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IMPACT OF EDUCATION ON ECONOMIC GROWTH. THE CASE OF RWANDA

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ABSTRACT

This paper focused on the impact of education on economic growth in Rwanda. It was an attempt to explore the extent to which investment in education level by the Government of Rwanda affects its economic growth hence the output level is achieved. The government of Rwanda has year by year increased budget for education. In 2019/20, the Government of Rwanda allocated FRW 310.2 billion to the education sector, up from FRW 278.2 billion in 2018/19, reflecting an increase of 11.5 per cent in nominal terms or 10.4 per cent in real terms. The study adopted Cobb-Douglas production function with rate of returns being constant to scale where human capital is treated as an independent factor of production in the human capital augmented growth model. Data that exists from the National Institute of Statistics Rwanda for a period 1999 to 2019 reports. The results revealed that human capital plays an important role in economic growth mainly as an engine for improvement of the output level. There is compelling evidence that human capital increases productivity, suggesting that education really is productivity-enhancing rather than just a device that individuals use to signal their level of ability to the employer. The variables were significantly fit the model as it was shown by the R^2 *Adjusted –higher than 55% which shows strong goodness of fit in the short run estimated model. As conclusion since there was no problem of multicollinearity the goodness of fit is achieved. The study concludes that education has positive effect on economic growth. The study recommends that the government of Rwanda should encourage the citizen to engage in education. The government of Rwanda might do this directly by supporting infrastructure, small farmers, building schools in order to resolve those problem and external aids have significant on economic growth.*

Keywords: *Education, Human Capital, Economic Growth, Cobb-Douglas Function, Rwanda*

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INTRODUCTION

Globally, there are many reasons why education is important. First, it increases the collective ability of the workforce to carry out existing tasks more quickly. Second, secondary and tertiary education especially facilitate the transfer of knowledge about new information, products, and technologies created by others (Barro & Lee 2010). Lastly, by increasing creativity it boosts a country's own capacity to create new knowledge, products, and technologies. The World Economic Forum 2016 notes that education is a critical component of a country's human capital as it increases the efficiency of each individual worker and helps economies to move up the value chain beyond manual tasks or simple production processes. Human capital has long been considered the most distinctive feature of the economic system and further work has proven the impact of education on productivity growth empirically (Haldar & Mallik, 2010).

Education is a leading determinant of economic growth, employment, and earnings. Ignoring the economic dimension of education would endanger the prosperity of future generations, with widespread repercussions for poverty, social exclusion, and sustainability of social security systems (Woessman, 2015). For every US$1 spent on education, as much as US$10 to US$15 can be generated in economic growth (UNESCO, 2012). If 75% more 15-year-olds in forty-six of the world's poorest countries were to reach the lowest OECD benchmark for mathematics, economic growth could improve by 2.1% from its baseline and 104 million people could be lifted out of extreme poverty (BNR, 2013).

Von Ludger and Loening (2002), notes that there has been increase in education levels since the 19th century which is estimated to account for between one-fifth and one-third of economic growth in any country. In addition, massive increases in schooling around the world, where now more than 9 in 10 children are enrolled in primary school, have shown that productivity and growth have been interrelated and improving. The macroeconomic evidence on level effect is consistent with microeconomic estimates of private rates of return to schooling, it appears, however, that there are also significant long-term growth effects that is the more educated is the workforce, the better it is able to implement technological advances (Lutz *et, al.,* 2008). Many growth models include education and offer predictions as to the implications of education policy changes on macroeconomic performance (Weir, & Knight, 2000).

In Africa most countries have their budget invested towards education. Among the selected East African countries with comparable data in 2017/19, Kenya allocated 23 per cent of total national budget to education, followed by Tanzania mainland with 17.3 per cent, Rwanda with 11.5 per cent, while Uganda allocated 8.9 per cent of total national budget to the education sector (UNICEF, 2020).

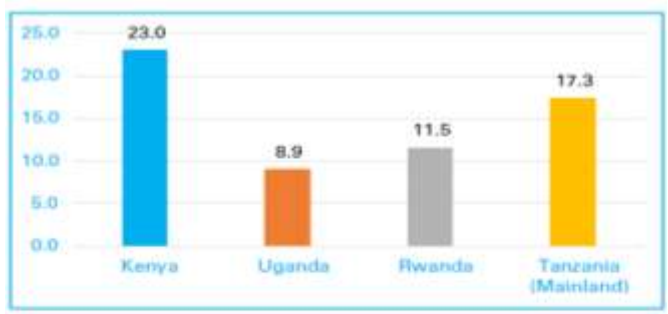

Figure 1: Education budget % of total government expenditure in selected ESAR countries, FY 2017/18
Source: *UNICEF- Budget briefs*

In Rwanda education is a government priority. The government of Rwanda is undertaking a major and far-reaching rebuilding effort after the genocide against Tutsi in 1994 and has committed itself to developing a society that is democratic and participatory and practices good governance (Jean, 2008). A necessity for such a society is human resource development that reaches down and out to all sectors of the nation and ensures that, within the limits of the country's

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resources, all individuals are given the opportunity to obtain the basic education and training that will facilitate their participation and decision-making in the economy, politics and society (DFID Rwanda, 2012). Therefore, Rwanda has embarked on the elimination of disparities in education a cornerstone of its rebuilding efforts (Abagi, Rubagiza, & Kabano, 2002).

Education is key to this transformation, and Rwanda has achieved remarkable success in increasing access to education, with primary school net enrollment standing at 97 percent (Kigabo, 2008). These forces and the needs of the future economy demand that the education sector focus on improving the quality and relevance of education and better fostering skills (Lee, 2010). Most regions in the world will reach a saturation point in terms of the number of years of schooling that workers complete, but there is still much improvement to be gained in the skills acquired within those years. Moreover, as technology continues to change, on-the-job training to update and adapt skills and lifelong learning will become increasingly important (Lawn, 2007).

Perspective of the growth theory in Rwanda

Rwanda's aspirations to reach upper-middle-income status by 2035 require drastic improvements in human capital. Economies that have grown rapidly over an extended period have made substantial investments in the education and health of their citizens (Abdullah, 2013). Human capital includes the knowledge and skills of the population, and it results from investments in education and health (MINEDUC, 2017a). Ultimately, human capital investment and economic growth form a virtuous cycle: greater human development increases economic growth, and greater economic growth finances further human development (Fukase, 2010). Cross-country analysis demonstrates that countries that invest in human capital early in the cycle enjoy the benefits of this virtuous cycle, whereas countries that experience high initial economic growth without investing in human capital almost always fall into a vicious cycle of low human capital followed by a slowdown of economic growth (Ranis, Stewart & Ramirez 2000).

