HUMAN CAPITAL DEVELOPMENT AND ECONOMIC GROWTH IN RWANDA: A TIME SERIES ANALYSIS

A Thesis Submitted in Partial Fulfilment for the Degree of Masters of Science in Economics of the University of Rwanda – College of Business and Economics.

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APPROVAL SHEET

This thesis entitled Human Capital Development and Economic Growth in Rwanda: A Time Series Analysis , written and submitted by ERIC MUTABAZI in partial fulfilment of the requirements for the degree of Master of Science in Economics, is hereby accepted and approved.

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DECLARATION

I hereby declare that this Master's Thesis report is my original work and has not been presented for an academic award in any university or higher learning institution.

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This thesis report has been submitted for an examination with my approval as University of Rwanda supervisor.

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DEDICATION

This Master's thesis work is dedicated to my parents GASORE Protais and Agnes UMWISENGENEZA, my uncle Charles NTAGERUKA, my brother NKUBITO Africa, all my sisters Rose, Diane and Sharon, uncles, aunties, cousins, close friends and coworkers at Tech Avenue 137 Ltd who include Arnold KAMANZI, Orrymain MURENZI, Christian RUGAMBA, NSHUTI Gacinya, Denyse UMUTONI, Louise NIYIGENA, and MUHIZI Aristide for their support of all kind i.e. prayers, financing, advices which collectively has enabled me to complete this endeavor. Hadn't it by them, I would not have persevered and progressed to the end.

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ABSTRACT

There's a general consensus that human capital development contributes to economic growth and development. This study, estimate this relationship using time series data on Rwanda for the last three decades (1988-2017). Cobb-Douglass production function and econometrics techniques of Johansen Cointegration test and the Vector Error Correction model confirms the presence of a long-run relationship between economic growth proxied by GDP per capita and explanatory variables i.e. gross fixed capital formation, labor force participation rate. Total government expenditure on education as percentage of GDP, life expectancy at birth and primary school enrolment rates as proxies for human capital development. Long-run model estimates show that fixed capital and life expectancy at birth are significant and with a positive trend. In the short-run, the role of human capital development in economic growth is estimated through the Vector Correction Mechanism. Its coefficient term which indicates the adjustment speed towards long-run equilibrium showed that previous deviation or shock in the human capital from the long-run equilibrium is to be corrected in the current period at an adjustment speed of 9 percent annually which may indicate that return on human capital is a time-consuming process. Overall, results are consistent with other studies which argues that human capital development leads to economic growth in the long-run.

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ABBREVIATIONS

ADF: Augmented Dickey-Fuller Unit-Root test

CE: Cointegration Equation (s)

ECD: Early Childhood Development

ECT: Error Correction Term

GDP: Gross Domestic Product

GER: Gross Enrolment Ratio

GoR: Government of Rwanda

HCI: Human Capital Index

ILO: International Labor Organization of the United Nations

MINECOFIN: Ministry of Finance and Economic Planning

MINEDUC: Ministry of Education, Rwanda

MoH: Ministry of Health, Rwanda

NISR: National Institute of Statistics of Rwanda

OLS: Ordinary Least Square

UNESCO: United Nations Educational, Scientific and Cultural Organization

UNICEF: United Nations International Children's Emergency Fund

VECM: The Vector Error Correction Model

WB: The World Bank

WDI: World Development Indicators

WFP: World Food Programme

WHO: World Health Organization

CHAPTER ONE: INTRODUCTION

1.1. Background of the study

Human capital consists of knowledge, skills, and health that people accumulate throughout their lives, enabling them to realize their potential as productive members of society (World Bank, 2018). In the global knowledge economy, people's skills, learning, talents, and attributes- their human capital has become key to both their ability to earn a living and to wider the economic growth (OECD, 2018).

The human capital theory pioneers who include Shultz (1961) and Becker (1964) also emphasizes that it is necessary and sufficient condition for economic growth and its impact has been studied in existing exogenous and endogenous growth models as widely accepted important driver for economic growth (Mankiw, N. G.; D. Romer and D. N. Weil, 1992). This fact is evidenced through the fact that most of the developed countries happen to also have strong human capital base (World Development Report, 2019).

The government of Rwanda is undergoing a shift from an economy based on subsistence-oriented agriculture to a modern service-oriented economy through investing in her people to overcome many developments constraints: poverty, land scarcity, high fertility and low base of mineral resources among others (Nkurunziza, 2015). The country aspires to achieve the middle-income status by 2035. Rwanda's current annual GDP growth rate of 6.8 percent is projected to increase to 7.5 percent in 2020.

Rwanda has reduced the percentage of people living below the poverty line from 58.9 percent in 2000 to 39.1 percent in 2013. The fertility rates have declined from 5.6 births per woman in 2000 to 4.0 births per woman in 2015, indicating a slow but positive trend toward population control; the current population of Rwanda is 12.2 million. To continue this momentum, the government is making efforts across sectors through four strategic areas: economic transformation, rural development, productivity and youth employment, and accountable governance (World Bank, 2018).

Currently, the government of Rwanda has made tremendous efforts in the area of human capital development as the principal asset to support economic and social transformation. Education and health are the main components of human capital development have been given priority as seen in the country's sector strategic plans. Rwanda's high-level commitments to the education and skills development can be evident from a range of activities and achievements in the education sector; Rwanda is one of the top-performing countries in the Sub-Saharan region in education, having achieved the Millennium Development Goal (MDG 2) for universal access to primary education with a net enrolment at 97.7% Primary Completion rate (2016): 65.2%, Pupil qualified teacher Ratio 62:1, Pre Primary Net Enrolment Rate 19.6%, Secondary Net Enrolment Rate 32.9% and tertiary enrolment at 7.9% (MINEDUC, 2016).

In addition to school enrolment improvement, Rwanda envisions becoming a regional tech-hub and now invests in its education system to advance in this direction, where Information and communication technology (ICT) can enable Rwanda leap-frog the key stages of industrialization and fast track economic transformation. ICT will help the development of high-quality skills and knowledge base which will transform the education system through improving accessibility, quality, and relevance to the development needs of Rwanda.

Despite impressive achievements in the education sector such as access to primary education, the quality has been a major concern. A recent study by the World Bank on the "future drivers of economic growth in Rwanda", identified the development of a world-class human capital as the first reform priority – with emphasis on the quality basic education and early literacy which is a foundation for human capital development. The need for improving quality is evident at all levels of education. Rwanda has an unfavorable pattern of progression in early grades where a significant share of grade 1 fail to progress to grade 2, this is related to issues of early childhood development. The issues of repetition, dropout, and low primary-to-secondary transition are prominent and most students in primary school do not acquire age-appropriate literacy and numeracy skills. The professional competence for teachers to implement the education sector reform is also low as for instance, during the 2017 Building Learning Foundations (BLF) baseline for pedagogic practices when 751 lower primary lessons were observed, it was found that only 28 percent of teachers met

the benchmark set for competence and one of the most challenges is the language of instruction and lack of motivation for low pay.

Lastly, education expenditure has been not commensurate with the country's goals as it is less than 5 percent of GDP which is very low for a country with a high population of children and youth and a need for developing the infrastructure. Hence, quality is hindered by the learning environment, materials, and facilities which are inadequate as shown by high student-teacher ratio, average textbook per student which is 1:5, shortage of learning facilities and infrastructures such as classrooms and laboratories (World Bank, 2018).

