Economic growth in Africa: Does gender education still matter?

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Abstract

This study examines the relevance of gender education to economic growth in Africa. This is investigated across different levels of education attainments and human capital stocks for females and males. Using the datasets of Barro and Lee (2013) and Lee and Lee (2016) which cover the period from 1960 to 2010 and static panel estimation methods (pooled, fixed effects and random effects) as well as dynamic GMM methods (one step and two step difference and system GMM) for analysis, it is found that education attainments and human capital stocks (for females and males) are indispensable to economic growth in Africa. Specifically, we find that male education attainment and human capital stock contribute more to economic growth than female education attainment and human capital stock. Based on these findings, it is imperative for governments in Africa to provide a quality education for both genders which would be based not only on theoretical learning but also on practical learning and skill development that would increase the stocks of human capital embodied in both genders. This would enable them to contribute more to economic growth of the continent.

Keywords: Female and Male Education Attainments, Human Capital Stocks, Economic Growth

JEL Classification: I20, J24, O40,

1.0. Introduction

In a bid to lay emphasis on how economic growth matters to countries across the world, Robert Lucas Jr. opines that when you think about economic growth, you don't think of any other thing. This assertion reveals the fact that economic growth is a precursor to any country's welfare. In fact, economic growth is like the heart of the economies across the world. Little wonder literature on the determinants of economic growth is voluminous (see Chirwa and Odhiambo, 2016 for extensive review). Over the years, several socioeconomic and political variables have been considered as proxies for the determinants of a long run economic growth (Barro, 1991; Barro and Lee, 1994; Barro, 1998; 2003). Among these, education has been singled out as an outstanding determinant (Romer 1986; Lucas 1988, Barro and Lee, 1994; Barro, 2001). The rationale for this assertion anchors on the fact that education is a precursor to human capital accumulation, economic growth as well as economic development. Although there are many theoretical channels through which education affects economic growth, however, it is believed among the economic scholars that education leads to development of cognitive skill that fosters innovative technology, improves the labour productivity, raises its earnings and ultimately spurs economic growth and development (see Ozturk, 2001; World Bank, 2008; Aghion et al., 2009). Put in another way, Hanushek and Woessmann, (2007) argue that innovative capacity of the economy is increased through education and thus promotes new technological know-how, products and economic growth.

Despite the laudable role of education in economic growth, there are several arguments against the veracity of the impact of education on economic growth. The arguments stem from different sources. The first source of the debates comes from the fact that there are plethora of variables used by authors to proxy education (Abdullah, 2013). Another source of debates stems from the way the researchers have modelled education-growth nexus. With regard to the measurement of education, some authors make use of school enrolment rates, literacy rate or the average years of schooling. Another set of authors have used human skills, physical capability and life expectancy as proxies for education (Cipolla, 1969; Houston, 1983 and Leeuwen, 2007). In recent time, the use of Barro and Lee, (2013) dataset has become popular in education-growth literature, while Hanushek and Kimko (2000) propose the use of cognitive skills based on the performance in international standard test, particularly in mathematics and science subjects as a measure of quality of education.

In terms of modelling education-growth nexus, several methods have been deployed in the literature by different researchers. Some authors model education-growth relation using the Ordinary Least Squares or Panel Estimation Methods. However, owing to the endogeneity

problem that usually occurs when modelling economic relations across countries, others have proposed instrumental variable methods to account for the endogeneity. Another issue as regards to the modelling of education-growth nexus is whether the relationship between the two variables should be modelled linearly or nonlinearly. While aforementioned methods, either accounting for endogeneity or not, are based on the linear modelling of education and growth relation, there are some authors who stated that the relation should not be modelled nonlinearly. (Temple, 2001; Kalaitzidakis et al., 2001 and Durlauf et al., 2001.) These issues have resulted in mixed empirical findings, giving rise to different policy implications for different countries.

Empirically, the findings on the relationship between education and economic growth are mixed. While some studies conclude that education has a positive impact on economic growth (Barro, 1991, 1998; 2001; Murphy, Shleifer and Vishny, 1991; Mankiw et al., 1992; Levine and Renelt, 1992; Sala-i-Martin et al., 2004; Barro and Lee, 2013), some studies, however, show that education has negative effect on economic growth (Islam, 1995; Bose et al. 2007, Ndiyo, 2007; Nurudeen and Usman, 2010; Phillips and Chen, 2011; Lawal and Iyiola, 2011). There are other studies that conclude that education has no significant impact on the economy (Benhabib and Spiegel, 1994; Siddiqui, 2006; Lee, 2010).

With regard to gender education and economic growth, some studies have been carried out to investigate the effect of gender education or gender education inequality on economic growth, albeit with mixed results. While on the one hand, the studies by Hill and King (1995), Forbes (2000) and Knowles et al., (2002) show that female education has a positive effect on economic growth and that that of male has an insignificantly positive effect, on the other hand, the studies by Barro and Lee, (1994); Barro and Sala-i-Martin (1995); Barro (1998) and Perotti, (1996) conclude that male education has a positive significant effect on economic growth whereas female education has a negative significant effect on economic growth. Stokey, (1994) who adopted Barro and Lee's method went further to state that the coefficient of female education in growth regression becomes insignificant when accounting for regional dummy variables. Durham (1999), however, found that both male and female education do not have significant impact on economic growth while accounting for political regime. These mixed results have had far reaching effects in terms of policy recommendations, formulations and implementations in both developed and developing countries.

Giving the mixed empirical findings, this study seeks to examine the effect of gender education attainment at different levels on economic growth in Africa. In recent time, it has been stated that the females enrolling in schools in developing countries, particularly in Africa are on the increase, albeit not at parity with their male counterparts (Odaga and Neveld, 1995;

Bunyi, 2003; Tuwor and Sossou, 2008; Ombati and Ombati 2012). If the number of females and males enrolling in schools are on the increase, it is expected that the stock of human capital embodied in them should also increase. This would increase their productivity and enable them to contribute more to the economy than before. As a result, it is expedient to find out whether such increments in gender education is still germane to the African economies. In this regard, our approaches are as follows: Two datasets are used to achieve our objective. First, we use education attainment for female and male population provided by Barro and Lee (2013) as the main variable. We consider female and male education attainment at different levels of education, namely primary school attainment, secondary school attainment and tertiary school attainment for the age bracket between 15 and 65. The data have been used extensively by several authors as a measure of education for males and females. The purpose of considering different levels of education attainments is to ascertain the level of gender education that is very paramount to economic growth in Africa. Second, for robust analysis, we also use Lee and Lee (2016) human capital stock data for males and females for the same age bracket. As regards with estimation techniques, we follow extant studies by first using pooled panel regression with its variants such as fixed effect and random effect panel regressions. Second, due to endogeneity problem, we use both difference and system GMM at one stem and two step level of estimation proposed by Arellano and Bond (1991) and Arellano and Bover (2005) respectively.

Following the introductory section, the rest of the section is organised as follows. In section two, we present the stylised facts of education and economic growth in Africa and compare it with some other regions in the world. Section three focuses on a brief review of extant literature. Our focus in section four includes provision of methodological and econometric frameworks and data sources. Section five presents the findings and section six concludes with policy recommendations.

2.0. Stylised Facts of Education and Economic Growth in Africa

This section presents the stylised fact of education and economic growth in Africa.[1] Beginning from African economy and comparing with some regions in the world, the economy has been performing relatively better in recent year. Table 1 shows African economic growth (average over five years) with the growth of economies of the regions such as East Asian and Pacific (EAP), European Area (EP), Latin America and Caribbean (LA&CA), Middle-East and North Africa (MENA) and North America (NA) over the period of 1971 and 2015. Computing the average of entire periods, Figure 1 shows that African economy ranks third after EAP and

[1] *Sub-Saharan Africa is used to represent Africa.*

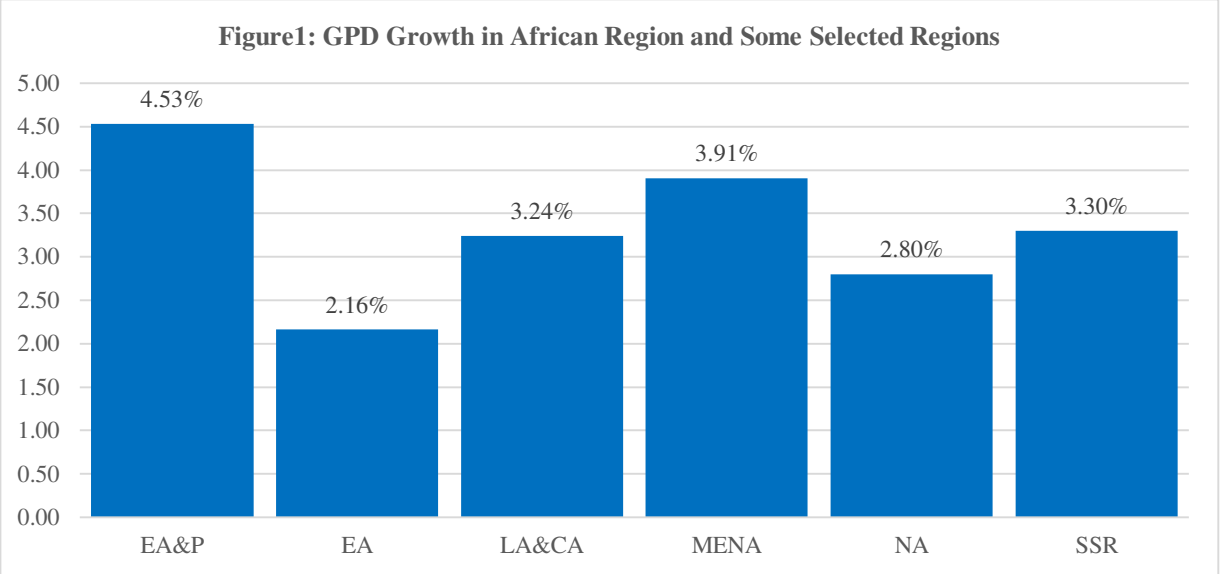
MENA with the average growth of 3.30% compared with 4.53% and 3.91% for EAP and MENA respectively. The appreciable economic growth in the continent has been ascribed to several factors such as favourable commodity prices, rising consumers' demands, external investments, favourable policies and structural reforms (Zamfir, 2016).

Table 1: Economic Growth in Africa and Some other Region in the World

Region	EA&P	EA	LA&CA	MENA	NA	SSA
Year	GDP Growth	GDP Growth	GDP Growth	GDP Growth	GDP Growth	GDP Growth
1971-1975	4.86	3.47	6.51	9.42	2.87	4.46
1976-1980	4.86	3.45	5.55	3.53	3.70	3.08
1981-1985	4.77	1.46	0.85	-1.00	3.29	0.66
1986-1990	5.60	3.41	2.11	3.95	3.28	1.88
1991-1995	4.09	1.67	3.32	3.46	2.51	0.83
1996-2000	3.27	2.85	2.96	4.01	4.27	3.40
2001-2005	4.15	1.59	2.67	4.29	2.54	5.98
2006-2010	4.80	0.86	3.74	4.23	0.82	5.56
2011-2015	4.47	0.78	2.20	3.12	2.19	4.27
Average	4.53	2.16	3.24	3.91	2.80	3.30

Source: Authors' computation from the data obtained from World Development Indicators (2017 version)

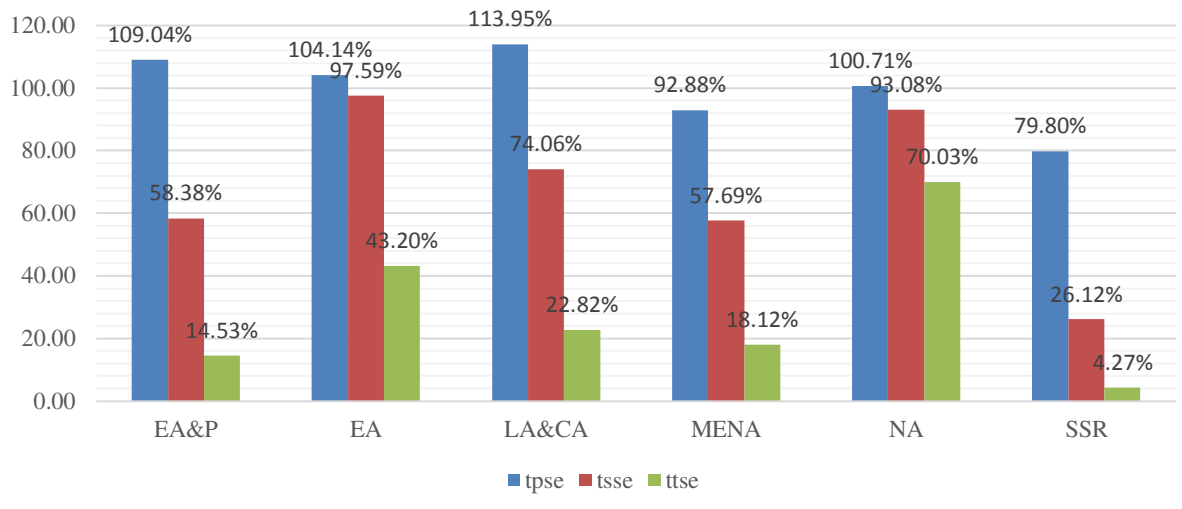
Note: EA&P, EA, LA&CA, MENA, NA and SSR denote East Asian and Pacific, Europe Area, Latin America and Caribbean, Middle East and North Africa, North America and Sub-Saharan Africa. The growth rate is measured in percentage.



