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EDUCATION, HEALTH AND ECONOMIC GROWTH IN AFRICAN COUNTRIES

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This paper provides new empirical evidence concerning the relationship between human capital (measured by education and health related variables) and economic growth for a large sample of 49 African countries over the period from 1996 to 2010. Using traditional cross-section and dynamic panel techniques, we find that public expenditures on education and health have a negative impact on economic growth, whereas human capital stock indicators have a slight positive effect. Furthermore, our empirical investigations suggest that education and health spending are complementary. Then, public investment in education and health should be jointly increased and their efficiency in order to expect positive impact of human capital on growth in African countries.

Keywords: Human Capital, Education, Health, Economic Growth, Panel Data, Africa
JEL classification: I15, I25, O47, C23, O55

1. INTRODUCTION

Investing in health and education has recently constituted important social objectives because a reasonably good level of human capital increases a laborer's skills, productivity and quality of life. In addition, through its effect on productivity, human capital accumulation has been shown to be a fundamental determinant of economic growth; and higher economic growth also allows more investment in human capital. Therefore, connections between economic growth and human capital accumulation through education and health can be established.

The nexus between education, health and growth is important, especially in the African countries where the level of education, health and social well-being is far behind that of other regions of the world. Moreover, the majority of African countries have poor

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performance in key development indicators like GDP per capita, life expectancy at birth and education enrolment etc. For these reasons health and education in the Millennium Development Goals (MDGs), were given considerable preference. Following the MDGs, developing countries are encouraged to increase their investment in schooling and health as their impact on social welfare, poverty reduction and productivity are well-known.

As far as academic research is concerned, a plethora of empirical papers investigate the growth effects of human capital (especially education); albeit with some conflicting results. Nevertheless, a tiny proportion of these studies have investigated the effect of growth on both major components of human capital, *i.e.*, education and health for the African countries. Compared to previous studies (Gyimah-Bempong and Wilson, 2004; Colantonio *et al*., 2010), our empirical investigation differs in the following ways: First, in contrast with the other studies that focus only on education, we use both education and health indicators to assess the impact of human capital on growth. For each human capital component, we use both stock and investment indicators. Second, unlike Gyimah-Bempong and Wilson (2004) who compare growth effects of health in African countries to those in OECD countries, our study focuses on a large sample of African countries and compares the education growth effect to the health growth effect. Given the scarcity of resources and fiscal constraints faced by the African economies, investments in social sector -mainly in health and education- may be in competition with other investments such as road construction, energy, etc. Furthermore, there could be a tradeoff between investment in education and health, depending upon whether they are substitutes or complements. Third, we investigate the nonlinearity between education and health investments in the African countries. Fourth, we make use of the Generalized Method of Moment (GMM) in order to complete a cross-section analysis. This analysis deals with endogeneity problems and unobserved specific effects that arise in standard growth regressions. Moreover, dynamic panel results allow testing for the robustness of cross-section findings.

The rest of the paper is organized as follows. Section 2 presents an overview of the human capital and growth relationship. Section 3 introduces the empirical methodology, while Section 4 discusses data. Section 5 presents and discusses the empirical results. Finally, Section 6 offers concluding remarks.

2. HUMAN CAPITAL AND GROWTH: AN OVERVIEW

The seminal papers on endogenous growth theory highlight the importance of human capital in the development and economic growth process. For instance, in their endogenous growth model, Lucas (1988) and Romer (1990) take into account human capital through education stock for the former; with technology and research and development (R&D) for the later. In these papers, human capital is considered as a positive externality on capital productivity and its accumulation favourably influences economic growth and welfare of a community. In short, human capital is the stock of

knowledge, competence, health, training, including creativity and other investments, embody the ability to perform labor tasks more productively. On the other hand, human capital formation refers to the process of acquiring and increasing the number of people who have the skills, good health, education and experience that are critical for economic development. Although human capital is multifaceted, many theories explicitly connect investment in human capital development to education and occult the other aspects, mainly stock and investment in health. However, health also plays an important role in human capital accumulation and is closely connected to education. For instance, a healthy population is easy to educate and the efficiency of people to produce human capital is also high. Inversely, an increase in education involves the enhancement of health conditions as qualified people have a more responsible behavior.

Recent empirical literature on the relationship between human capital and economic growth led to conflicting results due to differences in the indicators and methodologies used. Below, we present first studies related to education and growth, second health and growth and third the economic growth effects of both human capital components.

