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Growing a Knowledge-Based Economy: Evidence from Public Expenditure on Education in Africa[1]

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Abstract

In spite of its major development challenges, Africa is showing signs of a reversed trend: economies have been growing for the sixth consecutive year, conflicts are declining and many countries are now managing democratic political transitions. The continent now faces the best opportunity for growth in the past 30 years, as pessimism is gradually being replaced with greater confidence, assertiveness and optimism. The question that still remains critical is whether or not Africa will be able to sustain these positive trends. There is a consensus that for Africa to sustain this growth, it needs to harness science and technology in various sectors, integrate into global markets, and transform its economies to face the fierce global competition, in a world fueled by information and driven by knowledge. Against the background of declining knowledge infrastructure, brain-drain, limited support to research and development (R&D), outdated curricula and limited direct links between science and industry, Africa risks losing out in the new economy, unless deliberate and bold initiatives are implemented to reinvigorate higher education, science and technology and innovations on the continent (Juma and Awara, 2006).

The objective of this paper is to articulate the need for growing a knowledge-based economy in Africa, whereby research knowledge and innovation become central in paving the way to development and economic growth. Emerging issues related to the dynamics of public expenditure on education and economic growth and human capital development in Africa are critically examined, using empirical data from the 52 African countries. The paper concludes by discussing key issues that require attention is investing in education and knowledge generation in Africa, so as to maximize returns on such investments in the continent's quest for growing into a knowledge-based economies.

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Introduction

Achieving economic growth in Africa has been one of the most daunting challenges in the last decades. Since the 1980s, growth on the continent had been elusive, with economic stagnation and retardation becoming the defining characteristics for most countries (Kempe, 1997). Concerted efforts by international development financiers and donors, including Multilateral Financial Institutions (MFIs) did not make significant headway in reviving African economies, despite the experimentation of several development models and approaches, most of which emphasized structural reforms (UNCTAD, 2003). The 1990s saw a significant shift in Africa's development paradigm, with increasing attention being given to Africa's participation in its own development planning, ownership of its own development initiatives, capacity building of African professionals, knowledge management and improved governance among others (AEO, 2002).

At last, since the turn of the millennium, Africa has generally started recording economic growth on a fairly consistent basis, especially since the last six years. The emergence of growth on the continent is good news. However, the need for more clarity on its causes and disparage distribution across countries are giving rise to a need for generating more understanding on the continent's ability to sustain the emerging growth (Fachamps, 2000). These concerns call for a critical examination of the factors contributing to growth on the continent and its distribution across countries and sectors. The African Economic Outlook (AEO), jointly published by the African Development Bank (AfDB) and the Organization for Economic Cooperation and Development (OECD), which analyses Africa's annual economic performance from various perspectives, alludes to several factors contributing to Africa's economic growth (AEO, 2006).

Among these factors are improvements in commodity prices (oil and non-oil) which generate significant windfalls for countries endowed with natural resources. It is also believed that the positive trends could be emerging from pay-offs to institutional reforms that have been emphasized on the continent in recent years. These reforms could now be leading to modest improvements in governance and accountability, with concomitant improvement in public sector management and investment climate. Although the current growth trends are mixed and vary from country to country, it is clear that both propositions may hold true, as high growth rates have been recorded both in countries endowed with natural resources and those that are not (AEO, 2006). Thus, there may be an opportunity for realizing the continent's hope of sustaining growth, as it seems to be emerging from diverse sources, which may reduce the risk of strong reliance on volatile commodity prices that have largely been the traditional sources of growth.

With the increasing challenges of sustaining economic growth on the continent, the search for the foundations of growth sustainability in Africa is increasing, and the importance of knowledge, innovation and technology are ever becoming recognized. In particular, there is the recognition that Africa's growth needs to be centered around and driven by knowledge, in the context of growing knowledge-based economies on the continent. This recognition of knowledge as a critical element of economic growth is not new; the issue is long acknowledged as a factor behind the economic success of the developed world (OECD, 1996). The dynamics embedded in knowledge-based economies have been articulated by studies such as Romer and Gross (1994), with propositions that are now leading to new growth theories to explain the forces behind long-term economic growth.

In an environment where trends in knowledge development is taking a new twist, Africa now faces a big challenge as it tries to respond to the inevitable need to embrace science and technology as the basis for sustaining growth, and for competing in a global environment that is largely driven by knowledge and innovation. Thus, understanding the main elements of a knowledge-based economy, particularly the knowledge triangle and how it can be harnessed for Africa to sustain growth remains critical.

In this context, this paper is developed with the broad objective of articulating the relevance of knowledge and innovation to promote growth to achieve Africa's economic potential, and for sustaining that economic growth on the longer-term. The paper starts with a review of the concept of knowledge-based economy and discusses it from various perspectives. It then presents an overview of recent work on its diverging meanings and importance in the development of African economies. It also highlights the theoretical perspectives of public educational investment and economic growth, and uses this as a basis to conduct an empirical analysis of the effects of public investments in education in relation to economic growth and human capital development, using panel data on 52 African countries. This is followed by conclusions and recommendations for future investments in knowledge in African, with emphasis on the role of international development institutions in particular African Development Bank.

1. The Concept of Knowledge-Based Economy

The term 'knowledge-based economy' has emerged from a fuller recognition of the pivotal role that knowledge and technology plays in economic growth, as embodied in human capital, innovations and technology (Juma and Awara, 2006). This role is not new and has always been recognized in contemporary literature (OECD, 1996). From an analytical perspective, a knowledge-based economy refers to an economy in which the production,

exchange, distribution and use of knowledge is the main driver of economic growth, employment generation and wealth creation (McKeon and Weir, 2001). In the OECD for instance, it is estimated that more than 50 percent of the Gross Domestic Product (GDP) in major economies is knowledge-based or derived from knowledge-intensive activities. This implies that knowledge-intensive service sectors such as education, communications and information are growing at relatively speeds that are reasonable to drive economic growth (OECD, 1996). The knowledge trends in the OECD are leading to revisions in economic theories and models to fully establish and emphasize the role of knowledge in driving the economic successes of these countries. Therefore the move towards a knowledge-based economy is a prudent growth path that has been shown to be a crucial element of economic growth that cannot be ignored in the growth strategies of developing countries.