Considering the health sector, having a healthy workforce is key to the country's economic productive, evidence shows that a one-year increase in life expectancy at birth could raise GDP up to 4%. Rwanda has made significant improvements in the health status of its citizens resulting in a life expectancy at birth from 48% in 2000 to 67.5 in 2017 (World Bank, 2018). The under 5 mortality rate was reduced from 152 to 50 deaths per 1,000 live births between 2005 and 2015 while the maternal mortality ratio dropped from 1071 to 210 deaths per 100,000 live births between the same period. These improvements came from tireless efforts to improve access to health services through community – based services, community-based insurance schemes, integration of child and maternal health services as so on. Further efforts are now even in addressing health system deficiencies, child malnutrition and non-communicable diseases (MoH, 2016). The challenges, however, include a severe shortage of qualified medical staff with only 0.6 physicians per 10,000 patients in 2013 compared to the 2.5 minimum health providers recommended per 10,000 people (WHO, 2015).

Malnutrition has been a longstanding impediment to child health and the development of a world-class labor force. Although some progress has been made to address this challenge, it is still a major concern that 37.8% of under-five children are stunted (WFP, 2015). Despite all the significant efforts on developing Rwanda's human capital, problems hindering further development still exists; they include poor quality of schooling, malnutrition in under 5 age children among others. The recent evidence of Rwanda's low human capital development can also be seen from the 2018 World Bank Human Capital Index that has ranked Rwanda very poorly with

a score of 0.37 out 1 and ranked 145 out of 157 countries covered by the HCI. The Human Capital Index quantifies the contribution of health and education to the productivity of the next generation of workers (World Bank, 2018). In regard to this, the study seeks to understand the relationship between human capital development and economic growth in Rwanda.

1.2. Statement of Problem

Low human capital development has been a major constraint to Rwanda's economic growth and development. Education and health – the principal components for human capital development have not raised sufficient investment in relation to Rwanda's ambitious target of becoming an upper-middle-income country by 2035-and high-income by 2050. Despite, significant efforts made to develop her human capital base, problems of poor quality of education at all learning levels, literacy rate, diseases, nutrition issues among others are still present and their negative effects can be evidenced through Rwanda's unskilled and uncompetitive labor force, growing unemployment rate especially among the youth among others. These collectively affect productivity, output, and growth. Most recent evidence comes from the 2018 World Bank Human Capital Index which has ranked Rwanda among the poorly performing countries which hinders economic growth and sustainable development (World Bank, 2018). In line with this important problem, we study the relationship between human capital development and Rwanda's economic growth. Moreover, this specific topic has not been studied in the context of our country.

1.3. Research Objectives

1.3.1. Main objective

The principal aim of this study is to analyze the relationship existing between human capital development and economic growth in Rwanda.

1.3.2. Specific objectives

To achieve the main objective, the specific objectives are:

1) To estimate the long run relationship between education and economic growth
2) To estimate the role health plays in economic growth.

1.4. Significance of the study

Few studies have been conducted so far in the area of human capital development in Rwanda. And studies conducted did not specifically direct the emphasis on the relationship between human capital development and economic growth. In view of the country's aspirations for a knowledge based economy, an understanding of the dynamics in the country's human capital development is of a paramount importance. For that very reason, we have endeavored to study this relationship in our country's context which will shed light to this important issue and inevitably add on the existing small volume of literature on human capital in Rwanda.

1.5. Scope of the study

The study sought to only focus on the relationship between human capital development and economic growth in Rwanda between 1988 and 2017 fiscal years. The main limitation is the data used which does not include the outcomes of education/learning. Data on expenditure and enrollment are used in this study which may not capture precisely the relationship between economic growth and human capital development.

1.6. Organization of the study

This research is organized in five chapters: The first chapter contains the introduction of the study, statement of the problem, research objectives and scope of the study. In the second chapter, theoretical and empirical findings on education and health are discussed, the third chapter shows the methodology, model specification, data, sources, and estimation procedures, the fourth chapter present results in line with the objectives while the chapter five makes a summary of the main results, conclusion and possible recommendation based on the study findings.

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

This review focuses on the theoretical and empirical literature aspect of the study by making an emphasis on education and health - the main components of human capital development and how they relate to economic growth.

2.2. Definition of Key Concepts

Under this study, we define the concepts of Human Capital Development and Economic Growth.

Human Capital Development

Human Capital consists of the knowledge, skills and health that people accumulate throughout their lives, enabling them to realize their potential as productive members of the society (World Bank, 2018). As global economies continue to shift towards more knowledge-based, developing human capital inevitably becomes key in enabling people to earn income and thus contribute to economic growth and development.

Economic Growth

Macroeconomic indicators enable to analyze the level of economic activity and performance. Gross Domestic Product (GDP), is a widely used indicator which measures the monetary value of all final goods and services in a country in a given period. Real growth in an economy (Real GDP) has to be estimated because GDP data is collected at nominal, current prices hence adjustment for inflation must be done. The growth rate of real GDP is usually used as an indicator for the general health of the economy (IMF, 2019).

2.3. Theoretical review

The concept of human capital promotes growth dates back in the time of Adam Smith (Smith, 1776) and the early classical economists who fostered the importance of investing in human skills. The theory of human capital asserts a relationship between workers' cognitive skills, productivity, and efficiency. Theodore Shultz, Gary Becker, and Jacob Mincer introduced a perception that people invest in education with the purpose of increasing their stock of capabilities to be used for

productive use. Examples of such investment include expenditure on education, on-the-job training, health, and nutrition.

Human capital has considerable importance in the neo-classical growth literature and endogenous growth models which incorporate human capital into production function as an additional input and are often used to explain cross-country income differences, where they put forward that augmented Solow model as an improvement of the Solow growth model because it incorporates human capital which the original Solow model does not (Romer, 2012). The basic assumption in this approach is that an increase in workers' quality through human capital accumulated through education and health raises productivity.

In the discussion of human capital and how it relates to economic growth, two basic approaches are used to analyze the relationship; one is based on the concept that economic growth is driven by accumulating the human capital which implies that growth rates in per capita income is due to the rate by which economies accumulate human capital while the second is in the recent Schumpeterian growth literature and argues that human capital determines the economy's capacity for innovation, research and development (Benhabib and Spiegel, 1994).

Majority of studies use education and health indicators as proxies for human capital development because they argue that output rises through various empirical channels and serve as precondition for the utilization of physical capital by attracting investment hence increase in output and growth (Abbas, 2000).

According to (Bergheim, 2005), " Education affects human capital by increasing knowledge and skills which lead to more output and ultimately into better health". This is because education helps increase output steadily and simultaneously makes individuals aware of healthy living. Moreover, completion of primary school and joining secondary and vocational training has been linked with ability for people not rely on subsistence agriculture but become engaged in other vibrant jobs.

(Qadri and Waheed, 2011) argues that health is an important element of human capital because in the production process healthy workers contribute more than unhealthy ones. Moreover, they say

that health determines the level of return from education because a healthier person can learn more than an unhealthy counterpart. The majority of studies on human capital have been focusing on education only and few have incorporated health in measuring human capital (Sachs and Warner, 1997) however, the authors argues that more education has been found to be associated with better public health, better community participation, and social cohesion all of which turn back into economic growth.

2.4. Empirical review

On the other side, a big number of empirical studies have been conducted on the relationship between human capital development and economic growth. The first batch of these empirical studies include for example, the augmented Solow model that on one occasion incorporated human capital as an input in the Cobb- Douglas production function and without human capital. By using OLS estimator on estimator on a dataset of 121 countries from 1960 to 1985. The findings by Mankiw, Romer and Weil (1992) concluded that the model with human capital can explain over 80% in income differences between countries hence this framework was resulted into many other studies.