In Rwanda, policies and development strategies pointed out the key role of higher education, research, Science and Technology (S&T) and technical and vocational training in bringing about the structural economic changes sought (Habyarimana, 2007). To this end, the government opted for strengthening the capacity of main institutions of higher learning in Rwanda, such as the Kigali Institute of Science and Technology (KIST) (named later College of Sciences and Technology under University of Rwanda), to enhance their ability to add to the labor market qualified mid and high-level workers (Kantengwa, 2009). The project was then in line with the Rwanda Vision 2020 (Pillar 2 Human resources development and knowledge Economy) and Education Sector Policy (2008). Furthermore, the project was also in line with the Bank Group Country strategy paper (CSP) for Rwanda (2008-2011) and during its implementation it was backed by the subsequent CSPs (2012-2016 and 2017-2021). The project was also in-line with The Bank's Medium Term Strategy (MTS) 2008 to 2012, and The Bank's 2008 Higher Education Science and Technology (HEST) Strategy identified ICT development, Technical and Vocational Training regional integration as priority areas; the Bank's Human Capital Strategy (2013-2017) under its pillar of skills and technology for competitiveness and jobs; Job for Youth Strategy (2016-2025) (IMF, 2015). This vision is premised on the ability of Rwanda's education system to produce enough and appropriately skilled workforce capable of realizing this aspiration, as well as upgrading the skills and competencies of the existing workforce. The impact expected from successfully delivering this ESSP is to ensure Rwandan citizens have sufficient and appropriate skills, competences, knowledge and attitudes to drive the continued social and economic transformation of the country and to be competitive in the global market. The central theme of this ESSP is to improve learning achievement and to ensure that learning is relevant to the nation's development priorities. This can be seen in: -

Kigali Institute of Education (K.I.E.) opened its doors in 1999, a few years after the horrible 1994 genocide against the Tutsi. The Statute of Kigali Institute of Education (KIE) was enacted by the Law N° 49/2001 of December 27th 2001. Its prime aim is to produce qualified teachers to serve the nation. The genocide claimed many qualified Rwandans in various disciplines; education was one of the affected sectors. KIE was conceived to serve as a major instrument for dealing with the problem of the country's lack of sufficient numbers of professionally qualified primary and secondary school teachers (Mukamusoni, 2006). KIE embarked on its mission with the seriousness it deserved. Starting off on a modest number of enrolments, the institute has since grown to leaps and bounds with numbers reaching thousands. Rwanda now boasts of many well-trained teachers serving across the country. They have greatly filled the gap that was left by the killings during the genocide against the Tutsi (Education Development Centre, 2009). KIE has been on the top doing the training of secondary and college teachers, Kavumu and Rukara Teacher training colleges doing the training of primary teachers. This is a smart chain as the institute intends to have all teachers right from Kindergarten trained to acquire degrees in education. Since Education promotes Sustainable Development and is also a vision that seeks to empower people to assume responsibility most likely women for creating a sustainable future. This is what a post genocide society like Rwanda has invested with KIE to enhance growth.

Reconstruction efforts following the genocide against Tutsi have been associated with an emphasis on the role of science technology and engineering in economics of transformation. An example by the decision by the Rwanda government to convert military barracks into a home for new university the Kigali institute of science, technology and management (KIST), the first public institute of higher learning in Rwanda. KIST aims to contribute to Rwanda economic renewal through creation of highly skilled manpower. KIST was created as a project of UNDP in 1997. It was established with the help of the project and the German Agency for Technical Cooperation (GTZ) as the implementing agency. KIST was officially inaugurated in April in 1998. In July 2002 it held its first graduation awarding 403 diplomas and 62 degrees to its 465 proud pioneers in management and computer disciplines. His Excellency President Paul Kagame has also revamped the higher-education system in an effort to produce the graduates with the science, technology, engineering and mathematics skills that the country now needed. The country's seven tertiary institutions were merged into a single University of Rwanda, which was launched in 2013. The university has 14 campuses nationwide and more than 30,000 students—one-fifth of them studying science or engineering (UNESCO, 2015)

Genocide against Tutsi and civil war decimated the country's human capital, and created a desperate need to reconstruct the country's TVET system. TVET is provided by technical secondary schools and vocational training centers at the secondary level, as well as by polytechnics at the post-secondary level. The government has in recent years adopted various measures to better integrate the different forms of TVET and expand the system, including the creation of the TVET qualifications framework and the establishment of a single oversight body, the Workforce Development Authority (WDA) under the Ministry of Education (MINEDUC). The TVET system has since grown significantly, although enrollment levels still fall short of official goals. The government recently sought to boost enrollments in TVET programs to 60 percent of all upper-secondary enrollments by 2017 (up from 38 percent in 2013). While the total number of upper-secondary TVET students has increased from 64,866 in 2013 to 79,388 in 2018, the percentage of TVET students among all upper-secondary students actually dropped to 34 percent. There were 360 TVET institutions and 102,485 learners at all levels of TVET in Rwanda in 2018, most of them enrolled in private technical secondary schools (Republic of Rwanda's Vision 2020, EDPRS 2, 2017).

The government of Rwanda has ensured access to pre-primary education so as to increase pre-primary net enrolment rates from 17.5% (2016) to 45% by 2024. This is being achieved through providing standardized Early Childhood Education schools in all villages through partnership with private sector, communities and putting in place public-private partnership models for ECE and ECDs to enhance cost-effective rollout. The provision of education at lower primary level is being strengthened so that children develop better foundational skills in Kinyarwanda, English and Mathematics to enable them perform well at upper primary and secondary levels. Technical and Vocational Education and Training (TVET) are further promoted. In this regard the proportion of students pursuing TVET set to increase from 31.1% in (2017) to 60% by 2024 to address the challenge of mismatch in labor market demand. Increase effort to reduce dropout in primary, lower secondary and upper secondary from 5.6%, 6.3% and 3% in 2017 to 1.2%, 1.7% and 1% respectively by 2024. This is being done through: (i) introducing Abajyanama b'Uburezi/Education community workers at cell levels (Utugari). (ii) improving school data management system (SDMS) by introducing student identification numbers to track students' evolution and fight school dropouts, (iii) working with parents through School General Assembly Committees (SGACs) (Bulman *et al.*, 2014).

The government of Rwanda is committed and has done a lot of transformation in education. Over the past four years, the school drop-out rate has remained low (around 5 per cent). However, in 2018 there was a slight increase by one per cent from 5.6 per cent in 2017 to 6.7 per cent. The drop-out rate in primary school is slightly higher for boys (7 per cent) than for girls (6.3 per cent). Both drop-out and repetition remain an issue within the Rwandan education (MINECOFIN, 2018). The budget allocated to the Ministry of Education, its agencies and districts has shown a nominal increase over the past four years. In 2019/20, the Government of Rwanda has allocated FRW 310.2 billion to the education sector, up from FRW 278.2 billion in 2018/19, reflecting an increase of 11.5 per cent in nominal terms or 10.4 per cent in real terms (UNICEF, 2020).

