in SSA countries has soared over the last 10 years, but is still not adequate to fuel the region's fast growing economies. In this region, research has been growing more quickly in some countries than others. For example, west and central Africa increased its world article contribution from 0.23% in 2003 to 0.4% in 2012. While Southern Africa increased its share from 0.07% to 0.09% for the same period. Consequently, governments should support research-teaching in addition to education. This is in order to be more involved in society and try to offer solutions for weaknesses which some countries suffer.

An examination of university rankings in SSA countries (July 2016 edition) reveals that the five best universities are from South Africa. This ranking confirms the top ranking of this country in terms of the number of publications with an average of 9405 documents during the period 1996-2015 (see table 1). In total, this country has 26 universities accommodating 1 million students, with plans by the government to add 500,000 to that total by 2030. It is worth recalling that South Africa's universities and other

institutions in various disciplines are some of the best on the continent and in the world. Nigeria comes in second place with more than 100 universities. The ranking shows that Ibadan University is topping the list followed by the University of Lagos in second place and the University of Benin UNIBEN in third place. University rankings in SSA countries indicate that Somalia fills in last place. For this country, the average number of publications during the period 1996-2015 reached only 6 publications. This weak number indicates that the priority in Somalia's universities is given first to teaching instead of research. Despite the civil war for more than two decades, education remains key for many Somalis as the Somali proverb says "*To be without knowledge is to be without light*". Despite the wars and famine, students and staff have still turned up to class. However, the number of students that do not take classes remains very high. According to the UN development programme (UNDP) published in 2010, 43% of Somalia's population live below the poverty line. High educational fees have priced many potential students out of higher education.

Table 1.
Countries ranked by number of publications

Top 10 Countries with highest number of pub			Top 10 Countries with weakest number of pub		
Ranking	Countries	NB of paper	Ranking	countries	NB of Papers
1	South Africa	9405	1	Somalia	6
2	Nigeria	2969	2	Cape Verde	10
3	Kenya	1223	3	Chad	19
4	Ethiopia	668	4	Burundi	21
5	Tanzania	598	5	Guinea-Bissau	23
6	Ghana	577	6	Lesotho	23
7	Uganda	576	7	Mauritania	24
8	Cameroon	556	8	Eritrea	24
9	Zimbabwe	362	9	Dem. Rep. Congo	26
10	Senegal	352	10	Central African Republic	27

Source: The author from the International Scientific Journal & Country Ranking (SJR)

In conclusion, there is a strong need to firstly encourage and improve inter-regional cooperation among researchers in SSA countries, and secondly among international cooperation. This is in order to share and

improve knowledge, skills and experiences between researchers. Also, working in cooperation leads to well explored available data bases and to the investigation of many subjects.

Table 2 and graph 1 cited below indicate the average evolution of the growth of the number of publications and the GDP growth for 43 SSA countries over the period (1996-2015). This description is given to make a comparison and connection between scientific research and economic growth. In other words, the level of growth evolved adjusted parallel to research output. To this end, we used statistics related to the average number and the growth of the average number of papers compared to GDP growth.

Table 2.

Evolution of the average number of publications (Pub) and economic growth (GDPg) during the period 1996 -2015 for 43 Sub Saharan African Countries

Years	Papers	Papers growth in %	GDPg in %	Years	Papers	Papers growth in %	GDPg in %
1996	202	-	6.63	2006	429	16.58	5.36
1997	219	8.42	5.72	2007	476	10.96	5.53
1998	219	0.00	2.02	2008	515	8.19	2.49
1999	229	4.57	3.45	2009	606	17.67	4.28
2000	218	-4.80	2.55	2010	670	10.56	5.67
2001	216	-0.92	3.33	2011	762	13.73	5.31
2002	239	10.65	2.81	2012	818	7.35	4.44
2003	288	20.50	2.64	2013	884	8.07	4.07
2004	321	11.46	3.66	2014	977	10.52	4.21
2005	368	14.64	4.05	2015	921	-5.73	3.52

Source: The author from the International Scientific Journal & Country Ranking (SJR)