Some researchers have found evidence that education has significant effect on growth. For instance, Mankiw *et al*. (1992), Barro and Sala-i-Martin (1995) find a positive association between initial endowment levels of education and subsequent growth rates. Using cointegration analysis, Maksymenko and Rabani (2011) also find that education has a significant positive effect on growth in both India and South Korea. Hanushek and Kimbo (2000) use indexes of educational quality for 38 countries based on academic performance in mathematics and sciences over the period 1965-1999 and suggest a strong correlation between educational quality and increase in GDP per capita. Taking into account specification bias that originate from ignoring international differences in the quality of schooling, Dessus (2001) observed -for 83 countries over the period from 1960 to 1990- that education quality measured by pupil-teacher ratio, government expenditures on education and access to educational facilities are significantly correlated with economic growth.

On the contrary, other studies suggest either weak or negative growth effects of education. For instance, Caselli *et al*. (1996) do not support the views of Mankiw *et al*. (1992) that investing in human capital is necessary for growth. Similarly, Benhabib and Speigel (1994), Pritchett (1996) and Kumar (2006) find a weak relationship between educational attainment of a labor force and economic growth. In the same vein, Behbudi *et al*. (2010), take into account natural resource abundance and find a negative relationship between economic growth and education in countries who are major petroleum exporters. They conclude that resource-rich countries have neglected their human resource by devoting inadequate attention and expenditure to education. Using provincial data from 1996 to 2004 and cross-sectional and panel regression, Chi (2008) find that neither the stock nor the accumulation of education appears to have a significant and direct impact on per capita growth in China, but the human capital effect on economic growth may be created through physical capital investment.

As far as health is concerned, it is only since the early 90s that there has been a flurry

of studies on the effects of health on economic growth.[1] For example Fogel (1994) shows that about one-third of the economic growth in England, over the last two centuries, is due to improvement in nutrition and health. Barro (1996) finds a positive relationship between life expectancy and economic growth. Similarly, Jamison *et al.* (1998) suggest that the survival rate contributes to growth. Gallup and Sachs (1998) conclude that regions more prone to malaria grow less and the prevalence of malaria decreases the income growth rate. Ainsworth and Over (1996) argue that the HIV/AIDS epidemic reduces the growth rate by decreasing human capital and savings of per capita income by 0.33% in African countries. Gyimah-Brempong (1998) shows a positive correlation between economic growth and the share of government budget allocated to health care in African countries. Using the Granger causality test and measuring health by the probability of adult survival by sex and age group, Mayer (2001) concludes that health causes economic growth in Latin America. Moreover, improvement of health is associated with a 0.8-1.5% increase in annual income showing that health plays an important role in economic growth. From a study on ten developed countries over the last 100 to 125 years, Arora (2001) suggests that health improvements reduce constraints on human ability and increase the long term growth by 30 to 40%.

As discussed above, education and health may be inter-related. However, studies that analyze the relationship between growth and education or health did not consider this connection (Aka and Dumont, 2008). At most, some empirical works compared health and education contributions to economic growth. For instance, Knowles and Owen (1995) include life expectancy at birth as proxy of the health indicator and find that per capita income growth is more robust with a health indicator than an education variable. In the same vein, using panel data analysis for 77 countries, McDonald and Roberts (2002) confirm the findings of Knowles and Owen (1995). However, Webber (2002) reaches a different conclusion by using the enrolment rate for primary, secondary and tertiary education and suggests that growth oriented policies should favor investment in education over health. Using the intellectual factor (IQ) as another fundamental aspect of human capital, Ram (2007) found that the effect of IQ on growth of per capita income is more important than the health effect. Furthermore, the author suggests that the effect of IQ is always higher than life expectancy and education effects. Moreover, Li and Huang (2010) find that -for 11 East Asia countries over the period 1961-2007- both stock of education and health have a positive and significant effect on growth, but the statistical impact of health on economic growth is stronger than that of education. Li and Huang (2009) use a panel of 28 provinces in China over the period 1978-2005 and find that both education and health investment have a positive and significant effect on economic growth in China. They suggest that health has often contributed more to economic growth than education in China. Gyimah-Brempong and Wilson (2004) also show that

[1] For theoretical studies that investigate growth effects of health as one of the most important components in human capital, see Barro (1996).

both human capital indicators have a positive and significant effect on the growth of per capita income for sub-Saharan African and OECD countries. Their results indicate that the effect of health stock on growth is subject to diminishing marginal returns. Likewise, Colantonio *et al*. (2010) investigate the nexus between economic development, education and health indicators over the period 2003-2007, using multidimensional scaling methodology and find that countries who show a better status in relation to education, health and economic condition, enjoy a higher growth. Conversely, countries with a lower level of education and health show a sluggish level of growth.

