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Social Returns to Education: Evidence from Selected African Countries

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Abstract
This paper investigates the social return to education in some African countries. To achieve this, we regress the per capita economic growth rate and its main variants on a set of 15 education indicators. We use the Barro and Lee (1994)'s econometric models, and apply the instrumental variables estimator. The empirical estimates establish three major results: (i) as expected, the accumulation of human capital through education is a significant determinant of economic growth; (ii) combined with any indicator of education, government spending, life expectancy at birth and labor force are not considered as growth factors in Africa; (iii) on the contrary, gross fix capital formation as a proxy of investment, the nominal bilateral exchange rate to the dollar, foreign direct investment and inflation rate are globally growth enhancing in Africa. But the performance and the quality of an education system depends on the magnitude of expenditure or investment in the sector.
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1. INTRODUCTION

Some East Asian Countries relied upon exports promotion strategies to record very high economic growth rates which led many observers to talk about the ''East Asian Miracle''. It is worth noting that the rapid economic growth of this region took place in a context of a steady creation of human capital (World Bank, 1993). From this experience, numerous authors thought that openness is one of the most important and lasting determinants of economic growth. But successful growth and development policies have to account for both external and internal factors. New growth theories hold that education might be counted among significant internal factors of economic growth and human development.

After more than 50 years of investigation on linking education to economic activity, economists now understand better the private returns to schooling. But much is still to know about the social returns to education, *even though economists have speculated about the possibility of human capital externalities for at least a century* (Moretti, 2005). United Nations (1997) noticed that *education is fundamental to enhancing the quality of human life and ensuring social and economic progresses.* Without educated and skilled workers, we guest that no country should be able to effectively exploit the comparative advantages it has vis-à-vis the rest of the world.

Furthermore, it is generally contended that education is conducive to increasing individuals' capabilities and their probability to escape poverty. The human capital theory proponents hold that investing on education in particular seems to be an effective means to raising individual earnings (Mincer, 1974; Psacharopoulos, 1994; Filiztekin, 2011; Frank and Hovey, 2014, *etc*.). Finally, quality education for all could constitute an important tool of reducing economic, social, and political inequalities. *When delivered well, education cures a host of societal ills* (World Bank, 2018).

Finally, education is deemed important both for a strong macroeconomic growth and individuals' wellbeing. So that it is argued that accessing to education and health services are henceforth considered as social right in many international development discourses (Gauri, 2003). This point is put forth in particular by UNESCO (2000), UNDP (2000) and WHO (2002). However, the human right approach to education and health may not be sustainable without increasing support from external donors because of the binding budgetary constraints generally faced by almost all African low income countries in general, the African countries *of the bottom* in particular. Accumulated capital through education must be effectively used in view of creating wealth, strengthening growth, raising earnings/incomes and reducing poverty (Rankin *et al*., 2010).

Empirically, some macroeconomic studies have tested the human capital theory and found a significant and positive correlation between education ratios and GDP per capita growth and worker productivity (see, for example, Cameron et al. (1998); Canton (2007); Maazouz (2013); Burger and Teal (2015); Potelienė and Tamašauskienė (2015), Psacharopoulos and Patrinos (2018)). However, other studies have found a negative but insignificant impact of education on per capita income growth (Benhabib and Spiegel, 1994). By the same token, using the

growth accounting regressions, Pritchett (2001) found no significant association between increases in education indicators and the growth of output per worker.

The debate remains topical and pertinent, particularly in African countries where overall education outcomes have improved in the course of the last twenty years despite some stringent economic reforms implemented in the region (see Table 2 in appendix). This relative encouraging outcomes recorded in the field of education was accompanied by positive growth rate of GDP during the second half of the 1990s. Unfortunately, the economic growth was not enough to significantly increasing the GDP per capita and significantly reducing poverty (see Table 3 in appendix). Furthermore, the human development indicators are still less than those of many other developing countries elsewhere. For example, in 2014, the average index of human development of the sub-Saharan region was inferior to that of East and pacific regions, respectively 0.686 and 0.748 (UNDP, 2015).

In fact, compared with other developing economies, African countries' economy as the whole stagnated during the 1980s and early 1990s. The annual growth rate in per capita income was not more than 1 percent whereas the growth rate of similar economies elsewhere stood at 2 to 3 percent (World Bank, 1994). More stringent economic recovery programs were implemented after the early 1990s but failed to significantly improving the African economic situation (Collier and Gunning, 1999). Thus, poverty remains a serious threat to social stability in sub-Saharan Africa, particularly in those countries situated *at the bottom of world economy* where many states are failing or are about to fall apart (Collier, 2008).

In that context, we can keep asking ourselves with Pritchett (2001): *where has all the education gone?* Does it mean that education expansion is not significantly correlated with economic growth in these countries?

The paper endeavors to trace out the links between education and macroeconomic activity in a selected sample of African countries. To address this question, we firstly describe the selected literature review in section 2. In section 3, we present our empirical strategy. Section 4 turns to findings analysis, completed by some robustness checks in section 5. Section 6 provides some concluding remarks.

2. SELECTED LITERATURE REVIEW

Even if education has been the concern of intellectuals since the 16th century (Martin Luther (1463 – 1517) was a partisan of education both for women and children (Mathieu (2017)), major controversy keeps raging among theorists or policymakers around the expansion of the educational system and the impact of education on economic activity and human development. In particular, is education a consumer good or a capital good? If education is considered as a consumer good, it should be provided for its own sake and free of charge. In that sense, one can talk about the right to education. Contrary to that point of view, the human capital theorists state that education is a capital good that can be used to raise the human skill, the labor productivity and the economic growth. Therefore, education is merely a production factor and the returns to education a legitimate concern.

The second source of controversy around the concept of education comes from its potential or effective impact on the macroeconomic performance and on individuals' earnings. In fact, education likely produces positive externalities because knowledge and skills acquired by individuals may spread its positive effects to many other economic and social sectors of a country and beyond. For example, Sir Alexander Fleming discovered penicillin; Albert Einstein developed the relativity theory and Bill Gate created the famous 'Windows'. The benefits of all these individual works are spreading all over the world.