Using Cointegration method, Abbas and Foreman (2007) in Pakistan; estimate the effects of human capital base on the country's economic growth for a period between 1961 and 2003. School enrollments and expenditure on health care as percentage of GDP were used as proxy for human capital and results indicated rising returns from human capital especially through improvement in health. (Barro,1996) found a positive relationship between the growth rate of real per capita output and the level of school enrolment. The study argued that increasing the rate of investment in human capital development would close the gap between developing and developed countries.

A study conducted using Sub-Saharan and OECD countries data associated 22% and 30% of the growth rate of capita income with health respectively (Brempong and Wilson, 2004). They also argue that prevalence of tropical diseases reduces per capita growth rate. In another study, Brempong and Wilson (2005), studying the role of human capital investment on Africa's economic growth between 1960 and 2000 came to a conclusion that the relationship was positive.

By applying Cointegration analysis, and using a method of human capital measurement developed by Barro and Lee, Woubet (2006) not considering health component found that the impact of human capital on output level was insignificant between 1971-2005. The justification behind this results was that the study only considered education but ignored health. Hakoma, (2017) argues that "the impact of human capital on economic growth in Zambia was confirmed using Johansen Cointegration test and Vector Correction Models on an annual time series using education and health expenditure."

In a study by Hyongi Li and Liang (2010) on East Asia countries, origins of economic growth were traced by using augmented Solow model and panel data from 1961 to 2007 reveals an insignificant relationship. Employing total government expenditure on health and education, school enrolment and life expectancy as a proxy for human capital Hadir and Laurech (2015) working on Moroccan data from 1973 to 2011 found a positive relationship between dependent and independent variables. Using health and education time series data from 1980 to 2011 for Nigeria, Olaken (2014) evidenced a positive impact on economic growth. Employing Johansen Cointegration and ordinary least square regression, Jaeiyoba (2015) investigated relationship between education and health investment on Nigeria's economic growth and findings showed a long-run relationship between government expenditure on education and health with economic growth between 1982 and 2011.

(Maitra, 2016) enquires about the role of investment in human capital on economic growth in Singapore using Cobb-Douglass production function and Vector Error Correction Mechanism. He reached a decisive conclusion that investment in human capital does not give returns at initial periods but later on contributes significantly to economic growth. In their study GDP, education and health spending annual data series from 1981-2010 were used. Abu and Osman (2010) employed OLS estimator and Error Correction Mechanism and found that a 1% increase on health expenditure in the previous year raises economic growth by 0.06 %. In another study Maitra (2012) also found that public spending on health and education raise GDP in 12 Asia and Pacific countries.

Olayami (2012) using industrial production data for Nigeria as the dependent variable and total expenditure on health and education as proxy for human capital development found that 6.8 % increase in industrial production is associated with human capital development in the long-run. Working with Malaysian data from 1970 to 2010 and applying VAR technique, Hussin, Muhammad, and Razak (2012) confirmed that fixed capital, labor force and education expenditure was related to economic growth.

(Md Niaz Murshed et Al, 2018) working on Bangladesh data for a period of 35 and employing Ordinary Least Square (OLS), Johansen Co-integration to analyze the relationship between human capital and economic growth on an annual data series reached a conclusion in favor of a strong positive relationship. They use per capita GDP to represent economic growth while primary, secondary and tertiary levels school enrolments expenditure on education, health to represent human capital development.

Empirical studies linking human capital development and economic growth in Rwanda are almost non-existent and few studies conducted did not directly focus on this problem. In the human capital literature in Rwanda however, the World Bank's human capital index recently indicated that the country performs poorly in terms of human capital development. The index quantifies the contribution of education and health to the productivity of the next generation of workers. It measures the amount of human capital a child born in 2018 can expect to attain by the age of 18 in view of the risks of poor education and health that prevail in that particular country (World Bank, 2018). On a scale of 0-1, Rwanda scored 0.37 and is classified among poor performers in the area of human capital development.

As reviewed above, many theoretical and empirical studies reveal the impact and relationship between human capital development and economic growth especially in the long-run. Most empirical studies use proxy variables such education expenditure, school enrollment rates, learning outcomes, life expectancy among others. This study uses Real GDP variable as a proxy for economic growth and expenditure on education and health, life expectancy and school enrolment as explanatory variables in the context of Rwanda.

CHAPTER THREE: METHODOLOGY

3.1. Introduction

This section shows the methodology chosen in this study, covers the research design, model specifications, variables and data as well as the analysis methods.

3.2. Study design

This study follows the methodology used frequently in the empirical human capital development research. We use a Human Capital Augmented Cobb-Douglass production function, based on the theoretical framework of Lucas (1988) and Romer, Mankiw and Weil (1992) with human capital variables input in the model. Choosing Cobb-Douglass production function is due to the fact that it can handle multiple inputs. In their endogenous growth models, long-run growth is explained as a consequence of human capital accumulation. This study adopts a similar but modified model involving education and health annual time series data variables covering a period of 30 years.

3.3. Methodology Framework

The specification of the empirical model is based in general on economic theory and the literature of human capital development. Most previous studies employed Cobb-Douglas production function with Real Gross Domestic Product per Capita, Real Gross Domestic Product growth or per worker as dependent variables. The gross capital formation or investment GDP ratio is taken as Capital; labor force or employment is taken as input for labor in the production function. To construct human capital development variable, Waheed (2017) took primary school enrolment rates and multiplied by health expenditure variable. This can be a better measure because it takes into account both the education and health sectors variables. Human capital development is mainly captured through education and health indicators. In this study a modified model that originates from the works of Lucas (1988), Mankiw et al (1992) among others. This model takes in human capital as an input.

3.4. Specification of the model

Across economies, human capital development is well known to influence economic growth and development. In this line, a functional relationship is established.

Economic growth = f (Capital, Labor force, Expenditure on education, primary school enrolment rate and Life expectancy).

And in a Cobb-Douglas production function with all inputs, the model can be represented as follows:

$$Y_t = A_t K_t^{\alpha} LBF_t^{\beta} Hc_t^{\lambda} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots 1$$

Then the logarithmic form of the function becomes:

$$LogGDP_t = \alpha_0 + \alpha_1 \log K_t + \alpha_2 \log LBF_t + \alpha_3 \log EE_t + \alpha_4 \log LEXP_t + \alpha_5 \log PSE_t + \varepsilon_t \dots\dots 2$$

Where

GDP represents economic growth

K is Gross fixed capital formation as percentage of GDP which is the net increase in physical assets within an accounting period as percentage of GDP;

LBF is the Labor force participation rate which is the measure of the proportion of country's working-age population that actively engages in the labor market either by working or seeking employment;

EE is the Education expenditure as percentage of GDP, which is the spending of Rwanda's government on education;

LEXP is the average number of years an individual is expected to live measured at current mortality;

PSE is the total enrolment in primary school regardless of age expressed as a percentage of the population of official primary education age.

And in the logarithmic form represents variables GDP, K, LBF, LEXP, EE and PSE respectively. α_0 represents the constant term, ε_t is the error term. $\alpha_1,,,\alpha_6$ are the coefficients of the independent variables in the model and finally t represents the time periods of the observation (1988-2017).

Ordinary least square estimation technique is employed in this study to estimate the impact while Johansen Cointegration econometric technique is used to assess existence of long-run and relationship.