To sum up, empirical studies of growth effect concerning education and health are quite mixed and the literature results depend not only on proxy variables used for education and health, but also on the empirical methodology. Furthermore, only few studies have been conducted on education, health and economic growth relationship in Africa. This paper attempts to fill this gap and aims to compare the relative impact of human capital indicators and their interaction with growth.

3. EMPIRICAL METHODOLOGY

In this paper, two kinds of estimators are used: the OLS estimator for cross-sectional analysis is used in order to assess the long-run relationship and the Generalized Method of Moment (GMM) used on panel data for short run dynamics.

The cross-sectional analysis uses data averaged over 1996-2010, such that there is one observation per country. The basic regression takes the form:

$$growth_i = \alpha_0 + \alpha_1 hcap_i + \alpha_2 Z_i + \varepsilon_i , \quad (1)$$

where the dependent variable, *growth* equals the growth rate of real GDP per capita (constant 2000 US$), human capital variable (*hcap*) is either a health indicator or an education variable. Z represents a vector of conditioning information that controls for other factors associated with economic growth, and ε is the error term. Due to the potential nonlinear relationship between economic growth and the assortment of economic indicators, we use logarithms of the regressors. This regression is performed using a simple OLS estimator, corrected for heteroscedasticity. We complete cross-sectional regressions with panel analysis.

Estimation using panel data has several advantages over purely cross-sectional estimation. First, working with a panel allows us to take into account how human capital, within a country, may over time have an effect on the country's growth and yields degrees of freedom by adding the variability of the time-series dimension. Second, in a panel context, we are able to control for unobserved country-specific effects and thereby reduce biases in the estimated coefficients. Third, our panel estimator controls for the potential endogeneity of all explanatory variables.

We use the GMM system estimators developed for dynamic models of panel data

that were introduced by Arellano and Bond (1991), and developed by Arellano and Bover (1995), and Blundell and Bond (1998). The GMM system model is based on a stacked system comprising equations in first differences and equations in levels. For simplicity, we present the standard panel data equation as follows:

$$growth_{it} = \alpha_0 + \lambda_i + \gamma_0 \, lg\, dp_{i,t-1} + \gamma_1 educv_{it} + \gamma_2 healthv_{it} + \beta' X_{it} + \varepsilon_{it}, \quad (2)$$

where *growth* equals the growth rate of real GDP per capita (constant 2000 US$), *lgdp* is the logarithm of real GDP per capita, *educv* is education variable, *healthv* is health variable, *X* represents a vector of conditioning information that controls for other factors associated with economic growth and λ is an unobserved country-specific effect.[2] Arellano and Bond (1991) propose two estimators: one and two-step estimators. Here, we use the Arellano and Bond's two-step estimator to estimate the model, because it is the most optimal. In order to more accurate conclusions, the GMM system estimator uses lagged differences of the explanatory variables as instruments for equations in levels, in addition to lagged levels of the explanatory variables as instruments for equations in first differences (see Arellano and Bover, 1995; Blundell and Bond, 1998).

Consistency of the GMM estimator depends on the validity of the instruments. To address this issue we consider two specification tests suggested by Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998). The first is a Sargan/Hansen test of over-identifying restrictions, which tests the overall validity of the instruments by analyzing the sample analog of the moment conditions used in the estimation process. The second test examines the hypothesis that the error term ε_{it} is not serially correlated. In the system difference-level regression, we test whether the differenced error term is second-order serially correlated (by construction, the differenced error term is probably first-order serially correlated even if the original error term is not).

Finally, in order to account for a potential non-linearity, we include the interaction terms between health and education expenditure's ratios enable us to determine the effect of education spending (*resp.* health spending) on economic growth with respect to health spending (*resp.* education spending). Considering the following equation:

$$growth_{it} = \alpha_0 + \lambda_i + \gamma_1 educv_{it} + \gamma_2 healthv_{it} + \gamma_3 educv_{it} * healthv_{it} + \beta X_{it} + \varepsilon_{i,t}. \quad (3)$$

By differentiating Equation (3) with respect to the ratios of education (4) and health (5) we obtain:

[2] We also include time dummies to account for time-specific effects.

$$\frac{\partial growth_{it}}{\partial educv_{it}} = \gamma_1 + \gamma_3 healthv_{it}\,, \tag{4}$$

$$\frac{\partial growth_{it}}{\partial healthv_{it}} = \gamma_2 + \gamma_3 educv_{it}\,. \tag{5}$$

These expressions allow us to compute the marginal effect of education (*resp.* health) on growth with respect to health (*resp.* education). We can also determine the health (*resp.* education) threshold level that allows positive relationship between education (*resp.* health) and economic growth.