The neo-classical growth theories and the new growth theories are competing to explain the impact of education on economic activity. Both groups of theories tend to agree on the idea that education might exert significant positive effects on economic activity, the famous schooling externalities. Yet, differences still remain with regard to whether education affects long-run level or long-run growth of the economy. A critical review and an extensive summary of the empirical literature on the matter are proposed namely by Sianesi and van Reenen (2002), Heckman et al. (2006), Oreopoulos and Salvanes (2011), Oreopoulos and Petronijevic (2013), Psacharopoulos and Patrinos (2018).

One important contribution to the debate based on the neoclassical setting comes from Lucas (1988), who assumed that the level of output depends on the stock of human capital. In the long run, output will be increasing only if the human capital also increases. But the problem with this stream of thought is that if, as usually the case, the human capital is proxied by any of educational outcome (school enrollment ratios, years of schooling, *etc*.), it is difficult to hold that any of these variables will increase indefinitely over time. Bils and Klenow (2000) tried to solve the problem in interpreting human capital increment as increasing quality of education. Temple (2001; p. 3) gave the following example: ''*... the knowledge imparted to schoolchildren in 2000 is superior to the knowledge that would have been imparted in 1950 or 1960, and will make a greater difference to their productivity in late employment*''. Even if this argument was convincing, models based on the Lucas (1988) setting does not tell us how the increase in the quality of human capital (education) is brought about.

The augmented-Solow model includes the human capital variables into the neo-classical production function. In estimating the model on global or macro data, the considerations related to the educational externalities are taken care of. The neo-classical production function is specified as the relation between the output and a set of

production factors (inputs). For instance, Mankiw *et al*. (1992) extended the neo-classical production function to include the educational variables as follows.

$$Y_t = A_t K_t^a LF_t^b H_t^c \quad \ldots\ldots (1)$$

where Y is the GDP (the output); K, the physical capital; LF, the labor force; H, the education capital (the human capital indicator) and A captures the impact of unobservable residual variables (technical progress for instance); t refers to time; a, b and c are elasticity coefficients. The growth accounting method intends to assess the relative contribution of each factor to the total factors productivity. In fact, from equation (1), we can write the growth rate of Y as follows.

$$\frac{dY}{Y} = \frac{dA}{A} + a\frac{dK}{K} + b\frac{dL}{L} + c\frac{dH}{H} \quad \ldots\ldots (2)$$

Equation (2) shows that the growth rate of the production dY/Y is the sum of the contributions of the growth rate of the residual variable A (dA/A), that of capital K (dK/K), that of labor LF (dL/L) and that of human capital H (dH/H). If we assume constant returns to scale $(a + b + c = 1)$ and given available data on the output Y, K, LF, and H, we can decompose the growth rate of output into its different constituents depicted by equation (2). Even from this line of thought, empirical studies still diverge on whether they should account the output level like in Mankiw et al., (1992), Hall and Jones (1999), Klenow and Rodriguez (1997) for instance, or the output growth rates like in Jorgenson and Fraumeni (1992).

In order to narrowing the importance of the unobservable variable A, Equation (1) was extended to include more inputs that could contribute to the output growth. However, as Sianesi and van Reeven (2002), referring to Griliches (1997) put it, *accounting is no explanation*. In fact, the underlying assumption of the neo-classical literature is that education does not produce external effects. In other words, growth accounting works don't try to capture potential indirect effects of education on the level or the growth of output.

The new growth theories emphasize the role of education henceforth supposed to affect the national economic growth. The endogenous growth models for example, propose some mechanisms through which human capital can affect the economic activity. These models claim that the steady-state growth rate depends to a certain extent on the level of human capital. It is an important input to the production of new ideas, so that even a unique increase in the stock of human capital will raise the growth rate of aggregate output. Increasing individual investments in education or training and more investments in Research and Development by firms are possible channel through which human capital could affect the output growth in the long-run. In other words, human capital can contribute to creating new ideas that should lead to higher growth rates in the future (see Acemoglu and Angrist (1999)).

Following this line of thought, assumption of the constant returns to scale is relaxed. Therefore, education is explicitly considered as an input in the production function, with possible external effects on output. By the same token, it is assumed that technological changes are related to the stock of human capital. Education is necessary both for the knowledge accumulation and knowledge exploitation. Education is also important for the technology acquisition or transfer. Unfortunately, there is not yet any consensus in the empirical works on whether one has to focus on either the flow or the stock output impact of human capital (see Gemmell, 1996)). Anyhow, empirical works seem to disagree on the growth effect of human capital. Pritchett (2001) used the Solow aggregate production function extended by Mankiw *et al*. (1992), to account for the educational factor and concluded that *Cross-national data show no association between increases in human capital attributable to the rising educational attainment of the labor force and the rate of growth of output per worker*. The author attributes these disappointing results to bad governance, falling marginal returns to education (excess supply of education) and poor educational quality. In order words, Pritchett, like many other human capital theorists, is convinced that the problem is not education as such, since in general, *people with more education have higher wages*.

Whereas economic development is measured by the growth rate of GDP per worker, the educational capital is measured by the number of schooling years. This educational indicator is constructed from data extracted from previous micro studies namely from Barro and Lee (1993), Nehru *et al*. (1995). Pritchett (2001) also used cross-national data to estimate many versions of the augmented Solow production function model in which educational and physical capital were introduced. Estimates of these different versions yielded almost the same results that the correlation between education and the growth of output per worker tends to be negative. Benhabib and Spiegel (1994), estimating one version of the Cobb-Douglas aggregate production function, found that human capital has an insignificant and generally negative impact on per capita income growth.

Many other empirical studies utilize cross-country data to investigate the main sources of economic growth. The human capital theory setting is tested using macro data. Following the new growth theory framework, these studies try to explain the cross-country variation in GDP growth or in total factor productivity growth. The macroeconomic activity indicator chosen is regressed on a host of regressors including educational variables. In this line, assuming different formulations for human capital, Temple (2001) failed to establish a significant and positive impact of education on economic activity from cross country data.

Following Topel (1999), Krueger and Lindahl (2001) argued that results obtained by Temple (2001) could be attributed to the error in the measurement of the number of schooling years. Thus they used 'accurate' data and

found that changes in the years of schooling may yield large positive externalities.