3.4. Sources of Data

This study employs time series annual secondary data. The choice of time series data (1988-2017) is for the fact that data is collected over time and would, therefore, be used in understanding the relationship between human capital development and economic growth in Rwanda. The study uses the Gross Domestic Product as the dependent variable while Physical capital, Labor force and human capital development proxied by education expenditure, Life expectancy from birth and school enrolment rate at primary level explanatory variables.

Required data in this study, are obtained from the World Bank database for World Development Indicators, UNESCO Institute of Statistics (UIS) and Ministry of education (MINEDUC) statistical yearbooks which give a compilation of annual Pre-primary, primary, secondary, technical and vocational, tertiary and adult literacy data on Rwanda.

3.6. Handling of econometric issues

Econometric time series estimation technics are used and data processed using EVIEWS 10 statistical software package. Specifically, the following econometrics tests are conducted with the purpose of solving methodological issues that would arise otherwise.

3.6.1. ADF Unit –Root Stationarity test

Stationarity is defined as the quality of a process in which statistical parameters (Mean and Standard deviation) do not change with time i.e. a random time series Yt is said to be stationary if its mean and variance are constant over time and the value of covariance between two time periods depends only on the distance between them, not the actual time at which it is computed. (Gujarat, 2003) The econometric analysis emphasizes the importance of unit root testing in conducting empirical econometric work, for instance, Granger and Newbold (1974) found that non-stationary data yields spurious or misleading regression results. Before enquiring long-run relationships between variables in the time-series data, the prerequisite is to test the stationarity and integration order of the series.

In order to check for stationarity of the study variables, unit root test using Augmented Dickey-Fuller (ADF) was used. In case the unit root test does not hold at level, a differentiation is made to make a series stationary and in this case, if the first difference of a non-stationary variable is made stationary, it is said to be integrated of I (1) and the Augmented Dickey Fuller test helps running a regression of a first differenced series I (1) of the variables in concern in random walk.

Assume that χ_t is random walk process, $\chi_t = \chi_{t-1} + \varepsilon_t$, …………3

then the regression model becomes $\chi_{t-1} = \rho\chi_{t-1} + \varepsilon_t$ ……………….4

and subtracting χ_{t-1} from both sides of the equation,

$\Delta\chi_t = \pi\chi_{t-1} + \varepsilon_t$ where $\pi = (1 - \rho)$.

The null hypothesis is that $\chi_t = \chi_{t-1} + \varepsilon_t$, where $\varepsilon_t \sim$ NID $\left(0 - \sigma^2\right)$ and thus a one sided test is necessary for determining

H_0 : $\pi = 0\left[\chi_t \sim I(1)\right]$ against the Alternative hypothesis

Ha : $\pi < 0\left[\chi_t \sim I(0)\right]$

3.6.2. Johansen Cointegration Test

The property of Cointegration implies that variables will move closely together and will not drift arbitrarily overtime and the distance between them will be stationary. This concept mimics the existence of the long-run equilibrium relationship to which variables converge overtime (Johansen, 1991,1995). And testing for Cointegration is known as a necessary step to check if your modelling empirically meaningful relationship between variables. In most cases if two variables that are I (1), are linearly combined, then their combination will also be I (1). And more generally, if variables with differing orders of integration are combined, then combination will have an order of integration equal to the largest. If two process X_t and Y_t are both integrated of order one, I (1) and $Y_t - \alpha X_t = \varepsilon_t$ with ε_t trend stationary or simply I (0), then X_t and Y_t are called Cointegrated.

The Johansen Cointegration test is a recommended Cointegration test for more than one variable in an econometrical model because it has all desirable statistical properties. Originally Johansen derived two tests, the $\lambda - \max$ (or maximum Eigen value test) and the Trace test.

The maximum Eigen Value is constructed as follows;

$\lambda - \max [H_1(r\text{-}1)|H_1(r)] = T \log(1 - \lambda_r)$ for $r = 0,1,2\ldots$ And the null hypothesis is that there exists r Cointegrating vectors against the alternative of r+1 vectors.

On the other side, the Trace Cointegration test is as follows:

$\lambda_{trace}[H_1(r)|H_0] = -T \sum_{i=r+1}^{p} \log(1 - \lambda_i)$ where the null hypothesis $\lambda_i = 0$ so, only the first Eigen values are non-zero. It has been found that the Trace test is the best test since it appears to be more robust to skewness and excess Kurtosis.

3.6.3. Vector Error Correction Model (VEC)

Vector Error Correction Model is employed in estimating the dynamics of Cointegrating relationship of the variables, the model is built in such a way that it limits the long-run behavior of the endogenous variables, to converge on their long-run relationship but instead allowing for the short-run adjustment dynamics. The Cointegrating term is known as the Error Correction Term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments. The error correction term is derived from the Cointegrating vectors which shows stable meaningful long-run relationship at the equilibrium state. The error correction terms indicate the adjustment speed back to the equilibrium state after any disequilibrium.

The estimable Vector Error Correction model involving Per capita GDP, Gross capital formation, Labor force, Education expenditure, Life Expectancy at birth and Primary school enrolment consists of these equations

$$\Delta Y_t = \eta_1 + \rho_1(EC)_{t-1} + \psi_{1i}\sum_{i=n}^{n} \Delta y_{t-1} + \gamma_{1i}\sum_{i=1}^{n} \Delta K_{t-1} + \theta_{1i}\sum_{i=1}^{n} \Delta L_{t-1} + \lambda_{1i}\sum_{i=1}^{n} \Delta HC_{t-1} + \omega_t$$

……5

Where Δ is the first difference operator, $(EC)_{t-1}$ is the error correction term lagged one period, ρ is the short-run coefficients of the error correction term, known as the speed of adjustment parameters

CHAPTER FOUR: RESULTS PRESENTATION, ANALYSIS AND DISCUSSION

4.1. Introduction

This chapter presents and discusses results of the study. Real Gross Domestic Product, Expenditure on education, Primary school enrolments, Life expectancy at birth are analyzed in accordance with the research objectives in this study. The study aimed at analyzing the relationship between human capital development and economic growth in Rwanda from 1988-2017. The study employs Cobb-Douglas production function model framework, runs ordinary regression model and econometric tests of Cointegration and error correction model for assessing the relationship and impact of human capital on Rwanda's economic growth.

4.2. Results

4.2.1. Regression Analysis

Table 1: Regression Analysis results

Dependent Variable: Log GDP				
Variable	Coefficient	Std.Error	t-Statistics	Prob
Log K	23.79762	3.210501	7.412432	0.0000
Log LBF	4.204479	8.165225	0.514925	0.6113
Log EE	-8.628905	14.03055	-0.615008	0.5443
Log LEXP	3.009430	1.649394	1.824567	0.0805
Log PSE	0.114524	0.633410	0.180806	0.8580
C	-458.4361	743.4766	-0.616611	0.5433
R-Squared	0.918638			
Adjusted R-Squared	0.901687			

The table above represents regression estimate results; fixed capital formation is positive and significant at 5% level, while Labor force, Life Expectancy at birth are positive and significant at 10% level. Education expenditure is negative and insignificant, and primary school enrolment is having a positive coefficient but insignificant.

The analysis shows that human capital development is an important condition for economic growth in Rwanda. Life expectancy at birth is significant at 10 % while capital formation is positive and significant 5% level. This is consistent with the findings of Qadri and Waheed, 2011 who came to similar findings in Pakistan. Other variables are not significant. The variable life expectancy is a health outcome indicator that may reveal how healthy the population is and which in return affects their productivity (Weir, 2005). This can be related to the fact that educated people are more health and as a result more wealth. The gross fixed capital formation variable is also positive and significant indicating the role of physical capital in the output and productivity function. Here human capital helps the fixed capital to be utilized through technology. The constant is negative indicating that other variables outside the model negatively affect economic growth in Rwanda.