Despite the experienced economic growth and series of economic summits organised separately and sometimes jointly with development partners across the world to raise the bar of education for socioeconomic development of the continent, the continent is still lagging behind. Available statistics shows that African continent is not only lagging behind in terms of total enrolment in all levels of education (primary, secondary and tertiary education) but also

lagging behind in gender enrolment in schools. Averaging data over the period of 1971 and 2015, total enrolment in all levels of education in Africa, as depicted in Figure 2 rank lowest among the regions considered. For instance, while SSA recorded about 79.80% primary school enrolments, other regions such as EAP, EA, LA&CA, MENA and NA recorded primary school enrolment of about 109.04%, 104.14%, 113.95%, 92.88% and 100.71% respectively. The similar scenario is observed with regard to secondary and tertiary school enrolments. Although, the secondary and tertiary school enrolments declined in all the regions compared with primary school enrolment, the rate of decline is alarming in SSA. As shown in Figure 2, the school enrolments of 79.80% at primary level dropped to around 26.12% at secondary level in SSA, representing about 53.68% gap. This suggests two possibilities. First, most of African parents are poor and some of them can only afford the primary education. Second, it suggests that the insufficient or rather dilapidating school infrastructural facilities in most of the African countries have the potential to discourage the pupils from continue aspiring to get the secondary education. In other words, there is no incentive for the pupils to aspire for the secondary education. Hence, this gives rise to the high rate of drop-out between the primary school and secondary school. The case is worse in the case of tertiary school enrolment in SSA when compared with the other regions. As shown in Figure 2, while the tertiary school enrolment in SSA stood at 4.23%, those of EA&P, EA, LA&CA, MENA and NA stood at 14.53%, 43.20%, 22.82%, 18.12% and 70.03% respectively. This low level of enrolment in tertiary school in SSA suggests a low level of human capital development in SSA

Figure 2: Total Primary, Secondary and Tertiary School Enrolment (1971-2015)



With regard to gender education, the gap between male and female primary school enrolments is infinitesimal in all the regions. In fact, there is no significant difference between male and female enrolment in some regions such as EAP, EA and NA. As shown in Figure 3, the female enrolments in primary school in EAP, EA and NA stood at 105.60%, 103.84% and

100.71% compared with the male primary school enrolment which stood at 112.96%, 104.43% and 100.71% respectively. In SSA, female enrolment in primary education is 73.16% while the male enrolment in primary school is 86.35%. In other LA&CA and MENA regions, female primary school enrolments are 112.48% and 84.31% compared with 115.36% and 101.05% respectively. A cursory look at figure 3 shows that LA&CA ranks first in terms of female and male primary school enrolment, followed by EA&P while SSA is the least ranked among the regions.

Figure 3: Female and Male Primary School Enrolments (1971-2015)

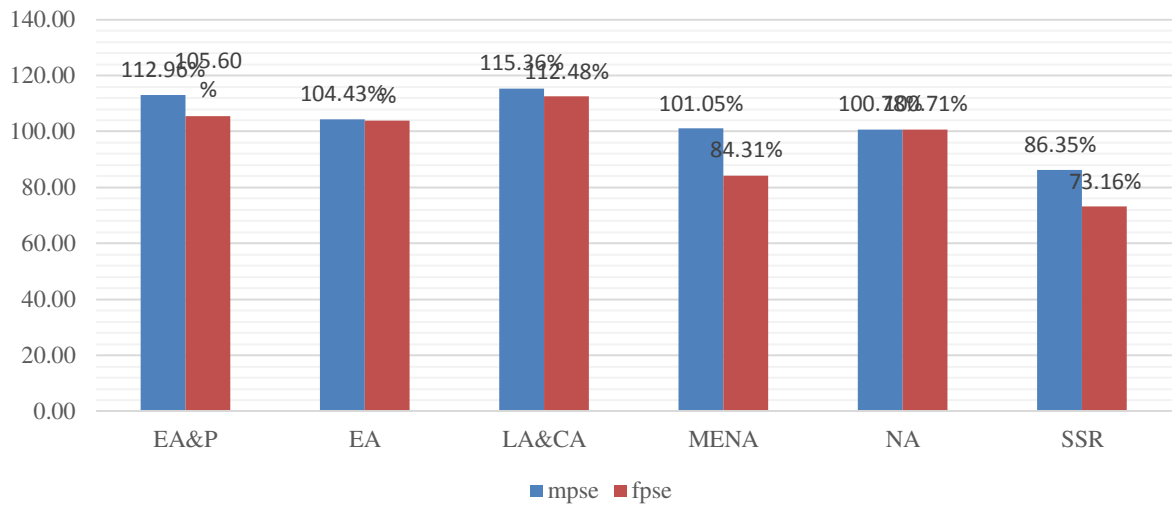
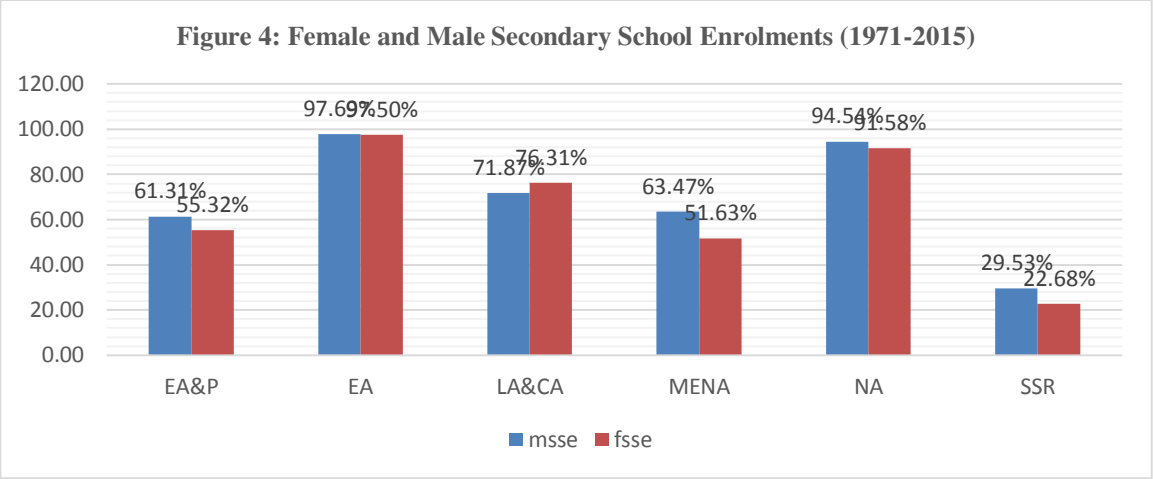
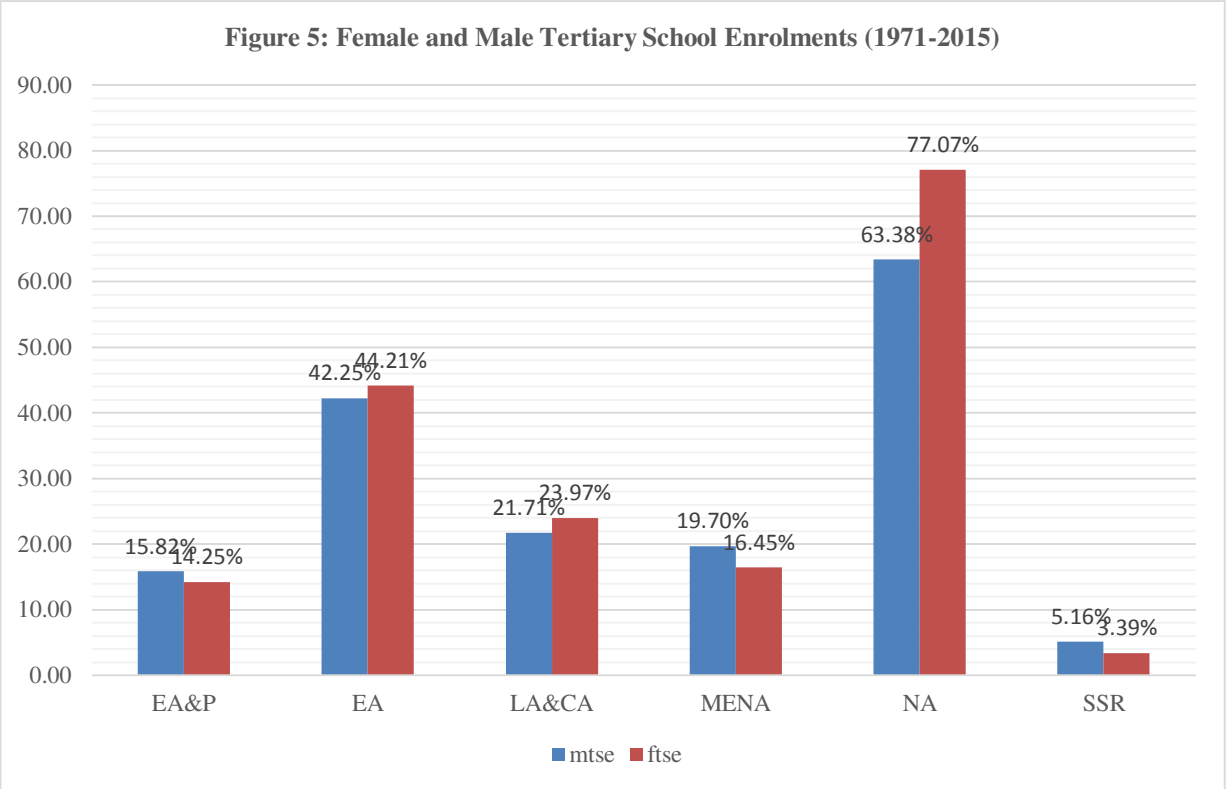


Figure 4 shows the female and male secondary school enrolments in SSA and some selected regions in the world. According to the Figure, among the regions, SSA recorded the lowest secondary school enrolments for both genders. Specifically, female and male secondary enrolments stood at 22.68% and 29.53% respectively. The other regions maintain a relatively parity in terms of both genders enrolments in secondary school. The heaviest dropped in school enrolments of percentage of pupils from primary school to secondary school could be attributed to several factors such as economic status of the parents, costs of schooling, school environment, engagement in extra-curricular activities in school and outside the school, attitude of teachers, cultural beliefs, home condition and school distance (Shahidul and Zehadul Karim, 2015; Tamene, 2015). It can also be observed that in LA&CA, the percentage of female students enrolling for secondary school is more than the male students enrolling for secondary school over the period under consideration. EA and NA maintain almost parity in female and male enrolments in secondary school.