Soto (2002) criticized these empirical findings on the ground that the regressions estimated by Topel, Krueger and Lindahl are not based on a specific growth model. In fact, including the lagged income as a regressor, he suggests that the equation estimated represents a convergence path towards steady state. If that is the case, it is actually difficult to justify the presence of both the change and the level of schooling among the right hand side variables. The model suggested by Mankiw *et al*. (1992) assumes that, in a convergence path, the growth rate of the economy depends on the investment rate in human capital and not on its level or its change.

The second argument put forward by Soto is that in all the regressions reported, the authors have not questioned the endogeneity of the years of schooling which may bias its coefficient upwards. A third reason to be cautious about these results is related to the robustness of the regression results. In fact, the explanatory power of the educational variable diminishes when change in the stock of physical capital is omitted from the regressions. Taking into account these remarks could improve the model specification and empirical results. On the basis on all these critics, Soto (2002) shows that education measured by the number of the years of schooling and income per worker are highly correlated.

3. METHODOLOGY

3.1. MODEL SPECIFICATION AND VARIABLES DESCRIPTION

It has been argued that the level of a country's development is to account for when studying the impact of different levels of education on the output level or the output growth. To avoid the potential bias induced by the choice of an indicator *a priori*, we opt to measure education by three categories of indicators. Beyond enrollment rates, we use completion rates and other indicators such as the pupil-teacher ratio at the primary and at the secondary levels, the age of beginning of secondary school. Our choice is justified by the fact that global indicators of the educational outcomes can be misleading because of the aggregation problems. In fact, analyzing the impact of education in a set of countries, highly aggregated variables could not be pertinent because of significant differences in the educational systems across countries.

Furthermore, different dimensions and levels of education may have different effects on economic activity. The World Bank (1995) for example, recognizes that basic education is effective in reducing poverty and fertility. Psacharopoulos (1994) observed that the primary school has the highest social profitability in all regions of the world. Moreover, Murphy, Schleifer and Vishny (1991) showed that the impact of the primary school enrollment on economic growth seems quite high. *A 1 percentage point increase in primary school enrollment rate is associated with a 2.2 percentage points increase in per capita GDP growth rate*. In the same vein, Heckman *et al*. (2016) found that *graduating college is not a wise choice for all*. Therefore, taking indicators individually proves to be a relevant approach.

The dependent variable, the proxy of the macroeconomic activity is the level of real GDP. The model estimated is inspired from Temple (2001), and Barro and Lee (1994). It is specified as follows.

$$Log(y_{i,t}) = a_0 + a_1 Log(K_{i,t}) + a_2 Log(LF_{i,t}) + a_3 (EDU_{i,t}) + a_4 Log(TGE_{i,t}) + a_5 Log(NER_{i,t}) + a_6 Log(LEB_{i,t}) + \mu_i + \tau_t + \varepsilon_{i,t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

- y is the real GDP, defined as the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant 2010 US dollars. Dollar figures for GDP are converted from domestic currencies using 2010 official exchange rates. For a few countries where the official exchange rate does not manifestly reflect the rate effectively applied to actual foreign exchange transactions, an alternative conversion factor is used (WDI, 2018). Many other proxies as growth rate, per capita growth rate, current GDP (in Logs), 2010 real GDP per capita (in Logs), current GDP per capita (in Logs) are used for sensitivity tests;
- K is the gross fixed capital formation. It includes land improvements (fences, ditches, drains, and so on), plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. Net acquisitions of valuables are also considered capital formation (WDI, 2018);
- LF is the labor force participation rate. Labor force comprises people ages 15 and older who supply labor for the production of goods and services during a specified period. It includes people who are currently employed and people who are unemployed but seeking work as well as first-time job-seekers. Not everyone who works is included, however. Unpaid workers, family workers, and students are often omitted, and some countries do not count members of the armed forces. Labor force size tends to vary during the year as seasonal workers enter and leave (WDI, 2018);
- EDU is an education indicator. In this paper, we use 10 indicators, namely the total primary school completion rate (% of relevant age group), the total completion rate of lower secondary education (% of relevant age group), the pupil-teacher ratio at the primary level, the continuation of studies until the end of the primary cycle (% cohort), the primary school enrollment (% gross), the primary school enrollment (% net), the secondary school

enrollment (% net), the secondary school enrollment (% gross), the pupil-teacher ratio at the secondary level, the age of beginning of secondary school (years) (WDI, 2018);

- TGE is the total government expenditure as a share of GDP. It is approximated as cash payments for operating activities of the government in providing goods and services. It includes compensation of employees (such as wages and salaries), interest and subsidies, grants, social benefits, and other expenses such as rent and dividends (WDI, 2018);
- LEB captures the total life expectancy at birth. It indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life (WDI, 2018);
- NER, the nominal exchange rate (quantity of country's i currency necessary to obtain one US dollar). Official exchange rate refers to the exchange rate determined by national authorities or to the rate determined in the legally sanctioned exchange market. It is calculated as an annual average based on monthly averages (local currency units relative to the U.S. dollar) (WDI, 2018);
- μ_i is country fixed effect, τ_t is the time dummy and $\varepsilon_{i,t}$ is a stochastic error term with zero mean and constant variance.

3.2. ESTIMATION TECHNIQUE

In general, there may be a bi-directional causality between human capital accumulation and economic performance. According to Todaro (2000), the link goes from education to economic activity. Education might affect the economic growth through improving workers' ability, increasing innovation possibilities and then technical progress resulting in improved quality in physical capital. Education might also reinforce the economic growth and human development through its positive impact on health outcomes (reduction in the fertility rate, increase in life expectancy at birth, *etc*.) and sanitation practices (see Lucas (1988), Barro (1991), *etc*.).

Due to a potential endogeneity bias caused by errors in the measurement of education indicators (Krueger and Lindahl, 2001), the use of conventional estimation techniques such as OLS is not consistent. We therefore have two alternatives, namely the Instrumental Variables (IV) estimator and the Generalized Method of Moments (GMM) estimator. However, because of a large number of periods and the presence of potential heterokedasticity, we choose the IV estimator, the instrumentation being made by the first order lags, which are appropriate in the absence of "good" external instruments (Griliches and Hausman, 1986). Many other estimators, transformations and specifications are used for robustness purpose.