R-squared is 0.91 indicating that over 90% of the variation in Per Capita GDP is explained by the model.

4.3. ADF Unit-Root test results

Before, any other estimation was made, stationarity of the variables in both their level and first difference were conducted as shown in table 1 and 2 respectively.

Table 2*: ADF Unit-Root test at level*

Ho Series has Unit-Root.				
Variable	**Confidence Level**	**Critical values**	**ADF Test Statistic Values**	**Prob***
Log GDP	At 1%	-4.309824	-1.813186	0.6722
	At 5%	-3.574244		
Log K	At 1%	-3.679322	-0.924051	0.7659
	At 5%	-2.967767		
Log L	At 1%	-3.699871	-1.164883	0.6744
	At 5%	-2.976263		
Log EE	At 1%	-3.679322	-2.511796	0.1231
	At 5%	-2.967767		
Log LEXP	At 1%	-4.339330	0.011882	0.9942
	At 5%	-3.587527		
Log PSE	At 1%	-4.309824	-2.603878	0.2813
	At 5%	-3.574244		
*MacKinnon (1996) one-sided p-values				

Source: Author's calculation

At level, we fail to reject the null hypothesis because test statistics (ADF) are less than calculated critical values. We therefore, conclude that all variables in the model are non-stationary at level

Table 3: ADF Unit-Root test upon first differencing.

Hₒ Series has Unit-Root.				
Variable	**Confidence Level**	**Critical values**	**ADF Test Statistic Values**	**Prob***
Log GDP	At 1% At 5%	- 3.689194 - 2.971853	- 5.627176	0.0001
Log K	At 1% At 5%	-3.689194 -2.971853	-6.315054	0.0000
Log L	At 1% At 5%	-3.699871 -2.976263	-6.897037	0.0000
Log EE	At 1% At 5%	-3.689194 -2.971853	-6.146247	0.0000
Log LEXP	At 1% At 5%	-4.339330 -3.587527	-12.14501	0.0000
Log PSE	At 1% At 5%	-3.699871 -2.976263	-5.679368	0.0001
*MacKinnon (1996) one-sided p-values.				

Source: Author's computation

Upon first differencing, ADF Unit-Root tests leads to the rejection of the null hypothesis at 5% level indicating that all variables become stationary upon first differencing. Therefore, all the variables are integrated of order one i.e. I (1) and to confirm this relationship, Johansen Cointegration method is used and results are presented in table 4 below.

4.4. Results for Johansen Cointegration test

Johansen Cointegration Test Hypothesis follows that:

- $H_0 =$ No Cointegrating equation
- $H_1 = H_0$ is not true i.e. There is Cointegrating equation.

The decision criteria are as follows:

- Reject the null hypothesis if the value of the Trace and Max statistics exceeds 5 % critical value, otherwise, fail to reject the null hypothesis

Table 4: Johansen Cointegration: Trace Test

Trace Test			
Hypothesized No. of CE(s)	Trace Statistic	0.05 Critical Values	Prob**
None *	226.5388	95.75366	0.0000
At most 1 *	116.7732	69.81889	0.0000
At most 2 *	62.34701	47.85613	0.0013
At most 3	28.34012	29.79707	0.0729
At most 4	12.52692	15.49471	0.1333
At most 5	3.595374	3.841466	0.0579
*MacKinnon, Haug and Michelis (1999) p-values			

Source: author's computation

Table 5: Cointegration Test: Maximum Eigen Value Test.

Max Eigen Value			
Hypothesized No. of CE(s)	Maximum Eigen Statistic	0.05 Critical Values	Prob**
None *	109.7656	40.07757	0.0000
At most 1 *	54.42618	33.87687	0.0001
At most 2 *	34.00689	27.58434	0.0065
At most 3	15.81320	21.13162	0.2360
At most 4	8.931547	14.26460	0.2919
At most 5	3.595374	3.841466	0.0579
*MacKinnon, Haug and Michelis (1999) p-values			

Source: author's estimation

Table 3 and 4 show that testing for the null hypothesis H_0 i.e. No Cointegrating equation against the alternative hypothesis i.e. presence of Cointegrating equation. Calculated Trace and Maximum Eigen statistics exceed the critical values at 0.05 implying that the null hypothesis that there's no Cointegrating equation in this model has been rejected because the model shows even up to 3 Cointegrating equations confirming existence of a long-run relationship in Rwanda.

4.5. Vector Error Correction results

To estimate the adjustment speed in the long-run Cointegrating equation 5 to short run dynamics in the endogenous variables, Error Correction model was employed and estimates presented by the table below:

Table 6**:** VECM Estimates results

Dependent Variable is Δ Log GDP per capita			
Regressor	Coefficients	S.E	t-statistics
Δ Log K	-10.27526	8.07976	-1.27
Δ Log LBF	0.372947	9.35486	0.0398
Δ Log Educ_Exp	-1.192946	12.9943	- 0.09181
Δ Log LEXP	1.354335	5.04212	0.26860
Δ Log PSE	-0.127440	0.63001	- 0.20228
C	11.47448	10.4244	1.10074

Cointegration equation and long-run model

$ECT_{t-1} = 1.000\ logGDP_{t-1} - 4.63\ logK_{t-1} + 36\ logLBF_{t-1} + 68\ log\ Educ\_Exp_{t-1} - 7\ logLEXP_{t-1} + LogPSE_{t-1} - 3527$

Error Correction and short –run model dynamics

$\Delta Log\ GDP = -0.09ECT_{t-1} - 10.27\Delta Log\ K_{t-1} + 0.37\Delta Log\ LBF - 1.19\ \Delta Log\ Educ\_Exp_{t-1} + 1.35\ \Delta Log\ LEXP_{t-1} - 0.12\ \Delta Log\ PSE_{t-1} + 11.47$

Cointegrating Equation (CT) is the coefficient of equilibrium for the error correction term which is the speed of adjustment toward the long-run equilibrium. Looking at this coefficient, the previous deviation or shock in the variables from the long-run equilibrium is to be corrected in the current period at an adjustment speed of approximately 9%. This finding is also consistent with the results of Maitra, 2016 on a study in Singapore which indicates that human capital investment often takes sufficient time to give return. Moreover, the results indicate that in the short run, life expectancy at birth, Labor force and primary school enrolment has a positive relationship with GDP. This positive relationship is consistent with the findings of Hadir and Laurech (2015) using Moroccan data.

On the other hand, the coefficients of education expenditure and gross capital formation are negative which is inconsistent with the prior expectations. The unexpected sign of the education coefficient is not consistent with the endogenous growth theory hence further research would be done to find out possible reasons (e.g. education quality) behind this result. In this regard, the World Bank (2018) suggests that among factors that would result in unexpected outcomes could depend on the nature of data and methodology used.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS.

5.1. Summary

This study estimates the relationship between human capital development and economic growth in Rwanda for the last three decades. Per capita GDP is used as the dependent variable, gross fixed capital formation, labor force participation rate, education spending as a percent of GDP, life expectancy at birth and primary school enrolment rate as explanatory variables.

All variables are found non-stationary at level but become stationary upon first difference hence series are integrated of order one i.e. I (1). Applying the Johansen Cointegration technique reveals existence of a long-run relationship between economic growth and human capital development. Life expectancy and physical capital formation as percentage of GDP were found to be positive and significant. This indicates the prime role health has on Rwanda's economic growth and this conclusion is reached by many human capital development studies such as Quadri and Waheed, 2011, Laurech and Hadir, 2015, and Hakooma, 2017. Education expenditure as percentage of GDP and primary school enrolment rate were insignificant in this study.