The most remarkable observation from table 2 above is that the number of papers seems to be constant during the first period 1996-2003. On average it went from 202 in 1996 to 288 in 2003. Since this year, we notice an increase in the number of publications registering 670 in 2010 and 977 in 2014. For the growth rate of papers, SSA countries recorded a positive value with the highest level being 20.50% in 2003 compared to 2002. However, the growth in the number of publications only indicates a negative value for three years. In 2000, the growth number was -4.80%. It continued to be

negative in 2001 with a rate of -0.92%. Recently, in 2015 the growth in the number of registered papers again reached a negative value of -5.73%. From these statistics we can conclude that although there is a weak number of publications in the SSA countries, research in this region have improved.

The level of growth in SSA countries during the past decades has remained unsatisfactory (Ghura & Hadjmichael, 1996). Many SSA countries have been hit by a multiple number of shocks. We quote the sharp decline in commodity prices and tighter financing conditions (Annual report of the International Monetary Fund, 2016). Recently, growth in this region fell in 2015 to its lowest level in some 15 years and it will continue to slow to 3% in 2016. However, oil exporting SSA countries have registered satisfactory growth performance.

Figure 1. Annual evolution of the average growth of GDP and the number of publications (PUBg) during the period 1996-2015 for 43 SSA Countries

With reference to table 2 and graph 1, we can interpret the level of economic growth within three phases. The first covers the period 1996-2003. In this phase, GDP growth has registered a negative trend. GDP growth was 6.63% in 1996 and became 2.64% in 2003, representing a decrease of 4 points. The second coincides with the period of 2004-2011. During these years, GDP growth registers an upward trend. It switches from 3.66% to reaching 5.31% in 2011. From the year of 2012 to 2014, GDP growth again regained a positive trend with a rate of 4.44% and 4.21% respectively.

Empirical Analysis

Data and Methodology

To test the relationship between research output and the level of growth, we used a sample of 43 SSA countries during the period 1996-2015. Data was collected from world development indicators (WDI). However, academic research is measured by the Naperian logarithm of the number of publications per year, which measures the quantity of research and the number of citation per document which refers to the quality of research. These data are collected from the International Scientific Journal & Country Ranking (SJR) website. This database provides information about the number of documents, the number of citations and the H index. Also, the number of publications can be extracted from all subject categories or within specific fields. In this study, we used the number of documents in all subjects. The empirical strategy is based on two approaches, panel data analysis and system GMM, to check the soundness of the results. The double dimensions, individual (countries) and temporal (years), of our sample oriented us towards the selection of panel data analysis. We can profit from the two sources of variation in statistical information: temporal or intra-individual variability and individual or inter-individual variability. Panel data generally presents less multicollinearity than time series or cross section data. Also, it leads to more precise coefficient estimations. The complexity of the behavior of the studied individuals is often raised. Using panel data, the non-stationarity of time series and estimate errors seem to have been reduced (Baltagi, 1995; Baltagi, 2001). Also, the GMM method has several advantages. It allows one to solve the problems of simultaneity bias, reverse causality and omitted variables which have weakened the results of previous studies. It also addresses the problem of the endogeneity of explanatory variables (Hansen, 1982; Hansen & Singleton, 1982; Liang et al., 2013; Tan, 2016). It is for these reasons that we have firstly chosen panel data analysis to estimate our model and secondly, system GMM to check the robustness of the results.

Model Specifications and Variable Definitions

Following the same approach adopted by recent empirical studies that have examined the linkage between research and growth and based on growth literature, the econometric model can be presented as follows:

$$\text{GDPpc}_{i,t} = \beta_0 + \beta_1 \text{PUB}_{i,t} + \beta_2 \text{CITAT}_{i,t} + \beta_3 \text{TECHN}_{i,t} + \beta_4 \text{EDEXP}_{i,t} + \beta_5 \text{CPS}_{i,t} + \beta_6 \text{FDI}_{i,t} + \beta_7 \text{INVES}_{i,t} + \beta_8 \text{GDSAV}_{i,t} + \beta_9 \text{OPEN}_{i,t} + \varepsilon_{i,t}$$

Table 3.

