**International Journal of Thesis Projects and Dissertations (IJTPD)**
Vol. 10, Issue 4, pp: (79-88), Month: October - December 2022, Available at: www.researchpublish.com

# HUMAN CAPITAL INVESTMENT AND ECONOMIC GROWTH IN RWANDA

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**DOI: https://doi.org/10.5281/zenodo.7376701**
**Published Date: 29-November-2022**

*Abstract:* **Acknowledging that human capital stocks influence the economic growth of such a country, this thesis was conducted for studying the relationship between human capital and economic growth in Rwanda. Time series data used were the secondary data from the World Bank, development indicators open source. The Ordinal Least Square (OLS) regression was used for performing the analysis of those time series (1980-2019). Different tests used by econometricians for running a robust model were run, that is ADF for testing the stationarity of the series and the Johansen Cointegration test for identifying whether there is cointegration of vectors among endogenous variables and the existence of long-run equilibrium. The time series were stationary in the first difference, denoted by I(1) and two vectors are cointegrated which directed the researcher to run the VECM. The estimates of VECM showed that there is a 9.82% adjustment of shock from the short-run to the long-run equilibrium. All the human capital proxy variables were statistically significant, however, some variables indicated unexpected negative signs, which are suspected to be caused by a lack of data collection over time and human capital constraints such as unemployment, quality of education and health system challenges. Therefore, it is recommended to improve the quality of education, and health services and conduct further research using other proxy variables of human capital in Rwanda for comparison purposes.**

*Keywords*: **Human capital investment; economic growth; cointegration; time series.**

## I. INTRODUCTION

There are two distinctions in the world, developed countries and developing countries. The average of economists questioned the reason why there are some countries which are developed and others less developed, and why some countries grow quickly and others slowly (North, 2001; Wolla, 2017). According to World Bank Report (2019), human capital investment was found as a response to the increased economic growth of a country (World Bank, 2019).

Appleton and Teal (2002), emphasized that education, good health, and longevity are intrinsic valuable outputs in the economy. They revealed that most countries subsidise health and education whereas, education is compulsory in many states for a certain school grade level. Many, if not most, governments incentivize health and education services. It is acknowledged that all over the world, governments primarily offer services related directly to human welfare (Appleton & Teal, 2002).

Even though human capital is a central driver of sustainable growth and poverty reduction, policymakers sometimes fail to allocate enough budget for human capital investments. The rationale is that the benefits of investing in people can take a long time to materialize whereas building infrastructures such as roads and bridges can generate quick economic as well as political benefits. Therefore, investing in the human capital of young children will not deliver economic returns until those children grow up and join the workforce. For that reason, some countries especially developing countries earmarked insufficient budgets for human capital investment which hinder the creation of a virtuous cycle between physical and human capital and growth and poverty reduction (World Bank, 2018).

Today, many efforts focused on human capital specializations as the current world economy is transitioning into the fourth industrial revolution. Globally, the role of human capital specialization within industrial organizations and labour markets has been prioritized (Karambakuwa et al., 2020). According to (Liao et al., 2019) the twentieth century was considered as the age of human capital in terms of enhancing education, skills, and acquisition of knowledge which are mainly the determinants of a country's standard of living rooted in advancing education and health of the majority of its population.

However, since the development of the human development index (HDI) in 1997 by UNDP, the Sub-Saharan Africa (SSA) region remains the worst-performing region in the world (IMF, 2020; UNDP, 2020). Recently, some countries namely Burkina Faso, Burundi, Ethiopia, Mozambique, Rwanda, and Senegal have achieved strong progress in accumulating human capital assets, but it is still below the threshold according to the Human Assets Index (HAI) criteria (RBA, 2020).

Rwanda has made impressive progress in sustaining high growth and improving human capital indicators in recent decades. It is undeniable to admit that Rwanda has sustained per capita economic growth of about 5 percentage points per year for over two decades (second-highest on the continent), and major strides in non-monetary indicators of well-being, especially maternal and child health where Rwanda performed similarly with or above many lower-middle-income countries (World Bank, 2020). In particular, Rwanda was one of two countries in Sub-Saharan Africa that achieved all Health Millennium Development Goals (MDGs). It is also the country that has the highest enrolment in health insurance, where more than 75 % of the population are covered by mutual health insurance, a community-based approach (UNDP, 2019).