The coefficient of the Error Correction Term (ECT) which shows the speed of adjustment toward long-run equilibrium indicated that the previous deviation or shock in the human capital development from the long-run equilibrium is to be corrected in the current period at an adjustment speed of 9 percent annually which implies a prolonged period of time until the shock dies away completely.

5.2. Conclusion

The study found a long-run relationship between human capital development and economic growth in Rwanda as shown by the Cointegration test results. These findings are generally consistent with other previous endogenous growth studies in the literature. Life expectancy as a proxy for health in this study was found to be positive and significant indicating its undisputable role in economic growth in the long-run.

5.3. Recommendations

The study aimed at estimating the role human capital plays on Rwanda's economic growth, by looking at the long-run relationship. Results are consistent with many other previous studies that emphasize the role of human capital accumulation in raising productivity and growth. In this realm, the study opts to give the following policy recommendations:

- Health care should be emphasized as it positively relates to economic growth in Rwanda;
- Expenditure on education should be increased and maintained for a reasonable enough time since the return on education is a time-consuming process;
- The government and policymakers should not only raise access to education through enrolment but more importantly, look to other aspects of education.

5.4. Recommendations for further research

In this study, data on proxies of human capital development were only simply school attainment and spending which may not give robust results as compared to using learning outcomes (Hanushek, 2013). In addition, it might be the same case that going to school or years of schooling do not necessarily result in better learning outcomes due to issues of poor education quality and health issues which affects productivity and output (World Bank, 2019). Therefore, future studies could do much better if they:

- Use data on learning outcomes instead of simply school attainment for capturing human capital;
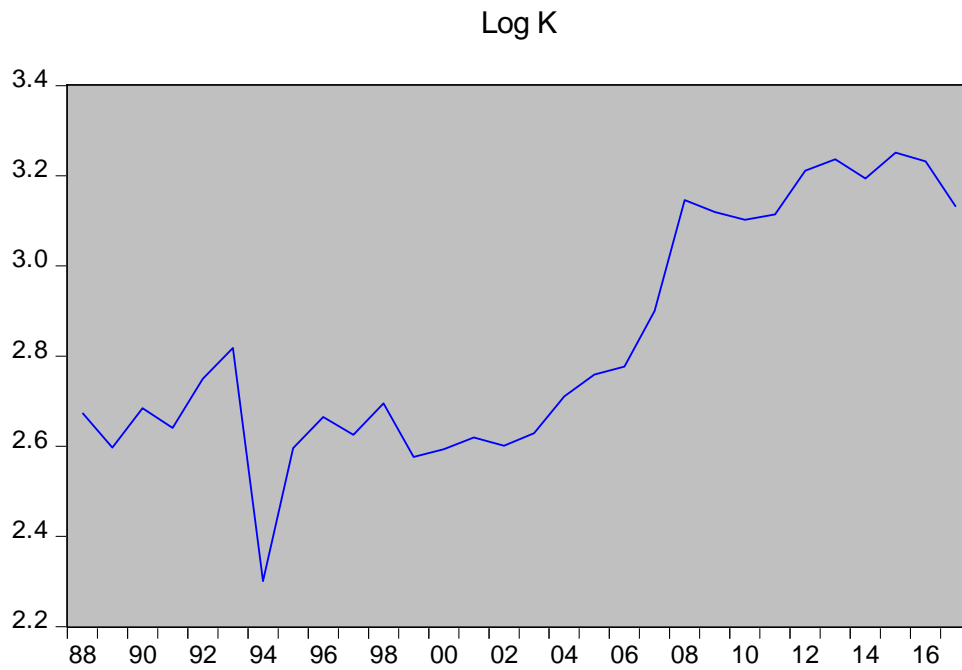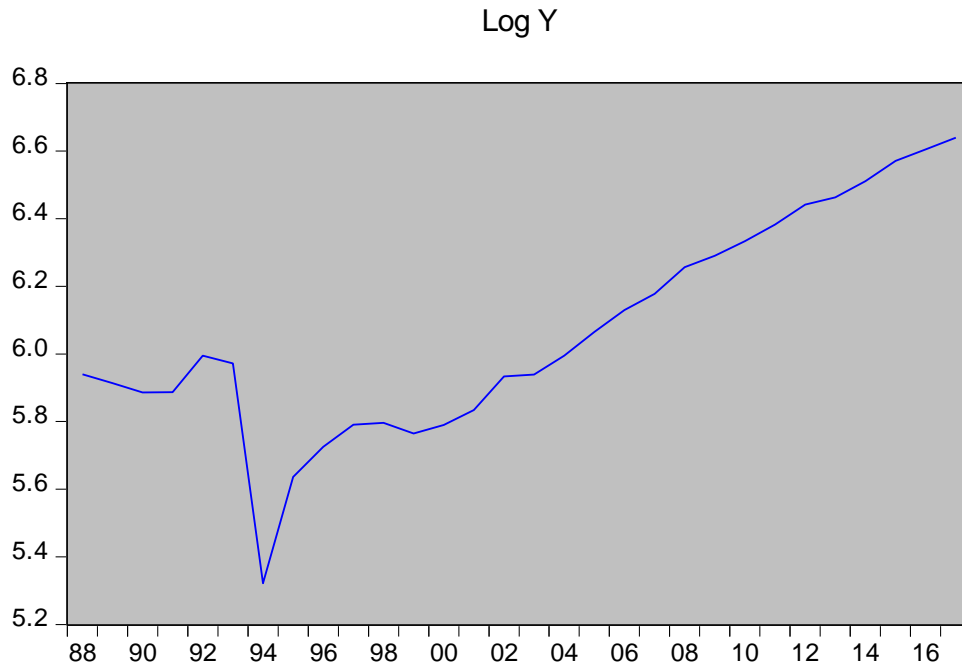- Assess the impact of quality education on economic growth.

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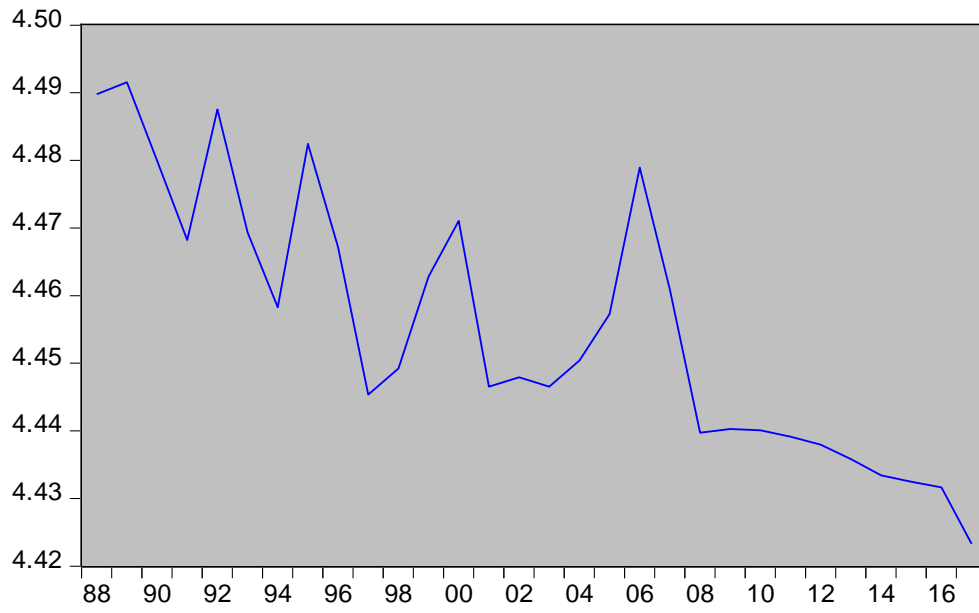
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Appendix