As the move towards a knowledge-based economy gathers momentum, whereby the primary medium of exchange becomes information and technology, a knowledge triangle emerges between education, research and industry, which creates a solid connect between knowledge generation, its utilization, its transformation (including its products) into economic growth via production of knowledge-intensive goods and services. This triangle, anchored within the framework of good governance and appropriate policies, is what lies at the hearth of growth in successful economies. The positive relationship between investment in research and development (R&D), innovation and economic growth, cannot be overemphasized, as it is relatively well established in the literature (Mytelka and Farinelli, 2000; EU, 2007). The increasing application of knowledge to production, its growing intensity of utilization in global exchange and distribution processes, coupled with globalization or the progressive elimination of international trade barriers, clearly underscore the need for a strong base of science, technology and innovation to sustain economic growth in Africa. Advanced industrialized countries are responding to these opportunities by seeking competitive advantages in general knowledge infrastructure and enriching knowledge capital: universities and colleges, public and private laboratories, education workers, as well as advanced physical infrastructure, and comparatively stable social, political, and market institutions.

Despite this recognition, developing countries are still lagging behind common indicators of knowledge intensity, such as expenditure in research and development (R&D) as a share of GDP, patent rates, relative employment or value-added in knowledge-oriented technology industries, and educational attainment (OECD, 2000; Mitchell, 1999; D'Cost, 1998). Recent studies establish that even in technology-intensive sectors and among high tech transitional corporations, innovation-oriented investments in developing countries are not primarily targeted toward research and product development, but toward reducing production costs and other cost-sensitive activities in the production chain (cf: Quadros, Furtado et al.2001; Melo, 2001; *Conceicao, Gibson et al*. 2001; Etzkowitz and Brisolla 1999). The difference between

developed and developing country in this context is as wide as the gap in status of development, both qualitative as well as quantitative terms. However, the advent of recent technology-led economic growth in Asia, particularly China and India, raise hopes that with the right policy choices, targeted interventions and investments, African countries may have a chance of transforming their economies from low-value primary production to knowledge-based economies that are driven by innovation of high value-addition.

The stride towards a knowledge-based economy starts with the recognition of human capital accumulation as a long-term potential engine of economic growth. The process starts with the governments' championing the important role of engaging in human capital development, by prioritizing education and availing funds for formal schooling. Existing literature thoroughly substantiates the link between government education spending and growth both in theoretical and empirical terms, with endogenous growth models that depict the direct influence of public education expenditures on human capital accumulation, and subsequently on long-term growth (Lucas, 1998; Glomm and Ravikumar, 1992, 1997, 1998; Eckstein and Zilcha, 1994; Kaganavich and Zilcha, 1999; Cassou and Lansing, 2001; Blankeanu, 2003). Others have expanded these models by assessing the indirect effects of public education expenditures, and have substantiated the indirect growth effects of public expenditures which accrue via private investments (Zhang, 1996; Milesi-Ferretti and Roubini, 1999; Brauninger and Vidal, 1999).

In Africa therefore, the challenges of sustaining economic growth, which we posit to be embedded in the challenge of growing a knowledge-based economy that is driven by innovation and technology, call for a critical examination of these issues across the continent. From the above analysis, it is clear that four main elements remain critical for the emergence of a knowledge-based economy: i) an economic and institutional regime that provides incentives for efficient use of existing and new knowledge, with a view to flourishing entrepreneurship; ii) an educated and skilled population, which creates, shares and uses knowledge to innovate and create economic value; iii) a dynamic information infrastructure to facilitate effective communication, dissemination, and processing of information; and iv) an efficient innovation system of firms, research centers, universities, and other organizations capable of tapping into the growing stock of global knowledge, and assimilating and adapting it to local needs. Therefore the challenges of developing into knowledge-based economies have to be conceptualized in a context that takes all the above elements into consideration, with the design of programs that could be nuanced from regular development financing and policy design, to adequately appreciate the central role of knowledge in African development.

2.1 Characteristics of Knowledge

Although the role of knowledge had long been acknowledged by classical and neoclassical economists, there is a recent realization of three distinct features which have formed the basis of the renewed attention to the role of knowledge in economic development. The *first*, as posited by Soete and Ter Weel (1999), is the recognition that knowledge can be analyzed like the accumulation of any other form of *capital good*. With this recognition, knowledge is analyzed as intrinsically endogenous to the economic and social systems, with its own specific features; that is, like any other capital good, it can be produced and used in the production of other goods and services or knowledge itself. Like other goods, knowledge can also be stored, can be subject to depreciation, may deteriorate in content and value, or may become obsolete, i.e. when new knowledge supersedes it or renders it outdated (Soete and Ter Weel, 1999). In spite of these similarities, there are fundamental differences with traditional material goods, which range form its production process, form of storage (a patent, a artifact, a design, a software program, a composition) or people and sometimes organizations. In these forms, knowledge cannot be completely alienated or appropriated. This implies that there are positive externalities associated with production, storage and distribution of knowledge, whereby it flows to others with little or no cost to the producer, while in some cases it is produced as a public good. From this perspective, knowledge has strong attribute of a non-rival good, which can be shared by many people without diminishing the amount available for others.

In spite of these attributes, there is what is referred to as *information asymmetry*, which implies the relative difference in access to information regarding a particular theme, product or entity about which an economic decision, choice or judgment is made. Information asymmetry often occurs among buyers and sellers, where by sellers usually are positioned to have more information about their products than buyers. This perhaps also explains why exchanges of knowledge are rare, and perhaps the main reasons why most firms prefer to do their in house research and development (R & D) rather than have them contracted out. This is also posited to be the rationale behind the policies which focus on the importance of investments on knowledge accumulation (Howitt, 1998). It is argued that such investments are likely to have high social rates of return, which often may be higher than the private rate of return (Soete and Ter Weel, 1999).

Second is the recognition that the increasing importance of knowledge for industrial competitiveness owes it to the emergence of a pool of information and communication technologies (ICTs), which now serve as an engine of accelerating knowledge processing and dramatically reducing costs, with a boom in international electronic networking and communication (Soete and Ter Weel, 1999). In particular, ICT has significantly increased access to codified knowledge and data across all sectors and political borders, and has

effectively linked all agencies in economies through electronic networks. Thus, ICTs have not only increased access to knowledge and information, but have also significantly enhanced knowledge memorization (mostly electronically), storage, manipulation, transformation and transfer from one user to the other. The result is improved efficiency and creativity, and in most cases improved competence and competitiveness of change-embracing individuals and systems. At the aggregate level, increased competence in processing knowledge and innovation, and in the use of economic data are critical for macroeconomic management, economic performance and income distribution.

Also, the current speed globalization emerges with associated opportunities that can only be efficiently harnessed with ICT. To effectively take advantage of these opportunities however, developing countries, especially African countries, need to have systems that are fully compatible with international trends and standards, so as to facilitate efficient application of information-related technologies at the national levels. The tendency for firms to customize production and related knowledge information will increase the adaptation needs for national entities and firms located in developing countries. For growing a knowledge-based economy in Africa, there is a need to critically examine these issues so as to smoothen the adaptation of national systems.