3.3. The data

The data we use are derived from World Development Indicators over the period 1980-2016. The analytic sample consists of 38 African countries (see the list in Appendix 1). These data are described in Table 1.

Table 1: *Descriptive statistics.*

Variables	N	Mean	SD	Min	Max	Source
GDP growth rate	1,394	3.54	5.31	-50.24	35.22	WDI
GDP per capita growth rate	1,394	0.972	5.160	-47.81	36.98	WDI
GDP2010 (Log)	1,396	22.80	1.542	19.62	26.86	WDI
Current GDP (Log)	1,391	22.37	1.593	18.52	27.07	WDI
2010 GDP per capita (Log)	1,396	6.992	0.990	5.322	9.518	WDI
Current GDP per capita (USD)	1,391	6.565	1.064	4.597	9.620	WDI
Gross fixed capital formation (% of GDP)	1,324	20.03	8.659	-2.424	60.02	WDI
Labor force, total (Log)	999	15.09	1.251	12.39	17.86	WDI
Primary school completion rate, total	947	60.20	25.17	6.326	126.5	WDI
Completion rate of lower secondary education, total	725	35.42	26.32	0.964	125.3	WDI
Pupil-teacher ratio at the primary level	1,123	41.07	13.71	12.47	100.2	WDI
Total school enrollment, primary (% net)	714	71.91	19.68	14.31	99.91	WDI
Primary education, number of teachers (Log)	1,125	10.16	1.423	6.30	13.30	WDI
Primary education, duration (years)	1,406	6.170	0.501	5	8	WDI
Primary education, number of students	1,255	13.81	1.52	9.06	17.08	WDI
Continuation of studies to the end of the primary cycle, total (% cohort)	721	66.35	19.04	7.541	99.12	WDI
School enrollment, primary (% gross)	1,255	89.97	27.07	17.29	152.2	WDI
School enrollment, primary (% net)	714	71.40	19.43	14.31	99.91	WDI
School enrollment, secondary (% net)	300	31.63	20.90	2.181	89.68	WDI
School enrollment, secondary (% gross)	958	36.39	25.12	2.484	116.0	WDI

Variables	N	Mean	SD	Min	Max	Source
Pupil-teacher ratio at the secondary level	652	23.42	8.141	8.442	80.05	WDI
Age of beginning of secondary school (years)	1,406	12.42	0.757	11	14	WDI
Secondary education, duration (years)	1,406	6.343	0.759	4	8	WDI
Expenditure (% of GDP)	485	22.18	9.119	2.046	52.74	WDI
Life expectancy at birth, total (years)	1,406	55.62	8.53	27.61	76.08	WDI
Official exchange rate (local currency units per US $, average for the period)	1,285	308.9	489.0	0	4,349	WDI

Source: The authors.

Table 1 displays some interesting information. *i*) The average GDP growth rate of the selected countries (3.54%) is lower than the annual average of the sub-Saharan countries on the period 2000-2017 (4.9%), lower than the annual average of the East Asian and Pacific countries (4.6%), but greater than the annual average of the Latin America countries (3.0%). *ii*) The average share of the gross fixed capital is relatively stable around a means of 20.03% of GDP. That share is lower than in East Asia and Pacific countries (31.92%) and in Middle East and North Africa (29.8%). *iii*) Education indicators remain relatively low.

In particular, the average completion rate of secondary education stands at 35.42% against 60.20 of the primary education; furthermore, the average net enrollment ratio in secondary school is only 31.63% and 71.40% in primary education. *iv*) The average life expectancy at birth 52.6 years is lower than the sub-Saharan Africa average (59.1 years), Middle East and North Africa (72.0 years), Latin America and Caribbean (72.6 years), and East Asia and pacific (73.5 years) (numbers in parenthesis are from WDI, 2018). *v*) The official exchange rates are very unstable since the means of the selected countries stands at 308.9, with a standard deviation of 489.0.

4. FINDINGS AND DISCUSSIONS

4.1. BASELINE RESULTS

The analysis of education indicators can be done through two approaches: an approach in terms of performance and quality of the system, and an inputs/outputs approach. In this work, we adopt the first approach because of the availability of data and the plurality of indicators, which allows us to verify the robustness of our results. Before commenting on these results highlighted in Table 2, let us recall the indicators classification giving the chosen approach. *i*) The internal indicators of education performance comprising completion rates (EDU1 and EDU2), enrolment rates (EDU4, EDU9, EDU10, EDU11 and EDU12), and continuation rates (EDU8). *ii*) Quality of education indicators comprising pupil teacher-ratios at the primary and the secondary (EDU3 and EDU13), age of entering secondary school (EDU14), number of teachers in the education system (EDU5), and the duration (year) in primary and secondary education (EDU6 and EDU15).

The coefficients associated with the education performance indicators (enrollment, completion and continuation) are globally highly significant and positively associated to GDP per capita (EDU1, EDU4, EDU9, EDU10, EDU11 and EDU12), except those of completion rate of lower secondary education (EDU2) and continuation of studies to the end of the primary cycle (EDU8). In the same line with Mankiw *et al*. (1992), Levine and Renelt (1992) and Keller (2006), but contrary to Krueger and Lindahl (2001), Appiah and McMahon (2002), the performance of an education system seams fundamentally determining for economic growth.

More precisely, if the number of children enrolled in school increases, it promises a future accumulation of human capital, factor of productivity of the workforce and therefore of growth. In addition, when a high proportion of these students complete their school career, this reinforces the good dynamic of human capital accumulation. But, completion indicators would be more relevant than the *ex-ante* enrollment indicators, because they allow for an *ex-post* evaluation.

As for the quality of the educational system, many indicators have the expected and significant sign in association with the dependent variable. They are EDU5 (Primary education, number of teachers), EDU6 (Primary education, duration in years), EDU7 (Primary education, number of students), and EDU15 (Secondary education, duration in years). For example, the number of teachers and the number of students in primary education are positively and significantly linked with the per capita GDP growth. The negative and significant link between the per capita GDP growth, the duration in primary and secondary education highlights the poor quality of African education systems. Thus, the lengthening of the training time in these systems reflects their inability to quickly train the students to allow them to reach higher levels. More generally, the better the quality, the higher the contribution of the educational system to economic growth and well-being (Frini and Muller, 2012).