1. Graph Analysis

Log Y

Log K

Log LBF

Log EDUC_EXP
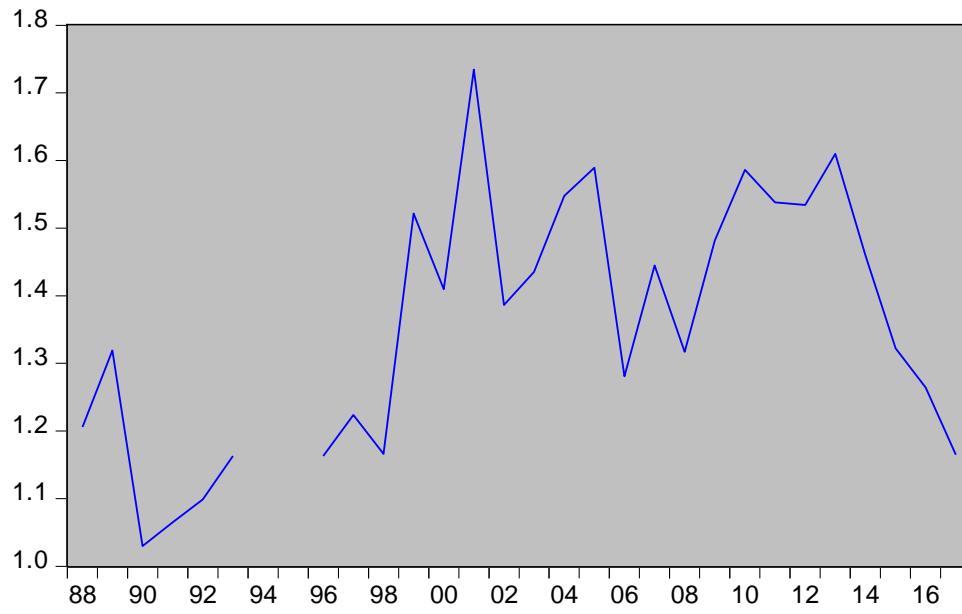
Log LEXP
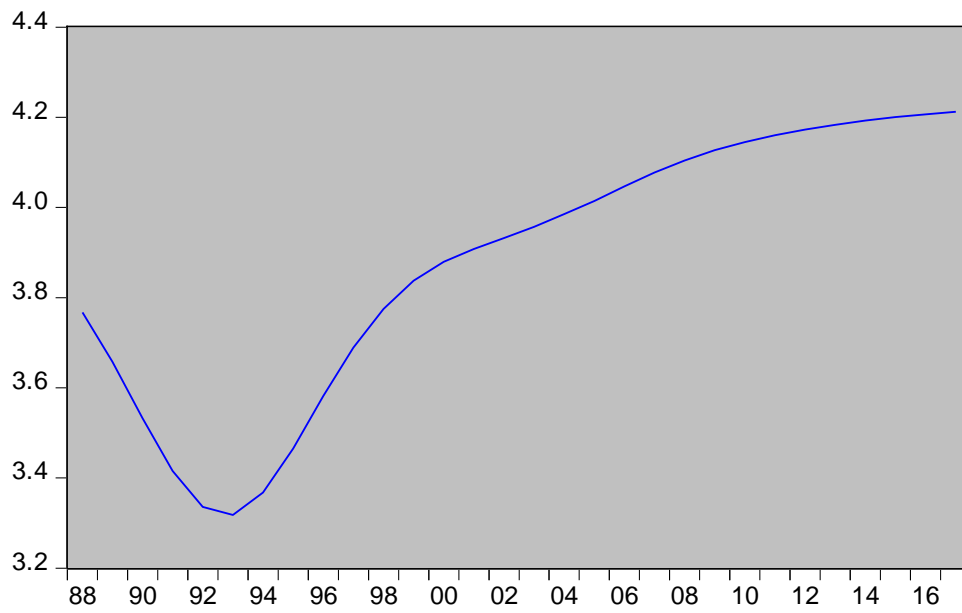
Log PSE
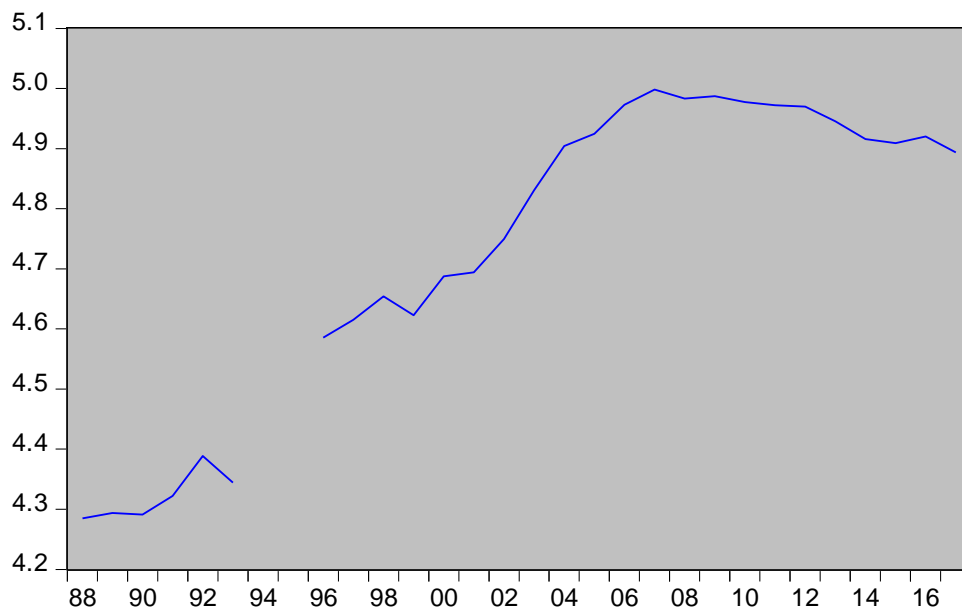
Graph analysis shows trend and intercept for variables.

2. Regression Analysis

Dependent Variable: GDP
Method: Least Squares
Date: 07/17/19   Time: 19:06
Sample: 1988 2017
Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
K	23.79762	3.210501	7.412432	0.0000
LBF	4.204479	8.165225	0.514925	0.6113
EDUC_EXP	-8.628905	14.03055	-0.615008	0.5443
LEXP	3.009430	1.649394	1.824567	0.0805
PSE	0.114524	0.633410	0.180806	0.8580
C	-458.4361	743.4766	-0.616611	0.5433

R-squared	0.918638	Mean dependent var	453.4753
Adjusted R-squared	0.901687	S.D. dependent var	149.2598
S.E. of regression	46.80020	Akaike info criterion	10.70651
Sum squared resid	52566.20	Schwarz criterion	10.98675
Log likelihood	-154.5976	Hannan-Quinn criter.	10.79616
F-statistic	54.19546	Durbin-Watson stat	0.602176
Prob(F-statistic)	0.000000		

3. ADF Unit – Root tests for Stationarity.

At level

Real Gross Domestic Product (GDP)

Null Hypothesis: Y has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=1)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.813186	0.6722
Test critical values:	1% level	-4.309824	
	5% level	-3.574244	
	10% level	-3.221728	

*MacKinnon (1996) one-sided p-values.