Definitions and Measurements of variables

variables	Definitions	Measurements
GDPPC	GDP per capita growth (annual %)	Annual percentage growth rate of GDP per capita based on constant local currency.
PUB	Number of publications	Naperian logarithm of the number of publications per year
CITAT	Citation of publication	Number of citation per documents
TECHN	High-technology exports	High-technology exports (% of manufactured exports)
EDEXP	Research and development expenditure	Research and development expenditure (% of GDP)
CPS	Domestic credit to private sector (% of GDP)	Domestic credit to private sector refers to financial resources provided to the private sector by financial corporations.
FDI	Foreign direct investment, net inflow (% of GDP)	Foreign direct investment refers to the direct investment equity inflow in an economy.
INVES	Gross capital formation (% of GDP)	Gross capital formation consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventory.
GDSAV	Gross domestic savings (% of GDP)	Gross domestic savings are calculated as GDP less final consumption expenditure.
OPEN	Trade openness	Total imports + total exports of goods and services as % of GDP

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Results and Interpretation

Pre-estimation: Descriptive Statistics and the Correlation Matrix

Table 4 reveals the descriptive results of the different variables of our study. The average level of GDPPC is 1.993% while the average level of the logarithm of the number of publications (PUB) is 4.538 with a maximum of

9.871 and a minimum of 0. The number of citation per document records on average a value of 15.145 and a maximum value of 85.58. The average value of export of High-technology is 4.772% with a maximum of 83.640%. Education expenditure in % of GDP registered a mean value of 3.759% and a maximum value of 68.153%. For these two variables, it seems that all SSA countries do not grant the same importance for factors that can improve research and stimulate economic growth. Credit to private sector to GDP (CPS) achieved an average of 20.027% with a minimum of 0.198 % and a maximum of 160.125%. The average level of foreign direct investment net inflow (FDI) remains very weak with an average of 0.141 %; having a maximum value of 33.667 % while its minimum value is -19.915%. Contrary to foreign investment, the average value of domestic investment (INVES) seems to be satisfactory with a level of 20.809 %; its maximum value is 78.822 % while its minimum value is -2.424%. For gross domestic savings (GDSAV), the average value is 10.922%; its minimum value is -70.457% and 69.706% as its maximum value. Descriptive statistics indicate respectable values for trade openness in the SSA region. We find that the average value of trade openness (OPEN) is 114.528% and the maximum value is 209.891%.

Table 4.

Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Gdppc	833	1.993	4.691	-38.231	30.342
Pub	860	4.538	1.719	0.000	9.871
Citat	860	15.145	10.086	0	85.580
Techn	612	4.772	7.906	0	83.640
Edexp	795	3.759	3.543	0.850	68.153
Cps	788	20.027	24.110	0.198	160.125
Fdi	669	0.141	2.204	-19.915	33.667
Inves	790	20.809	10.177	-2.424	74.822
Gdsav	773	10.922	17.193	-70.457	69.706
Open	803	114.528	1127.232	17.859	209.891

The correlation coefficients of all variables used in our models are presented in table 5. Results of the correlation matrix indicate that only CPS is negatively correlated with the dependent variable. Also, table 5 shows that

all coefficients are very weak. Consequently, we conclude the absence of bi-variable multicollinearity for our model.

Table 5.

The Correlation Matrix

	gdppc	cita	pub	cps	fdi	inves	gdsav	open	techn	expedu
gdppc	1.0000									
cita	0.0060	1.0000								
pub	0.0340	-0.1359	1.0000							
cps	-0.0626	-0.2146	-0.1485	1.0000						
fdi	0.1765	-0.0617	-0.0513	-0.0202	1.0000					
inves	0.4900	-0.0187	0.1748	-0.0220	-0.0358	1.0000				
gdsav	-0.0264	-0.0605	0.0674	0.0596	-0.2630	0.0340	1.0000			
open	0.3409	-0.0190	0.1398	-0.0233	0.1273	0.6785	-0.2105	1.0000		
techn	0.0233	0.0643	0.0032	0.0397	-0.0495	0.0610	0.1471	0.0186	1.0000	
expedu	0.0078	-0.0266	0.0414	0.0274	0.0790	0.0117	-0.1074	0.1406	-0.0414	1.0000

Consequently, we conclude the absence of bi-variable multicollinearity for our model.