4. DATA, DESCRIPTIVE STATISTICS AND CORRELATION

The present study covers the period from 1996 to 2010 and focuses on a sample of 49 African countries,[3] according to the data availability. Our data are taken from World Development Indicators (WDI, 2011). Following the main components of human development defined in the economic theory, we use both health and education indicators to assess the effect of human capital variables on growth. For each human capital component, we use both stock and investment indicators. Although human capital investment does not completely transform into human capital stock due to corruption and inefficiency of public expenditures (for example in African countries), we can consider human capital stock as an indicator of efficiency of human development expenditures. All other things being equal, if more resources are devoted to human capital investment, we expect a larger stock of human capital over time.

For health variables, we use aggregate health expenditure as percentage of GDP (*health*) as measure of investment in health human capital, and two aggregate health stock variables, mainly life expectancy at birth (*life*) and survival to age 65 as percentage of cohort (*survi*). As far as education variables are concerned, we similarly used public spending on education as percentage of GDP (*educ*) to assess investment in educational human capital, and two gross aggregate education stocks variables as school enrolment in primary (*pse*) and secondary (*sse*) sectors. The stock variables can be considered as indicators of effectiveness of spending in education and health sectors. Thus, an efficient allocation of education and health expenditures should respectively lead to higher

[3] Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo Dem. Rep., Congo Rep., Cote d'Ivoire, Djibouti, Egypt Arab Rep., Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia The, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Seychelles, South Africa, Sudan, Swaziland, Togo, Tunisia, Uganda, Zambia and Zimbabwe.

enrolment rates and life expectancy.

Following empirical works on growth determinants, we use a set of variables that control for other factors associated with economic growth, for assessing the strength of an independent link between human capital and economic growth. The initial GDP per capita (*GDP0*) allows testing for the conditional convergence in the spirit of the neoclassical growth theory (Barro and Sala-i-Martin, 1995). We use the inflation rate (*inflat*) and the ratio of government expenditure to GDP (*gov*) as indicators of macroeconomic stability and the sum of exports and imports (*open*) as a share of GDP, in order to capture the degree of openness of an economy. As far as health or education public expenditure is concerned, we isolate their effects by using government expenditure minus health and education expenditure (*overexp*). The investment ratio (*gfcf*) is measured as the ratio of gross fixed capital formation to GDP, the foreign direct investment (*fdi*), net inflows (% of GDP) and the money and quasi money (*findev*) as percentage of GDP to appease the financial depth. Table 1 provides summary statistics on the used variables.

Table 1. Descriptive Statistics, Cross-Section: 1996-2010

Variables	Obs.	Mean	Std. Dev	Minimum	Maximum
growth	49	2.520	3.596	-2.756	20.148
gdp0	49	969.843	1443	58.083	6366
educ	49	4.482	2.363	0.412	13.400
pse	49	94.068	22.413	40.710	136.708
sse	49	39.250	25.598	8.709	108.354
health	49	5.312	2.090	0.008	13.366
life	49	54.710	8.742	42.402	73.184
survi	49	49.246	14.090	25.494	80.935
gov	49	15.199	7.088	7.363	44.020
overexp	49	7.820	5.569	1.318	31.754
fdi	49	4.574	5.252	0.103	25.556
open	49	77.597	36.659	32.460	182.943
gfcf	49	12.866	6.632	3.146	41.566
inflat	49	24.838	74.920	0.911	375.855
findev	49	33.225	24.940	6.988	121.190

Over the period 1996-2010, the descriptive statistics show that GDP growth is higher in African countries with regard to the world average (nearly 2%). The Equatorial Guinea records on the recent year's exceptional economic growth (20.14% on the studied period) that is due to oil and public investment. At the same time various crises,

whether they are political, or food and inflationist explain the lower growth rate in Zimbabwe. Although the primary school enrolment rate is higher on average in African countries (94.06%) that benefit from investment in this sector through sponsors and national governments, the enrolment in the secondary sector remains very low (39.25%). Similarly, indicators of health (life expectancy at birth and survival to age 65 as percentage of cohort) are lower compared to the level of developed countries. For example, life expectancy is greater than 80 years in OECD countries against 54 years in African countries. Regarding government spending, the mean is very low (15.19%) compared to the average for the European Union, which is at more than 40%. The low proportion of the overall expenditure in GDP, affects spending on education and health. Thus, although the shares of public expenditure in education and health sectors are relatively low in African countries (respectively, 4.48% and 5.31%), we note that these sectors alone receive over 60% of public expenditure; this reflects the importance of these sectors in the different development strategies of these countries. Except the inflation rate that maintains a high level (24%), African economies stay relatively open (77.59% for the openness to trade). However, this level of openness can be somewhat explained by the dependence of African countries on foreign imports. In addition, other macroeconomic variables such as the ratio of investment to GDP, foreign direct investment and the level of financial development are below the threshold needed to stimulate economic growth. Furthermore, the descriptive statistics suggest that data exhibited high variability, which denoted a lack of macroeconomic convergence between African countries.