Third, innovation is now perceived more in terms of its ability to exploit systematically the effects produced by further utilization of existing pieces of knowledge stocks, than in the context of the discovery of new technology. This situation has significantly changed perceptions about what is meant by innovation processes. This new model, according to Soete and Ter Weel (2007 – add to ref. list), implies that a more routine use of a technological base is emerging, which allows for innovation without the need for leaps in technology. This requires efforts to access state-of-the-art knowledge and innovation, where by each firm tries to introduce procedures for the dissemination of information on the stock of available knowledge, allowing innovators to draw upon of the work of other innovators. In this process, knowledge generation critically relies on re-use of known processes, with property right issues becoming more important in accessing existing stock of knowledge.

This implies that science and technology are experiencing a shift towards a more complex structure of knowledge production activities, with increasing diversity of institutions or learning entities having the explicit goal of producing knowledge. This contrasts with the old system which has exhibited a dichotomy between deliberate learning and knowledge generation in laboratories and universities (via R& D), and productive activities in industries and other sectors where the key motivation was not to acquire new knowledge but to efficiently produce cost-effective good and services. This changing situation has emerge with a policy challenge of bringing back investments in knowledge accumulation, particularly

through education, research, innovation, knowledge transfer and diffusion, or getting knowledge to the top of the policy agenda.

2.2 Knowledge Types and Innovation

For analytical purpose, we examine the different kinds of knowledge as an entry point to generating a deeper understanding of the knowledge-based economy, following a framework proposed by (Lundvall and Johnson, 1994). From the perspective of innovation, the literature generally distinguishes four types of knowledge, which for simplicity are summarized as *know-what*, *know-why*, *know-how* and *know-who* (Lundvall and Johnson, 1994). In this framework, the *know-what* refers to knowledge about technical facts, and is close to what is normally termed technical information, such as those depicted by the presence of practicing professionals in law, medicine, and so on. The *know-why* refers to knowledge about scientific principles, such as laws of nature. This kind of knowledge underlies technological development, as well as their utilization in the production process, as is witnessed today advances in industries. The production of know-why is often organized in specialized organizations, such as research laboratories and universities. Knowledge of this kind can be accessed when firms interact with education and research entities (universities, research institutes), through outsourcing high-value labor or directly through contacts and joint activities in product development (Lundvall and Johnson, 1994). In the African context, a key challenge is to create functional linkage between public, private entities (firms) and knowledge generating institutions in the quest for transforming Africa into a knowledge economy.

Know-how is the most frequently used jargon in innovation theory, which generally refers to skills or capability to do something. Know-how is typically a kind of knowledge that may be developed and kept within the border of an individual firm. For example the industrial networks use know-how and share combined elements of it through patenting and blueprinting. The *know-who*, which is relatively new in the conceptualization, remains a critical element as it refers to who knows ‘what’ and who knows how to do ‘what’. This largely corresponds to formal and informal networking, and involves the formation of social relationships that facilitate access to experts and enhance the use their knowledge efficiently. This kind of knowledge is internal to the organization to a higher degree than knowledge of any other kind.

The key element of a knowledge-based economy is its ability to embrace these four kinds of knowledge and innovation as central elements of engaging the economy on a pathway to development in a permanent way. In this process, the knowledge types are perceived not as isolated linear processes, but as ones that depend on interplay of numerous actors particularly private firms, as well as research institutions (private and public), government entities, donors

and other private entities. Through these stakeholders, the economy then strives to facilitate a synergy between the knowledge types and innovation on the one hand, and key policy areas that relate to education, research, knowledge infrastructure, development on the other.

A more intensive interaction between knowledge generation (education, research), innovation and industry is facilitated, to the extent that they become mutually reinforcing elements that are central to economic growth. This central role is achieved through the prioritization of knowledge creation, innovation processes and technological progress. These together become the engine of economic growth, a proposition that is relatively well recognized in the literature (Grossmann and Helpman, 1991; Aghion and Howitt, 1998; Soete and Ter Weel, 1999). It is also important to know the different channels through which knowledge takes place. While it looks easier for Africa to access the know-what and know-why through reading books, attending lectures and accessing databases, the other two kinds of knowledge are rooted primarily in practical experience. For example know-who is learned in social practice and sometimes in specialized educational environments. Know-who is a socially embedded knowledge which cannot easily be transferred through formal channels of information.

2.3 Knowledge Networks

The analysis of knowledge networks is important for Africa to understand the dynamics of a knowledge-based economy. The literature acknowledges that the diffusion and use of knowledge and innovation is as important as its creation (David and Foray, 1995). The success of national economies and enterprises is underscored by their ability to effectively gather and utilize knowledge and innovation as central elements of the economy. Such economy is centered on a hierarchy of networks driven by an accelerated rate of learning, innovation and change. A network society then emerges with increased knowledge opportunities and enhanced capabilities to access knowledge, and learning-intensive relations characterize the socio-economic spheres of interaction of individuals and firms as key elements of economic growth.

2.4 Mechanisms of Knowledge Transfer

The hallmark of a knowledge-based economy is a recognition of the significance of knowledge dissemination which leads to increased attention being paid to knowledge distribution networks and national systems of innovations. These are the agents and structures which support the advances and use of knowledge in the economy and the linkages between them (OCED, 1996; Wolfe, 2005). For knowledge creation and distribution, there is a now radical departure from the linear model of innovation, which was based on the assumption of a simple conversion taking place from investments in basic science (to generate knowledge) to economic growth, passing through applied science, technology development and

marketing. In this stylized model, the process of innovation starts with basic research which leads to discoveries without any consideration to potential future applications (Bramwell and Wolfe, 2005). The discoveries then engender potential applications that get pursued and applied by firms through applied research and development, production and marketing. This model has been adapted to incorporate applied research into current into the traditional basic research role of knowledge institutions.

The growing knowledge-based economies have called for emphasizing interactive learning in the production and application of knowledge. The perception of knowledge as codified information is now been replaced by the perception of innovation as an interactive process (Lundvall, 2004). The rapidly changing attribute of the knowledge frontier is recognized, whereby successful innovation is achieved through learning as a key element of the knowledge-based economy. Bramwell and Wolfe (2005) recognize that because knowledge transfers are effected mainly through people, the ability to put knowledge into productive use requires extensive and interactive learning processes, experience and skills development, and strong networking among researchers, firms and other institutions to absorb and apply knowledge. Cohen and Levinthal (1990) emphasize that knowledge transfer is strongly conditioned by the internal knowledge base and the capacity of firms. In this context, they speak of absorptive capacity to describe the capacity of the firm to acquire and apply research results, rather than an end in itself, where overlaps between the firms internal research allows a business entity to augment its knowledge base.