Following Barro and Sala-i-Martin (2004), our results suggest that education level and quality matter for economic growth in Africa, although the results could be controversial (Chen and Gupta, 2009; Lenkei *et al*., 2017) or sensitive to the education systems, the methods, but also the data used (Benos and Zotou, 2014).

Table 2: *Educational indicators and growth (bivariate analysis).*

	Dependent variable : Per capita GDP growth														
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
EDU1	0.0349***														
	(0.0129)														
EDU2		0.0173													
		(0.0170)													
EDU3			0.0359												
			(0.0248)												
EDU4				0.0438***											
				(0.0145)											
EDU5					4.06e-05***										
					(5.18e-06)										
EDU6						-1.704*									
						(0.966)									
EDU7							8.32e-07***								
							(1.09e-07)								
EDU8								-0.00431							
								(0.0407)							
EDU9									0.0381***						
									(0.00770)						
EDU10										0.0452***					
										(0.0148)					
EDU11											-0.0555				
											(0.0351)				
EDU12												0.0357***			
												(0.0127)			
EDU13													-0.0899		
													(0.0753)		
EDU14														0.266	
														(0.659)	
EDU15															-2.204***
															(0.521)
Observations	788	553	999	563	1,003	1,358	1,153	538	1,153	563	201	809	481	1,358	1,358
R-squared	0.016	0.006	0.001	0.025	0.065	0.001	0.052	-0.001	0.030	0.025	0.024	0.013	-0.005	-0.000	0.010
# of countries	38	36	38	36	38	38	38	34	38	36	24	38	35	38	38
Anderson LM stat	628.905	446.704	762.527	489.923	857.973	890.489	1078.964	121.786	1045.880	489.927	145.473	736.028	281.899	951.658	1008.118
Cragg-Donald Wald F	3889.914	3278.993	3688.293	6950.447	7727.837	2734.632	3.3e+04	160.272	1.7e+04	6951.141	812.113	1.6e+04	764.439	3407.805	4263.501
Stock-Yogo (10%)	16.38	16.38	16.38	16.38	16.38	16.38	16.38	16.38	16.38	16.38	16.38	16.38	16.38	16.38	16.38

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

EDU1= Primary school completion rate, total; **EDU2**=Completion rate of lower secondary education, total; **EDU3**=Pupil-teacher ratio at the primary level; **EDU4**=Total school enrollment, primary (% net); **EDU5**=Primary education, number of teachers; **EDU6**=Primary education, duration (years); **EDU7**=Primary education, number of students; **EDU8**=Continuation of studies to the end of the primary cycle, total (% cohort); **EDU9**=School enrollment, primary (% gross); **EDU10**=School enrollment, primary (% net); **EDU11**=School enrollment, secondary (% net); **EDU12**=School enrollment, secondary (% gross); **EDU13**=Pupil-teacher ratio at the secondary level; **EDU14**=Age of beginning of secondary school (years); **EDU15**=Secondary education, duration (years). Anderson LM stat is for under-identification test. Cragg-Donald Wald F is for weak identification test, compared to Stock-Yogo value.

Source: The authors.

4.2. AUGMENTED SPECIFICATION RESULTS

Several variables of interest are integrated in the model in order to evaluate their combined effects with education on economic growth (see Table 3).

Table 3: *Education, growth and some control variables.*

	Dependent variable : Per capita GDP growth									
	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)
GFCF	0.0514	0.0988	0.0752	0.103*	0.0891*	-0.0597	0.104*	0.0590	0.0914*	0.0948*
	(0.0622)	(0.0632)	(0.0614)	(0.0608)	(0.0506)	(0.0699)	(0.0574)	(0.0619)	(0.0540)	(0.0500)
EXP	-0.0327	0.00842	-0.0499	-0.0511	-0.0617*	0.0537	-0.0697**	0.0280	-0.0385	-0.0736**
	(0.0391)	(0.0460)	(0.0380)	(0.0368)	(0.0340)	(0.0411)	(0.0353)	(0.0412)	(0.0315)	(0.0349)
LEB	-0.0721*	-0.0612	-0.0648*	0.0126	0.0605*	-0.0540	-0.00250	-0.000467	-0.0395	0.0548
	(0.0402)	(0.0430)	(0.0390)	(0.0309)	(0.0366)	(0.0454)	(0.0319)	(0.0448)	(0.0301)	(0.0338)
LF	0.0800	-0.167	0.207	-1.164***	0.201	0.0555	0.204	-0.0601	-0.240*	0.0314
	(0.189)	(0.242)	(0.193)	(0.288)	(0.179)	(0.202)	(0.182)	(0.191)	(0.145)	(0.177)
OER	0.00163***	0.00176***	0.000850	0.00134**	0.000786**	0.00151*	-0.000251	0.00140**	0.00128***	0.000662*
	(0.000494)	(0.000494)	(0.000544)	(0.000543)	(0.000385)	(0.000891)	(0.000535)	(0.000661)	(0.000455)	(0.000365)
FDI	-0.00189	0.0611	0.0623	-0.00604	0.0628	0.194**	0.0669	0.165*	0.191**	0.0575
	(0.0604)	(0.0750)	(0.0643)	(0.0628)	(0.0573)	(0.0838)	(0.0621)	(0.0863)	(0.0818)	(0.0572)
CPI	-0.120***	-0.142***	-0.0144**	-0.0105*	-0.0173***	0.121	-0.0122*	-0.00392	-0.00468	-0.0185***
	(0.0437)	(0.0473)	(0.00627)	(0.00612)	(0.00408)	(0.121)	(0.00641)	(0.00610)	(0.00507)	(0.00410)
CPI_SQ	5.04e-06***	5.97e-06***	5.87e-07**	4.28e-07*	7.13e-07***	-0.00882	4.97e-07*	1.53e-07	1.84e-07	7.62e-07***
	(1.84e-06)	(1.99e-06)	(2.64e-07)	(2.57e-07)	(1.71e-07)	(0.00609)	(2.69e-07)	(2.56e-07)	(2.13e-07)	(1.72e-07)
EDU1	0.0771***									
	(0.0180)									
EDU2		0.0621***								
		(0.0177)								
EDU3			-0.0895***							
			(0.0214)							
EDU4				1.97e-05***						
				(3.49e-06)						
EDU5					1.327**					
					(0.587)					
EDU6						0.101***				
						(0.0297)				
EDU7							0.0254*			
							(0.0138)			
EDU8								0.0385		
								(0.0237)		
EDU9									0.0400***	
									(0.0117)	
EDU10										-0.922***
										(0.333)
Constant	-0.353	3.286	5.422	15.79***	-13.72**	-3.486	-4.219	-2.568	4.365*	3.308
	(2.982)	(3.394)	(3.488)	(4.275)	(5.588)	(3.567)	(3.081)	(3.404)	(2.508)	(3.614)
Observations	226	169	267	268	339	166	293	187	202	339
R-squared	0.157	0.245	0.105	0.144	0.127	0.025	0.063	0.146	0.235	0.130
Anderson	117.963	96.388	145.600	143.619	183.604	95.620	168.324	126.354	124.307	186.007
Cragg-Donald	117.923	105.530	154.115	148.953	194.361	105.972	191.039	184.388	153.597	199.998
Stock-Yogo	7.03	7.03	7.03	7.03	7.03	7.03	7.03	7.03	7.03	7.03