5. EMPIRICAL RESULTS

5.1. Cross Section Estimations

In this section, we discuss human capital and the growth relationship, using cross-section and dynamic panel methodologies. We finally analyze the conditional effect of education and health on growth.

Table 2 presents cross-section results that highlight long-run relationship between human capital variables and economic growth. The signs of the control variables are sometimes consistent with theoretical predictions. For instance, the financial development variable is positively linked to growth, suggesting that the financial sector has a favorable impact on the output growth. The convergence hypothesis is not verified for the sample of African countries, considering the non-significance of the coefficient of initial GDP. Furthermore, the ratio of the sum of import and export to GDP is not significant suggesting that more open African countries do not have a greater ability to catch up the leading technologies of the rest of the world, while the inflation rate is negatively associated with economic growth in the long run. On the other hand, the coefficients of investment and foreign domestic investment are positive and significant;

this outcome confirms that investment can be considered as a key determinant of long running economic growth in African countries. As far as global government expenditure to GDP is concerned, the coefficients obtained are negative and significant; this result highlights the inefficiency of public spending, which is found in many studies.

Like the overall spending, education spending has a negative and significant impact on growth in African countries, while health spending is not significant. Similar results, with respect to growth effects of education and health expenditures, were found by some authors. For example, Devarajan *et al*. (1996) find a negative relationship between education expenditures and growth rate. The growth effect of health expenditure is also consistent with Gyimah-Brempong's (1998) findings. However, Barro (1991) suggests a positive growth effect of education expenditure. These outcomes can be explained by the degree of inefficiency in which such expenditures are converted in human capital stock and the low amount of resources devoted to each component of human capital.

Grossman (1972) suggests that expenditure on human capital can be viewed as an input in the health and education production. Therefore, the negative growth effect of education and health can be justified by the inefficiency of the human capital production process. This inefficiency is due to structural and institutional factors (such as the public-private mix of health facilities and corruption), the market structure of various health care services, etc. Then, the negative impact of human capital is reflected in indicators measuring the performance of investments in the health and education sectors that do not have overall significant effects on growth.

The allocation of resources to education and health depends on the global public expenditure and the way in which it is allocated within these sectors. As suggested by Ranis *et al*. (2000), the determinants of the share of resources allocated to human capital are complex. They include the tax capacity of the system, the strength of the demand for military expenditure and for other non human capital priorities of the government and various interactions between bureaucratic forces and popular pressures. Therefore, if there is underinvestment in health and education in most of African countries, the growth effect of human capital may not be significant. In most African countries, underinvestment in human capital could be partly explained by Structural Adjustment Programs that have encouraged these countries to reduce public resources allocated to health and education. In addition, slower economic growth has restricted the ability of many African governments to finance the social sector for their growing population.

Since human capital sectors suffer underinvestment in African countries, one can ask whether there is a threshold effect in the education, health and growth relationship. In other words, is there a health (*resp.* education) expenditure threshold for the positive effect of education (*resp.* health) stocks on growth? This could allow us to conclude whether health and education are complementary or not.