3. Knowledge and Economic Growth

The linkages between education, knowledge and innovation in most poor countries are inherent in the perceived role of education in enhancing employment, improving income and reducing poverty. This role is fairly well established in the literature (Barro, 1991; Chu et al., 1995; Tanzi and Chu, 1998; Tiongson 1999; Gupta and Verhoeven, 2001). The ultimate objective of developing countries in pursuing economic growth, regardless of the development model followed, are three folds vis: long-term increases in the expected incomes of its citizens, high growth of the economy, and lower poverty levels. Thus, a policy of better-educated citizens can yield high paybacks for all these three areas, which have already been discerned by empirical investigation on various aspects of education.

The role of education in economic development is a lot more diverse than may appear, since education has a multi-dimensional influence on the economy. *Firstly*, better education increases the stock of human capital in the economy, improves the efficiency of the workforce and raises aggregate productivity. Education is thus associated with positive

externalities that have an overall welfare increasing effect on society. Higher levels of education are generally associated with the attainment of higher wages in the labor markets, which results into high economic opportunities generated in society. As summarized in Mundle (1998), empirical analysis shows that human capital plays a key role in explaining the divergence in growth rates observed across countries. The literature cites schooling as a major determinant of differences in productivity, albeit the existence of debate on the appropriate method to proxy the schooling variable in analysis.

The contribution of knowledge to economic growth is further realized through employment creation, and through augmentation of the value of the labor force and wage premiums. To begin with, with an increasing state of economic development raises the demand for highly qualified and skilled workers increases. This phenomenon is currently observed in most developing countries, including Africa, and it is a crucial element of emerging knowledge-based economies. In particular, the existence of a knowledge-based economy is marked by an increasing demand for highly skilled labor, with commensurate high wage premiums that have a potential for raising standards of living (Dietrichs and Nas, 1995). Thus improved human capital through increased knowledge and innovation is associated with higher wage rates for employees and positive effects on employment and economic growth over the long-term. In particularly, where economic growth is matched by rapid introduction of knowledge-intensive means of production, such as those based on information technologies, the demand for highly skilled workers increases (Dietrichs and Nas, 1995). On the other hand, the increased demand for skilled labor with competencies in handling codified knowledge, due to the emergence of knowledge-based economies, may have the implication of decreased demand for unqualified less skilled labor. Thus, investments in education and human capital development have redistribution effect that may redress inequity.

Having recognized the role of knowledge in economic growth through its effects on human capital development, incomes and employment, the literature presents several propositions of investment in knowledge activities (education, innovation and technology) as incentives for economic growth. The thrust of the argument is focused on the assertion that public expenditure allocations for education can lead to improvement in economic growth while promoting equity. Gupta et al. (1999) and Gupta and Verhoeven (2001) for instance, opine that both the size and efficiency of public education expenditure are important in improving socioeconomic performance. Promoting the education sector normally entails increasing public expenditure on education, which can be directed at improvement in the quality of existing education or availing more opportunities for increased access in the form of expansion of educational facilities.

In the endogenous growth models, human capital is looked at as a force that sustain growth per capita, a proposition that was supported by studies such as Uzawa (1965) and by Lucas (1998). Some argue that public spending on education is a process of human capital formation (Glomm and Ravikumar, 1992; Ni and Wang, 1994; Beauchemin, 2001; Blankenau and Simpson, 2001), and that human capital accumulation results either from both private and public services or from public spending alone. In empirical analysis, studies such as Levine and Renelt (1992) have shown that human capital, measured by secondary enrollment rate, is a robust variable in explaining growth. Thus, government policies, particularly those relating to science and technology, industry and education are critical for emphasizing knowledge-based economy. Further, there is a strong need to articulate the pivotal role of the firms and private entities, national innovation systems and knowledge infrastructures, and associated incentives which encourage investments in research and training (OECD, 1996). Therefore the challenge of developing knowledge-based economies in Africa need to be addressed in a context that takes into account the interrelation of the three elements. We examine these issues with an empirical model which examines the dynamics of public expenditure on education in African, and analyze the impact of these expenditure on economic growth continent wide.

4. Empirical Analysis of Knowledge and Economic Growth

In then context of the above framework, we develop an empirical model to assess the effects of public educational expenditure on economic growth in selected African countries. The approach uses panel data with fixed effect to estimate the effect of public expenditure on education: *first* on economic growth, and *second* on human capital development. The model is conceptualized on the premise that there is a rationale for investing in education, since the latter generates benefits both to individuals and to society as a whole. As documented in literature, earlier stages of education (primary and secondary) are particularly associated with higher social returns to educational investments, in some cases beyond private individual benefits, which strengthens the case for public expenditure. Thus the developed human capital that accumulates generates positive impacts on productivity, which has a positive effect on economic growth. This has been well substantiated with models on economic growth that use schooling as an explanatory variable in economic growth models.

The positive externalities associated with investment in the education sector serve as further justification of public expenditure in education, with redistribution and equity effects. These effects are more pronounced where there is good governance and institutional arrangements that permit the achievement of equal educational opportunities in terms of the provision and

access, as well as minimizing inefficiencies of public funding and delivery of knowledge services.

4.1 The Model

For the empirical analysis, an econometric model is developed and estimated. The purpose is to analyze the effect of public educational expenditure on economic growth for a sample of 52 African countries for the period spanning from 1999-2004. The model consists of four analytical equations that explain economic growth and human capital development. For this analysis, we proxy economic growth in terms of Gross Domestic Product (GDP) and use the growth rate of GDP per capita (*Growth*) as a dependent variable. The explanatory variables for this specification are population growth rate (*POP*), life expectancy (*LifeExpec*) and public expenditure on education (*PubExp*). This specification gives the following analytical equation:

$$Growth_{it} = \alpha_0 + \alpha_1 POP_{it} + \alpha_2 LifeExpec_{it} + \alpha_3 PubExp + \varepsilon_{it} \quad (1)$$

In this equation, we introduce the ratio of public expenditure on higher level education to total public expenditure on education as a proxy for public expenditure on education. We use population growth rate as a proxy for the population variable and life expectancy is simply in years. While we hypothesize a general positive relationship between public expenditure on education and economic growth, we proceed to specify a second equation that investigates the relationship between public expenditure on education and human capital development in terms of school enrollment. The proxy for human capital (*HK*) is the effective number of students enrolled in tertiary educational institution, which we express as a function of public expenditure on education (*PubExp*) to GDP, and average income levels in terms of GDP per capita, given as:

$$HK_{it} = \beta_0 + \beta_1 PubExp_{it} + \beta_2 GDP_{it} + \mu_{it} \quad (2)$$