Figure 2: The Education sector budget in nominal FRW billion and as % of total budget and GDP

The government has been proactive in the education sector by setting its strategic direction and adopting policies in critical areas of the education system. In line with the Millennium Development Goals (MDGs) on education particularly, the Government of Rwanda committed itself to advancing Education for All (EFA), thus progressively rendering the primary education free, then established a free 9YBE and later the 12YBE in an increasingly decentralized education system (UNDP, 2010). However, this highly commendable government's policy agenda requires considerable implementation and monitoring capacity at central, district, school and teacher levels in order to optimize

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expected results (UNDP, 2010a). As the sector begins to address emerging challenges, appropriate measures and attention needs to be paid to the need of ensuring adequate capacity and quality education (World Bank, 2015).

The Nine-Year Basic Education (9YBE) is a major priority for the Government of Rwanda. As set out above it increasingly replaces the distinction between primary (school years P1 – P6) and lower secondary school (schools' years S1 - S3). The 9-year basic education encountered a challenge of shortage of classrooms, which led to the double use of the available rooms in morning and afternoon sessions for different groups of students/ pupils (World Bank, 2016).

12YBE program was launched in 2012 after the successful implementation of the 9YBE. It will provide all Rwandans who reach the end of 9YBE with an entitlement to a further three years of education. This learning could either be in a Teacher Training College (TTC), General Secondary or in Technical, Vocational, Educational and Training (TVET). An expansion of opportunity at the upper secondary level is the right strategic decision that Rwanda opted for. It reflects the need to ensure improved access for the larger cohorts of students who will finish 9YBE in the future, but also ensures a larger pool of people entering the labor market with higher level skills. Given all these commendable achievements, Rwanda is recognized as one of lead countries in achieving education for all and the civil society of Rwanda appreciates these great achievements (EICV, 2011).

Even if average educational attainment is constant over time, the stock of human capital could be increasing in a way that drives rising levels of output. Yet this argument runs into difficulties, even at the level of high institution of learning. These includes: -

Schooling versus skills

Education is key since it leads to growth and innovations (Pillay, 2010). Growth can generate virtuous circles of prosperity and opportunity. Strong growth and employment opportunities improve incentives for parents to invest in their children's education by sending them to school. This may lead to the emergence of a strong and growing group of entrepreneurs, which should generate pressure for improved governance. Strong economic growth therefore advances human development, which, in turn, promotes economic growth (GoR, 2010).

Rwanda's government in partnership with Microsoft is building "smart" classrooms across the country and plans to bring computers, internet connectivity, and basic software packages to all of Rwanda's schools. The country's development strategy prioritizes "science and technology education and ICT skills," and emphasizes "vocational and technical training in the fields of technology, engineering and management" to develop human capital and turn Rwanda into a "sophisticated knowledge-based economy" (Republic of Rwanda, 2014).

TVET is one of the most powerful tools to fight poverty. Not only do TVET provide skills to gain paid employment but also to promote and support creativity, innovation and entrepreneurship to develop the ability to create jobs and employment opportunities. TVET trains the youth to acquire basic skills relevant for employment and wealth creation. The apprenticeship creates a clear path to gainful employment. Developing countries should put much emphasis on technical training to build a strong skilled labour force (NISR, 2015).

Yet there is much evidence that measuring skills and education by the number of years workers spend in school is flawed. The quality of education and the level of skills gained while in school vary widely across the Rwanda. For example, In the wake of COVID 19 Rwandan biomedical engineers developed a ventilator which is the first locally made ventilator in the central African country. The developers came up with the idea of producing locally made ventilators following the reported breathing complications caused by COVID-19 in areas where the virus has killed people due to lack of ventilators, hence a boost to economic growth.

Similarly, Nkurunziza (2015) have developed measures of human capital that account for both the quantity and the quality of schooling, combining average years of schooling and performance on international student and adult skills assessments. Their results also find that high-quality schooling has a significant impact on growth across countries.

Including skills when measuring human capital has important implications for the impact of education on productivity and economic growth (MasterCard foundation, 2017). Rather than school progression and attainment alone, learning outcomes and skills are increasingly used to measure the success of education systems, and disparities in skills across countries have called attention to low-quality schooling in many countries. Together, these findings emphasize that skills, and not just schooling, are an important factor in productivity. It is no longer sufficient to focus on increasing the number of years workers spend in school, but instead policies aiming to improve human capital and productivity must focus on quality and the relevance of skills learned.

Skills and Technology

The skills that are needed to best complement technology in the workplace are particularly relevant for the economy today and into the future. While advances in technology would predict increases in productivity, allowing workers and firms to produce more with less time and resources, productivity growth in fact has been declining recently (EDPRS 2, 2013). For example, Positivo BGH, the Latin American company that produces laptops locally with various specifications to meet the needs of students. The computers are made in Rwanda, by Rwandans, for Rwandans and for the rest of the world. The company has employed most ICT students from schools in Rwanda. This emancipates the skills versus technology of IPRC students in Rwanda (IMF, 2014).

In addition to the increased base of technology is the Mara phone, which has a production plant in Rwanda and South Africa launched in Kigali in 2019. The company has a capacity of producing 1.5million phones (mara X and Z models) annually. In Rwanda the plant has in the four months managed to put over 40, 000 phones on the market. The technology being applied here is gained from the different students who have qualified in Rwanda. This makes Rwanda and Africa at large to have smartphones being manufactured. This lays out evidence on which skills are uniquely human and will improve productivity and innovation by working with technology, versus the increasing list of skills that can be automated.

Rwanda's first domestically built car rolled off the assembly line at Volkswagen's (VOWG p.DE) new factory in Kigali on 2018 as Europe's biggest carmaker taps into demand for ride-sharing to expand in the region. The $20 million investment, created up to 1,000 jobs, and is an example of much needed spending by overseas firms in the nation, which receives $1 billion in foreign aid and development assistance but is making business-friendly reforms. Mostly the students from TVETs are the one employed by the company due to vast knowledge, skills and technology.

This includes both manual tasks such as working on a factory assembly line as well as cognitive tasks like accounting (Aedo *et, al.* 2013). As digital technologies continue to advance, a central question is how education systems can equip young people with skills that will allow them to work with technology to increase productivity and growth (Winthrop & McGivney, 2016).

Changes in technology today are predicted to make the labor market and the jobs of the future fundamentally different from the world of work today (World Economic Forum 2016). In order to improve productivity, young people will need the right mix of skills to take advantage of the new technologies. Strong essential skills like literacy, numeracy and academic knowledge are crucial, but workers will also need to be flexible and adaptive, able to think critically to filter and analyze large amounts of information, and will need strong interpersonal skills to collaborate and effectively communicate with diverse groups of people.