In that perspective, Rwanda has reduced the maternal mortality rate from 750 per 100,000 live births in 2005 to 203 per 100,000 in 2019/20. As well, the neonatal death rate decreased from 37 per 1,000 live births in 2005 to 19 in 2019/20 while the infant mortality rate fell from 86 per 1,000 live births in 2005 to 33 in 2019/20. The under-5 mortality rate declined from 152 per 1,000 live births to 45 in 2019/20 (UNICEF, 2021). However, it is recommended to strengthen neonatal services toward automation of health services and enhanced community health care services package including intrapartum/ neonatal programmes across district hospitals and reinforce immunization programmes among others for improving children's health services toward reducing the neonatal death rate, maternal mortality rate and under 5 mortality rate among others stagnated over the past five years for reaching the target to achieve by the end of 2024.

Furthermore, Rwanda has achieved a remarkable increase in human resources for health in the last decades (ie, from 2010 to 2019) where the ratio of doctors per population increased from 1:16,001 to 1:8,294; while the ratio of nurses per population increased from 1:1,291 to 1:1,040. Statistics from the Ministry of Health (2019) indicated that Rwanda has 1,492 medical doctors (642 specialists and 850 general practitioners), 10,409 nurses, and 1,561 midwives which are continuously increasing for raising the number of qualified health professionals with the target to reach and exceed the minimum ratio required by WHO (N.Bigirimana et al, 2021; MoH, 2019).

In the education sector, recent data from MINEDUC (2019) showed that in 2019, the school net enrolment rate stands at 36.8% for nursery, 98.5 % for primary, 70.9% for secondary and 14.2% for tertiary education. The Ministry of Education is trying to improve the school enrolment rate for nursery and secondary schools which remained very low compared to others. It is also good to mention that Rwanda has achieved gender parity in school enrolment and completion at the primary level (MINEDUC, 2019). These achievements were possible because of the free twelve years of basic education (12YBE) adopted for developing the human capital stock devastated by the 1994 Tutsi genocide (J. Nkurunziza,2015).

Social protection remains a top priority, and over the last decade, significant investments have been made to build and operationalize an integrated system that promotes poor and vulnerable households' resilience to shocks, access to various social services, and enhanced opportunities to sustain themselves in the long run (World Bank, 2020).

However, excepts those mentioned achievements, Rwanda's Human Capital Index (HCI) is weak due to the low quality of education and health system deficiency (World Bank, 2020). HCI measures the degree to which health and education contribute to the productivity of the next generation of workers. It is estimated that a child born today in Rwanda will be just 38 percent as productive as an adult compared to what s/he could have achieved with good education and health (World Bank, 2021).

Education expenditure remains below 5% of GDP which is very low relative to a country with high population growth and UNESCO standards. Whereas the health sector accounts for several challenges such as mortality, malnutrition, and stunting whereby 33% of children are stunted with a higher proportion of children in rural areas (36%) than in urban areas (20%). Also, there is 45 per 1000 live births rate of child under-5 mortality, 33 per 1000 live births rate of infant mortality and 19 per 1000 live births rate of neonatal as reported by RDHS 2019/20. Among other challenges, there is also health system deficiency due to low health infrastructures and a shortage of qualified medical staff with only one doctor per 8,294 people which is very low relative to one doctor per 1000 people as recommended by WHO. The overall number of skilled health workers (physicians, nurses, and midwives) in Rwanda is still very low, 1.09 relative to 4.45 per 1000 population as the target to achieve the SDGs (MoH, 2019).

Furthermore, the Covid-19 pandemic deteriorated the economies of the countries, particularly developing countries including Rwanda among others. According to IFM (2021), Economic Report on Africa (2021), and J.B Nsengiyumva (2020), more than 55 million Africans dropped into extreme poverty in 2020 and the poverty reduction from more than two decades ago reversed. They added that middle-income earner people getting between $1.90-$2.09 a day fell into poverty due to price volatility, few assets, limited access to credit, being employed in the informal sector that was severely hit by Covid-19, loss of jobs due to lockdown measures imposed for stopping the spread of that pandemic.