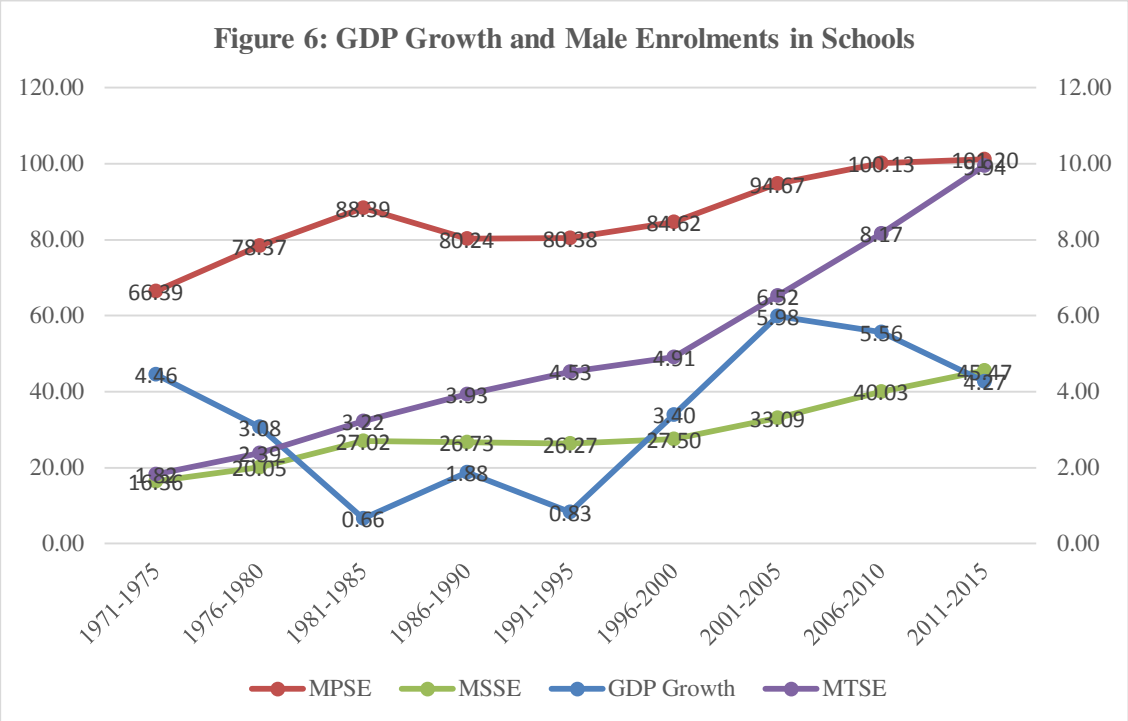


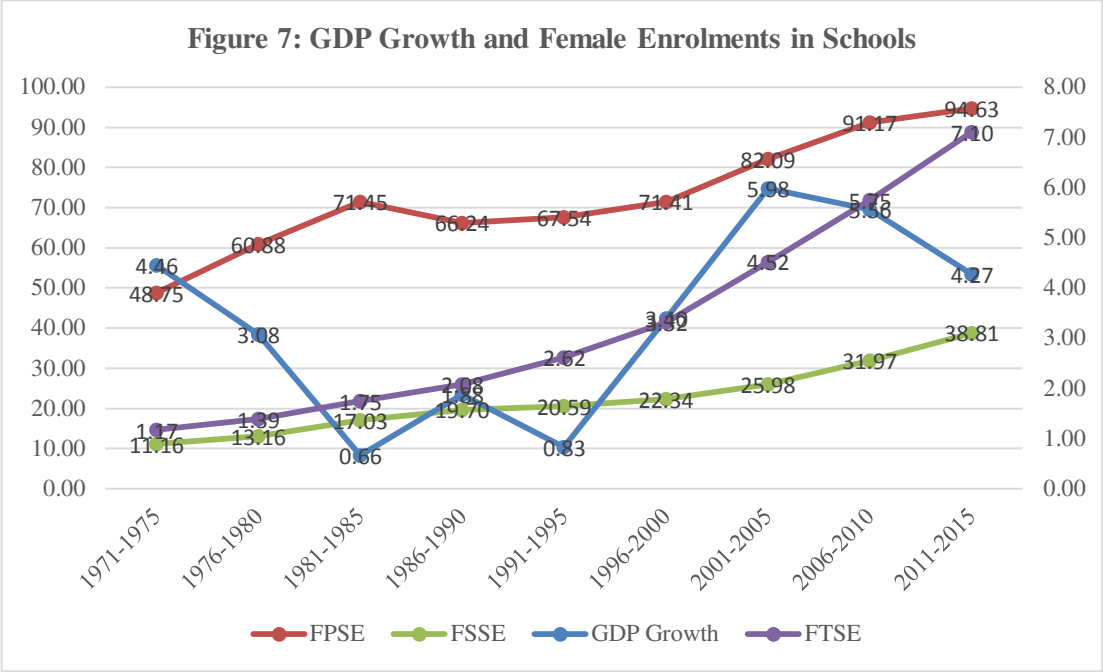
The drop in school enrolments continues in SSA with a significant drop at the tertiary level. In Figure 5, the percentage of female and male enrolments in tertiary school stood at 3.39% and 5.16% while region like NA recorded about 77.07% and 63.38% female and male enrolments in tertiary school respectively. The similar trend is observed in EA and LA&CA where female enrolments in tertiary school are higher than male enrolment at the same level of education. In other regions, EAP and MENA, as in SSA, male enrolments for tertiary education is greater than that of female enrolments for tertiary education. In summary, it can be submitted that there is still disparity in terms of gender education at all levels of education in SSA. Males appear to be enrolling in school than their female counterparts.



Trend of Relationship between GDP Growth and Gender Enrolments in Schools

Figures 6 and 7 show the plot of GDP growth vis-à-vis female and male enrolments in primary, secondary and tertiary enrolments in school. A cursory examination of the figures show that African economies performed poor around the 1970s and 1980s before it witnessed a rebound around the 1990s and the early 2000s. The poor performance of African economies during these periods can be ascribed to global economies crises of the 1970s and macroeconomic crises witnessed in most of the countries in Africa around the 1980s. However, improvement in the conditions of economies across the world in the later 1990s and the early 2000s and some macroeconomic policies implemented by some African countries as well as a rise in the primary commodity prices being sold by African countries in the international market led to the renaissance of the continent economies. More so, male enrolments in primary, secondary and tertiary schools have improved over time with occasional drop in school enrolments, particularly at the secondary level. The similar trend is observed as regards the female enrolment at all levels of schools. This implies that the enrolments in all levels of education have been on increase over time but increasing marginally compared other continents or regions.





3.0. Brief Literature Review

This section briefly reviews the extant studies on the education-growth nexus. Historically, economists have been interested in the role of education in the course of economic growth (Schultz, 1962; Becker, 1962; Weisbrod, 1962; Uzawa, 1965; Nelson and Phelps, 1966). These authors developed the concepts of human capital, formulated growth models that try to explain the role of schooling and investment in education and provided explanations for the benefit a country can derive from investing in education. However, the real theoretical foundation was firmly laid in endogenous growth model developed first by Paul Romer in 1986 and later popularised by Robert Lucas Jr., Paul Romer himself and others (Romer, 1986, 1990; Lucas, 1988; Barro, 1990; Rebelo, 1991). The new endogenous model was developed due to the failure of neoclassical growth model developed by Robert Solow in 1956 to account for the determinants of a long-run economic growth. Consequently, in 1986, Paul Romer developed A-K model, otherwise known as endogenous growth model, which accounts for the role of physical capital (technology) through research and development and innovation in driving the long run economic growth with the assumption of increasing returns to scale of physical capital. However, this model also failed to provide a lucid explanation of what constitutes the determinants the growth rate of the economy overtime and the role of human capital in the model. To incorporate the human capital into his initial A-K model, Romer (1990) developed a new model which extends the initial A-K model to account for the role of human capital in augmenting physical capital to explain the rate of economic growth. In this new model, the role assigned to human capital is to create or bring about a new knowledge or idea that would further

led to technological growth or advancement. Hence, the higher the level of human capital, the higher the creation of a new technology that would determine the long-run economic growth. Previously, Lucas (1988) had advanced the important of schooling and learning by doing through participation in the job-training in human capital accumulation. Developing two models that account separately for the role of schooling and learning by doing, Lucas (1988) offers the rationales for differences in the rate of economic growth across the countries in the world. According to him, given the initial technology, each county produces goods and services that cumulatively result in economic growth that its human capital can comparative produce and since each country invests differently in education and training of workers, each country would experience different economic growth rate or be at different level of economic growth. As aforementioned, other authors have contributed to theoretical literature on the effect of human capital on economic growth rooted in endogenous growth model (see Benhabib and Spiegel, 1994). To account for the role of human capital in neoclassical growth framework, Mankiw, Romer and Weil (1992) incorporated human capital into the neoclassical growth model formally developed by Solow in 1956 to serve two purposes. The model first provides explanations for the differences in standard of living measured by income across the countries and further explains how accumulation of human capital ensures convergence in the standard of living across the countries in the world.

Empirically, several issues related to the education-growth have generated a lot of mixed empirical findings in the literature (Ramos et al. 2012). Specifically, aside theoretical issue as addressed above, there are other three main issues which the economists have preoccupied themselves with. First is the choice of various indicators to proxy education. The second issue deals with econometric approaches suitable to model education-growth nexus. The third issue is whether male education contributes more to economic growth than female education and vice versa.

With regard to the choice of variables to proxy education, some studies have used measures of quantity of education such as school enrolments or enrolment ratios, average years of schooling, education attainment, literacy rate, life expectancy, human capability among other as indicators of human capital accumulation (Barro, 1991; Barro and Lee, 1993; Levine and Zervos, 1993; Abbas and Mujahid-Mukhtar, 2000; Abbas and Nasir, 2001; Abdullah, 2013). Using some of these variables, some studies have documented a positive nexus between education and economic growth (Rebelo, 1991; Mankiw et al. 1992; Abbas and Mujahid-Mukhtar, 2000; Abbas and Nasir 2001; Hall and Jones, 1999; Haldar and Malik, 2010; Pegkas and Tsamadias, 2014; Umut, 2015). Using enrolment, Mankiw et al. (1992) document a positive effect of school enrolment on the economic growth. Pegkas and Tsamadias (2014) find

that high education enrolment has a long-run relationship with the economic growth in Greece. The same finding is recorded for the economies of African countries by Gyimah-Brempong, Paddison and Mitiku, (2006). Specifically, Gyimah-Brempong, Paddison and Mitiku, (2006) find a positive nexus between higher education and per capita GDP in Africa. In Pakistan, India and Sri-Lanka, Abbas and Mujahid-Mukhtar, (2000) and Abbas and Nasir, (2001) show that primary education has a positive effect on economic growth in Pakistan and India while the primary and secondary education have a positive impact on economic growth in Sri-Lanka. For 14 countries, seven developed countries and seven developing countries, Umut, (2015) reports positive relationship between human capital and economic growth. Despite this, there are some studies which record the existence of negative relationship between education (human capital and economic growth while some report no relationship exists between the two variables (Benhabib and Spiegel, 1994; Islam, 1995; Liu and Stengos, 1999; Maasoumi et al. 2007; Pritchet, 2001; Delgado, Handerson and Parmeter 2012; Abdullah, 2013; Mandiefe and Tieguhong, 2015). While studies by Benhabib and Spiegel, (1994), Pritchet, (2001), Abdullah, (2013) and Mandiefe and Tieguhong, (2015) report an inverse relationship between human capital and economic growth, the studies by Islam, (1995), Liu and Stengos (1999), Maasoumi et al. (2007) and Delgado, et al. (2012) show that education has an insignificant effect on economic growth.

The use of quantity measures of education, however, has been intensively criticised in the literature. The arguments against the quantity measures are that years of schooling and enrolment vary across countries in the world. Hence, one year of schooling is not the same thing in Niger and the United States of America and such the same accumulation of knowledge cannot be achieved using enrolment or average years of schooling. This is because the system of education, quality of teaching, teaching environment and educational facilities are different across the countries in the world (Hanushek and Woessmann 2007) As a result, quality measures of human capital have been suggested to capture adequately the nexus between human capital and economic growth. In a series of studies by Hanushek and others, scores in the international tests, particularly in Mathematics and Science Subjects have been used to proxy quality of education. One main problem associated with the use of this indicator of human capital is that it is only available for some countries, particularly developed countries (Hanushek and Kim, 1995; Hanushek and Kimbo, 2000). Using this measure of human capital, some studies have documented positive effects of quality of education on economic growth (Hanushek and Woessman, 2008; 2011a, b; 2012).

On the econometric or methodological approaches deployed to examine the nexus between education and growth, several techniques have been used in the literature. Some

maiden and recent studies on education-growth nexus based their techniques on cross sectional regression method using Panel Ordinary Least Squares (Barro, 1991, 2001, Mankiw et al. 1992; Barro and Lee, 1993; Benhabib and Spiegel, 1994; Islam, 1995; Klassen, 2002; Cohen and Sotos, 2007; Portela, Alessie and Teulings, 2010; Tansel and Grungor, 2012; Kampelmann and Rycx, 2012; Abdullah, 2013; El-Alaoui, 2015; Umut, 2015). However, some authors have pointed out that using OLS method may result in bias estimation arising from endogeneity problem inherent in the relationship between education and economic growth. To take into consideration the issue of endogeneity, these authors have used different econometric techniques such as Two Stage Least Squares (2SLS), Three Stage Least Squares (3SLS) as well as Generalised Method of Moments (GMM) (Dessus, 1999; Barro, 2001; Gyimah-Brempong, Paddison and Mitiku, 2006; Cooray, 2009; Fukase, 2010; Umut, 2015) one main issue in using instrumental variable techniques mentioned above is to find the appropriate instrument that would be suitable for addressing endogeneity problem. Aside these methods, other authors are of the opinion that the relationship between education and economic growth are not linear. Hence some of the authors have adopted non-linear econometric methods (Durlauf et al. 2001; Kalaitzidakis et al. 2001; Durlauf et al. 2008; Eicher et al., 2011). Other methods that have used to model education-growth relation include error correction method (ECM), seemingly unrelated regression method (SURE), Granger-causality test, Johansen cointegration, method, vector autoregressive method (VAR), fully modified OLS among others (Babatunde and Adefabi, 2005; Zaman, Khan Ahmad and Ikram 2010; Haldar and Mallik 2010; Kotásková et al. 2018).