Table 2. Human Capital and Growth: Cross-Section Regressions, 1996-2010

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
educ	-1.727*	-	-	-	-	-	-9.839***	-11.954***
	(0.945)						(3.100)	(3.486)
pse	-	2.239**	-	-	-	-	-	1.630*
		(1.085)						(0.920)
sse	-	-	1.393	-	-	-	-	-
			(1.160)					
health	-	-	-	0.283	-	-	-3.851*	-4.638**
				(0.665)			(2.072)	(2.190)
life	-	-	-	-	1.344	-	-	8.380**
					(1.860)			(4.733)
survi	-	-	-	-	-	1.260	-	-
						(1.893)		
educ×		-	-	-	-	-	4.868**	5.937***
health							(1.941)	(2.149)
gdp0	-0.294	-0.348	-0.051	-0.522	-0.466	-0.369	-0.512	-0.428
	(0.601)	(0.605)	(0.684)	(0.612)	(0.699)	(0.619)	(0.576)	(0.557)
overexp	-0.135	-	-	-0.508	-	-	-0.020	0.399
	(0.809)			(0.817)			(0.794)	(0.748)
gov	-	-1.147*	-0.918*	-	-1.374**	-0.992*	-	-
		(0.614)	(0.452)		(0.798)	(0.520)		
fdi	1.153**	1.456***	1.201**	1.211**	1.229**	1.259**	0.941*	1.089**
	(0.525)	(0.562)	(0.533)	(0.552)	(0.543)	(0.542)	(0.499)	(0.517)
open	0.350	-0.018	0.262	0.436	0.595	0.616	-0.068	-0.501
	(1.434)	(1.559)	(1.507)	(1.492)	(1.513)	(1.499)	(1.328)	(1.366)
gfcf	1.923*	1.735	1.964*	1.946*	1.841*	1.788*	1.986**	1.670*
	(1.037)	(1.059)	(1.064)	(1.092)	(1.094)	(1.073)	(0.978)	(0.987)
inflat	-0.960	-0.543	-0.401	0.272	-0.498	-0.164	0.770	1.307
	(1.474)	(1.451)	(1.454)	(1.031)	(1.522)	(1.543)	(1.820)	(1.819)
findev	1.267*	1.311**	1.824*	1.533**	1.271**	1.594*	1.231**	1.875**
	(0.699)	(0.576)	(1.064)	(0.723)	(0.614)	(0.972)	(0.646)	(0.824)
cons.	-5.006	-13.926	-7.552	-9.029	-5.500	-10.893	-0.884	-2.100*
	(7.122)	(9.128)	(7.086)	7.307	(7.461)	(9.592)	(6.832)	(1.508)
Adj. R^2	0.370	0.349	0.347	0.318	0.322	0.330	0.466	0.489
Fisher	4.08***	3.80***	3.78***	3.44***	3.48***	3.57***	4.74***	4.75***
Obs.	49	49	49	49	49	49	49	49

Notes: Standard error presented below the corresponding coefficient, is corrected for heteroscedasticity. Symbols ***, ** and * show 1%, 5% and 10% level of significance, respectively.

To this end, we estimate a nonlinear regression by taking into account an interaction variable, which is the product of education and health expenditures. The results are

displayed in the columns (7) and (8) of the Table 2. Then, we provide new empirical evidence on the relationship between human capital indicators and economic growth. Our findings confirm the negative impact of education expenditure on growth and the growth effect of health expenditure has changed and become significantly negative. Moreover, a higher and more robust negative impact of education expenditure compared to health expenditures is found. The outcome also suggests that human capital stocks measured by primary school enrolment and life expectancy are positively associated with output growth and health variables are more robust than education variables. This result is consistent with previous empirical works (Knowles and Owen, 1995; Mayer *et al*., 2001; Li and Huang, 2009; Li and Huang, 2010) but diverges from those of (McDonald and Roberts, 2002; Ram, 2007) who suggest that growth oriented policies favor investment in education over health. Furthermore, our empirical results suggest that the coefficient of the interaction variable is positive and significant. These outcomes show that there is a nonlinear relationship between education and health expenditures. Subsequently, a threshold for education expenditure is required, as a positive growth effect of health expenditures is expected. Similarly, above a threshold of health expenditures, education expenditure has positive and significant impact, showing that education and health expenditures are complement.

5.2. Dynamic Panel Results

Table 3 presents the results using GMM system estimator on dynamic panel. The regressions satisfy the specification tests. There is no evidence of a second serial correlation, but there is evidence of a first serial correlation. Moreover, the regressions pass the Hansen test and confirm the validity of the instruments. It is also worth noting that many of the auxiliary variables enter significantly with the expected signs. Thus, the coefficients of the control variables are consistent with cross-section results, having a lower magnitude and significance.

Regarding human capital, the coefficients obtained from the dynamic panel estimations are consistent with those of the cross-section regressions. For example, spending on education and health negatively affect growth, with a lower magnitude compared to cross-section coefficients, while there is no evidence of a real impact of human capital stocks. This outcome reinforces the idea that the drawbacks of inefficient public spending are not only observed in the long run, but are also apparent in the short run. This leads us to question policy recommendations of high human capital investment in order to spur growth and economic development in low income countries. The remaining issue is how investment in education and health sector can stimulate long-term growth and to achieve the MDGs in African countries? It is well-known that a healthier and better educated population contributes more to economic growth. For example, improvements in health are reflected in an increase of the life expectancy and improvements in population health and functioning at later ages. Therefore, this higher quality of health capital improves welfare and increases labor productivity which is

analyzed in an extended version of the standard growth model focusing on human capital. As pointed out above, policy-makers need better information on ways in which human capital expenditures affect economic growth, in order to maximize the growth impact of investment in health and education. The public sector needs to become more selective in the use of subsidies. For example, not all forms of educational investment are equally productive. Along the same lines, the social rates of return are much higher for the primary than post primary education. Spending in education however, does not seem to be directed toward equalizing the social rates of return. In this perspective, African governments should reduce expenditure for services that have lower externalities and favor only the rich classes.