After giving an overview of descriptive statistics for our sample and the nature and level of correlation between all variables of our study, we will interpret the econometric results in the following section. Precisely, we will focus on the economic interpretation of all significant associations.

Findings

In this section, we provide the results of our model using three methods of estimation. The first one is the fixed effect regression, the second is the random effect regression and the third one presents the results of system GMM regression.

The validity of the system GMM requires that three conditions be fulfilled. First, the Sargan test of over-identifying restrictions should provide no correlation between instruments and error term. Second, for the second order correlation, there should be no serial correlation. System GMM results indicate that the Sargan and serial-correlation tests do not reject the null hypothesis of correct specification (P-value of Sargan test and P-value of AR(2) test of Arellano and Bond are larger than 5%), providing support for our estimation results. The p-value of the Sargan test of over-identifying restrictions is equal to 16% which is higher than 5%. Hence, we confirm the

overall validity of the instruments. Also, the P-value of $AR(2)$ is equal to 40.6% (more than 5%) which implies that there is no correlation.

Table 6.

Results of fixed, random and GMM regression

	Model (1) Fixed Effect		Model (2) Random Effect		Model (3) GMM	
	Coef.	Z-Stat	Coef.	Z-Stat	Coef.	T-Stat
Gdppc	—	—	—	—	0,144	2,62***
gdppcL1.	—	—	—	—	0,066	0,95
Pub	0,546	1,980**	0,335	2,14**	0,0004	1.45
Citat	0.0007	0.651	0.0009	0.881	-0.024	-1.55
Techn	-0.049	-1.48	-0.047	-1.49	-0.841	-0.89
Edexp	-0.002	-1.37	0.002	-1.09	-0,029	-0,40
Cps	-0,057	-2,310**	-0,022	-2,09**	0,010	1,67*
Fdi	0,038	0,510	0,011	0,16	0,002	0,56
Inves	0,083	3,130***	0,085	3,95***	0,031	3,07***
Gdsav	0,103	4,320***	0,035	2,57***	0,044	2,29***
Open	0,004	0,320	0,005	0,83	—	—
_cons	-2,335	-1,850*	-1,956	-2,06	—	—
Fisher	8,400	—	—	—	28,450	—
Prob>chi2	0,000	—	—	—	0,000	—
Wald	—	—	40,330	—	—	—
Prob > chi2	—	—	0,000	—	—	—
AR (1), Pr > z	—	—	—	—	0,000	—
AR (2), Pr > z	—	—	—	—	0,406	—
Sargan test chi 2 (18)	—	—	—	—	09,01	—
Prob > chi2	—	—	—	—	0,214	—
Nb of instruments	—	—	—	—	42	—
Nb of observations	597	—	597	—	567	—

***, ** and * denote the level of significance respectively at 1%, 5% and 10%

The GDPPC lag is positively and highly significantly correlated with the dependent variable. This implies that the level of economic growth depends on the past level. A high level of economic growth registered in the preceding year can positively affect the growth rate of the current year.

With regard to the effect of research output, precisely quantity of research (PUB) on the level of growth, the fixed and the random effect regressions indicate that there is a positive and significant association at 5%. This result implies that the improvement of academic human capital as the main creator of knowledge exerts a positive effect on the level of growth. The SSA government should aim to foster economic growth through public expenditure in tertiary education. Also, these countries should encourage and improve inter-regional cooperation among researchers in SSA countries first,

and among international cooperation second. This is for the purpose of sharing and improving knowledge, skills and experience between researchers. The positive linkage between output research and economic growth is in line with many previous studies (Inglesi-Lotz & Pouris, 2013; Inglesi-Lotz et al., 2014; Ntuli et al., 2015; Lundberg, 2015).