There are vast number of empirical studies that examine the role of gender education on economic growth, albeit with mixed empirical findings (see Lorgelly, 2000). Study by Barro and Lee (1994) find that male education contributes positively to economic growth while female education has a negative significant effect on economic growth. Similar finding is documented by Lorgelly and Owen (1999). Barro (2001) further provides explanation why female education has such effect on economic growth. According to Barro (2001) highly educated women are not well utilized in the labour market, particularly in developing countries. Other studies, however, have found that women education is positively related to economic growth. For instance, Kaur and Letic, (2012) conduct a study on female education and economic growth for India and Niger and find that woman education has a positive impact on economic growth El-Alaoui, (2015) documents the similar finding for countries such as Morocco, Algeria, Tunisia and Egypt (see also Oztunc, Oo and Serin 2015 for Bangladesh, Cambodia, China, India, Indonesia, Lao PDR. Malaysia, Myanmar, Philippines, Thailand and

Vietnam). In their study, Birdsall, Rose and Sabot, (1997) states that there is no significant difference between the gender education.

From the foregoing review, it can be submitted that the role of education in the course of the economic growth remains inconclusive, particularly that of gender education. This is because the outcomes of empirical studies reviewed above depend on factors such as indicators used to proxy education, the methodological approaches and the type of education being considered. The implication is that there would be diverse policy prescriptions that may not be relevant to policymakers in particular region of the world. Thus it is expedient to re-examine particularly the education-growth nexus for a particular region so that the policy emanating from such study or studies can be adapted for the region. Hence, this study focuses on African region. The main aim of the study is to examine whether gender education still matter for economic growth in African region.

4.0. The Theoretical and Econometric Frameworks

4.1. The Theoretical Framework

This study employs Knowles et al, (2002) framework which arguments Mamkw, Romer and Weis, (1992) endogenous growth model to account for separate effect of female and male education on the economic growth. The theoretical framework begins by extending the aggregate Cobb-Douglass production and specified as:

$$Y_{it} = K_{it}^{\alpha} F_{it}^{\beta f} M_{it}^{\varphi m} X_{it}^{\lambda} (A_{it} L_{it})^{1-\alpha-\beta f-\varphi m-\lambda} \quad (1)$$

The equation 1exhibits constant returns to scale under the assumption that the marginal product of each factor is positive and follows the law of diminishing return. Technology is assumed to be labour-augmenting so that advancement in technology leads to increase in output per worker. Where Y denotes the level of real output, K the stock of physical capital, F the stock of female education, M the stock of male education, X the stock of health capital, A is the level of technology and L the labour force. The subscript *i* and *t* capture country *i* and time period t respectively.

When equation 1 is divided by AL, the quantities per effective unit of labour are obtained as follows:

$$y_{it} = k_{it}^{\alpha} f_{it}^{\beta f} m_{it}^{\varphi m} x_{it}^{\lambda} \quad (2)$$

Following MRW, the labour force and technology are assumed to be determined by

$$L_{it} = L_{io} e^{nt} \quad (3)$$

$$A_{it} = A_{io} e^{gt} \quad (4)$$

Where n and g are the growth rate of the labour force and the technology respectively (they are assumed to be constant across countries). The accumulation of physical capital, female and male education and health capital are expressed as follows

$$\dot{k} = s_{ki} y_{it} - (n + g + \delta) k_{it} \tag{5}$$

$$\dot{f} = s_{fi} y_{it} - (n + g + \delta) f_{it} \tag{6}$$

$$\dot{m}_{it} = s_{mi} y_{it} - (n + g + \delta) m_{it} \tag{7}$$

$$\dot{x}_{it} = s_{xi} y_{it} - (n + g + \delta) x_{it} \tag{8}$$

Where the rate of change of m_{it} and x_{it} is denoted by dots and s_{ki}, s_{fi}, s_{mi} and s_{xi} stand for the shares of real output invested in physical capital, female education, male education and health respectively. δ is the rate depreciation assumed to be the same across countries and time. At a steady state assuming that $\alpha + \beta_f + \phi_m + \lambda < 1$, then equations 5 to 8 become

$$k_i^* = \left(\frac{s_{ki}^{1-\beta_f-\varphi_m-\lambda} s_{fi}^{\beta_f} s_{mi}^{\varphi_m} s_{xi}^{\lambda}}{n + g + \delta}\right)^{1/\eta} \tag{9}$$

$$f_i^* = \left(\frac{s_{ki}^{\alpha} s_{fi}^{1-\alpha-\varphi_m-\lambda} s_{mi}^{\beta m} s_{xi}^{\lambda}}{n + g + \delta}\right)^{1/\eta} \tag{10}$$

$$m_i^* = \left(\frac{s_{ki}^{\alpha} s_f^{\beta_f} s_m^{1-\alpha-\beta_f-\lambda} s_{xi}^{\lambda}}{n + g + \delta}\right)^{1/\eta} \tag{11}$$

$$x_i^* = \left(\frac{s_{ki}^{\alpha} s_{fi}^{\beta_f} s_{mi}^{\varphi_m} s_{xi}^{1-\alpha-\beta_f-\varphi_m}}{n + g + \delta}\right)^{1/\eta} \tag{12}$$

Where an asterisk stands for steady-state output per worker and $\eta = 1 - \alpha - \beta_f - \phi_m - \lambda$. By substituting the equations 4 and 9 to 12 into equation 2 and by taking the natural log and rearranging yields

$$\ln\left(\frac{Y_{it}}{L_{it}}\right)^* = \ln A_{i0} + gt - \frac{1-\eta}{\eta}\ln(n + g + \delta) + \frac{\alpha}{\eta}\ln(s_{ki}) + \frac{\beta_f}{\eta}\ln(s_{fi}) + \frac{\phi_m}{\eta}\ln(s_{mi}) + \frac{\lambda}{\eta}\ln(s_{xi}) \tag{13}$$

Equation 13 shows steady-state output per worker as a function of the savings rate for each factor of production. Solving equations 10 to 12 for their respective savings rates as functions of the steady-state stocks and substituting these into equation 13 yields

$$\ln(\frac{Y_{it}}{L_{it}})^{*} = \ln A_{i0} + gt - \frac{\alpha}{1-\alpha}(n+g+\delta) + \frac{\alpha}{1-\alpha}\ln(s_{ki}) + \frac{\beta_f}{1-\alpha}\ln(f_{it}^{*}) + \frac{\phi_m}{1-\alpha}\ln(m_{it}^{*}) + \frac{\lambda}{1-\alpha}\ln(x_{it}^{*}) \tag{14}$$

If the growth rate of technology becomes constant, say a and an error term ε_t is incorporated, equation 14 becomes:

$$\ln(\frac{Y_{it}}{L_{it}})^{*} = a + \ln A_{i0} + \frac{\alpha}{1-\alpha}\ln(s_{ki}) - \ln(n+g+\delta) + \frac{\beta_f}{1-\alpha}\ln(f_{it}^{*}) + \frac{\phi_m}{1-\alpha}\ln(m_{it}^{*}) + \frac{\lambda}{1-\alpha}\ln(x_{it}^{*}) + \varepsilon_{it} \tag{15}$$

From equation 15, the restricted form of the equation can be expressed as follows:

$$\ln(\frac{Y_{it}}{L_{it}})^{*} = a + \ln A_{i0} + \ln(n+g+\delta) - \frac{\alpha}{1-\alpha}\ln(s_{ki}) + \frac{\beta_f}{1-\alpha}\ln(f_{it}^{*}) + \frac{\phi_m}{1-\alpha}\ln(m_{it}^{*}) + \frac{\lambda}{1-\alpha}\ln(x_{it}^{*}) + \varepsilon_{it} \tag{16}$$

The unrestricted and restricted forms of the model written in terms of the gender gap and the male education are given in equations 17 and 18 respectively.

$$\ln(\frac{Y_{it}}{L_{it}})^{*} = a + \ln A_{i0} - \frac{\alpha}{1-\alpha}\ln(n+g+\delta) + \frac{\alpha}{1-\alpha}\ln(s_{ki}) + \frac{\beta_f+\phi_m}{1-\alpha}\ln(f_{it}^{*}) - \frac{\beta_f}{1-\alpha}(\ln(m_{it}^{*}) - \ln(f_{it}^{*})) + \frac{\lambda}{1-\alpha}\ln(x_{it}^{*}) + \varepsilon_{it} \tag{17}$$

$$\ln(\frac{Y_{it}}{L_{it}})^{*} = a + \ln A_{i0} + \frac{\alpha}{1-\alpha}\ln(n+g+\delta) - \frac{\alpha}{1-\alpha}\ln(s_{ki}) + \frac{\beta_f+\phi_m}{1-\alpha}\ln(f_{it}^{*}) - \frac{\beta_f}{1-\alpha}(\ln(m_{it}^{*}) - \ln(f_{it}^{*})) + \frac{\lambda}{1-\alpha}\ln(x_{it}^{*}) + \varepsilon_{it} \tag{18}$$

Similar to the equations above, the model can be reparameterised to account for the gender gap and female educations as follows:

$$\ln(\frac{Y_{it}}{L_{it}})^{*} = a + \ln A_{i0} - \frac{\alpha}{1-\alpha}\ln(n+g+\delta) + \frac{\alpha}{1-\alpha}\ln(s_{ki}) + \frac{\beta_f+\phi_m}{1-\alpha}\ln(f_{it}^{*}) - \frac{\phi_m}{1-\alpha}(\ln(m_{it}^{*}) - \ln(f_{it}^{*})) + \frac{\lambda}{1-\alpha}\ln(x_{it}^{*}) + \varepsilon_{it} \tag{19}$$

$$\ln(\frac{Y_{it}}{L_{it}})^{*} = a + \ln A_{i0} + \frac{\alpha}{1-\alpha}\ln(n+g+\delta) - \frac{\alpha}{1-\alpha}\ln(s_{ki}) + \frac{\beta_f+\phi_m}{1-\alpha}\ln(f_{it}^{*}) - \frac{\phi_m}{1-\alpha}(\ln(m_{it}^{*}) - \ln(f_{it}^{*})) + \frac{\lambda}{1-\alpha}\ln(x_{it}^{*}) + \varepsilon_{it} \tag{20}$$

If coefficients of $\ln(s_{ki})$ and $\ln(n+g+\delta)$ in equation 15 are assumed to be summed up to zero, then the equation becomes

$$\ln(\frac{Y_{it}}{L_{it}})^{*} = a + \ln A_{i0} + \frac{\beta_f}{1-\alpha}\ln(f_{it}^{*}) + \frac{\phi_m}{1-\alpha}\ln(m_{it}^{*}) + \frac{\lambda}{1-\alpha}\ln(x_{it}^{*}) + \varepsilon_{it} \tag{21}$$

Since we want to examine the effect of gender education separately on economic growth, we follow Barro and Lee (1994) and Barro and Sala-i-Martin (1995) and allow both female and

education to enter equation 16 as a separate explanatory variables. Thus, equation 16 yields equations 17 and 18 respectively as follows:

$$\ln(\frac{Y_{it}}{L_{it}})^{*} = a + \ln A_{i0} + \frac{\beta_f}{1-\alpha}\ln(f_{it}^{*}) + \frac{\lambda}{1-\alpha}\ln(x_{it}^{*}) + \varepsilon_{it} \quad (22)$$

$$\ln(\frac{Y_{it}}{L_{it}})^{*} = a + \ln A_{i0} + \frac{\phi_m}{1-\alpha}\ln(m_{it}^{*}) + \frac{\lambda}{1-\alpha}\ln(x_{it}^{*}) + \varepsilon_{it} \quad (23)$$

Suffice to say that we expect that the coefficients of female and male education to be positive.