Skills and Inequality

Before giving people more opportunities to participate in society, we need to address some specific obstacles to participation. Often the most vulnerable communities aren't recognized as equals in their community (Winthrop & McGivney, 2014). As a result, they lack representation, power, and status. But, at an individual level, education is a basic human right for all. One of the biggest inequalities that perpetuates the cycle of poverty is gender. When gender inequality in the classroom is addressed, this has a ripple effect on the way women are treated in their communities. When girls are welcomed into the classroom, they can build skills, gain knowledge, and socially grow during their formative years. This establishes a foundation for lifelong learning.

Around the world, gaps in schooling have been narrowing for generations, with more and more young people and adults attending and completing formal education than ever. Examining their extensive dataset on educational attainment of adults from the 19th century to today, Barro and Lee (2015) find that faster rates of human capital accumulation in developing countries relative to advanced countries helped to reduce the worldwide per-capita income gap. They note that while for some time the world was divided into those with and without education, by 2040 most countries will achieve similar levels of schooling. Other research finds that global gaps will persist much longer (Psacharopoulos, 2006), but undoubtedly schooling levels are rising in all regions.

However, despite increased access to schooling, deficiencies and lags in the quality and relevance of education and skills needed to be successful in the future world of work are limiting the impact of the new technologies on productivity and economic growth. They are also contributing to a rise in income inequality. Technology and automation have polarized the labor market by types of skills demanded. Not only is the demand for interpersonal and analytical skills on the rise, but there has also been growth in low-skill services jobs. Labor market polarization and unemployment due to skills mismatch can lead to high levels of inequality, and according to the 2016 *Global Risks Report*, unemployment and underemployment are the top risk for 31 countries (World Economic Forum, 2016).

In Rwanda though, 85 per cent of all girls aged six and above have ever attended school. 50 per cent of females have not completed primary education and 4.5 per cent of females have attained upper secondary school, this is according to The Fifth Integrated Household Living Survey (EICV5). It is easy for a woman to be economically empowered if they are educated. This helps them to fight poverty; they are equipped with enough knowledge on how to groom their children with the right values. Such women are equipped with knowledge on matters such as health care, something that facilitates proper feeding of children, good care during pregnancy among other things.

The focus on human capital as a driver of economic growth for developing countries has led to undue attention on school attainment. Developing countries have made considerable progress in closing the gap with developed countries in terms of school attainment, but research has underscored the importance of cognitive skills for economic growth. This result shifts attention to issues of school quality, where developing countries have been much less successful in closing the gaps with developed countries. Without improving school quality, developing countries will find it difficult to improve their long run economic performance (Hanushek *et. al,* 2017).

Evidence on education and growth

In Rwanda the drivers of growth were launched in Kigali on November 10th, 2018 and have already proven change. It has brought new ideas and fresh thinking to fundamentally shift the mindset toward long-term economic development and reform in Rwanda. Education has contributed to capacity building within the government for long-term strategy development and has informed the country's Vision 2050 and 2018-2024 Seven-Year Plan. Education was used as an organizing framework for 2018 National Leadership retreat, a key political decision-making event. Education has provided a reference point for action on human capital, Information Communications Technology (ICT), private sector development, regional integration and trade, infrastructure, agriculture and urbanization. For instance, its emphasis on human capital development found strong resonance among Rwanda's senior leadership and led to an additional $150 million support from the World Bank for human capital development.

Pritchett (2001) has argued that poor policies and institutions have hampered growth in many of the least developed economies, directing skilled labor into relatively unproductive activities, hence disrupting the statistical relationship between education and growth in samples that include less-developed economies. Krueger and Lindahl (2001) suggest that the problem of unobserved variation in educational quality is exacerbated in panel data. Taking data quality into account, they show that increases in the stock of schooling do improve short-run economic growth. Hanushek and Woessmann (2015) confirm that direct measures of labour-force quality, from international mathematics and science test scores, are strongly related to growth.

Education impacts on household livelihood in Rwanda

Education has played a major role in making development a success in Rwanda. Achieving rapid economic growth, 26 years after the genocide against Tutsi the country has been transformed from one of the world's poorest nations into a lower-middle-income country (World Bank, 2016). Over the last decades, Rwanda's focused investments in developing primary education, combined with greater access to all levels, have paid off and have enabled an increasing proportion of the population to exploit the advantages of expanding economic opportunities (OECD, 2013). The Rwandan Government has implemented various education policies that contribute to higher enrolment in education, but has become aware that these policies might be less effective for children from poor families.

Report by UNESCO (2012) notes that the rental income constitutes investment capital for various livelihood needs, for example, paying education fees for family members or running a small business. Therefore, the loss of such rental income has significant effects in some households. Moreover, the households that have been waiting to be relocated also reported a loss of saving capacity due to a decline or loss of income. Last, as a consequence of loss of saving capacity, households reported the loss of access to loans, especially in their community-based saving groups, due to their failure to make contributions.

Econometrics analysis on impact of education on economic growth; case of Rwanda

Stevens and Weale (2003) believed that at a more specific level, a wide range of econometric studies indicates that the incomes individuals can command depend on their level of education. If people with education earn more than those without, shouldn't the

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same be true of countries? If not the rate of change of output per hour worked, at least the level of output per hour worked in a country ought to depend on the educational attainment of the population. In order to determine the extent to which education impacts economic growth in Rwanda an econometric model was carried out where a Cobb-Douglas production function with constant returns to scale was used and human capital is treated as an independent factor of production.

Preliminary tests were conducted for stationarity, multicollinearity and causality in order to identify the nature of the variables before put them in various models for practical analysis. Multicollinearity test relied on Variance inflation factor (VIF), the larger the value of VIF, the more troublesome or collinear the variable is, VIF of 5 or 10 and above indicates a multicollinearity. Residual tests or diagnostic test were conducted to justify the model. The tests included, test for autocorrelation (DW-test), heteroscedasticity (Breusch-Pagan test), significance test for individual variables (t-test), combined significance of regressors (R^2), an over-all significance of the model (F-test) statistic.

In economics "economic to start education the country. "Economic growth" typically refers to growth potential output, i.e. production at "full employment", which caused by aggregate demand or observed output. The Researcher specifies the economic growth function in Rwanda. The model comprises one equation, the model that we develop here, on econometric analysis to the impact of education on economic growth in Rwanda. A number of variables and annually adjusted data were used. Consequently, adapting from Benhabib and Spiegel (2003) the human capital augmented growth model is used to examine the impact of education on economic growth. The model depicts that:

$$\boldsymbol{Y = CK^{\alpha}H^{\beta}L(1-\alpha-\beta)} \ldots\ldots\ldots\ldots\ldots\ldots \textbf{Equation (1)}$$

Where; $\boldsymbol{\alpha}$ *= the elasticity of production relative to capital,* $\boldsymbol{\beta}$ *= human capital,* **1- α - β** *= labour,* Y *= output,* **C** *= the level of technology or total factor productivity,* **K***= physical capital,* **H** *= human capital and* **L** *= labour*