Our results are in line with some empirical studies that analyzed the relationship between human capital and growth, using panel data methods. For example, Caselli *et al*. (1996) and Kumar (2006) find no evidence of positive growth effects of health and education. In addition, a negative effect of educational expenditure on economic growth is consistent with Dessus (2001).

As Kumar (2006) suggests the negative impact of human capital investment, also observed here, does not mean marginal role of human capital in growth process for African economies. This can be interpreted as a need to better estimate human capital. For example, Gundlach (2001) supports that the presumed link between education and economic growth did not hold in empirical research because most of empirical studies ignored the productivity aspect of education as proposed by a new growth model and international difference in rates of return in education. There is a need to include schooling quality, vocational training, an institutional health variable etc. to get a more accurate effect of the human capital. These explanations are in line with Dessus (2001) who argues that the educational infrastructures, the initial endowment in human capital, and the ability of the system to equally distribute educational services within a country, can largely explain why investments in African countries' education have not been rewarded by higher growth. We believe that large enrolment rates, that African countries have recently recorded, are detrimental to the quality of the education supplied. Furthermore, the unequal distribution of educational services has hampered the efficiency of public expenditures.

We check the robustness of cross-section results by taking into account the nonlinearity between spending in the health and education sectors, by including an interaction variable (see columns 7 and 8). The results show that education and health expenditures negatively affect growth -with a negative and slightly higher impact of education spending- and positive and significant coefficient of the interaction variable. The higher coefficient (in absolute value) of education expenditures compared to health expenditures means that the inefficiency of public spending is higher in education than in health sector. The positive sign of the interaction variable suggests that, beyond the nonlinearity of the relationship between education and health expenditures in the short run, there is a complementary relationship between both expenditures.

Table 3. Human Capital and Growth: Dynamic Panel-Data Estimation, Two-Step System GMM

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
educ	-0.053*	-	-	-	-	-	-0.146*	-0.174**
	(0.030)						(0.085)	(0.053)
pse	-	0.035	-	-	-	-	-	0.111
		(0.044)						(0.171)
sse	-	-	0.008	-	-	-	-	-
			(0.031)					
health	-	-	-	-0.068**	-	-	-0.112*	-0.143*
							(0.066)	0.079
				(0.033)				
life	-	-	-	-	0.153	-	-	0.147
					(0.109)			(0.105)
survi	-	-	-	-	-	0.090	-	-
						(0.092)		
educ × health		-	-	-	-	-	0.067*	0.071*
							(0.039)	(0.044)
gdp0	1.007***	0.989***	0.991***	1.005***	1.033***	1.017***	1.017***	0.965***
	(0.025)	(0.015)	(0.023)	(0.019)	(0.012)	(0.018)	(0.031)	(0.038)
overexp	-0.008	-	-	-0.002	-	-	-0.046	-0.002
	(0.005)			(0.009)			(0.074)	(0.009)
gov	-	-0.070	-0.092*	-	-0.038**	-0.041**	-	-
		(0.053)	(0.051)		(0.011)	(0.020)		
fdi	0.004	0.003	0.008*	0.002	0.003	0.004	0.004	0.003
	(0.005)	(0.005)	(0.004)	(0.005)	(0.061)	(0.006)	(0.004)	(0.007)
open	0.025	0.060*	0.044	-0.049	-0.044	-0.038	-0.017	0.057
	(0.039)	(0.035)	(0.041)	(0.039)	(0.043)	(0.041)	(0.057)	(0.086)
gfcf	0.042**	0.040**	0.039**	0.056**	0.056**	0.056**	0.047**	0.051**
	(0.018)	(0.015)	(0.017)	(0.026)	(0.028)	(0.028)	(0.021)	(0.023)
inflat	-0.098**	-0.109*	-0.076*	-0.064*	-0.065*	-0.069**	-0.064**	-0.060**
	(0.046)	(0.063)	(0.044)	(0.040)	(0.038)	(0.033)	(0.027)	(0.023)
findev	0.033	0.047*	0.039	0.038	0.065**	0.082***	0.068**	0.065*
	(0.021)	(0.028)	(0.034)	(0.034)	(0.025)	(0.030)	(0.033)	(0.040)
cons.	0.414	0.338	0.194	0.453	0.970	0.769	0.273	-0.519
	(0.270)	(0.352)	(0.227)	(0.250)	(0.939)	(0.574)	(0.575)	(1.250)
AR1	0.055	0.002	0.028	0.003	0.007	0.038	0.013	0.045
AR2	0.685	0.765	0.654	0.441	0.387	0.377	0.407	0.470
Hansen test (p-value)	0.928	0.821	0.918	0.923	0.781	0.834	0.912	0.937
Obs.	99	99	99	99	99	99	123	147

Notes: Standard error is presented below the corresponding coefficient. Symbols ***, ** and * show 1%, 5% and 10% level of significance respectively.