4.2. The Econometric Frameworks

In this section, the econometric frameworks deployed to investigate the role of gender education in economic growth of Africa are presented. Following the existing studies, we begin with specification of the pooled regression model and its variants such as the fixed and random effects regression models. The panel estimation method is usually used to model data characterised by individual country behaviour over time. The pooled panel estimation method assumes that the countries being considered have homogenous slope and coefficient. In other words, all the countries have the same slope and coefficient over time. Given this assumption, the pooled estimation model is specified as follows:

$$y_{it} = \alpha + \beta x_{it} + \phi' X_{it} + \varepsilon_{it}; \quad i = 1,...,N. \qquad t = 1,...,\mathrm{T}. \quad (24)$$

Where y_{it} is the natural log of real GDP, x_{it} stands for education variables (school attainments and human capital stocks for males and females), X_{it} are the vector of other explanatory variables such as foreign direct investment (FDI), gross capital formation, life expectancy for females and males, female and male population as a percentage of total population, broad money, general government final consumption expenditure and trade openness, ε_{it} is the error term that satisfies the conditions of zero mean and constant variance, α is the intercept assumed to be ditto for all countries, β and ϕ are the coefficients of education variables and other vector of explanatory variables respectively. Subscript i denotes country while t is the time.

While the pooled estimation model above assumes that all countries should be treated the same across time, fixed effect estimation method, on the other hand, assumes that there are differences between the countries and hence the differences have to be considered when using fixed effect estimation method. To do this, an intercept is usually included in the pooled estimation model. Thus, we specify the fixed effect model as follows:

$$y_{it} = \alpha + \beta x_{it} + \phi' X_{it} + \varphi_i + \varepsilon_{it}; \qquad i = 1,...,N. \qquad t = 1,...,\mathrm{T}. \quad (25)$$

Where φ_i captures intercept that stands for unobserved individual country difference that is peculiar to the country (individual country effects or heterogeneity). Sometimes, in fixed effect

model, it is also possible to account for time differences which show that distinction from one period to another period (time effects). Thus, when both individual country effect and time effect are accounted for, equation 25 becomes:

$$y_{it} = \alpha + \beta x_{it} + \phi' X_{it} + \varphi_i + \gamma_t + \varepsilon_{it}; \qquad i = 1,...,N. \qquad t = 1,...,\mathrm{T}. \qquad (26)$$

Where γ_t denotes time effect. The differences across individual country and time are usually accounted for by the introduction of dummy variables based on the number of countries and time spans. However it has been observed that two problems often arise from this approach, first is the loss of degree of freedom and second is the problem of dummy trap. The loss of degree of freedom can be easily overcome if it is assumed that the differences are not constant but randomly stochastic. Thus, following Baltagi (2008) the two way error components random effect model is typically specified as follows:

$$y_{it} = \alpha + \beta x_{it} + \phi' X_{it} + \lambda_i + \mu_t + \nu_{it}; \qquad i = 1,...,N. \qquad t = 1,...,\mathrm{T}. \qquad (27)$$

Here, λ_i assumed to be independently and identically distributed with zero mean and constant variance, that is, ($\lambda_i \sim iid(0, \sigma_\lambda^2)$. λ_i is the unobservable individual country effect, μ_t is the unknown time effect and ν_{it} is the error term. Other variables remain as previously defined. To choose the best fit model between fixed effects and random effects, Hausman specification Test is usually used in the literature. The Hausman test, under the null hypothesis of no correction between λ_i and x_{it}, is specified as follows:

$$H_o : \mathrm{cov}(\lambda_i, x_{it}) = 0 \qquad (28)$$

The null hypothesis implies there is no correlation between explanatory variables and any of the effect (individual country effect or time effect). In this case, both fixed effects and random effects are consistent but random effects are more efficient asymptotically. This is obtained when the estimated Hausman specification test in insignificant. Alternatively, however, when the Hausman test is statistically significant, that is, when there is correlation between the regressors and any of the effects, the random effect estimation method should not be used. Only fixed effect model is consistent and hence should be used.

The pooled panel method and its variants (fixed and random effects), however, fail to account for endogeneity problem that often arises from issues such as measurement errors and omitted variables in the any growth regression. To take care of these issues, econometricians have suggested the use of GMM original proposed by Arellano and Bond (1991) and has been used in growth model by several authors such as Benhabib and Spiegel (1994) and Levine et al. (2000). The basic idea behind the GMM Bond, Hoeffler and Temple (2001) is to first write the panel model in dynamic form, take the first difference with the goal to remove any unknown

time-invariant country-specific effect and then find the right instrument to instrument the right-hand-side of the variable in the first-difference equations using the series lagged for two or more periods. Hence we use both first-difference and system GMM in this study. The first difference system GMM following Arellano and Bond (1991) is specified as:

$$\Delta y_{it} = \alpha \Delta y_{i(t-i)} + \beta' \Delta x_{it} + \Delta \upsilon_t + \Delta \nu_{it} \qquad i = 1,...,N. \qquad t = 2,...,\mathrm{T}. \qquad (29)$$

In equation 6, assume that the error terms are serially not correlated with the regressors, then the lags of dependent variables, lagged in two or more periods, could be used as a valid instrument because the lags of dependent variable is assumed not be serially correlated with the error terms. Another assumption is that the regressors (Δx_{it}) are weakly exogenous in the sense that they are correlated with error terms but may be correlated with the lags of error terms. Given these two conditions, Arellano and Bond (1991) suggest two conditions which are:

$$\mathrm{E}\left[y_{i(t-s)} \Delta v_{it} \right] = 0, for \ s \geq 2; t = 3,...,T \qquad (30)$$

$$\mathrm{E}\left[x_{i(t-s)} \Delta v_{it} \right] = 0, for \ s \geq 2; t = 3,...,T \qquad (31)$$

Although this method has been used extensively to implement the growth regression model, it has been, however, pointed out that the method is likely to perform poorly in the presence of persistent time series and small number of time periods (Arellano and Bover, 1995; Blundell and Bond, 1998). This arises as result of weak instrument provided by the lags of dependent and independent variables. It may also be attributed to the fact that using difference GMM eliminates not only the country specific effect but also the variation across the countries which the researchers need to take into consideration when using panel dataset. Due to these two weakness in difference-GMM, Arrellano and Bover (1995) and Blundell and Bond (1998) proposed the system GMM which is capable of combining difference regressors with the level regressors, that is, instruments derived from the equation in level form apart from the instrument from difference equation. According to Blundell and Bond (1998, 2000), the regressors may be allowed to be correlated with country's specific effect and thus they proposed additional two moment conditions given as:

$$\mathrm{E}\left[y_{i(t-s)} \upsilon_i + \nu_{it} \right] = 0, \ for \ s = 1 \qquad (32)$$

$$\mathrm{E}\left[x_{i(t-s)} \upsilon_i + \nu_{it} \right] = 0, \ for \ s = 1 \qquad (33)$$

Given the equation 32 and 33, the efficient and consistent estimation of system GMM, however, depends on the validity of instruments being used in the model estimation. To test for the validity of the instruments, Sargan's test for over-identification is usually deployed in

the literature. The Sargan's test for over-identification assumes that the parameters in the panel model are identified by imposing some sort of restrictions on the coefficients and the test for the validity of over-identification restrictions with the goal to examine the exogeneity of the instruments (Sargan, 1958, 1988). Other authors have proposed the use of Hansen's test for over-identification of the instruments (Baum, Schaffer and Stillman, 2003). Hence, this study employs both tests to test for the validity of instruments used.

4.3. Data Sources and Description

The aim of this study is to investigate separately the effect of female and male education attainment and human capital stocks on economic growth in Africa. To achieve this object, we source data from three sources which include Barro and Lee (2013) dataset on education attainment, Lee and Lee (2016) dataset on human capital stock and World Development Indicators (WDI).[2] Variables such as foreign direct investment (FDI), gross capital formation (gcf), life expectancy for female and male (lef and lem), trade openness (tradeop), broad money (bm), general government final consumption expenditure (gce), female and male population as a percentage of total population (fpg_tp and mpg_tp) are sourced from WDI. Female primary school attainment (fpsc), female secondary school attainment (fssc), female tertiary school attainment (ftsc), male primary school attainment (mpsc), male secondary school attainment (mssc) and male tertiary school attainment (mtsc) are sourced from Barro and Lee (2013) while variables such as female human capital (fhc), female human capital alternative (fhca), male human capital (mhc) and male human capital alternative (mhca) are sourced from Lee and Lee (2016). The unbalanced panel data series are annual spanning the period from 1960 to 2010 and averaged over five year intervals. Table 2 presents the summary of the descriptive statistics of the variables. From the table, it can be observed that the average female primary, secondary and tertiary education attainments are 9.70%, 5.37% and 0.65% while the average male primary, secondary and tertiary education attainments are 13.96%, 7.83% and 1.19% respectively. This connotes that the number of males attaining different levels of education is higher than their female counterparts. It is also revealed that level of education attained by each of the gender drops over time. It is higher at the primary level and lower at the tertiary level. Thus, the stock of human capital embodied in males is higher than that of females as shown by their values. Specifically, the average female human capital stock is 1.31% while that of the male is 1.52%.

Table 2: Descriptive Statistics of the Variables

Variables	Obs	Mean	Std.Dev.	Min	Max	p1	p99	Skew.	Kurt.
rgdp	358	1.80e+10	4.19e+10	1.87e+08	3.62e+11	2.28e+08	2.23e+11	4.62	27.90

[2] For details on the construction of education attainment and human capital stock (including alternative human capital stock) see Barro and Lee (2013) and Lee and Lee (2016).

fpsc	385	9.70	7.62	0.20	37.54	0.25	33.93	1.09	3.85
fssc	385	5.37	7.13	0.02	54.65	0.06	31.88	2.59	12.33
Ftsc	385	0.65	1.21	0.00	9.72	0.00	7.12	4.15	23.58
mpsc	385	13.96	8.07	0.50	40.23	1.21	34.42	0.69	2.82
mssc	385	7.83	7.80	0.16	52.9	0.25	31.79	1.76	7.50
mtsc	385	1.19	1.35	0.00	8.71	0.03	6.97	2.47	
Fhc	297	1.34	0.32	1.01	2.68	1.01	2.44	1.32	4.54
fhca	297	2.35	0.98	1.14	5.38	1.18	5.22	0.89	3.02
mhc	297	1.52	0.35	1.03	2.69	1.05	2.413	0.77	2.95
mhca	297	2.94	1.02	1.27	5.47	1.36	5.26	.395	2.18
fdi	225	2.24	5.04	-3.86	47.96	-3.53	24.50	5.60	42.11
gcf	337	19.37	8.68	2.02	53.19	4.64	45.41	0.685	3.64
lef	385	52.42	9.15	29.03	76.99	31.97	75.62	0.217	3.11
lem	385	49.26	8.53	27.44	72.75	28.77	71.53	0.173	3.09
tradop	349	64.92	31.48	0.00	197.92	14.51	154.33	1.02	4.00
bm	325	27.01	18.15	0.36	109.62	0.61	92.14	1.81	6.58
gce	335	15.07	6.19	2.68	56.40	5.46	37.53	2.27	13.40
fpg_tp	385	50.56	0.91	47.88	53.85	48.17	53.49	0.52	4.62
mpg_tp	385	49.44	0.91	46.15	52.12	46.51	51.83	-0.52	4.62

Source: Author's computation

5.0. Presentation of the Results

5.1. Correlation Results

In this section, we present our findings. We begin by presenting the results of correlation estimates. The correlation analysis is conducted for two reasons. First is to ascertain the degree of relationship between or among the variables we use. Second is to examine whether there is an existence of problem of serial correlation among the variables. The results of correlation are presented in Table 3. According to the table, there are positive but weak correlations between the measures of gender education and the economic growth. However, there are also positive but moderate correlations between female life expectancy, male life expectancy and economic growth. FDI, general government final consumption expenditure and female population expressed as a percentage of total population are negatively correlated with economic growth. Variables such as gross capital formation and male population as a percentage of total population are also positively associated with economic growth. Among the other variables, there is no problem of serial correlations as shown by the results of the correlation for most of the values are weakly or moderately correlated.

5.2. Female Education Attainment and Economic Growth

This section presents the results of the effects of female education attainment and economic growth in Africa. The results are presented in Table 4 using pooled, fixed effect and random effect estimation method. Judging by Hausman specification test which is statistically significant, we report the results of fixed effect estimation method. Comparatively, at all levels of education, female education attainment has a positive and significant effect on economic growth with the highest effect coming from female primary school attainment. To be specific, a 1% change in female primary school attainment, female secondary school attainment and

female tertiary school attainment, economic growth would increase by 0.327 %, 0.314% and 0.318% respectively. The findings are similar to the one documented by Kaur and Letic, (2012), El-Alaoui, (2015) and Oztunc, Oo and Serin (2015). Kaur and Letic (2012) find a positive relationship between female education and economic growth for India and Niger while El-Alaoui, (2015)'s findings also show that female education has positive effect on economic growth of countries such as Morocco, Algeria, Tunisia and Egypt. However, our results are different from Barro and Lee (1994) and Barro (2001) findings which show that female education has a negative impact on economic growth. Table 5 and 6 report the results of the effects of female gender education attainment on economic growth using both one step and two step difference and system GMM. Comparing the results of static fixed effects with the results of dynamic GMM, we find that female secondary and tertiary education attainment still have positive effects on economic growth, albeit it is not statistically significant while female primary school is found to have a negative insignificant effect on economic growth. These findings are based on one step and two step difference GMM. However, based on the results of two step system GMM, only female secondary education attainment has a positive significant effect on economic growth. Thus, if female secondary education attainment increases by 1%, economic growth would increase by 0.048%.