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 **GFCF**= Gross fixed capital formation (% of GDP); **EXP**=Expenditure (% of GDP); **LEB**= Life expectancy at birth, total (years); **LF**= Labor force, total (log); **OER**=Official exchange rate (local currency units per US $); **FDI**=; **CPI**=consumer price index (log); **CPI_SQ**= consumer price index squared (log); **EDU1**= Primary school completion rate, total; **EDU2**= Completion rate of lower secondary education, total; **EDU3**= Pupil-teacher ratio at the primary level; **EDU4**= Primary education, number of teachers; **EDU5**= Primary education, duration (years); **EDU6**= Continuation of studies to the end of the primary cycle, total (% cohort); **EDU7**= School enrollment, primary (% gross); **EDU8**= School enrollment, primary (% net); **EDU9**=School enrollment, secondary (% gross); **EDU10**=School enrollment, secondary (% net)

Source: The authors.

Combined with any indicator of education (EDU1, EDU2, …, EDU10), government spending (EXP), life expectancy at birth (LEB) and labor force (LF) could not be considered as growth factors in Africa. On the contrary, gross fix capital formation (GFCF) as a measure of investment, the nominal exchange rate to the dollar (OER), calculated according to an uncertain trading system, foreign direct investment (FDI) and inflation captured by the consumer price index (CPI) are pro-growth in some specifications. Thus, they can be considered as factors influencing the dynamics of growth in Africa.

Taking the case of GFCF, the positive link, although weak, recall the traditional key role devoted to investment as the main economic growth determinant (Menshikov *et al*., 2015; Bakari, 2017). Secondly, our estimates show that the more the attractiveness of a country, the more it grows (Sita, 2018; Snieska et *al.,* 2019). Thus, foreign capital is a significant complementary factor for growth to domestic capital. Thirdly, the positive link between the official exchange rate to the dollar and the economic growth deals with local currencies appreciation, highlighting indirectly a loss of competitiveness that obstructs growth (Fagerberg, 1988; Nijkamp et *al.,* 2010).

Relatively to CPI, the results just show that the hypothetic low inflation rates in some African countries (some of them are members of monetary unions) is associated with weak economic growth. But, there exists a certain threshold where inflation is beneficial for economic growth in Africa (Kremer et al., (2013); Salami and Kelikume (2010)). In other terms, more inflation is not too bad for growth. This is the message send by the squared value of CPI, showing a non-linear relationship between the two variables in Africa (Sarel, 1996). In conclusion, our main results remain stable, showing that the selected education indicators (both performance and quality indicators) are

suitable for growth in Africa. They appear to be significantly linked with the GDP per capita growth as logically expected.

5. ROBUSTNESS CHECKS

We implement four robustness tests. The first test puts the IV estimator in opposition to several others complementary to it, adopting a static panel specification (OLS, fixed/random effects, and some variants of XTIVREG and XTIVREG2). The second test implements as Ogundari and Awokuse (2018) a dynamic panel specification by using the System GMM estimator designed by Arellano and Bover (1995), Blundell and Bond (1998). Thirdly, we use some variants and/or proxies of the growth rate in order to be comforted of the stability of our results. For this purpose, we retain, as dependent variables (in Log), the real GDP (2010), the current GDP, the per capita real GDP (2010), and the per capita current GDP. The last test upsets the instrumentation technique. Econometric theory indicates by default two main approaches for instrumentation: internal instrumentation and external instrumentation. As mentioned above, due to the difficulty of choosing proper external instruments (Lewbel, 2012), it is recommended to resort to internal instrumentation using first differences or first order lags. Since the results in Table 2 are established using first order lags, we now check the sensitivity of our instruments by applying differences. The results of all these tests are given in Tables 4, 5, 6 and 7.

Table 4: *Robustness checks with competing estimators.*

	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)
		Static panel		XTIVREG		XTIVREG2		
VARIABLES	OLS	FE	RE	FE	RE	FE	gmm2s FE	Cluster, FE
Completion rate (prim)	0.0344***	0.0449***	0.0368***	0.0349***	0.0267***	0.0349***	0.0349***	0.0349**
	(0.00617)	(0.0113)	(0.00856)	(0.0129)	(0.00932)	(0.0129)	(0.0129)	(0.0141)
Constant	-0.706*	-1.336*	-0.863	-0.635	-0.126			
	(0.429)	(0.691)	(0.591)	(0.797)	(0.635)			
Observations	938	938	938	788	788	788	788	788
Number of countries	38	38	38	38	38	38	38	38
R-squared	0.034	0.017				0.016	0.016	0.016
R-squared within		0.0174	0.0174	0163	0.0168			
R-squared between		0.0715	0.0715	0.0012	0.0012			
R-squared overall		0.0335	0.0335	0.0301	0.0301			
Fixed Effects test Prob		0.0000		0.0000	0.0000			
Breusch and Pagan LM test			0.0000					
Cragg-Donald Wald F stat						3889.914	3889.914	3889.914
Stock-Yogo value (10 %)						16.38	16.38	16.38
Kleibergen-Paap LM								18.499
Kleibergen-Paap Wald								1075.662
Hansen J test prob.								0.1420
Anderson LM stat						628.905	628.905	

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Source: The authors.