These outcomes confirm the predictions of the cross-sectional analysis and suggest that education expenditures must exceed a threshold for a positive impact of health spending on economic growth in African countries. Similarly, a threshold of health expenditure is also required for a positive effect of education expenditure on growth.

5.3. Conditional Effects of Education and Health on Growth

Figures 1 and 2 plot the estimates of the marginal effects of education (*resp.* health) on growth with respect to health (*resp*. education). We use the coefficients of column 7, (Table 3) which provide the same marginal effects, with those of column 8. The figures reveal that the marginal effects increase monotonically with education or health expenditures. This result suggests that it must simultaneously increase spending on education and health to expect a positive impact on growth. However, this increasing complementary is more likely to be explained by the fact that a well-educated population will adopt the appropriate behavior for a healthy living. Thus education improves health and the efficiency production function. Similarly, a healthy population can devote more time to education. Moreover, the threshold value for a positive marginal effect is higher for health spending (8.83%) than education (5.32%).[4] The figures highlight two facts: the number of countries who cross the threshold in terms of health expenditure is very low, while in many African countries, the level of education spending is beyond the threshold. We note the importance of efforts in education and the need to increase these efforts not only in education but also in health sector. Then, an increase of health spending can contribute to improving its impact on growth, allow many countries to overcome the development trap, and therefore increase the education effects.

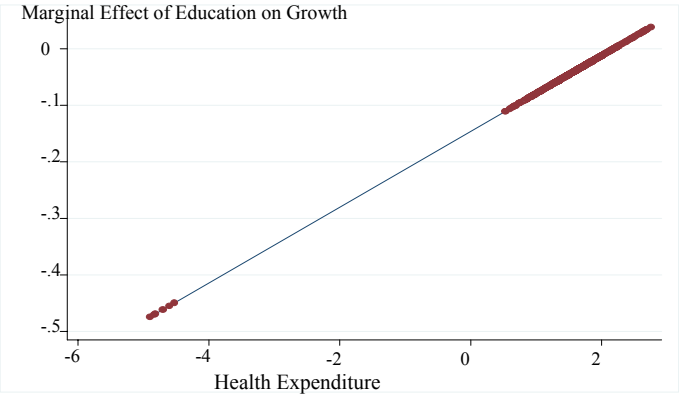

Figure 1. Marginal Effect of Education on Growth with Respect to Health

[4] The corresponding values in natural logarithm on the Figures are respectively 2.18 and 1.67.

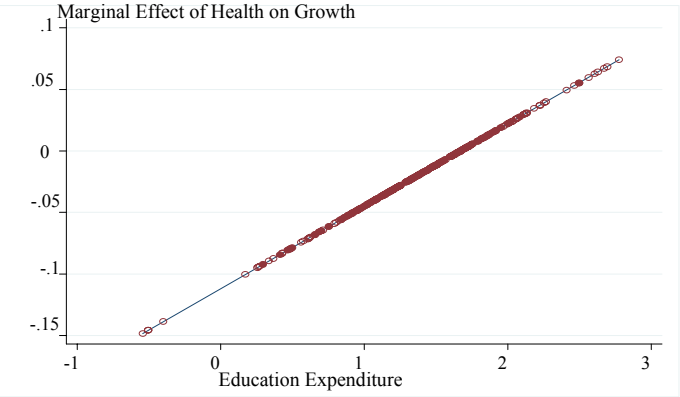

Figure 2. Marginal Effect of Health on Growth with Respect to Education

6. CONCLUSION

Our evidence points out that education and health expenditures have a negative impact on economic growth for a sample of African countries due to their inefficiency, corruption, bureaucracy and underinvestment. However, the inefficiency of public spending is higher in education than health sector and the health indicators contribute more to economic growth than the education variables. This result suggests that, governments can increase spending in the health sector and improve the efficiency in the education sector. It is worth noting that this recommendation should not be interpreted as a reduction of investment toward the education sector.

Indeed, our results also suggest that spending on education and health is interdependent, characterized by nonlinearity and the existence of threshold effects. Thus, given the complementarities between education and health expenditures, a threshold of health expenditure is required to expect positive effects of education spending and vice versa. This policy implication should be taken into account in the public expenditures allocation in order to expect beneficial effects of human capital on growth in African countries.

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