In order to avoid multicollinearity between capital and labour the study standardized the output and capital stock by labour units which also impose the restriction that the scale elasticity of the production factors is equal to unity. In per-worker terms, it results as follows:

$$\boldsymbol{Y = Ck^{\alpha}h^{\beta}L} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textbf{Equation (2)}$$

Where **y = Y / L** and **k = K / L** are output and physical capital in intensive terms and **h = K / L** stands for average human capital. Taking log on both sides the production function is estimated as follows:

$$\boldsymbol{lny = lnC + alnk_t + \beta lnh_t + \mu_t} \ \ldots\ldots \textbf{Equation (3)}$$

As per the analysis equation (3) seems more suitable for estimation. However, some problems may arise since most macroeconomic time-series contain unit roots and that regression of one-stationary series on another is likely to yield spurious results. A well-known difficulty with estimating aggregative production functions is the possibility of a correlation between the error term and the regressors which would yield biased coefficient estimates. For example, a stochastic shock to the production function would typically be expected to result in the faster growth of accumulated inputs in that period. If shocks are also persistent, this will induce a positive correlation between future shocks and future levels of physical and human capital. By transforming the time series to stationary by first differencing, the estimation bias can be removed. However, in any case this will create its own problems, notably because of the risk in losing information on the long run relationships of the variables.

One approach in dealing with this dilemma is to employ an error correction model which combines long run information with a short-run adjustment mechanism.

The error-correction model may be estimated in two ways. The generalized "one-step" error correction model is a transformation of an autoregressive distributed lag model. As such, it can be used to estimate relationships among non-stationary processes. In order to estimate the human capital augmented production function, the error-correction model may be written as follows:

$$\Delta lny_t = y_1 \Delta lnk_t + y_2 \Delta lnh_t - y_3(lny_{t-1} - \alpha lnk_{t-1} - \beta lnh_{t-1} - \text{lnC} + \mu_t) \ldots\ldots \textbf{Equation (4)}$$

Since we do not have information on α and β, the equation can be transformed as follows:

$$\Delta lny_t = \text{lnC} + y_1 \Delta lnk_t + y_2 \Delta lnh_t - y_3 lny_{t-1} - y_4 lnk_{t-1} - y_5 lnh_{t-1} + \mu_t) \ldots\ldots \textbf{Equation (5)}$$

Estimates of the parameter 3 y can be used to calculate the required elasticities α and β . The coefficient 3 y contains additional information because it can be interpreted as a measure of the speed of adjustment in which the system moves towards its equilibrium on the average. Once the overall model has been found satisfactory, equation (3) is reformulated in order to incorporate an error-correction term. This "two-step" procedure, in which the error-correction term EC_{t-1} is derived from the lagged residuals t u of the level's regression in equation (2) and can be used to estimate the following model:

$$\Delta lny_t = \text{lnC} + y_1 \Delta lnk_t + y_2 \Delta lnh_t + y_3 EC_{t-1} + \mu_t) \ldots\ldots\ldots\ldots\ldots \textbf{Equation–(6)}$$

Where $EC_{t-1} = lny_{t-1} - \alpha lnk_t - \beta lnh_t - LnC + \mu_t$

Note: *Equation 5 and 6 should in principle produce similar results as one equation has been obtained from the other.*

The data used in this paper has been obtained from the National Institute of Statistics of Rwanda and the National Bank of Rwanda published reports for the period 1999 to 2019. In the model, Y is used as a proxy for real Gross Domestic Product (GDP) while K has been taken as the proxy for capital stock. Human capital stock is represented by H and L is a proxy for labour. The study analysis, have used real GDP as a proxy for output. The gross domestic product (GDP) or gross domestic income (GDI) is one of the measures of national income and output for a given country's economy. GDP is defined as the total market value of all final goods and services produced within the country in a given period of time (usually a calendar year). It is also considered the sum of value added at every stage of production (the intermediate stages) of all final goods and services produced within a country in a given period of time, and it is given a money value. The most common approach in measuring and understanding GDP is the expenditure method:

GDP = Consumption + Gross Investment + Government Spending + (Exports – Imports).

Gross Fixed Capital Formation (GDFCF) is a macroeconomic concept used in official national accounts. The statistical aggregate of GDFCF is a measure of the net new investment by enterprises in the domestic economy in fixed capital assets during an accounting period. While it is not possible to measure the value of the total fixed capital stock very accurately, it is possible to obtain a fairly reliable measure of the trend in new fixed investment. GFCF is a flow value. It is usually defined as the total value of additions to fixed assets by resident producer enterprises, less disposals of fixed assets during the quarter or year, plus additions to the value of non-produced assets (such as discoveries of mineral deposits, or land improvements). The figure below shows the trend in real GDP and Gross capital formation of Rwanda for the period 1999 to 2019.

Table 1: Raw data

Year	*GDP per capita (constant LCU)*	*Labor force, total*	*Labor force participation rate, total (% of total population ages 15-64) (modeled ILO estimate)*	*Gross capital formation (constant LCU)*
1999	238976.6249	3618078	87.676	2.19E+11
2000	231411.1252	3781974	87.322	2.56E+11
2001	237112.7601	3933699	86.982	2.56E+11
2002	247934.4335	4045193	86.647	2.76E+11
2003	274118.0198	4135370	86.328	3.03E+11
2004	275895.7089	4224852	86.04	3.39E+11
2005	292230.6303	4325877	85.789	3.93E+11
2006	313861.8235	4440129	85.607	4.8E+11
2007	339732.3355	4563000	85.464	6.08E+11
2008	356579.5394	4691690	85.344	8.04E+11
2009	385941.8214	4824053	85.22	8.27E+11
2010	399232.1193	4958711	85.076	8.83E+11
2011	417563.1899	5089382	84.948	9.67E+11
2012	439670.7927	5226281	84.794	1.18E+12
2013	466058.3953	5368436	84.609	1.27E+12
2014	476234.4283	5513220	84.399	1.38E+12
2015	493178.2759	5668191	84.356	1.63E+12
2016	523433.0932	5837087	84.279	1.79E+12
2017	540491.2477	6007191	84.233	1.91E+12
2018	558609.481	6178259	84.173	2.35E+12
2019	590856.6934	6361963	84.158	2.19E+11

Source: *World Development Indicators (Last update as at 9th April, 2020)*

From the Table 1 above the trend of GDP from 1999 up to 2019.The GDP increased respectively on upward trend from 1999-2019. This means that Rwandan economies has been improved and develop considerably through government policies implemented in different sector of activities. This implied that different macroeconomic indicators show clearly that the Rwandan government has been mostly concerned by reorganizing all sectors of the economy, and that a lot effort has been putted. The growth of GDP was positive in several years and seems to become more increased than stable. From 2000 up to 2002, Gross Domestic Product was increasing slowly because the economy was still in the recovery and There are different years where GDP increased in high percentage in 2002 up to 2019 GDP grew at high rate that why an upward trend becomes more stip, GDP grew significantly due to external aids, investment and government policies all economic sector activities, and good performance of service sector, and the performance of this sector was encouraged by wholesale and trade as well as real estate's that has grown significantly.