However, for the second dimension of academic research which measures the quality of research, results indicates that the number of citation exerts a positive but not significant effect on the level of growth in SSA countries. Also, variables that reflect mechanisms through which research affects economic growth such as technology and education expenditure have a negative but insignificant effect on the GDPpc. These results imply that SSA countries are invited to grant more attention to the mechanisms of transmission from research to growth such as technology and education expenditure. Certainly there was a threshold of these mechanism in which their effects become positive and significant. For the effect of the quality of research measured by the number of citation which is not significant, this means that SSA countries should improve the quality of academic research to be more cited in well indexed journal and to be canalized in productive system to generate more economic growth.

Contrary to theoretical literature, the effect of credit to private sector (CPS) is negative and significant for both fixed and random effects. The role of the financial sector in promoting growth has been highly acknowledged since the work of Schumpeter (1934). Access to credit leads to more investment which turns positively on the level of growth (Rajan & Zingales, 1998; Guiso et al., 2004). However, our results have revealed negative relationships. These results indicate that the governments of SSA countries should adopt a more flexible but prudent credit policy to stimulate investment, especially in the private sector as an important key to boosting economic growth in this region. It obvious that foreign direct investment (FDI) is an important factor in stimulating economic growth. Results of system GMM show a positive and significant association between FDI and GDPpc. This finding supports the positive role of FDI as a channel of technological transfer and a factor for promoting employment and improving the productivity of local firms. However, these results are only significant at 10% and the coefficient is very weak at only 3.8%. This implies that SSA

countries should put more effort into financial reform, business environment and fighting corruption to attract more foreign investment. It is better for foreign investment to be cleaner to protect the environment and more productive to absorb the high rate of unemployment. The positive association between FDI and GDPPC is in line with the findings of Lamsiraroj (2016), Lamsiraroj and Ulubasoglu (2015), and Borensztein et al. (1998). Like foreign direct investment, domestic investment (INVES) is recognized as an important key for economic growth. Domestic direct investment (DDI) is considered as smarter capital. In China for example, DDI represents 40% of all investments. However, FDI is only about 3%. Our empirical findings indicate that there is a highly positive and significant association between domestic investment and economic growth in SSA countries. This result is very important for policy makers in this region in order to encourage and promote local investment. Governments of these countries should provide the necessary funding for projects. Also, they should stimulate private investment and encourage young and independent entrepreneurs. Contrary to the work of Bornmann (2013), our results are in line with the works of Adams (2009), and Tang et al. (2008). Since the work of Solow (1957), the critical role of gross domestic savings on economic growth has continued to attract the interest of researchers. It is for this purpose that we introduced this variable to our model. For the three models, this variable exerted a positive and significant effect at 1% on the dependent variable. A high gross domestic savings rate usually leads to a high rate of investment which positively affects the level of growth. Our results confirm the findings of Lean and Song (2009) and Ciftcioglu and Begovic (2010).

Trade openness is usually used to measure the importance of international transactions relative to domestic transactions. It is considered as a driver for economic growth and it contributes to poverty and inequality reduction through providing new market opportunities for domestic firms. The results of system GMM show a positive and highly significant association between trade and growth. In economic literature, it is acknowledged that trade enhances the level of growth (Dollar & Kraay, 2002; Greenway et al., 2002). From this study, we can observe that academic research can give a solution for the slow level of growth in SSA countries since it exerts a positive impact. Consequently, governments and policy

makers are invited to grant more importance for research activities and education. Also, they should encourage and improve regional and international cooperation for sharing skills and knowledge. More importantly, it is necessary to create and reignite the connection between universities and other institutions in society. This study has revealed that growth in this region can be driven through two important factors; domestic investment and gross savings. Based on the results of this research, these two indicators can spur economic performance in SSA economies.