We proceed do develop a third equation (Equation 3), which is intended to test the effect of public educational expenditure on long-term economic growth, using a dynamic panel methods (Arellano and Bond, 1991). The dynamic panel specification makes it possible to remove any multi-colinearity among the explanatory variables. The dependent variable is the growth rate of GDP per capita, which we express as the difference between the DGP per capita in time *t* and time *t-1*, defined as a function of public expenditure on education to GDP, which gives the following analytical equation:

$$GDP_t^{\,i} - GDP_{t-1}^{\,i} = \alpha_0 + \alpha_1 PubExp_t^{\,i} + (\varepsilon_t^{\,i} + \eta_t^{\,i}) \quad (3)$$

This specification allows us to assess the long-term effects of public expenditure for education on economic growth, through knowledge expenditure and human capital development over the long-term. Finally, we investigate the long-term effect of public education expenditure on knowledge and human capital development. The express the difference between human capital stock in time *t* and *t-1* as a function of the ratio of public educational expenditure to GDP. This specification gives the following analytical education:

$$HK_t^i - HK_{t-1}^i = \alpha_0 + \alpha_1 PubExp_t^i + (\varepsilon_t^i + \eta_t^i) \quad (4)$$

The equations were as ordinary least squares and the results are presented and discussed in the subsections following hereafter.

4.2 Data Characteristics

The model was estimated using data from the database of the UNESCO Institute for Statistic. The data covered 52 African countries and comprised the basic macroeconomic characteristics that are developed into the indicators presented in Table 1, with details in Annexes 1 to 3. These indicators comprise public expenditure on education and on other sectors, expenditure on higher education, gross domestic product (DGP) for the period 1999 to 2004 for all the 52 countries, GDP per capita and various population variables including growth rates and life expectancy.

Variables used in the analysis include public educational expenditure per student, expressed as a percentage of GDP per capita. From Table 1, it is interesting to see that on the average, public expenditure on education per student is far higher than per capita GDP in nearly all the countries by over 250%. From 1999 to 2004, this proportion seems to be declining from 350% in 1999 to about 260% in 2004. Public expenditure on education in African countries is about 19% of the total public expenditure, although this figure has dropped to about 17% in 2004. Between 80% and 90% of public expenditure in education during 1999 to 2004 was allocated to higher education. Average per capita GDP in Africa over the same period, which measures the standard of living, has been growing from about USD 1,003 in 1999 to about USD 1,357 in 2004, which indicates improved economic performance.

Growth in GDP per capita has increased from about 0.32% in 1999 to 0.5% in 2001, falling back sharply in 2002 and 2003, and then rose back to 0.5% in 2004. Population growth in African countries over the same period has been fairly constant at about 2.3%, while life expectancy went up slightly between 1999 to 2000 from 47 to 72 years, and fell back sharply 50 years in 2003. These improvements in the life expectancy have been accompanied by

reduction in the population growth rate as well, from 2.5% to 2.1%. The data is fairly reliable for all the years covered and thus suitable for the econometric analysis, with only few missing values.

Table 1: Selected Macroeconomic Indicators Used in the Analysis

Variables used in the Model	Period Covered					
	1999	2000	2001	2002	2003	2004
Public educational expenditure per student to GDP per capita (%)	350.6	309.5	309.9	266.7	261.2	263.8
Public higher educational expenditure to total public expenditure (%)	19.6	21.0	19.7	19.3	19.1	17.2
Public higher educational expenditure to total public edu. expenditure (%)	85.5	90.1	86.2	87.8	85.5	87.5
GDP per capita (US Dollars)	1003.0	1039.6	995.5	1013.7	1177.2	1357.2
Per capita GDP growth (%)	0.32	0.29	0.50	0.32	0.31	0.50
Population growth rate (%)	0.25	0.24	0.23	0.22	0.22	0.21
Life expectancy (years)	47.1	72.1	72.3	50.1	50.0	-

[a] Panel data covering 52 African countries
Source: Authors, using data from UNESCO Institute of Statistics

4.2.1 Descriptive Statistics of Variables in the Model

For the entire period under consideration (1999-2004), the descriptive statistics of the panel data show that public expenditure of higher education for the 52 African countries is higher than per capita GDP, by about 300% on the average (Table 2). For the 69 observations on this variable, the lowest value is about 9%, the highest over 1000%, with a standard deviation that approximates the mean, implying that for a majority of the countries there is no significant variation in the distribution of this variable. Public expenditure on higher education accounts for about 20% on educational expenditure, which varies considerably across countries. Average GDP per capita for the 206 panel observations is about USD 1,110, with a minimum of USD 84 and a maximum of USD 1,633. Average growth rate of GDP per capita is extremely low (less than 2%) and some cases negative, while average life expectancy for the 124 panel observations of 52 countries is about 50 years.

4.2.2 Public Higher Educational Expenditure for Selected Countries

Annexes 1 to 6 summarize the public expenditure of selected African countries on higher education to the total public expenditure on education from 1999-2004. The data reveals that expenditure differs considerably across countries, with high expenditure being recorded in those countries that recently emerged from conflict situations (e.g. Congo, Eritrea and Burundi, etc). Further, countries that have been experiencing a stable political environment

Table 2: Variables Used in the Model

Variables	Descriptive Statistics[a]				
	Observ.	Min	Mean	Max	Std. Dev.
Public educational expenditure per student to GDP per capita (%)	69	9.20	297.59	1237.4	294.29
Public higher educational expenditure to total public edu. expenditure (%)	94	40.80	87.15	100	10.84
Public higher educational expenditure to total public expenditure (%)	87	7.70	19.40	100	6.59
GDP per capita (US Dollars)	306	84.00	1111.38	8912	1633.25
Per capita GDP growth (%)	306	-0.349	0.37	0.50	0.6
Population growth rate (%)	306	-0.014	0.22	0.90	0.10
Life expectancy (years)	124	36.483	50.68	73.18	11.22

[a] Panel data covering 52 African countries
Source: Authors, estimated using data from UNESCO Institute of Statistics

have recorded lower educational expenditures on higher education, including South Africa, Morocco and Kenya. This may indicate an association between growth and expenditure on higher education, as reduced expenditure is recorded by those countries that have consistently recorded stable growth rate over the years. Overall, the data suggest that expenditure by the African countries is far below the levels which other newly emerging economies have invested in human capital development, such as China, India and Brazil.