Gross Capital Formation (K)

Null Hypothesis: K has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=1)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.924051	0.7659
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

*MacKinnon (1996) one-sided p-values.

Labor Force Participation rate (LBF)

Null Hypothesis: LBF has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=2)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.164883	0.6744
Test critical values:	1% level	-3.699871	
	5% level	-2.976263	
	10% level	-2.627420	

*MacKinnon (1996) one-sided p-values.

Education Expenditure (EE)

Null Hypothesis: EDUC_EXP has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=1)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.511796	0.1231
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

*MacKinnon (1996) one-sided p-values.

Life Expectancy at birth (LEXP)

Null Hypothesis: LEXP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=2)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.011882	0.9942
Test critical values:	1% level	-4.339330	
	5% level	-3.587527	
	10% level	-3.229230	

*MacKinnon (1996) one-sided p-values.

Primary School Enrolment rate (PSE)

Null Hypothesis: PSE has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=2)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.603878	0.2813
Test critical values:	1% level	-4.309824	
	5% level	-3.574244	
	10% level	-3.221728	

*MacKinnon (1996) one-sided p-values.

At first difference

Real Gross Domestic Product (GDP)

Null Hypothesis: D(Y) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=1)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.627176	0.0001
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

*MacKinnon (1996) one-sided p-values.

Fixed Capital Formation K

Null Hypothesis: D(K) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=1)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.315054	0.0000
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

*MacKinnon (1996) one-sided p-values.

Labor Force Participation rate (LB)

Null Hypothesis: D(LBF) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=1)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.897037	0.0000
Test critical values:	1% level	-3.699871	
	5% level	-2.976263	
	10% level	-2.627420	

*MacKinnon (1996) one-sided p-values.

Education Expenditure (educ_exp)

Null Hypothesis: D(EDUC_EXP) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=1)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.146247	0.0000
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

*MacKinnon (1996) one-sided p-values.

Primary School Enrolment rate (PSE)

Null Hypothesis: D(PSE) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=1)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.679368	0.0001
Test critical values:	1% level	-3.699871	
	5% level	-2.976263	
	10% level	-2.627420	

*MacKinnon (1996) one-sided p-values.

Life Expectancy at birth (LEXP)

Null Hypothesis: D(LEXP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=1)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.14501	0.0000
Test critical values:	1% level	-4.339330	
	5% level	-3.587527	
	10% level	-3.229230	

*MacKinnon (1996) one-sided p-values.

4. Johansen Cointegration Test results.

Date: 07/18/19   Time: 11:39
Sample (adjusted): 1990 2017
Included observations: 28 after adjustments
Trend assumption: Linear deterministic trend
Series: Y K LBF EDUC_EXP LEXP PSE
Lag interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.980163	226.5388	95.75366	0.0000
At most 1 *	0.856840	116.7732	69.81889	0.0000
At most 2 *	0.703151	62.34701	47.85613	0.0013
At most 3	0.431502	28.34012	29.79707	0.0729
At most 4	0.273113	12.52692	15.49471	0.1333
At most 5	0.120504	3.595374	3.841466	0.0579

Trace test indicates 3 Cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.980163	109.7656	40.07757	0.0000
At most 1 *	0.856840	54.42618	33.87687	0.0001
At most 2 *	0.703151	34.00689	27.58434	0.0065
At most 3	0.431502	15.81320	21.13162	0.2360
At most 4	0.273113	8.931547	14.26460	0.2919
At most 5	0.120504	3.595374	3.841466	0.0579

Max-eigenvalue test indicates 3 Cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

5. Vector Error Correction Model estimates

Vector Error Correction Estimates
Date: 07/22/19   Time: 14:59
Sample (adjusted): 1990 2017
Included observations: 28 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
GDP(-1)	1.000000
K(-1)	-4.634977
	(1.46884)
	[-3.15554]
LBF(-1)	36.38193
	(4.40952)
	[8.25076]
EDUC_EXP(-1)	68.64568
	(7.12890)
	[9.62921]
LEXP(-1)	-7.085616
	(0.64866)
	[-10.9235]
PSE(-1)	1.159190
	(0.26459)
	[4.38102]
C	-3527.494

Error Correction:	D(GDP)	D(K)	D(LBF)	D(EDUC_EXP)	D(LEXP)	D(PSE)
CointEq1	-0.089179	-0.003150	-0.001083	-0.006430	-0.002395	-0.204156
	(0.10762)	(0.00515)	(0.00241)	(0.00161)	(0.00147)	(0.03136)
	[-0.82867]	[-0.61106]	[-0.44875]	[-3.98359]	[-1.63078]	[-6.51034]
D(Y(-1))	0.454254	0.012080	0.003862	0.006491	-0.004792	0.549446
	(0.48028)	(0.02300)	(0.01077)	(0.00720)	(0.00655)	(0.13995)
	[0.94582]	[0.52514]	[0.35869]	[0.90105]	[-0.73124]	[3.92607]
D(K(-1))	-10.27526	-0.321900	-0.178376	0.113292	0.088263	-3.206506
	(8.07976)	(0.38699)	(0.18116)	(0.12119)	(0.11025)	(2.35437)

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	[-1.27173]	[-0.83182]	[-0.98464]	[0.93480]	[0.80054]	[-1.36194]
D(LBF(-1))	0.372947	0.139783	-0.174726	0.406430	0.053403	5.647537
	(9.35486)	(0.44806)	(0.20975)	(0.14032)	(0.12765)	(2.72593)
	[0.03987]	[0.31198]	[-0.83303]	[2.89647]	[0.41834]	[2.07179]
D(EDUC_EXP(-1))	-1.192946	-0.156139	0.210450	-0.251242	-0.010206	5.819036
	(12.9943)	(0.62237)	(0.29135)	(0.19491)	(0.17732)	(3.78642)
	[-0.09181]	[-0.25088]	[0.72233]	[-1.28902]	[-0.05756]	[1.53682]
D(LEXP(-1))	1.354335	-0.011511	0.048611	-0.025220	0.786516	-3.086710
	(5.04212)	(0.24150)	(0.11305)	(0.07563)	(0.06880)	(1.46923)
	[0.26860]	[-0.04767]	[0.43000]	[-0.33347]	[11.4314]	[-2.10090]
D(PSE(-1))	-0.127440	-0.005476	-0.025681	0.013647	0.003120	-0.195218
	(0.63001)	(0.03017)	(0.01413)	(0.00945)	(0.00860)	(0.18358)
	[-0.20228]	[-0.18147]	[-1.81800]	[1.44418]	[0.36292]	[-1.06339]
C	11.47448	0.357040	-0.206020	-0.081251	0.385858	0.396602
	(10.4244)	(0.49928)	(0.23373)	(0.15636)	(0.14225)	(3.03757)
	[1.10074]	[0.71511]	[-0.88145]	[-0.51964]	[2.71257]	[0.13057]

R-squared	0.151033
Adj. R-squared	-0.146105
Sum sq. resids	43626.59
S.E. equation	46.70471
F-statistic	0.508292
Log likelihood	-142.6473
Akaike AIC	10.76052
Schwarz SC	11.14115
Mean dependent	14.10542
S.D. dependent	43.62630

Determinant resid covariance (dof adj.)	4352.554
Determinant resid covariance	578.0640
Log likelihood	-327.4173
Akaike information criterion	27.24409
Schwarz criterion	29.81334
Number of coefficients	54