A cursory look at the effects of other explanatory variables on economic growth, particularly based on fixed effect estimation method, show that foreign direct investment, gross capital formation (capital stock), life expectancy, broad money (money supply) and trade openness have positive effects on economic growth while female population expressed as a percentage of total population and government final consumption expenditure exhibit negative impacts on the economies of Africa. These findings follow a priori expectations. For instance foreign direct investment that spur investment and employment serve as a precursor for economic prosperity. Similarly, good capital formation and improvement in life expectancy are good catalysts for economic growth. Sound monetary policy is also a prerequisite for economic well-being. However, an unabated rise in population and unproductive government consumption expenditure are detriment to economic growth.

Table 3: Pairwise correlation Results

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) lrgdp	1.000														
(2) lfpsc	0.220*	1.000													
(3) lfssc	0.439*	0.579*	1.000												
(4) lftsc	0.415*	0.541*	0.746*	1.000											
(5) lmpsc	0.327*	0.234*	0.242*	0.368*	1.000										
(6) lmssc	0.295*	0.304*	0.314*	0.372*	0.330*	1.000									
(7) lmtsc	0.159*	0.208*	0.358*	0.397*	0.305*	0.726*	1.000								
(8) fdi	-0.131*	0.031	0.169*	0.211*	-0.210*	0.205*	0.098	1.000							
(9) lgcf	0.342*	0.284*	0.427*	0.410*	0.187*	0.175*	0.185*	0.107	1.000						
(10) llef	0.509*	0.552*	0.717*	0.661*	0.212*	0.249*	0.233*	0.045	0.494*	1.000					
(11) llem	0.507*	0.546*	0.703*	0.663*	0.219*	0.269*	0.241*	0.051	0.501*	0.991*	1.000				
(12) lbm	0.312*	0.196*	0.300*	0.381*	0.139*	0.277*	0.273*	0.104	0.213*	0.374*	0.382*	1.000			
(13) lgce	-0.074	0.223*	0.227*	0.232*	-0.044	0.077	0.069	0.113	0.288*	0.248*	0.258*	0.216*	1.000		
(14) lfpg_tp	-0.318*	-0.080	-0.037	-0.076	-0.141*	-0.012	-0.028	0.220*	-0.121*	-0.160*	-0.180*	-0.146*	0.010	1.000	
(15) lmpg_tp	0.317*	0.084	0.040	0.072	0.144*	0.017	0.031	-0.226*	0.121*	0.163*	0.183*	0.144*	-0.010	-0.999*	1.000

* shows significance at the .05 level

Source: Author's computation

Table 4: Female Education Attainment and Economic Growth

	Primary School Attainment			**Secondary School Attainment**			**Tertiary School Attainment**		
	Pooled	**Fixed**	**Random**	**Pooled**	**Fixed**	**Random**	**Pooled**	**Fixed**	**Random**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
	lrgdp	**lrgdp**	**lrgdp**	**lrgdp**	**lrgdp**	**lrgdp**	**lrgdp**	**lrgdp**	**lrgdp**
Lfpsc	-0.010	0.327***	0.310***						
	(0.087)	(0.045)	(0.049)						
Lfssc				0.364***	0.314***	0.306***			
				(0.070)	(0.033)	(0.036)			
Lftsc							0.193***	0.318***	0.317***
							(0.074)	(0.028)	(0.030)
Fdi	-0.002	0.038***	0.014	-0.000	0.032***	0.011	-0.002	0.033***	0.015
	(0.020)	(0.013)	(0.012)	(0.018)	(0.012)	(0.011)	(0.019)	(0.011)	(0.011)
Lgcf	0.995***	0.014	0.114	1.058***	0.025	0.124	1.058***	0.077	0.154**
	(0.195)	(0.082)	(0.088)	(0.184)	(0.077)	(0.083)	(0.194)	(0.071)	(0.076)

Llef	4.387***	1.035***	1.273***	2.663***	0.472*	0.664**	3.527***	0.144	0.285
	(0.551)	(0.278)	(0.297)	(0.610)	(0.275)	(0.300)	(0.638)	(0.264)	(0.285)
lfpg_tp	-16.807***	-2.987	-5.114	-19.766***	1.121	-1.639	-16.540***	-1.245	-2.909
	(4.288)	(3.489)	(3.626)	(4.091)	(3.282)	(3.444)	(4.243)	(2.967)	(3.115)
lbm	0.230**	0.169***	0.190***	0.178**	0.047	0.075	0.184*	0.229***	0.239***
	(0.095)	(0.050)	(0.054)	(0.090)	(0.050)	(0.053)	(0.095)	(0.042)	(0.046)
lgce	-0.964***	-0.110	-0.216**	-0.921***	0.005	-0.104	-1.008***	-0.081	-0.167**
	(0.198)	(0.091)	(0.096)	(0.186)	(0.083)	(0.090)	(0.195)	(0.076)	(0.081)
ltradop	-1.283***	0.192	0.050	-1.521***	0.152	0.002	-1.459***	0.007	-0.101
	(0.180)	(0.119)	(0.125)	(0.176)	(0.111)	(0.118)	(0.190)	(0.102)	(0.108)
_cons	75.329***	28.536**	36.344**	94.168***	15.195	25.662*	78.671***	26.588**	32.831***
	(17.109)	(13.958)	(14.514)	(16.559)	(13.062)	(13.724)	(16.995)	(11.855)	(12.453)
Obs.	231	231	231	231	231	231	229	229	229
R-squared	0.527	0.492		0.578	0.560				
Hausman Tests		22.365 (0.004)			28.384 (0.000)			36.27 (0.000)	

Standard errors are in parenthesis
*** p<0.01, ** p<0.05, * p<0.1
Source: Author's computation

Table 5: One-Step and Two-Step Difference GMM Results for Female Education Attainment and Economic Growth

	ONE STEP DIFFERENCE GMM			TWO STEP DIFFERENCE GMM		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	Lrgdp	**lrgdp**	**lrgdp**	**lrgdp**	**lrgdp**	**lrgdp**
lrgdp_l1	1.043***	1.033***	1.024***	1.037***	1.021***	1.024***
	(0.118)	(0.089)	(0.107)	(0.171)	(0.135)	(0.158)
lrgdp_l2	-0.289**	-0.286**	-0.280**	-0.211*	-0.204*	-0.200
	(0.110)	(0.111)	(0.111)	(0.124)	(0.120)	(0.122)
lrgdp_l3	0.163*	0.165*	0.162*	0.100	0.100	0.096
	(0.092)	(0.089)	(0.092)	(0.109)	(0.109)	(0.107)
lfpsc	-0.007			-0.006		
	(0.015)			(0.019)		
lfssc		0.000			0.003	
		(0.017)			(0.022)	
lftsc			0.003			0.001
			(0.012)			(0.015)
fdi	0.008	0.008	0.008	0.005	0.006	0.006
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)

lgcf	0.186***	0.186***	0.186***	0.188***	0.188***	0.187***
	(0.037)	(0.036)	(0.036)	(0.045)	(0.046)	(0.044)
llef	0.385***	0.380**	0.375**	0.382*	0.374	0.372
	(0.140)	(0.154)	(0.155)	(0.206)	(0.237)	(0.234)
lfpg_tp	0.780	0.748	0.746	0.592	0.607	0.595
	(0.921)	(0.864)	(0.904)	(1.051)	(1.020)	(1.004)
lbm	0.018	0.019	0.020	0.016	0.015	0.016
	(0.014)	(0.015)	(0.013)	(0.014)	(0.017)	(0.013)
lgce	-0.022	-0.023	-0.024	-0.014	-0.015	-0.017
	(0.032)	(0.032)	(0.032)	(0.038)	(0.038)	(0.037)
ltradop	0.012	0.013	0.012	0.013	0.014	0.013
	(0.029)	(0.029)	(0.027)	(0.039)	(0.038)	(0.035)
Obs.	171	171	170	171	171	170
F-test	797.857	875.637	797.857	793.253	895.837	849.878
AR(1)	0.001	0.001	0.001	0.008	0.004	0.007
AR(2)	0.892	0.894	0.889	0.405	0.381	0.368
Sargan Test	0.225	0.219	0.240	0.225	0.219	0.240
Hansen Test	0.215	0.211	0.244	0.215	0.211	0.244

Standard errors are in parenthesis
*** p<0.01, ** p<0.05, * p<0.1
Source: Author's computation

Table 6: One-Step and Two-Step System GMM Results for Female Education Attainment and Economic Growth

	ONE STEP SYSTEM GMM			TWO STEP SYSTEM GMM		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	Lrgdp	**Lrgdp**	**Lrgdp**	**Lrgdp**	**lrgdp**	**lrgdp**
lrgdp_l1	1.109***	1.053***	1.048***	1.041***	0.952***	0.948***
	(0.097)	(0.124)	(0.126)	(0.120)	(0.168)	(0.199)
lrgdp_l2	-0.351***	-0.332***	-0.317***	-0.296***	-0.250*	-0.259**
	(0.101)	(0.113)	(0.105)	(0.103)	(0.131)	(0.120)
lrgdp_l3	0.159*	0.159**	0.160**	0.156*	0.134**	0.164**
	(0.079)	(0.071)	(0.078)	(0.086)	(0.062)	(0.070)
lfpsc	-0.003			0.002		
	(0.011)			(0.014)		

lfssc		0.026			0.048*	
		(0.031)			(0.028)	
lftsc			0.007			0.020
			(0.022)			(0.028)
Fdi	0.004	0.004	0.004	0.004	0.003	0.003
	(0.003)	(0.003)	(0.003)	(0.005)	(0.003)	(0.003)
lgcf	0.244***	0.281***	0.273***	0.268***	0.326***	0.319***
	(0.035)	(0.063)	(0.062)	(0.045)	(0.066)	(0.085)
llef	0.340**	0.390*	0.425**	0.390*	0.485*	0.525
	(0.147)	(0.216)	(0.199)	(0.211)	(0.272)	(0.327)
lfpg_tp	-2.158***	-2.981**	-2.640*	-2.689***	-3.989***	-3.596**
	(0.771)	(1.357)	(1.351)	(0.856)	(1.361)	(1.723)
lbm	0.026*	0.029	0.030	0.032	0.038	0.039
	(0.015)	(0.021)	(0.018)	(0.020)	(0.030)	(0.025)
lgce	-0.082***	-0.108**	-0.107**	-0.089**	-0.132**	-0.131*
	(0.029)	(0.050)	(0.049)	(0.034)	(0.061)	(0.071)
ltradop	-0.114***	-0.172*	-0.152*	-0.128**	-0.229**	-0.201
	(0.038)	(0.095)	(0.088)	(0.047)	(0.096)	(0.121)
cons	9.008***	13.023**	11.316*	11.245***	17.735***	15.646*
	(3.178)	(6.109)	(6.228)	(3.490)	(6.050)	(7.994)
Obs.	205	205	204	205	205	204
F-stats	1157.513	741.822	850.826	905.67	850.87	788.50
AR(1)	0.001	0.011	0.005	0.007	0.042	0.055
AR(2)	0.901	0.959	0.873	0.973	0.757	0.974
Sargan Test	0.228	0.412	0.330	0.228	0.412	0.330
Hansen Test	0.429	0.527	0.574	0.429	0.527	0.574

Standard errors are in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

Source: Author's computation

5.3. Male Education Attainment and Economic Growth

In this section, the results of the effects male education attainment at various levels of education on economic growth in Africa are presented in Table 7, 8 and 9. Based on Hausman specification test results, we report the fixed effects results for primary and secondary school attainment while we report the random effects results for tertiary education. Irrespective of the models that are chosen, male education attainments also contribute positively and significantly to economic growth in Africa. Specifically, an increase in male education attainments at primary, secondary and tertiary by 1% would result in economic growth by 0.338%, 0.442% and 0.348% respectively. Barro and Lee (1994) and Barro (2001) have also shown that male education has a positive effect on economic growth. From the results, it is possible to deduce that male secondary school education attainment contributes more to economic growth than other levels of education attainments. With regard to the results from difference and system GMM, male education attainments at all levels have negative effects on economic growth, albeit mostly not statistically significant.