Table 5: *Robustness checks with system GMM ($T = 5$ for each sub-period, but 6 for the last)*

	(34)	(35)	(36)	(37)	(38)	(39)	(40)
VARIABLES	$t < 1985$	$1985 \leq t < 1990$	$1990 \leq t < 1995$	$1995 \leq t < 2000$	$2000 \leq t < 2005$	$2005 \leq t < 2010$	$t \geq 2010$
Completion rate (prim)	0.000137	-0.00191	0.00669*	0.0245***	0.0449***	0.0395***	0.0244**
	(0.00704)	(0.00470)	(0.00377)	(0.00409)	(0.0142)	(0.00856)	(0.00921)
Observations	96	110	100	73	124	118	160
Number of countries	30	29	26	23	32	32	35
AR1-stat	1.63	2.72	-1.13	-0.97	-0.17	-0.33	0.79
Prob>z	0.102	0.006	0.260	0.451	0.862	0.184	0.865
AR2-stat	2.22	2.04	1.72	-0.75	-0.54	-1.39	-0.17
Prob>z	0.026	0.041	0.086	0.334	0.588	0.165	0.431
Hansen J-stat	9.16	23.93	23.17	19.88	21.32	24.72	30.73
Prob>chi2	0.761	0.199	0.230	0.402	0.319	0.170	0.282

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: The authors.

In general, the robustness tests tend to confirm the improving effect of education on growth. First, the competing estimators validate the positive link between education and growth in Africa, although there is a difference in the magnitude of the effect. Secondly, the GMM estimator shows that the effect of schooling on growth is changing over time. This effect is dynamic, time-sensitive or non-linear (not significant before 1990, but significant after this date). This results implies that education systems in Africa are improving over the time. Thirdly, the use of other proxies for growth or production variables reinforces the previously established positive education-growth link. Finally, instrumenting the model by the first differences does not alter the main results. Thus, as stated by Lucas (1988) and Mankiw *et al*. (1992), investing in education in general can be considered as a fundamental commitment for promoting economic growth.

Table 6: *Robustness checks with growth or GDP indicators*

	(41)	(42)	(43)	(44)
VARIABLES	Real GDP (2010)	Current GDP	Per capita Real GDP (2010)	Per capita current GDP
Completion rate (prim)	0.0275***	0.0313***	0.0282***	0.0320***
	(0.00363)	(0.00337)	(0.00329)	(0.00308)
GFCF	0.0238*	0.0338***	0.0196*	0.0297***
	(0.0126)	(0.0117)	(0.0114)	(0.0107)
EXP	0.00495	-0.00304	0.00696	-0.00103
	(0.00790)	(0.00733)	(0.00715)	(0.00671)
LEB	0.00279	0.000119	0.00369	0.00102
	(0.00813)	(0.00754)	(0.00736)	(0.00690)
LF	0.971***	0.965***	-0.0651*	-0.0706**
	(0.0383)	(0.0355)	(0.0347)	(0.0325)
OER	-0.000469***	-0.000403***	-0.000365***	-0.000299***
	(9.99e-05)	(9.26e-05)	(9.04e-05)	(8.48e-05)
FDI	-0.0130	-0.00755	-0.0159	-0.0105
	(0.0122)	(0.0113)	(0.0111)	(0.0104)
CPI	-0.0188**	-0.0343***	-0.0154*	-0.0309***
	(0.00883)	(0.00819)	(0.00800)	(0.00750)
CPI_SQ	7.88e-07**	1.44e-06***	6.48e-07*	1.30e-06***
	(3.71e-07)	(3.44e-07)	(3.36e-07)	(3.15e-07)
Constant	6.347***	6.074***	5.778***	5.504***
	(0.603)	(0.559)	(0.546)	(0.512)
Observations	226	226	226	226
R-squared	0.806	0.828	0.643	0.688
Anderson LM stat	117.963	117.963	117.963	117.963
Cragg-Donald Wald	117.923	117.923	117.923	117.923
Stock-Yogo (10 %)	7.03	7.03	7.03	7.03

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

GFCF= Gross fixed capital formation (% of GDP); **EXP**=Expenditure (% of GDP); **LEB**= Life expectancy at birth, total (years); **LF**= Labor force, total (log); **OER**=Official exchange rate (local currency units per US $, average for the period); **FDI**=; **CPI**=consumer price index (log); **CPI_SQ**= consumer price index squared (log).

Source: The authors.

Table 7: *Robustness checks with first difference instrumentation.*

	Dependent variable : Per capita GDP growth														
VARIABLES	(45)	(46)	(47)	(48)	(49)	(50)	(51)	(52)	(53)	(54)	(55)	(56)	(57)	(58)	(59)
EDU1	0.108**														
	(0.0481)														
EDU2		0.187**													
		(0.0792)													
EDU3			-0.0609												
			(0.0959)												
EDU4				0.225**											
				(0.0928)											
EDU5					2.96e-05										
					(2.76e-05)										
EDU6						1.099									
						(2.524)									
EDU7							1.07e-06**								
							(4.31e-07)								
EDU8								0.0347							
								(0.0404)							
EDU9									0.226***						
									(0.0680)						
EDU10										0.207**					
										(0.0913)					
EDU11											-0.136				
											(0.0896)				
EDU12												0.172*			
												(0.0917)			
EDU13													0.283*		
													(0.165)		
EDU14														-0.640	
														(1.991)	
EDU15															1.454
															(1.852)
Observations	788	553	999	563	1,003	1,358	1,153	538	1,153	563	201	809	481	1,358	1,358
R-squared	-0.024	-0.181	-0.014	-0.259	0.060	-0.005	0.049	-0.001	-0.484	-0.192	-0.001	-0.131	-0.051	-0.001	-0.026
Number of countries	38	36	38	36	38	38	38	34	38	36	24	38	35	38	38
Anderson LM test	47.131	24.367	52.007	15.377	30.358	131.113	69.509	123.563	20.522	15.701	22.827	16.254	61.447	104.386	82.637
Cragg-Donald Wald	50.224	25.522	54.925	15.809	31.312	145.462	74.063	163.370	20.888	16.153	26.059	16.583	71.106	113.264	88.089
Stock-Yogo (10%)	16.38	16.38	16.38	16.38	16.38	16.38	16.38	16.38	16.38	16.38	16.38	16.38	16.38	16.38	16.38