The measure of quantity of labour is the economically active population. In economics the people in the labour force are the suppliers of labour. Normally, the labour force of a country consists of everyone of working age typically above certain age (around 14 to 16) and below retirement age who are participating workers, people actively employed or looking for work.

Human capital refers to the stock of productive skills and technical knowledge embodied in labor. Labour is one of the three factors of production, and it is considered to be a fungible resource that is homogeneous and easily interchangeable. The human capital stock of Rwanda is defined as the average years of schooling of the total population aged 15 and above. The estimated average years of schooling have been used. Human capital is multifaceted and includes a complex set of human attributes; the genuine level of human capital is hard to measure in quantitative form. At best, average years of schooling are currently the most commonly employed measure it is problematic for at least two reasons. First, years of schooling do not raise human capital by an equal amount regardless of whether a person is enrolled in a primary, secondary or tertiary schooling level. Secondly, average years of schooling measures do not take into account quality changes within the educational system. This makes it difficult to interpret intertemporal comparisons. In terms of data availability, it seems difficult to account for the quality of educational patterns for Rwanda. Defining human capital stock implicitly gives the same weight to any year of schooling acquired by a person. Another way to measure human capital is through schooling rates (schooling enrolment ratios). Since these rates are easily available in many countries they have been used in numerous studies. The main drawback of these rates (real or gross) is that they only reflect the current flows of education. The accumulation of these flows is an element of human capital stock that will be available in the future. As education process evolves over various years, temporal lag between flows and stocks is generally very high. Even if an adequate temporal lag is considered, determining human capital stock requires an estimate of initial stock. In conclusion, the average years of schooling may provide a reasonable approximation of human capital stock, which also has the advantage of being interpreted more easily.

RESULTS AND FINDINGS

In this research, the researcher used time series data for the period 1999 up to 2019 and famous test used in econometrics have been performed. The first test performed by the researcher was stationarity test. It is clear that most of macroeconomic time series data are not stationary. When dependent and independent variables in time series data are non-stationary, a non-sense regression or spurious regression model is likely to occur. The R-square is high but combined with low Durbin Watson statistic, and as a consequence the coefficients seem to be statistically significant while they aren`t. this case can mislead the economic interpretation. In order to avoid obtaining misleading statistical inferences, the researcher performed the stationarity test of all variables used in the model.

Coefficient of Correlation between Variable

The value of correlation coefficient ranges between -1 and 1, the greater the absolute value of correlation coefficient, the stronger the linear relationship. The weakest linear relationship is indicated by the correlation coefficient closer to 0, the positive correlation means that if one variable gets bigger the other variable tends to get bigger and the negative correlation means that if one variable gets bigger, the other variable tends to get smaller.

Table 2: *Correlation matrix*

Variables	y	k	h
y	1.0000	0.9984	0.9426
k	0.9984	1.0000	0.9516
h	0.9426	0.9516	1.0000

Source: E-views 7.0

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Test and Analysis of the Data

The long run estimated equation has been elaborated using Eviews7 to see whether there is any relationship that exist between GDP and its expected determinants after testing the significance of the coefficients estimated, the co-integration test was performed to see whether there is a long run relationship between GDP and its expected determinants, the ECM (Error correlation model) was performed to test whether there is a short run relationship between GDP as dependent variable and independent variable which is education and make sure that errors founded in our model are collected, the Diagnostic test including stability test and residual test to make sure that the estimators in our model are BLUE (Best Unbiased Estimator).

The Augmented-Dickey-Fuller (ADF) unit root test is performed to check for stationarity of the time series of each variable. If a variable exhibits strong trends, that is, they are non-stationary and it implies that the use of conventional estimation methods in models that include such variables will tend to lead to erroneous statistical inference.

Thus, in the presence of non- stationary variables, the use of conventional estimation methods brings the danger of obtaining "spurious regression" whose estimates are deprived of any economic meaning. Recent studies on time series analysis refer to co-integration techniques as the most adequate estimation method when variables of a model are non-stationary. Hence, the ADF test will be applied on each of the variables used in the model.

Table 3: Stationarity of the Time-Series

Variables	ADF Test Statistics	95% Critical Value	Results
Ln y	0.68	-1.10	non-stationary
Ln k	0.61	-0.91	non-stationary
Ln h	-0.80	-1.30	non-stationary
Δ Ln y	-4.95**	-4.52***	stationary
Δ Ln k	-4.19**	-5.36***	stationary
Δ Ln h	-4.62*	-7.06***	stationary

Source: Designed by the researcher from Eviews 7results.

Hint: (*): stationary at 10% (**): stationary at 5% (***): stationary at 1%

Conclusion: According to the above results extracted from E-views 7, the researcher found that all series are non-stationary at level but they become stationary after the first difference.

Co-integration test

Having applied the ADF unit root test, it is therefore possible to estimate the regression and obtain the residual. A test for cointegration for the model is carried out and the following results have been obtained.

Table 4: Co-integration test

	ADF Test Statistics	95% Critical Value
Residuals (μt)	-5.436	-5.012

Results in Table 4 indicated that the ADF test statistic exceeded 95% critical DF, hence the study concluded that that cointegration exists among the variables in the model above. The basic idea behind cointegration is that, in a long run, if two or more series evolve together, then a linear combination of them might be stable around a fixed mean, despite of their individual trends (that cause nonstationary). Thus, there could be one or more stationary linear combination of the series, suggesting stable long run relationship between them.

Test of Multicollinearity

Multicollinearity is a state of very high inter-correlations or inter-associations among the independent variables. It arises when there is a high degree of correlation (either positive or negative) between two or more independent variables. It caused by the inclusion of a variable which is computed from other variables in the data set. A tolerance of less than 0.20 and/or a VIF of 5 and above indicates a multicollinearity problem. The primary concern is that as the degree of multicollinearity increases, the regression model estimates of the coefficients become unstable and the standard errors for the coefficients can get wildly inflated. Hence, to detect multicollinearity problem we have run the variance inflation factor (VIF) or the detection-tolerance for multicollinearity test.

Table 5: Test of Multicollinearity

Variance Inflation Factors
: 10/06/20 Time: 13:57
Sample: 1999 2019
Included observations: 21

Variable	Coefficient	Uncentered	Centered
Variable	Variance	VIF	VIF
C	0.01098	85.4517	NA
K	0.00245	711.328	4.42
H	0.00479	1072.895	4.42

Source: E-views 7.0

Results in Table 5 above indicates that the mean VIF obtained is 4.42 implying that there is no problem of multicollinearity in the study estimates. However, it should be noted that to avoid multicollinearity between capital and labour we have standardized output and the capital stock by labour units.