Conclusion and Policy Recommendations

During the last decades, the number of studies exploring the determinants of economic growth and aiming to propose solutions in order to improve development has been increasing. Several papers have been published in highly indexed journals which confirm the added value of this research and originality of the ideas discussed here. However, many economies are still resisting development. In some countries, the main indicators of society's development such as poverty, unemployment and inequality are in progress. Hence, what is happening? Why does research output not contribute to enhance economic growth? It is a question of the quality of the research. It is a question of the institutions and policy makers and the ability of some countries to inspire and practice the findings and recommendations of academic research output. The research/growth relation is multidimensional and it has been discussed differently in many studies. Also, it is necessary to explore this relation in a region which has been qualified as less developed. This is in order to test the real effect of academic research on the level of growth. To this end, we have used a sample of 43 SSA countries during the period 1996-2015. By applying the panel data analysis method and the system GMM technique, our results indicate that academic research measured by the Naperian logarithm of the number of publications per year (PUB) exerts a positive and significant effect on the level of economic growth for both fixed and random effects. However, quality of research proxied by the number of citation per document does not exert any significant effect.

These results have important policy implications. To get the full benefit of research output, the connection between universities and other institutions should be improved in SSA countries. Also, there is a strong need to encourage and improve inter-regional cooperation among researchers in this region first, and among international cooperation second. This is in order to share and improve knowledge, skills and experience between researchers. Also, cooperation leads to well explored available databases and to the investigation of many subjects. Finally, an important factor that could impede the research/growth relation is the cost of education. High educational fees have priced many potential students out of higher education. World associations and local governments have a big job ahead to ensure everyone is able to pursue their primary, secondary and tertiary studies.

References

- Adams, S. (2009). Foreign direct investment, domestic investment, and economic growth in Sub-Saharan Africa. *Journal of Policy Modeling*, 31, 939–949. doi: [10.1016/j.jpolmod.2009.03.003](https://doi.org/10.1016/j.jpolmod.2009.03.003)
- Baltagi, B.H. (2001). *Econometric Analysis of Panel Data*. 2d ed. New York: John Wiley and Sons.
- Baltagi, B.H. (1995). Editor's introduction: panel data. *Journal of Econometrics*, 68, 1-4. doi: [10.1016/0304-4076\(95\)90009-8](https://doi.org/10.1016/0304-4076(95)90009-8)
- Becker, G.S, Murphy, K.M., & Tamura, R. (1990). Human capital, fertility and growth. *Journal of Political Economy*, 98, S12-S37. doi: [10.1086/261723](https://doi.org/10.1086/261723)
- Borenztein, E., De Gregorio, J., & Lee, J.-W. (1998). How does foreign direct investment affect economic growth. *Journal of International Economics*, 45, 115-135. doi: [10.1016/S0022-1996\(97\)00033-0](https://doi.org/10.1016/S0022-1996(97)00033-0)
- Bornmann, L. (2013). What is societal impact of research and how can it be assessed? a literature survey. *Journal of the American Society for Information Science and Technology*, 64(2): 217-233. doi: <https://doi.org/10.1002/asi.22803>

- Butler, M. (2003). Managing from the Inside Out: Drawing on 'Receptivity' to Explain Variation in Strategy Implementation. *British Journal of Management*, 14, S47- S60. doi: [10.1111/j.1467-8551.2003.00392.x](https://doi.org/10.1111/j.1467-8551.2003.00392.x)
- Ciftcioglu, S., & N. Begovic (2010). Are Domestic Savings and Economic Growth Correlated? Evidence from a Sample of Central and East European Countries. *Problems and Perspectives in Management*, 8(3), 30-35.
- Colombo, M.G., D'Adda, D., & Piva, E. (2010). The contribution of university research to the growth of academic start-ups: an empirical analysis. *Journal of Technology Transfer*, 35, 113–140. doi: [10.1007/s10961-009-9111-9](https://doi.org/10.1007/s10961-009-9111-9)
- De Moya-Anegón, F., & Herrero-Solana, V. (1999). Science in America Latina: A comparison of bibliometric and scientific-technical indicators. *Scientometric*, 46, 299–320. doi: [10.1007/BF02464780](https://doi.org/10.1007/BF02464780)
- Dollar, D., & Kraay, A. (2002). Growth is Good for the Poor. *Journal of Economic Growth*, 7, 195-225. doi: [10.1023/A:1020139631000](https://doi.org/10.1023/A:1020139631000)
- Elkana, Y., Lederber, J., Merton, R.K., Thackray, A., & Zuckerman, H. (Eds.) (1978). *Toward a metric of science: the advent of science indicators*. New York: John Wiley & Sons.
- Fedderke, J.W., & Schirmer, S. (2006). The R&D performance of the South African manufacturing sector, 1970-1983. *Economic Change*, 39, 125-151. doi: [10.1007/s10644-007-9023-3](https://doi.org/10.1007/s10644-007-9023-3)
- Ghura, D., & Hadjimichael, T. (1996). Growth in Sub-Saharan Africa. *IMF Staff Papers, International Monetary Fund*, 43(3), 605-634. doi: [10.2307/3867556](https://doi.org/10.2307/3867556)
- Greenaway, D., Morgan, C.W., & Wright, P.W. (2002). Trade Liberalisation and Growth: New Methods, New Evidence. *Journal of Development Economics*, 67(1), 229-44. doi: [10.1016/S0304-3878\(01\)00185-7](https://doi.org/10.1016/S0304-3878(01)00185-7)
- Guiso, L., Paola, S., & Luigi, Z. (2004). Does Local Financial Development Matter? *Quarterly Journal of Economics*, 119(3), 929-969. doi: [10.1162/0033553041502162](https://doi.org/10.1162/0033553041502162)
- Haiqi, Z., & Yuha, Z. (1997). Scientometric study on research performance in China. *Information Processing and Management*, 33, 81-89. doi: [10.1016/S0306-4573\(96\)00018-0](https://doi.org/10.1016/S0306-4573(96)00018-0)