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

EDU1= Primary school completion rate, total; **EDU2**=Completion rate of lower secondary education, total; **EDU3**=Pupil-teacher ratio at the primary level; **EDU4**=Total school enrollment, primary (% net); **EDU5**= Primary education, number of teachers; **EDU6**= Primary education, duration (years); **EDU7**= Primary education, number of students; **EDU8**= Continuation of studies to the end of the primary cycle, total (% cohort); **EDU9**= School enrollment, primary (% gross); **EDU10**= School enrollment, primary (% net); **EDU11**= School enrollment, secondary (% net); **EDU12**= School enrollment, secondary (% gross); **EDU13**= Pupil-teacher ratio at the secondary level; **EDU14**= Age of beginning of secondary school (years); **EDU15**= Secondary education, duration (years).

Source: The authors.

6. CONCLUSION

We used a panel data approach to estimate the relationship between education and economic activity measured by the real GDP per capita. Education was captured by 15 proxies, namely: EDU1=Primary school completion rate, total; EDU2=Completion rate of lower secondary education, total; EDU3=Pupil-teacher ratio at the primary level; EDU4=Total school enrollment, primary (% net); EDU5=Primary education, number of teachers; EDU6=Primary education, duration (years); EDU7=Primary education, number of students; EDU8= Continuation of studies to the end of the primary cycle, total (% cohort); EDU9=School enrollment, primary (% gross); EDU10=School enrollment, primary (% net); EDU11= School enrollment, secondary (% net); EDU12=School enrollment, secondary (% gross); EDU13= Pupil-teacher ratio at the secondary level; EDU14=Age of beginning of secondary school (years); EDU15=Secondary education, duration (years). The model estimated is one version of the standard augmented Solow model. We are aware of some problems involved in using the panel data technique. But, overall, the results of this paper suggest significant positive effects of schooling on economic growth in Africa. This finding strengthens the literature on education externalities (Mincer, 1974; Filiztekin, 2011; Frank and Hovey, 2014, World bank, 2018, etc.).

Consequently, the so-called "Pritchett hypothesis" indicating the lack of empirical link between changes in educational attainment and economic growth may not mean that education and economic activity are not correlated. Nevertheless, findings by Psacharopoulos (1994) indicating that the returns to the primary education is higher than that of the secondary education is not globally confirmed by our results. In other words, if African policy makers implement reforms that are conducive to their education systems, their countries would probably experience higher levels of economic growth. To that effect, attention is to be paid to the whole educational system. But the performance and the quality of an education system depends on the magnitude of expenditure or investment in the sector.

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APPENDIX

Table A1: *List of the selected countries.*

1. Algeria	14. Gambia	27. Rwanda
2. Benin	15. Ghana	28. Senegal
3. Botswana	16. Guinea-Bissau	29. Seychelles
4. Burkina Faso	17. Kenya	30. Sierra Leone
5. Burundi	18. Lesotho	31. South Africa
6. Cameroon	19. Madagascar	32. Swaziland
7. Central African Republic	20. Malawi	33. Tanzania
8. Chad	21. Mali	34. Togo
9. Congo, Dem. Rep.	22. Maurice	35. Tunisia
10. Congo Republic	23 Mauritania	36. Uganda
11. Cote d'Ivoire	24. Morocco	37. Zambia
12. Egypt	25. Niger	38. Zimbabwe
13. Gabon	26. Nigeria	

Source: The authors.

Table A2: *Evolution of some Education Indicators (African averages).*

Schooling Indicators	**2001 – 2005**	**2006 – 2010**	**2011 – 2015**
School enrolment ratios (%)			
Primary			
Male	85.45	103.23	104.63
Female	97.43	94.55	97.06
Total	**91.50**	**98.94**	**100.89**
Secondary			
Male	34.77	46.50	51.35
Female	38.03	39.47	45.01
Total	**38.03**	**43.02**	**48.21**
Pupils-teacher ratios			
Primary	39,22	40.59	38.34
Secondary	22,52	21.79	21.88
Adult illiteracy rate (%)			
Male	31.18	28.71	28.71
Female	50.57	45.03	45.03
Total	**41.17**	**37.03**	**37.03**

Source: African Development Bank (2016).

Table A3: *Share of population living on less than 1 USD (PPP2011) a day (%).*

	1990	**1993**	**1996**	**1999**	**2002**	**2005**	**2008**	**2011**	**2015**
East Asia and Pacific	61.3	53.7	40.9	38.5	29.7	18.9	15.3	8.6	2.3
Europe and Central Asia	N.a	5.2	7.3	7.9	6.0	4.9	2.8	2.1	1.5
Latin America and the Caribbean	14.8	14.0	13.7	13.5	11.8	9.9	6.9	5.7	3.9
Middle East and North Africa	6.2	7.0	6.2	3.8	3.4	3.1	2.7	2.7	4.2
South Asia	47.0	45.0	40.0	N.a	39.0	34.0	30.0	20.0	N.a
Low and Middle Income	44.4	41.8	36.0	34.8	30.8	25.0	21.9	16.4	11.8
Sub-Saharan Africa	**54.7**	**59.6**	**58.9**	**58.3**	**55.3**	**50.8**	**48.0**	**45.0**	**41.0**
World	**36.4**	**35.1**	**30.4**	**29.1**	**26.1**	**21.1**	**18.6**	**14.5**	**9.9**

Source: The World Bank, World Development Indicators, 2019 update. N.a = Not available.