Durbin-Watson Test

In addition, the study checked for serial correlation using the Durbin-Watson statistic test. Conventionally, if the Durbin-Watson statistic is substantially less than 2, there is evidence of positive serial correlation. However, as a rule of thumb, if Durbin-Watson is less than 1.0, then there may be cause for alarm. The coefficient obtained for the study regression model is 0.86 indicating that there is no problem of serial correlation in the model.

Estimation of the Long Run Model

Cobb-Douglas production function was applied to estimate human capital as an independent factor of production. That the study expects to find that human capital does increase the amount of output in an economy hence leading to economic growth. The long run equation shows the long run relationships in the model and e-views7 software provided the estimated long run equation as follows:

Table 6: Estimation of long run model of Production Function for Rwanda ((Human Capital as a factor input)

Dependent Variable: Percentage change of GDP/ Worker
Method: Least Squares
Date: 10/06/20   Time: 14:44

Sample: 1999 2019
Included observations: 21

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant (C)	0.27210	0.036629	30.29951	0.0000
Percentage Change of Capital/Worker	0.81219	0.036629	7.428806	0.0000
Percentage Change of Schooling/Worker	1.21816	0.036629	2.428110	0.0000
In GDP/Worker (-1)	0.52108	0.036629	3.115816	0.0000
In capital/worker (-1)	0.25719	0.036629	2.785466	0.0000
In Average Schooling	0.19848	0.121038	0.856669	0.0000

Long-run Elasticity of Capital	0.547		
Long-run Elasticity of schooling	0.275		
R-squared	0.550841	Mean dependent var	4.557891
Adjusted R-squared	0.540859	S.D. dependent var	0.169738
S.E. of regression	0.115014	Akaike info criterion	-1.445896
Sum squared resid	0.595275	Schwarz criterion	-1.367167
Log likelihood	35.97856	Hannan-Quinn criter.	-1.416270
F-statistic	55.18715	Durbin-Watson stat	0.864319
Prob(F-statistic)	0.000000		

From Table 6, an estimation of equation (5) in the standard growth equation is done by regressing log differences in real GDP on log differences of factors. This methodology is used in providing estimates for the magnitudes of α, β and 1- α -β. Human capital as a production factor measured by average years of schooling appears to have a positive and significant impact on the growth of output per worker. The estimated long-run effect of 1 percent increase of the average years of schooling on GDP per unit of labour is approximately 0.272 percent, as shown in equation (7)

$$\boldsymbol{\Delta lny_t = 0.272 + 0.812\Delta lnk_t + 1.218\Delta lnh_t - 0.521ny_{t-1} + 0.257lnk_t + 0.198lnh_t} \ldots\ldots\ldots\ldots\ldots\text{ Equatio (7)}$$

The log differences in physical capital and human capital are shown to be positively correlated with log differences in output. The coefficient of the log difference of capital stock t Δ ln k enters positively and significantly at the 5% confidence level. The coefficient of the log difference of capital stock is approximately 0.812. The log difference in human capital ht Δ ln enters significantly at the 5% confidence level, and with a positive coefficient which is approximately 1.218. One explanation for the magnitude of this coefficient is that, over the years, Rwanda achieved an improvement in its educational level and this led to huge improvements in its stocks of human capital. It is also well-known that Rwanda did experience similar improvements in output, implying a high coefficient for Δlnh_t. The long-run relationship of output with respect to its explanatory variables can be derived from equation (5) in Table 6. The results in terms of the human capital augmented Cobb-Douglas production function are follows:

$$\boldsymbol{Y = CK^{0.625}H^{0.203}L^{0.145}} \ldots\ldots\ldots\ldots$$

From Table 6 the adjusted R^2 (0.540859) of the error-correction model and the F-statistics (55.18715) is on the high side. The already computed test statistics does not show any evidence of serial correlation nor misspecification at conventional levels.

The study further included an additional variable to take into account two factors. The variable includes investments. Initially, the study analyzed the changes when this variable is included. Normally, the overall result should continue to produce a significant and positive effect on output or economic growth in the economy. Moreover, the study used this model to analyze to what extent human capital affects the overall productivity of the economy. Human capital accumulation is commonly cited as a pre-requisite for development and most countries have government policies which encourage human capital accumulation. Besides, human capital is seen to facilitate the adoption and implementation of new technologies, which are continuously invented at exogenous rate. Nelson (1966), suggests that the growth of technology depends on the level of education in a particular country. The basic framework for the second specification is a standard Cobb- Douglas production function with constant returns to scale yielding equation 9.

$$Y = CK^{\alpha}L^{\beta} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \textbf{Equation (9)}$$

Where α and β represent the elasticity of production relative to capital and labour respectively. This function is standardized by labour units in order to avoid multicollinearity between capital and labour. In per worker terms, this can be presented as follows:

$$y = Ck^{\alpha} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \textbf{Equation (10)}$$

Where **y = Y / L** and **k = K / L** are output and physical capital respectively. Converted into logarithmic expression, the equation becomes:

$$lny = lnC + \alpha lnk + \mu_t \ldots \ldots \textbf{Equation (11)}$$

Combining the long-run information of the variables with the short-run adjustment mechanism, the equation can be represented in its error-correction form:

$$\Delta lny_t = \gamma 1 \Delta lnk_t + \gamma 2 (lny_{t-1} + \alpha lnk_{t-1} - lnC) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \textbf{Equation (12)}$$

In contrast to the human capital augmented growth model however, total factor productivity is considered to be a function of exogenous variables, namely education and foreign inputs. Benhabib and Spiegel (2003) postulated that an educated labour force may play a key role in determining productivity rather than entering on its own as a production factor. They assumed that human capital is exogenously given and higher levels of years of schooling lead to an increased productivity. Equation 12 is transformed by including the additional variable which is the ratio of imports over investment. Hence, we have the one- step error correction model in its re-parameterized form:

$$\Delta lny_t = \alpha + \gamma 1 \Delta lnk_t + \gamma 2 \Delta lny_t + \gamma 3 lnk_t + \gamma 4 lnh_t + \frac{\gamma 5 IM_t}{I_t} + \mu_t \ldots \ldots \ldots \ldots \ldots \ldots \textbf{Equation (13)}$$

The average level of schooling should not be treated as an extra input into the production function but may directly affect total factor productivity. Based on the regression results of equation (13) in table 7 below, the following formulas in terms of the Cobb-Douglas production function can be obtained:

$$Y = CK^{0.7368}L^{0.2632} \ldots \ldots \ldots \ldots \ldots \textbf{Equation (14)}$$

$$lny = lnC + 0.7368 lnk \ldots \ldots \ldots \ldots \ldots \ldots \textbf{Equation (15)}$$

$$\Delta lny_t = -0.081 + 1.856 \Delta lnk_t - 1.18 \Delta lny_{t-1} + 0.56 lnk_{t-1} + 0.26 lnh_t + 0.52 \frac{IM_t}{I_t} \ldots \ldots \ldots \ldots \ldots \textbf{Equation (16)}$$