Despite these, Rwanda aspires to become an upper-middle-income country by 2035 and high-income by 2050. It will not achieve that goal once the budget earmarked for education and health sectors which are the principal components of human capital investment remain insufficient. That is, lower literacy and numeracy skills especially in primary (UNICEF &World Bank, 2018), malnutrition and stunting, unskilled and uncompetitive labour force, growing unemployment rate, especially among youth that represents a big proportion of the population (RDHS,2019) among other challenges, will continue to affect productivity, output, and growth and in return hinder Rwanda to achieve its goals of becoming a high-income country as projected in the NST1 and vision 2050.

It is in this context that studying the relationship between human capital and economic growth is paramount for determining whether both education and health are statistically significant to influence economic growth in Rwanda and providing recommendations that should contribute to improving human capital.

## II. LITERATURE REVIEW

Empirical studies conducted on the relationship between human capital and economic growth, including the study conducted by Mankiw, Romer, and Weil (1992), revealed that human capital contributes over 80% in explaining income disparities between countries under consideration. Md Niaz Murshed et Al, 2018 added that human capital has strong positive effect on economic growth.

Jaiyeoba and Similola (2015) conducted an empirical study for investigating the relationship between investing in education and health on the economic growth. The findings proved that there is a long-run relationship between government expenditure on education, health, and economic growth. Hanif and Arshed (2016), explored the impact and contribution of primary, secondary, and tertiary education on economic growth whereby tertiary education has a higher impact on growth compared to primary and secondary education enrolment. Even though both education and health have a positive effect on growth, in Sub-Saharan Africa (SSA), evidence showed that the contribution of health is relatively more than that of education (Ogundari & Awokuse, 2018).

(Hanushek, 2013) revealed that even though there is progress in school attainment, there is a considerable gap in cognitive skills in developing countries relative to developed countries which hinders economic growth. Developing countries should focus on the quality of education for achieving long-run economic performance.

However, the study conducted by E. Mutabazi (2019) on human capital investment and economic growth in Rwanda, explained that life expectancy and physical capital formation are statistically significant and influence positively economic growth whereas education was insignificant. In the same context, J Nkurunziza (2015) highlighted that free compulsory basic education is not automatically implying transmitting the quality education which is considered to contribute to effective labour. Children from extreme and poor families do not complete the school grade due to frequent absenteeism and drop out linked to poverty in their households. G. Nizeyimana et al., (2021), complemented that even though 9YBE &12YBE increased school enrolment rate, there are enormous challenges such as low quality of education due to poor quality of learners joining these schools; inadequate human, material and financial support; poverty of parents and professorial system.

This is the reason why this study investigated the relationship between human capital and economic growth in Rwanda to test the hypotheses set and more specifically find out if there is much evidence to conclude that education is not statistically significant and whether 12YBE or in the general sense that an additional year of schooling does not contribute to the economic growth in Rwanda.

## III. METHODOLOGY AND DATA

This study adopted the model of human capital called the "Augmented-Solow model" developed by Lucas (1988), and Romer, Mankiw, and Weil(1992) which included human capital as inputs of the production function developed by Cobb-Douglas such that $Y(t)= 〚K(t)〛^{\alpha} 〚H(t)〛^{\beta}(A(t) 〚L(t))〛^{(1-\alpha-\beta)}$ where Y is output, A is technology, K is physical capital, H is human capital, and L is labour. The parameters α and βare the output elasticities to physical and human capital (shares of physical and human capital in total income), respectively. This model helped the researcher to model education and health as indicators of human capital. This study used the time series data on Rwanda (ie, economic growth and human capital proxy's variables data) from World Bank Development indicator, as open source for 40 years (1980 to 2019).

**Specification of the model**

Empirical studies have shown that human capital investment drives the economic growth of a country. Econometricians used the Cobb-Douglas production function which was adjusted as the augmented Solow model that integrates human capital in the model.

Based on the findings of the study carried out by (Hanif & Arshed, 2016), concluded that tertiary education has a higher impact on economic growth and adopting the model used by Md Niaz Murshed et Al,.(2018), Jaiyeoba and Similola (2015), the economic growth is function of physical capital, labour force, expenditure on education and health, life expectance, and school enrolment ratio (Primary, secondary and tertiary enrolment ratios), ie Economic Growth = f(Capital, Labour force, Expenditure on education and health, primary school enrolment ratio, secondary enrolment ratio, tertiary enrolment ratio, and Life expectancy) helped to determine the variables used in this study.