- Hansen, L.P. (1982). Large Sample Properties of Generalized Method of Moments Estimators. *Econometrica*, 50, 1029-1054. doi: [10.2307/1912775](https://doi.org/10.2307/1912775)
- Hansen, L.P., & Singleton, K. J. (1982). Generalized Instrumental Variables of Nonlinear Rational Expectations Models. *Econometrica*, 50, 1269-1286. doi: [10.2307/1911873](https://doi.org/10.2307/1911873)
- International Monetary Fund: Annual Report (2016); www.imf.org/external/index.htm
- Inglesi-Lotz, R., & Pouris, A. (2013). The influence of scientific research output of academics on economic growth in South Africa: an autoregressive distributed lag (ARDL) application. *Scientometrics*, 95 (1), 129-139. doi: [10.1007/s11192-012-0817-3](https://doi.org/10.1007/s11192-012-0817-3)
- Inglesi-Lotz, R., Balcilar, M., & Gupta, R. (2014). Time-varying causality between research output and economic growth in US. *Scientometric*, 100(1), 203-216. doi: [10.1007/s11192-014-1257-z](https://doi.org/10.1007/s11192-014-1257-z)
- Inglesi-Lotz, R., Chang, T., & Gupta, R. (2015). Causality between Research Output and Economic Growth in BRICS. *Quality & Quantity*, 49(1), 167-176. doi: [10.1007/s11135-013-9980-8](https://doi.org/10.1007/s11135-013-9980-8)
- Jin, J.C. (2009). Economic research and economic growth: Evidence from East Asian economies. *Journal of Asian Economics*, 20, 150–155. doi: [10.1016/j.asieco.2008.12.002](https://doi.org/10.1016/j.asieco.2008.12.002)
- Kealey, T. (1996). *The Economic Laws of Scientific Research*. New York: St. Martin's Press.
- King, D.A. (2004). The scientific impact of nations. What different countries get for their research spending. *Nature*, 430, 311–316. doi: [10.1038/430311a](https://doi.org/10.1038/430311a)
- Lamsiraroj, S., & dan Ulubasoglu, M.U. (2015). Foreign Direct Investment and Economic Growth: A Real Relationship or Wishful Thinking. *Economic Modelling*, 51, 200-213. doi: [10.1016/j.econmod.2015.08.009](https://doi.org/10.1016/j.econmod.2015.08.009)
- Lamsiraroj, S. (2016). The foreign direct investment–economic growth nexus. *International Review of Economics & Finance*, 42, 116-133. doi: [10.1016/j.iref.2015.10.044](https://doi.org/10.1016/j.iref.2015.10.044)