Table 7: Estimation of long run model of Production Function for Rwanda (Human Capital affecting the Technology Parameter)

Dependent Variable: Percentage change of GDP/ Worker
Method: Least Squares
Date: 10/06/20 Time: 16:07
Sample: 1999 2019
Included observations: 21

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant (C)	-0.080560	0.029298	2.749626	0.0087
Percentage Change of Capital/Worker	1.855398	0.042580	43.57395	0.0000
Percentage Change of Schooling/Worker	-1.179634	0.066291		
In GDP/Worker (-1)	0.569882	0.026628	33.115816	0.0000
In capital/worker (-1)	0.257194	0.036629	22.785466	0.0000
In Average Schooling	0.486486	0.121038	10.856669	0.0000
Ratio of Imports/ Gross Domestic Investment	0.52108	0.021170	7.115816	0.8653

Long-run Elasticity of Capital	0.736		
R-squared	0.149533	Mean dependent var	1.969430
Adjusted R-squared	0.129754	S.D. dependent var	0.069417
S.E. of regression	0.064757	Akaike info criterion	-2.592933
Sum squared resid	0.180317	Schwarz criterion	-2.512637
Log likelihood	60.34099	Hannan-Quinn criter.	-2.562999
F-statistic	7.560441	Durbin-Watson stat	0.712294
Prob(F-statistic)	0.008691		

The production function in the long run is represented by equation (15) and equation (16) shows the short-term dynamics of growth per labour unit. The estimated equation is accepted on statistical and economic grounds. It is noticed that the estimated production elasticity of physical capital in the long-run equation is now larger than its factor shares (as estimated in the human capital augmented production function) reflecting its correlation with human capital. An estimation of equation (11) is made by regressing log of income on log of total factor productivity and physical capital. This methodology has provided estimates of the magnitudes of α and $(1-\alpha)$ where the factors appear to have a positive and significant impact on the growth of output per worker. In Table 6, the estimated production elasticity of physical capital in the long-run equation that is equation (5) is 0.547. However, in Table 7, the estimated long-run effect of a one percent increase of the physical capital on GDP per unit of labour performs slightly better, approximately 0.547. An important factor influencing GDP growth is the 'disequilibrium error' from the previous period. The coefficient (1.18), in equation (17) from Table 7 below determines the extent to which the disequilibrium in period $t-1$ for the period.

Error Correction Model or Short Run Model

An error correction model is a dynamical system with the characteristics that the deviation of current state from its long run relationship will be fed into its short-run dynamic. An error correction model is a category of multiple time series model that directly estimates the speed at which a dependent variable returns to equilibrium after a change in an independent variable. It is also a theoretically driven approach useful for estimating both long-run and short-run effects of a time series on another. ECM is useful model when dealing with integrated data, but can also be used with stationary data. It makes easy interpretation of short run and long run effects and it can be estimated with OLS.

The E-views 7.0 is used to run the following ECM model Estimation Equation:

DLGDP = C (1) *RESIDLR (-1) + C (2) *DLEDU… . . … … … … … … . . … … … . … … **Equation (17)**

Table 8: Error correction model

Dependent Variable: Percentage change of GDP/ Worker
Method: Least Squares
Date: 10/06/20 Time: 16:53
Sample (adjusted): 1999 2019
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant (C)	0.134194	0.012301	5.218055	0.0002
DLEDU	0.328203	0.056141	7.484730	0.0000

R-squared	0.550841	Mean dependent var	4.557891
Adjusted R-squared	0.540859	S.D. dependent var	0.169738
S.E. of regression	0.115014	Akaike info criterion	-1.445896
Sum squared resid	0.595275	Schwarz criterion	-1.367167
Log likelihood	35.97856	Hannan-Quinn criter.	-1.416270
F-statistic	55.18715	Durbin-Watson stat	0.864319
Prob(F-statistic)	0.000000		

Source: E-views7

Substituted Coefficients: DLGDP = 0.134194 + 0.328203*DEDU … . . … … … … … **Equation (18)**

P-value (0.0003) (0.0000)

R^2 Adjusted=0.811652

From the above short-run equation 18 Education has positive impact on economic growth in short-run, the above result means that, if Investment increases one unit the economic growth increases 0.32 units which is 32% when other variable remain constant and then the education affects positively economic growth of Rwanda in short-run. According to the above results, the researcher concludes that there is a short run relationship in our model, because the probability of independent variables is less than 5%. The error correction term is also positive (RESIDLRt (0.134194) because there was no aspect of multicollinearity. This is a good indicator that the correction of errors is possible. Basing on the value of the error correction term, the researcher

CONCLUSION

Basing on economic theory, human capital or educational attainment in an economy has long been viewed as an important factor in enhancing and promoting output or economic growth. In order to test this hypothesis, human capital was considered as an important role in economic growth mainly as an engine for improvement of the output level. The results obtained do support the argument. The significance of the analysis leads us to conclude that indeed human capital does lead to an increase in output of the Rwandan economy and hence it also facilitates the implementation of new technology in the country. We could find that capital formation has played a dominant role in explaining approximately sixty percent of Rwanda growth rate of GDP, followed by the accumulation of human capital and labour force growth. There is compelling evidence that human capital increases productivity, suggesting that education really is productivity-enhancing rather than just a device that individuals use to signal their level of ability to the employer.

Of late education expansion promoted or even has determined the rate of overall Gross National Product (GNP) growth. Developing countries like Rwanda, are deficient in the supply of middle and high-level skilled manpower which is created through developmental formal educational, leadership in both public and private sectors would be lacking. Growth is determined by good education which is a trait of leadership. In the absence of such leadership to plan, budget, coordinate and control hence the management will be making the economic growth.

However, it is extremely difficult to document statistically, it seems clear that expansion of educational opportunities at all levels have contributed to aggregate economic growth by:

- Creating a more productive labour force and endowed it with increased knowledge and skills;
- Provide employment and income generating opportunities for teachers.
- Creating a class of educated leaders to creating a critical mass of educated and trained professionals and managers within the public service
- Provision of training and education that would promote literacy, numeracy and basic skills while encouraging positive attitudes on the part of diverse segment of population.
- Provision to initiate technological innovations that enhance creativity.

The kind of education system a country has will have a major impact on its capacity to respond to population needs. Access to good-quality education at all levels bearing in mind the poverty and inequality of individuals hence a pathway to liberation towards the fulfilment of basic rights. This will transform lives and bring children out of the shadows of poverty and marginalization where in societies; it acts as a leveler and an agent for greater equality towards economy growth.

Given there is a significant importance, the existence of such externalities, or social returns, and their quantification are undoubtedly important when designing educational policies in order to avoid underinvestment in education. Individuals tend to decide the level of educational training they wish to attain based on the private returns they expect to receive and do not take social returns into account. A significant social return would therefore justify policies to encourage greater investment in education.

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