The data also shows that public expenditure on education as a proportion of total expenditure is high. Also, post conflict countries such as Burundi recorded the highest in expenditure allocation to higher education per student as a proportion of GDP per capita. The trend remained high from 1999 to 2002, followed by Lesotho while Eritrea recorded the highest from 2002 onwards. South Africa, Morocco, Tunisia maintained relatively low levels of the proportion of resources allocated to higher education, with minimal variations in the trend throughout the period under observation.

4.3 Results and Discussion

These equations were estimated with ordinary least squares (OLS) using the STATA Software. For some equations, the estimations were done with different specifications and definition dependent variables, so as to have a deeper understanding of relationship among public expenditure on education, knowledge and human capital accumulation and short- and long-tern economic growth.

4.3.1 Public Educational Expenditure and Economic Growth

The public expenditure equation (Equation 1) was estimated in three different specifications. The results indicate that public expenditure on education is positively correlated with economic growth in African countries in all the three different specifications of Equation 1 (Table 3). In the first specification, public expenditure on higher education, expressed as a proportion of total expenditure on education has a positive effect on growth rate of GDP per capita, although the effect is not statistically significant. In the second specification, we estimate the effect of public educational expenditure on economic growth, using the ratio of public educational expenditure on education to GDP as an explanatory variable. As with the first specification, the analysis indicate a positive relationship between public expenditure on education and economic growth, though the coefficient is not statistically significant. A similar positive relationship is observed in the third specification, where the proxy for public educational expenditure is the ratio of public educational expenditure to total public expenditure in all sectors. The coefficient bears the expected positive sign but is not statistically significant.

Table 3: Public Expenditure on Education and Economic Growth

Explanatory Variables	Dependent Variable: Growth rate of GDP per capita[a]		
	Specification I	Specification II	Specification III
Constant	-0.946 (-1.42)	-1.615** (-2.59)	-0.770 (-0.86)
Public expenditure on higher education to total educational expenditure (%)	0.0267 (0.54)		
Public expenditure on higher education as a proportion of GDP (%)		0.014 (0.60)	
Public expenditure on higher education to total public expenditure (%)			0.131 (0.72)
Population growth (%)	-7.289 (-1.54)	-10.289** (-2.62)	-3.878 (-0.63)
Life expectancy (years)	0.018 (1.41)	0.0312** (2.61)	0.005 (0.31)
R-Squared	0.177	0.44	0.079
No. of Observations	35	25	36

*, **, *** = significant at 1%, 5% and 10% probability levels respectively;
[a] Panel data covering 52 African countries;
Source: Authors, using data from UNESCO Institute of Statistics

The positive relationship between public expenditure on education and economic growth expected, due to knowledge generation and human capital development which have an effect

on aggregate labor productivity. The relative weakness of this relationship, which is not statistically significant, may emanate from the fact that in many African countries, public expenditure on education per student is far higher than GDP per capita, which in some cases is more than 300% as evidenced in Burundi, Kenya, Republic of Congo, Lesotho, Madagascar and Swaziland (Table 1, also detailed in Annex 1). This expenditure on education may not be having a proportionate effect on economic growth, especially since in most cases many students fail to reach the tertiary level, which is associated with higher returns on investments. Therefore increasing expenditure on education should be targeted at enhancing the access to tertiary education as well, so as to have significant impacts on human capital development and subsequently on economic growth.

Population growth has negative and significant effect on economic growth in terms of GDP per capita in all the three specifications of the Equation 1. The effect is significant at the 5% probability level in the second specification, but is not significant in the others. This result is not surprising because in most African countries, population growth rate exceeds GDP growth rates, with a resultant increase in the demand for educational expenditure. This may result in an inability on the side of the governments to meet the needs of the educational sector, without crowding out resources that would otherwise have been spent on other sectors. In the absence of external sources of funding to augment existing public budget, this diversion of resources may deprive other social sectors such as health, transport, utilities and effectively impair on production capacity of countries and low level of investment. Therefore population growth has to be within manageable levels that would create a demand on education that matches government's capacity to respond effectively without crowding out resources and depriving other sectors.

Also, in a scenario of high population growth, whereby governments fail to provide equitable access to social services for the entire population, investment in education may not yield proportionate returns in the form of human capital development that may be sufficient to contribute to significant increases in economic growth. Finally, the positive relationship between life expectancy and economic growth is consistent with theoretical expectations. The coefficient of this variable is significant at the 5% probability level in the second specification.

4.3.2 Public Educational Expenditure and Human Capital Development

In Equation 2, we estimate the effect of public educational expenditure on human capital accumulation with two specifications. In the first specification, we proxy human capital accumulation by the effective number of student enrolled in tertiary institutions or higher education (Universities, Poly-Techniques, etc.), and in the second specification, we use the effective number of students in secondary school as a proxy. The results indicate that public

Table 4: Public Expenditure on Education and Human Capital Development

Explanatory Variables	Dependent Variable: Human capital Development[a]	
	Specification I: Effective No. of Students in Tertiary Institutions	Specification II: Effective No. of Students in Secondary Schools
Constant	8.796*** (10.01)	10.820*** (18.52)
Public expenditure on higher education as a proportion of GDP (%)	0.054* (1.67)	0.019 (0.82)
GDP per capita (%)	0.104 (0.79)	0.222*** (2.54)
R-Squared	0.039	0.148
No. of Observations	102	119

*, **, *** = significant at 1%, 5% and 10% probability levels respectively;
[a] Panel data covering 52 African countries;
Source: Authors, using data from UNESCO Institute of Statistics

expenditure on education positively affect human capital development (Table 4). The coefficient of the ratio of public educational expenditure to GDP is significant at 10% probability level for the first specification. This implies that public expenditure on education does contribute to knowledge and human capital accumulation, which may positively affect economic growth.

The positive effect of public educational expenditure on human capital is consistent within the second specification of the equation, where the dependent variable is the effective number of students in secondary school, but not significant. This may be related to the fact that in African countries, the number of people with access to secondary school education is usually higher than those who eventually get access to tertiary or higher education. This increased access to secondary education may create a reservoir of secondary school graduates ready to enter university, without a corresponding access opportunity. Also, unequal distribution of resources within African countries may induce pressure on people to seek jobs even before acquiring tertiary education, thus bringing down the average working age lower, as is observed in many African countries.

GDP per capita has a positive effect on human capital accumulation, i.e. increase in the effective number of students in tertiary institutions. The coefficient is however not significant, with a t-statistic of 0.79. In the second specification however, which proxy human capital as the effective number of students in secondary schools, the coefficient of the GDP per capita retains its positive sign and is robust and statistically significant at 1% probability

level. This further corroborates the earlier findings of the positive effects of economic growth on human capital development.