As in the case of female education attainment model, FDI, gross capital formation, male life expectancy, male population as a percentage of total population, broad money and trade openness have positive effects on economic growth while we find that government final consumption expenditure also exhibit a negative effect on economic growth.

Table 7: Male Education Attainment and Economic Growth

	Primary School Attainment			Secondary School Attainment			Tertiary School Attainment		
	Pooled	**Fixed**	**Random**	**Pooled**	**Fixed**	**Random**	**Pooled**	**Fixed**	**Random**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
	Lrgdp	**lrgdp**	**lrgdp**	**lrgdp**	**lrgdp**	**Lrgdp**	**lrgdp**	**lrgdp**	**lrgdp**
lmpsc	0.108	0.338***	0.320***						
	(0.125)	(0.071)	(0.075)						
lmssc				0.080	0.442***	0.424***			
				(0.081)	(0.045)	(0.048)			
lmsac							-0.188***	0.382***	0.348***
							(0.070)	(0.036)	(0.041)
fdi	-0.005	0.051***	0.022*	-0.010	0.023*	0.003	-0.002	0.034***	0.011
	(0.020)	(0.014)	(0.013)	(0.020)	(0.012)	(0.011)	(0.020)	(0.012)	(0.011)
lgcf	1.040***	0.031	0.143	0.999***	0.030	0.109	1.063***	0.014	0.105
	(0.198)	(0.087)	(0.093)	(0.197)	(0.075)	(0.080)	(0.194)	(0.073)	(0.082)
llem	4.178***	1.079***	1.327***	4.234***	0.805***	1.010***	4.330***	0.999***	1.241***
	(0.575)	(0.301)	(0.318)	(0.562)	(0.253)	(0.271)	(0.552)	(0.240)	(0.267)
lmpg_tp	15.224***	1.748	3.961	15.671***	-2.032	0.243	15.725***	-2.334	0.317
	(4.299)	(3.624)	(3.721)	(4.272)	(3.161)	(3.305)	(4.214)	(3.083)	(3.346)
lbm	0.230**	0.196***	0.218***	0.220**	0.141***	0.160***	0.288***	0.144***	0.166***
	(0.096)	(0.053)	(0.056)	(0.097)	(0.046)	(0.049)	(0.097)	(0.045)	(0.050)
lgce	-0.983***	-0.029	-0.148	-1.016***	-0.057	-0.145*	-1.014***	-0.011	-0.115
	(0.199)	(0.095)	(0.100)	(0.200)	(0.082)	(0.087)	(0.196)	(0.080)	(0.088)
ltradop	-1.263***	0.185	0.039	-1.229***	0.087	-0.001	-1.304***	0.183*	0.064
	(0.182)	(0.126)	(0.131)	(0.186)	(0.109)	(0.115)	(0.180)	(0.106)	(0.116)
_cons	-49.346***	9.369	0.225	-51.085***	25.905**	16.456	-51.621***	26.693**	15.710
	(16.685)	(13.932)	(14.299)	(16.568)	(12.194)	(12.741)	(16.345)	(11.883)	(12.890)
Obs.	231	231	231	231	231	231	231	231	231
R-squared	0.517	0.433		0.518	0.578		0.531	0.599	
Hausman Tests		19.407 (0.013)			29.504 (0.000)			3.519 (0.898)	

Standard errors are in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

Source: Author's computation

Table 8: One-Step and Two-Step Difference GMM Results for Male Education Attainment and Economic Growth

	ONE STEP DIFFERENCE GMM			TWO STEP DIFFERENCE GMM		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	lrgdp	**lrgdp**	**Lrgdp**	**Lrgdp**	**lrgdp**	**lrgdp**
lrgdp_l1	1.034***	1.031***	1.082***	1.012***	1.037***	1.059***
	(0.108)	(0.111)	(0.112)	(0.153)	(0.158)	(0.158)
lrgdp_l2	-0.280**	-0.278**	-0.298**	-0.195	-0.203	-0.208
	(0.113)	(0.111)	(0.115)	(0.124)	(0.121)	(0.124)
lrgdp_l3	0.158*	0.159*	0.158*	0.099	0.098	0.098
	(0.087)	(0.091)	(0.087)	(0.101)	(0.107)	(0.098)
lmpsc	-0.015			0.001		
	(0.023)			(0.025)		
lmssc		-0.005			-0.016	
		(0.022)			(0.024)	
lmtsc			-0.028**			-0.029*
			(0.012)			(0.015)
fdi	0.007*	0.008**	0.007*	0.005	0.005	0.005
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)
lgcf	0.185***	0.186***	0.188***	0.189***	0.188***	0.194***
	(0.036)	(0.035)	(0.035)	(0.044)	(0.045)	(0.042)
llem	0.398***	0.388***	0.388***	0.392*	0.406*	0.400**
	(0.135)	(0.137)	(0.133)	(0.200)	(0.203)	(0.190)
lmpg_tp	-0.855	-0.901	-0.666	-0.732	-0.569	-0.531
	(0.825)	(0.835)	(0.854)	(0.975)	(0.996)	(1.060)
lbm	0.021	0.021	0.018	0.018	0.016	0.016
	(0.012)	(0.013)	(0.011)	(0.013)	(0.014)	(0.012)
lgce	-0.023	-0.023	-0.026	-0.017	-0.019	-0.023
	(0.031)	(0.031)	(0.031)	(0.036)	(0.036)	(0.035)
ltradop	0.010	0.013	0.005	0.012	0.014	0.000
	(0.028)	(0.028)	(0.028)	(0.037)	(0.035)	(0.036)
Obs.	171	171	171	171	171	171
F-stats	1244.72	871.73	947.71	1321.87	889.63	999.49
AR(1)	0.001	0.001	0.001	0.007	0.006	0.007
AR(2)	0.892	0.884	0.874	0.407	0.428	0.387
Sargan Test	0.236	0.250	0.255	0.236	0.250	0.255
Hansen Test	0.213	0.207	0.246	0.213	0.207	0.246

Standard errors are in parenthesis
*** p<0.01, ** p<0.05, * p<0.1
Source: Author's computation

Table 9: One-Step and Two-Step System GMM Results for Male Education Attainment and Economic Growth

	ONE STEP SYSTEM GMM			TWO STEP SYSTEM GMM		
	(1)	(2)	(3)	(4)	(5)	(6)
	lrgdp	lrgdp	Lrgdp	Lrgdp	Lrgdp	lrgdp
lrgdp_l1	1.089***	1.092***	1.181***	1.000***	1.030***	1.130***
	(0.139)	(0.103)	(0.093)	(0.195)	(0.146)	(0.108)
lrgdp_l2	-0.332***	-0.329***	-0.378***	-0.272**	-0.282**	-0.300**
	(0.110)	(0.101)	(0.106)	(0.118)	(0.105)	(0.113)
lrgdp_l3	0.150**	0.148*	0.148*	0.157*	0.151*	0.122
	(0.072)	(0.078)	(0.081)	(0.087)	(0.082)	(0.108)
Lmpsc	0.005			0.017		
	(0.024)			(0.022)		
Lmssc		-0.008			-0.010	
		(0.013)			(0.016)	
Lmtsc			-0.025***			-0.025***
			(0.007)			(0.009)
Fdi	0.004	0.004	0.005	0.003	0.004	0.005
	(0.003)	(0.003)	(0.003)	(0.004)	(0.005)	(0.006)
Lgcf	0.254***	0.251***	0.217***	0.289***	0.270***	0.219***
	(0.056)	(0.041)	(0.034)	(0.074)	(0.060)	(0.046)
Llem	0.398**	0.388**	0.213*	0.485	0.446	0.205
	(0.195)	(0.187)	(0.116)	(0.314)	(0.304)	(0.179)
lmpg_tp	2.204**	2.138**	1.505**	2.765**	2.639**	1.757*
	(1.059)	(0.916)	(0.684)	(1.114)	(1.049)	(0.917)
Lbm	0.027	0.027	0.025**	0.033	0.032	0.023
	(0.018)	(0.017)	(0.012)	(0.023)	(0.023)	(0.015)
Lgce	-0.096**	-0.091**	-0.061**	-0.110	-0.093	-0.057*
	(0.045)	(0.038)	(0.028)	(0.067)	(0.057)	(0.032)
Ltradop	-0.126**	-0.125**	-0.081**	-0.145*	-0.135**	-0.085**
	(0.056)	(0.048)	(0.030)	(0.075)	(0.065)	(0.038)
Cons	-7.966**	-7.749**	-5.659**	-10.035**	-9.688**	-6.643*
	(3.823)	(3.353)	(2.566)	(4.009)	(3.809)	(3.529)
Obs.	205	205	205	205	205	205
F-Stats	993.06	999.02	3326.75	736.27	751.26	2965.80
AR(1)	0.001	0.002	0.000	0.025	0.013	0.004
AR(2)	0.879	0.937	0.995	0.944	0.999	0.699
Sargan Test	0.247	0.255	0.117	0.247	0.255	0.117
Hansen Test	0.415	0.416	0.304	0.415	0.416	0.304

Standard errors are in parenthesis
*** p<0.01, ** p<0.05, * p<0.1
Source: Author's computation

5.3. Robustness Check

The results of effects of human capital and its alternative measurement on economic growth are reported in Table 10, 11 and 12 respectively. This robust analysis is carried to examine whether change in the measure of gender education will change our baseline results. However, we discovered that there is no significant change in the baseline results but there is a significant improvement in terms of coefficients of the variables of interest. For instance, results based on panel pooled, fixed effects and random effects estimation methods show that, irrespective of the gender and measurement, human capital stock raises economic growth. Reporting random effect results based on Hausman Test values, a 1% rise in female human capital stock and its alternative would raise economic growth by 2.554% and 1.423% respectively. Similarly, if male human capital stock and its alternative rise by 1%, economic growth world rise by 2.629% and 1.541% respectively.

Using both one step and two step difference and system GMM methods, we also find that gender human capital stock still is positively related to economic growth, however, most of these positive effects are not statistically significant. The exception to this is when we use alternative measure of human capital under two step difference GMM estimation technique, the effect female human capital stock on economic growth is positive and statistically significant. Moreover, there are some cases when male human capital stock and its alternative have negative significant effects on economic growth. This occurs when the one step and two step GMM methods are used. However, none of these negative coefficient is statistically significant.

From the findings so far, it is evident that both female and male education attainments have significant impacts on economic growth in Africa. This shows the importance of investing in the education of both genders and development of their skills as both have potential to contribute to the economy substantially. Although all levels of gender education are indispensable to African economies, it is apparent that primary education attainment for females and secondary education for males have highest effects on economic growth. This finding corroborates the saying that primary and secondary education are the bedrocks of cognitive development and human capital accumulation. Comparing male education attainment with their female counterpart, our findings further show that male education attainment at all levels of education contribute more to the economic growth than female education attainment at all levels of education. This suggests that there is an urgent need to provide incentive for both genders, particularly females that would serve as bait to attract them to schools. Using gender human capital also add robustness to findings, implying that gender education attainment can help to spur economic growth in Africa, it would, however, take holistic gender human capital development to raise the economies of the continent significantly.