- Lean, H.H., & Song, Y. (2009). The domestic savings and economic growth relationship in China. *Journal of Chinese Economic and Foreign Trade Studies*, 2(1), 5–17. doi: [10.1108/17544400910934315](https://doi.org/10.1108/17544400910934315)
- Lee, L-C., Lin, P-H., Chuang, Y-W., & Lee, Y-Y. (2011). Research output and economic productivity: a Granger causality test. *Scientometrics*, 89, 465–478. doi: [10.1007/s11192-011-0476-9](https://doi.org/10.1007/s11192-011-0476-9)
- Liang, Q., Xu, P., & Jiraporn, P. (2013). Board characteristics and Chinese bank performance. *Journal of Banking & Finance*, 37, 2953-2968. doi: [10.1016/j.jbankfin.2013.04.018](https://doi.org/10.1016/j.jbankfin.2013.04.018)
- Lucas, R. (1988). On the Mechanics of Economic Development. *Journal of Monetary Economics*, 22(1), 3-42. doi: [10.1016/0304-3932\(88\)90168-7](https://doi.org/10.1016/0304-3932(88)90168-7)
- Lundberg, J. (2015). Does Academic Research affects Local Growth? Empirical Evidence Based on Swedish Data. *Regional Studies*, 51(4), 586-601. doi: [10.1080/00343404.2015.1107182](https://doi.org/10.1080/00343404.2015.1107182)
- Nelson, R., & Phelps, E. (1966). Investment in Humans, Technological Diffusion, and Economic Growth. *American Economic Review*, 56, 69-75.
- Ntuli, H., Inglesi-Lotz, R., Chang, T., & Pouris, A. (2015). Does Research Output Cause Economic Growth or Vice Versa? Evidence from 34 OECD Countries. *Journal of the Association for Information Science and Technology*. doi: [10.1002/asi.23285](https://doi.org/10.1002/asi.23285)
- Pouris, A. (2003). South Africa's research publication record: the last ten years. *South African Journal of Science*, 99, 425-428.
- Pouris, A., & Pouris, A. (2009). The state of science and technology in Africa (2000-2004): A scientometric assessment. *International Journal of Scientometrics*, 79, 297-309. doi: [10.1007/s11192-009-0419-x](https://doi.org/10.1007/s11192-009-0419-x)
- Price, D.S. (1978). Toward a model for science indicators. In Y. Elkana, J., Lederber, R.K. Merton, A. Thackray & H. Zuckerman (Eds.), *Toward a metric of Science: The advent of Science Indicators* (pp. 69-96). New York: John Wiley & Sons.
- Rajan, R., & Zingales, L. (1998). Financial dependence and growth. *American Economic Review*, 88, 559–586.

- Romer, P.M. (1986). Growth Based on Increasing Returns Due to Specialization. *American Economic Review*, 77, 56–62.
- Romer, P.M. (1990). Endogenous Technological change. *The Journal of Political Economy*, 98(5), S71-S102. doi: [10.1086/261725](https://doi.org/10.1086/261725)
- Schumpeter, J.A. (1934). *The Theory of Economic Development*. Cambridge, MA: Harvard University Press.
- Solow, R.M. (1957). Technical Change and the Aggregate Production Function. *Review of Economics and Statistics*, 39, 312-320.
- Tan, Y. (2016). The impacts of risk and competition on bank profitability in China. *Journal of International Financial Markets, Institutions and Money*, 40, 85-110. doi: [10.1016/j.intfin.2015.09.003](https://doi.org/10.1016/j.intfin.2015.09.003)
- Tang, S., Selvanathan, E.A., & Selvanathan, S. (2008). Foreign direct investment, domestic investment and economic growth in China: A time series analysis. *World Economy*, 31(10), 1292–1309. doi: [10.1111/j.1467-9701.2008.01129.x](https://doi.org/10.1111/j.1467-9701.2008.01129.x)
- Vinkler, P. (2008). Correlation between the structure of scientific research, scientometric indicators and GDP in EU and non-EU countries. *Scientometrics*, 74, 237–254. doi: [10.1007/s11192-008-0215-z](https://doi.org/10.1007/s11192-008-0215-z)

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