4.3.3 Long-Term Effects of Public Expenditure on Economic Growth and Human Capital

In Equation 3 we estimate the long-term effect of public educational expenditure to GDP on economic growth, using the dynamic panel method. This analysis is important so as to assess the returns on initial public investments in education over the long-term. The results indicate that public expenditure on education, expressed as the ratio of public educational expenditure to GDP, is negatively related to economic growth over the longer term (Table 5). The coefficient is statistically significant at 5% probability level. The result is unexpected but not surprising, since the level of public educational expenditure per student in several African countries is far higher then the GDP per capita, in some cases over 300% (see Annex 1). This may imply that African governments spend more on education, perhaps beyond its own budgetary sources, since the public sources of financing education in most African countries are augmented by grants or loans, which may sometimes associated with longer-term debt service burden.

Table 5: Long-Term Effects of Public Educational Expenditure on Economic Growth and Human Capital Development

Explanatory Variables	Dependent Variables[a]	
	Equation 3: Growth rate of GDP per Capita	**Equation 4: Effective No. of Students in Tertiary Education**
Constant	1.360 (1.21)	3.244** (2.33)
GDP_{L1}	1.021*** (9.42)	--
Public expenditure on higher education as a proportion of GDP (%)	-.450** (-2.24)	2.144*** (5.17)
Arellano-Bond test for AR(1)	-1.03	-3.19***
Arellano-Bond test for AR(2)	0.77	4.34***
No. of Observations	62	58

*, **, *** = significant at 1%, 5% and 10% probability levels respectively
[a] Panel data covering 52 African countries
Source: Authors, using data from UNESCO Institute of Statistics

Also, the often lack of capacity to retrain trained human capital, with a subsequent brain drain are further reasons behind this observation. Because the expected results of human accumulation is not realized due largely to high dropout rates and brain drain, there is less than proportionate returns to public investment in education on the longer term. Therefore,

for educational expenditure to get the highest return in terms of knowledge accumulation and human capital development, programs should be structured such that students offered opportunities to reach the tertiary level of education, so as to make public education expenditures worthwhile and positively impact on economic growth on the longer term.

In particular, as indicated in the results of Equation 4 (Table 5), we see that the long-term effect of public educational expenditure on human capital accumulation, which we proxy by the effective number of students in higher education is positive and significant. The result of the regression is statistically significant at 1% probability level, using the ratio public educational expenditure to GDP as an as an explanatory variable. Since the indicator for human capital accumulation is effective number of students in tertiary institution, then it implies that improving the capacity of governments to retain trained graduates and develop strategies for targeting the creation of jobs, are crucial in African countries. These results are consistent with finding in other parts of the world as corroborated in the empirical literature.

5. CONCLUDING REMARKS

From the review, it is evident that human capital development in Africa may remain elusive unless governments of African countries invest equitably in education and social services. The role of intellectual capital can not be underestimated in the continent's drive towards knowledge-based economies. There is a strong need for governments exert efforts in all stages of creation, expansion, and application of knowledge so as to narrow down the ever increasing knowledge gap, as well as human capital accumulation in order to maximize returns to educational investments.

Indeed, there is evidence that African countries are making reasonable investments in education and knowledge generation, in relation to the size of their generally feeble economies. The descriptive statistics, for instance reveal that on the average, public expenditure on education per student is far higher than per capita GDP in most African countries by more than two folds. The data also shows that public expenditure on education in many African countries, on the average, was about 20% of the total public expenditure, a figure that has declined to about 17% between 2000 and 2004. In physical terms however, these investments are relatively low compared to elsewhere in the world where (e.g. Asia), where targeted investments in knowledge generation, utilization and innovation have led to the emergence of knowledge-based economies.

Also, public expenditure on education differs considerably across countries, with the highest expenditure recorded in countries emerging from conflict situations, including Congo, Eritrea and Burundi, while countries with relatively stable political environment record lower

educational expenditures, including South Africa, Morocco and Kenya. With the highest education expenditure recorded in post conflicts countries, it is reasonable to assume that most of this expenditure is targeted at availing basic educational infrastructure and basic education, and less on tertiary education, innovation and application of knowledge products to productive processes, and diffusion into the economy as a public good.

From the literature review, we see that in a knowledge-based economy the diffusion and application of knowledge is equally as important as its creation. An excessive focus on the latter hinders the maximization of its external economic effects and impair its characteristics as a public good, thus impeding the effective distribution of intangible intellectual capital. Undoubtedly, policy reform, especially in effecting public expenditure targeting on the critical elements of knowledge dissemination and utilization, remains key. In this regard, there is a unique opportunity for donors and development practitioners to focus their investments on these issues to augment Africa's intellectual capital necessary for emerging knowledge economies.

On the *short-term*, there is a positive relationship between public expenditure on education and economic growth in Africa, as well as on knowledge generation and human capital development, which have a potential to positively effect aggregate labor productivity. This is confirmed by all the three specification of the public expenditure equation (Equation 1) as well as the human accumulation equation (Equation 2). On the *long-term* however, public expenditure is negatively related to economic growth, due to the often lack of capacity to retrain trained human capital, with a subsequent brain drain (Equations 3 and 4). Because the expected results of human accumulation is not realized due largely to high dropout rates and brain drain. Lack of capacity of African governments to retain trained human capital, coupled with brain drain and increased school dropout rates, lead to lower returns on public investment in education on the long-term.

For donors and international financiers therefore, there is a strong need to work with government to ensure that education financing programs are structured in a way that offer students the opportunities to reach the tertiary level of education and to enhance governments capacity to retain trained manpower through incentive and job creation, so as to guarantee ling-term positive impact of such educational investments on economic growth. This means that accessibility and attending high educational institutions should be emphasized by African countries in tandem with skill improvement, increasing the size of research and development workforce, adoption and utilization of science and technologies.

Thirdly, there is a potential for the positive effect educational investment on economic growth to be offset by high population growth, especially when the latter exceeds GDP growth rates,

as is observed in most African countries. This is substantiated in the analysis. The higher demand on education associated high population scenarios and the resulting pressure on government educational budget may lead to diversion of resources from other sectors or failure to meet the demand, especially in the absence of external sources of funding to augment existing public budget. Therefore there is need for population growth to be kept within manageable levels that match government's capacity to respond effectively without crowding out resources and depriving other sectors. In a scenario of high population growth with unequal access to social services for the population, returns on investment in education in the form on human capital development become lower and insufficient to yield significant increases in economic growth. Thus, there is a need for development assistance assume the role of facilitating a link between education planning and investments in knowledge generation, population growth and access to other social services.