Table 10: Female and Male Human Capital Stock and Economic Growth

	Female Human Capital			Female Human Capital Alternative			Male Human Capital			Male Human Capital Alternative		
	Pooled	**Fixed**	**Random**	**Pooled**	**Fixed**	**Random**	**Pooled**	**Fixed**	**Random**	**Pooled**	**Fixed**	**Random**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	lrgdp	lrgdp	lrgdp	Lrgdp	lrgdp	lrgdp	lrgdp	lrgdp	lrgdp	lrgdp	lrgdp	lrgdp
lfhc	3.255***	2.480***	2.554***									
	(0.471)	(0.197)	(0.197)									
lfhca				2.252***	1.373***	1.423***						
				(0.289)	(0.111)	(0.113)						
lmhc							4.288***	2.494***	2.629***			
							(0.493)	(0.233)	(0.238)			
lmha										3.153***	1.541***	1.639***
										(0.356)	(0.164)	(0.171)
fdi	-0.018	0.027**	0.014	-0.021	0.039***	0.022*	-0.019	0.038***	0.016	-0.016	0.052***	0.024*
	(0.025)	(0.014)	(0.013)	(0.024)	(0.014)	(0.013)	(0.023)	(0.015)	(0.013)	(0.023)	(0.015)	(0.014)
lgcf	0.821***	0.288***	0.317***	0.865***	0.234***	0.268***	1.066***	0.310***	0.360***	1.085***	0.219***	0.276***
	(0.260)	(0.069)	(0.070)	(0.252)	(0.069)	(0.070)	(0.249)	(0.076)	(0.078)	(0.248)	(0.077)	(0.081)
lle	-1.255*	0.484**	0.476**	-2.260***	0.184	0.168	-2.374***	0.396	0.373	-3.050***	0.336	0.319
	(0.755)	(0.237)	(0.241)	(0.780)	(0.253)	(0.259)	(0.764)	(0.258)	(0.267)	(0.798)	(0.282)	(0.297)
lpg_tp	-15.552**	4.631	3.739	-15.667**	5.700*	4.633	12.341**	-8.113***	-6.922**	13.958**	-9.412***	-7.860**
	(6.517)	(2.915)	(2.938)	(6.328)	(2.939)	(2.991)	(6.173)	(3.065)	(3.141)	(6.122)	(3.232)	(3.368)
lbm	0.573***	0.120***	0.126***	0.520***	0.090**	0.095**	0.594***	0.114***	0.122***	0.554***	0.085*	0.093**
	(0.117)	(0.039)	(0.039)	(0.113)	(0.040)	(0.041)	(0.110)	(0.042)	(0.043)	(0.109)	(0.044)	(0.047)
lgce	-0.594**	0.072	0.056	-0.532**	0.008	-0.013	-0.519**	0.016	-0.009	-0.520**	-0.060	-0.098
	(0.271)	(0.071)	(0.072)	(0.264)	(0.071)	(0.073)	(0.254)	(0.075)	(0.078)	(0.253)	(0.078)	(0.082)
ltradop	-0.780***	-0.104	-0.123	-0.811***	-0.089	-0.107	-0.958***	-0.094	-0.119	-1.050***	-0.101	-0.129
	(0.262)	(0.094)	(0.095)	(0.255)	(0.095)	(0.097)	(0.249)	(0.101)	(0.104)	(0.250)	(0.106)	(0.111)
Cons	88.351***	1.046	4.377	91.856***	-2.036	2.001	-17.650	50.941***	46.157***	-22.488	56.204***	49.976***
	(26.245)	(11.571)	(11.675)	(25.484)	(11.663)	(11.883)	(23.726)	(11.927)	(12.214)	(23.512)	(12.603)	(13.117)
Obs.	184	184	184	184	184	184	184	184	184	184	184	184
R-squared	0.401	0.744		0.434	0.739		0.470	0.706		0.475	0.674	
Hausman		3.519			10.204			11.993			20.879	
Test		(0.898)			(0.251)			(0.152)			(0.007)	

Standard errors are in parenthesis
*** p<0.01, ** p<0.05, * p<0.1

Source: Author's computation

Table 11: Female Human Capital Stock and Economic Growth

	Human Capital Stock				Alternative Hunan Capital Stock			
	One Step Diff. GMM	**Two Step Diff. GMM**	**One Step Sys GMM**	**Two Step Sys GMM**	**One Step Diff. GMM**	**Two Step Diff. GMM**	**One Step Sys GMM**	**Two Step Sys GMM**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
	lrgdp	**Lrgdp**	**lrgdp**	**lrgdp**	**Lrgdp**	**Lrgdp**	**lrgdp**	**lrgdp**
lrgdp_l1	1.368***	1.346***	1.287***	1.135***	1.219***	1.084***	1.297***	1.056***

	(0.216)	(0.284)	(0.135)	(0.163)	(0.154)	(0.204)	(0.161)	(0.233)
lrgdp_l2	-0.337**	-0.272	-0.282**	-0.197	-0.287**	-0.188	-0.287**	-0.148
	(0.142)	(0.196)	(0.106)	(0.122)				
lfhc	0.235	0.173	0.072	0.209				
	(0.372)	(0.341)	(0.231)	(0.381)				
lfhca					0.272	0.403**	0.060	0.290
					(0.163)	(0.181)	(0.222)	(0.338)
fdi	0.022	0.017	0.004	0.053**	0.017**	0.012	0.005	0.046*
	(0.015)	(0.020)	(0.005)	(0.025)	(0.006)	(0.009)	(0.006)	(0.024)
lgcf	0.156	0.244*	0.198***	0.255***	0.175***	0.242***	0.207**	0.302**
	(0.094)	(0.130)	(0.065)	(0.080)	(0.054)	(0.063)	(0.076)	(0.114)
llef	-0.466	-0.582	-0.382	-0.119	-0.570	-0.682**	-0.457	-0.406
	(0.630)	(0.684)	(0.229)	(0.342)	(0.426)	(0.275)	(0.305)	(0.379)
lfpg_tp	14.954	13.306	0.915	-3.137	2.395	-0.996	0.171	-5.697
	(11.800)	(11.626)	(4.366)	(11.501)	(4.896)	(6.824)	(4.354)	(9.548)
lbm	-0.137	-0.161	0.023	-0.140	-0.048	-0.070	0.010	-0.124
	(0.122)	(0.144)	(0.053)	(0.117)	(0.067)	(0.094)	(0.048)	(0.102)
lgce	0.150	0.180	-0.081	-0.100	0.067	0.130	-0.093	-0.048
	(0.155)	(0.161)	(0.128)	(0.197)	(0.131)	(0.210)	(0.136)	(0.266)
ltradop	-0.049	-0.095	-0.020	-0.224*	-0.036	-0.063	-0.017	-0.233*
	(0.122)	(0.125)	(0.056)	(0.109)	(0.062)	(0.099)	(0.070)	(0.116)
Cons			-2.433	15.039			0.677	26.458
			(17.098)	(45.605)			(16.922)	(37.970)
Obs.	146	146	173	173	146	146	173	173
F-stat	90.79	167.10	846.54	260.55	230.24	529.52	976.34	357.32
AR(1)	0.016	0.059	0.005	0.025	0.007	0.023	0.005	0.025
AR(2)	0.152	0.116	0.206	0.268	0.093	0.069	0.191	0.295
Sargan Test	0.977	0.977	0.294	0.968	0.393	0.393	0.356	0.926
Hansen Test	0.468	0.468	0.496	0.734	0.503	0.503	0.439	0.802

Standard errors are in parenthesis
*** p<0.01, ** p<0.05, * p<0.1
Source: Author's computation

Table 12: Male Human Capital Stock and Economic Growth

	Human Capital Stock				**Alternative Hunan Capital Stock**			
	One Step Diff. GMM	**Two Step Diff. GMM**	**One Step Sys GMM**	**Two Step Sys GMM**	**One Step Diff. GMM**	**Two Step Diff. GMM**	**One Step Sys GMM**	**Two Step Sys GMM**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
	lrgdp	**Lrgdp**	**lrgdp**	**lrgdp**	**Lrgdp**	**Lrgdp**	**Lrgdp**	**lrgdp**
lrgdp_l1	1.304***	1.158***	1.344***	1.296***	1.220***	1.153***	1.374***	1.331***

	(0.173)	(0.229)	(0.140)	(0.217)	(0.137)	(0.168)	(0.149)	(0.189)
lrgdp_l2	-0.333**	-0.219	-0.300**	-0.264*	-0.270**	-0.212	-0.308**	-0.285*
	(0.123)	(0.157)	(0.116)	(0.143)	(0.104)	(0.146)	(0.128)	(0.139)
lmhc	0.408	0.327	-0.106	-0.078				
	(0.399)	(0.471)	(0.320)	(0.487)				
lmhca					0.064	0.047	-0.127	-0.081
					(0.210)	(0.252)	(0.182)	(0.288)
fdi	0.020*	0.017	0.007	0.006	0.016**	0.013	0.007	0.007
	(0.010)	(0.014)	(0.006)	(0.007)	(0.007)	(0.008)	(0.005)	(0.006)
lgcf	0.168*	0.223**	0.167**	0.158	0.142**	0.160*	0.158**	0.153*
	(0.087)	(0.105)	(0.071)	(0.100)	(0.059)	(0.093)	(0.062)	(0.079)
llem	-0.441	-0.271	-0.371	-0.381*	-0.137	-0.112	-0.363	-0.381
	(0.621)	(0.592)	(0.274)	(0.215)	(0.389)	(0.375)	(0.310)	(0.260)
lmpg_tp	-10.772	-9.326	-0.175	1.443	-2.572	1.196	-0.190	1.493
	(7.026)	(10.629)	(4.806)	(2.178)	(5.145)	(2.626)	(4.741)	(2.039)
lbm	-0.090	-0.108	0.026	0.022	0.016	0.021	0.018	0.012
	(0.085)	(0.112)	(0.049)	(0.055)	(0.068)	(0.106)	(0.054)	(0.061)
lgce	0.093	0.108	-0.117	-0.141	-0.069	-0.107	-0.117	-0.142
	(0.114)	(0.202)	(0.135)	(0.171)	(0.126)	(0.125)	(0.127)	(0.184)
ltradop	-0.047	-0.074	0.010	-0.021	-0.033	-0.062	0.028	-0.012
	(0.097)	(0.128)	(0.089)	(0.117)	(0.048)	(0.068)	(0.098)	(0.111)
Cons			1.002	-4.765			0.606	-5.226
			(18.970)	(8.015)			(18.162)	(8.267)
Obs.	146	146	173	173	146	146	173	173
F-stat	98.27	384.33	561.94	906.26	399.58	390.67	547.79	711.94
AR(1)	0.016	0.059	0.006	0.044	0.013	0.046	0.008	0.035
AR(2)	0.143	0.154	0.258	0.284	0.322	0.320	0.239	0.304
Sargan Test	0.812	0.812	0.330	0.330	0.109	0.109	0.437	0.437
Hansen Test	0.452	0.452	0.439	0.439	0.267	0.267	0.427	0.427

Standard errors are in parenthesis
*** p<0.01, ** p<0.05, * p<0.1
Source: Author's computation

6.0. Conclusion and Policy Implications

The objective of this study is to examine whether gender education (females and males) in terms of education attainments and human capital stock still have impacts on economic growth in Africa. To implement this objective, we use three datasets, namely Barro and Lee (2013), Lee and Lee (2016) and World Development Indicators (2017 version). We extract female and male education attainments and female and male human capital stocks from Barro and Lee (2013) Lee and Lee (2016) respectively. Other variables mentioned in the section for data sources are extracted from WDI. The data is an annual covering the period from 1960 to 2010, albeit it is averaged over five-year intervals. Two estimation techniques are deployed to ascertain the impact of gender education on economic growth, namely: static panel estimation methods (pooled, fixed effects and random effects) and dynamic GMM (one step and two step difference and system GMM).

Our results show that both female and male education attainments and human capital stock have positive effect on the economic growth. However, male education attainments have more effect on economic growth compared with female education attainments. The same is applicable to male human capital stock compared with their female counterpart. The findings are, however, subject to the method of estimation because most of the results stated above come from the static panel estimation method, particularly fixed effects and random effects methods. The results from difference and system GMM (either one step or two step) are mixed. Other explanatory variables included in the estimations follow a priori expectations. Specifically, we find that FDI, gross capital formation (capital stock), life expectancy (for female and male), broad money and trade openness have positive effects on economic growth. The results of gender population are mixed. While female population (% of total population) has a negative effect on economic growth, male population (% of total population) has a positive impact on economic growth. Government final consumption expenditure negatively affects the economy.

Given the findings above, it is important for the governments in Africa to focus on the development of their female and male citizens through the provision of quality education. A great attention must particularly be paid to the education of female citizens which is still lagging behind their male counterparts. The provision of access to education must not only based on theoretical learning but also on practical learning that would guarantee the development of their skills so as to be more relevant in all sectors of the economy after their graduation from the schools. Access to all-round education approach like this will not help in developing them but also assist in fostering the long-term economic growth in the continent.

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Appendix

S/N	Countries Selected from Barro and Lee (2013) Dataset	Countries Selected from Lee and Lee (2016) Dataset
1	Algeria	Algeria
2	Benin	Benin
3	Botswana	Cameroon
4	Burundi	Congo, D.R.
5	Cameroon	Cote dIvoire
6	Central African Republic	Egypt
7	Congo, Dem. Rep.	Gambia
8	Congo, Rep.	Ghana
9	Cote dIvoire	Kenya
10	Egypt	Lesotho
11	Gabon	Liberia
12	Gambia	Malawi
13	Ghana	Mali
14	Kenya	Mauritius
15	Lesotho	Morocco
16	Liberia	Mozambique

17	Malawi	Niger
18	Mali	Senegal
19	Mauritania	Sierra Leone
20	Mauritius	South Africa
21	Morocco	Sudan
22	Mozambique	Swaziland
23	Namibia	Togo
24	Niger	Tunisia
25	Rwanda	Uganda
26	Senegal	Zambia
27	Sierra Leone	Zimbabwe
28	South Africa	
29	Sudan	
30	Swaziland	
31	Togo	
32	Tunisia	
33	Uganda	
34	Zambia	
35	Zimbabwe	