Also, there is a need for African countries to develop attractive remuneration packages that enables countries to retain and utilize trained human capital so as to reverse the bran drain. In particular, Africa should focus on improving the infrastructure for the expansion and application of knowledge and making it more competitive, and focus on targeted job creation to continuously absorb the increasing number of qualified labor force that emerges out of tertiary institutions. This alludes to the need for the formulation of strategic policy measures that are sound and suitable for coping with the needs of emerging knowledge-based economies. The educational attainment of youth and adults should be high for attaining maximum returns and also to propel the economy further through the opportunities that emerges with the occurrence of knowledge-based economies.

Finally, there is a need for appropriate models to be utilized to improve on the public expenditure on higher education to facilitate the emulation of emerging knowledge economies especially in Asia, and learning from their experiences. As we focus on human capital accumulation, knowledge generation and strengthening the labor force, the structure of the labor market also changes, and this calls for a need for diversification of skills. The service industry, which usually employs the largest number of females, also emerges and should be given incentives to strengthen its response to the needs of these social groups. The changing structure of the demand for skilled and unskilled labor, usually in favor of skilled workers with emerging knowledge economies also needs to be given attention to ensure that inequity effects are minimized.

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ANNEXES

Annex 1: Public Expenditure On Higher Education Per Student to GDP per Capita (%) (Selected Countries)

COUNTRY	1999	2000	2001	2002	2003	2004
South Africa	64.3	57.8	54.4	53.3	49.5	46.8
Burundi	1190.1	966.5	1081.9	636.5	579.6	442.1
Kenya	-	249.8	268.6	-	-	274.7
Congo	404.9	-	277.3	245.9	-	-
Lesotho	1237.4	670.7	647.4	602	-	-
Morocco	109.6	125	106.6	100.9	92.3	87.2
Tunisia	-	78.7	70.5	62.8	80.9	-
Madagascar	180.9	189.6	184.1	184.2	-	-
Swaziland	392.2	487	305.6	240.2	343.4	320.1
Eritria	-	-	428.9	426.8	699.8	1105.4

Source: Authors, using data from UNESCO Institute of Statistics

Annex 2: Public Expenditure on Higher Education to Total Public Expenditure on Education (%)(Selected Countries)

COUNTRY	1999	2000	2001	2002	2003	2004
South Africa	15.2	14.5	14.5	14.6	14.1	13.3
Burundi	24.3	26.9	27.8	24.9	20.8	18.3
Kenya	11.5	11.7	13.1	-	12.1	12.9
Congo	31.1	-	32.6	25.5	-	-
Lesotho	21.9	16.7	18.6	18.6	-	-
Morocco	17.1	18.5	17.9	16.3	15.8	15.3
Tunisia	-	21.7	22.1	22.8	26.6	-
Madagascar	14.3	11.9	12.2	-	-	-
Swaziland	32.1	36.8	16.3	22.4	25.5	26.6
Eritria	-	-	14	14.9	24.6	31.9

Source: Authors, using data from UNESCO Institute of Statistics

Fig 1: public expenditure on higher education level per student to GDP per capita (%)

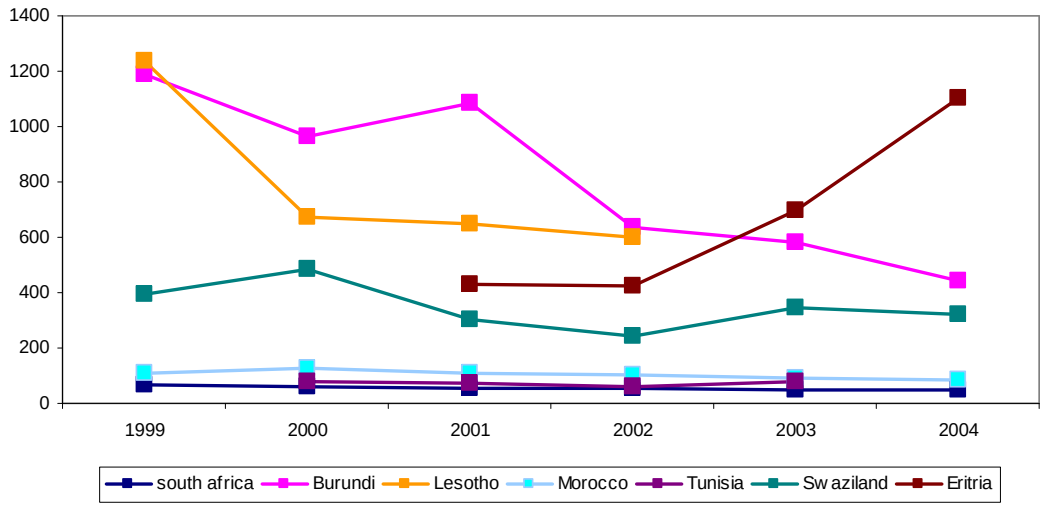

Fig 2: public expenditure on higher education level to total public expenditure (%)

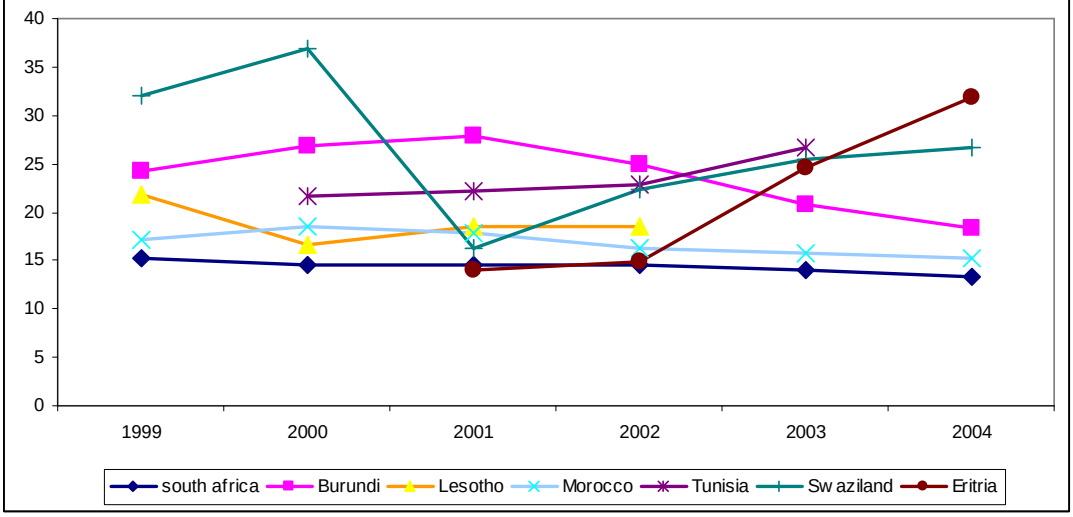

Fig 3: public expenditure on education to total public expenditure (%)