Cobb-Douglas model, $Y(t) = 〚K(t)〛^{\alpha} 〚H(t)〛^{\beta}(A(t) 〚L(t))〛^{(1-\alpha-\beta)}$ was linearized by using the logarithm function. Then, the model becomes $\ln (Yt) = A(t) +\alpha \ln K(t) + \beta \ln H(t) +\gamma \ln L(t)$ where $\gamma=1-\alpha-\beta$.

Setting the model to suit the Rwandan context, the model was specified as follows:

GDP=f (K, LF, PER, SER, TER)

$\log GDP = \alpha 0 + \alpha_1 \log K + \alpha_2 \log LF + \alpha_3 \log PER + \alpha_4 \log SER + \alpha_5 \log TER + \varepsilon t$

Where;

GDP per capita which indicates the economic growth as a proxy variable

K (Gross capital formation) as a percentage of GDP which is the net increase in physical assets within an accounting period as a percentage of GDP,

LF (Labour force participation rate) which is the measure of the proportion of the country's working-age population that actively engages in the labour market either by working or seeking employment,

PER (gross enrolment rate in primary school) is expressed as a percentage of the population of official primary education age,

SER (gross enrolment rate in secondary school) is expressed as a percentage of the population of official secondary education age and,

TER (gross enrolment rate in tertiary school) is expressed as a percentage of the population of official tertiary education age

$\alpha_i$ is expressed as the parameters, εt as the error term and t indicates the period (1980-2019).

The Ordinary Least Square (OLS) was used to estimate the relationship between human capital investment and economic growth. Whereas the Johansen Cointegration test was performed for indicating if there is a long-run relationship between the endogenous variables. After proving the existence of the long-run relationship, the vector error correction model was employed and it indicated the adjustment of the short-run model for maintaining the equilibrium in the long run.

## IV. EMPIRICAL ANALYSIS

### 4.1 Stationarity test

The unit root was tested for our time series using the Augmented Dickey-Fuller (ADF). The ADF test was performed, both, at the level and first difference of the time series. The results are presented in table 1 and table 2.

**Table 1: Stationary test of the series in levels**

| Ho: Series has Unit-Root. | | | | | | |
|---|---|---|---|---|---|---|
| Variables | With trend | | | | | |
| | Test statistic | 1% Critical Value | 5% Critical Value | 10% Critical Value | p-value | Decision-conclusion |
| logGDP | -1.830 | -4.251 | -3.544 | -3.206 | 0.6900 | No-stationary |
| logK | -2.772 | -4.251 | -3.544 | -3.206 | 0.2074 | No-stationary |
| logPER | 0.250 | -4.251 | -3.544 | -3.206 | 0.9960 | No-stationary |
| logSER | -0.595 | -4.251 | -3.544 | -3.206 | 0.9792 | No-stationary |
| logTER | -0.458 | -4.251 | -3.544 | -3.206 | 0.9850 | No-stationary |
| logLF | 0.519 | -4.251 | -3.544 | -3.206 | 0.9969 | No-stationary |

**Source**: Author's calculations

For the ADF test, the null hypothesis (H0= Unit root) is that there is a unit root in the series against the alternative hypothesis (H1= no unit root) which indicates that the series is stationary. Table 1 shows all t-statistics are less than t-critical for all variables and P-values are greater than 0.05 meaning that the series are non-stationary in the levels. Therefore, to check whether these series are stationary, differentiation of the time series was applied.

**Table 2: Stationarity test of the series in the first difference, ie I(1)**

| Ho: Series has Unit-Root. | | | | | | |
|---|---|---|---|---|---|---|
| Variables | Test statistic | 1% Critical Value | 5% Critical Value | 10% Critical Value | p-value | Decision-conclusion |
| logGDP | -7.530 | -3.662 | -2.964 | -2.614 | 0.0000 | Stationary |
| logK | -9.614 | -3.662 | -2.964 | -2.614 | 0.0000 | Stationary |
| logPER | -3.306 | -3.662 | -2.964 | -2.614 | 0.0146 | Stationary |
| logSER | -3.986 | -3.662 | -2.964 | -2.614 | 0.0015 | Stationary |
| logTER | -3.844 | -3.662 | -2.964 | -2.614 | 0.0025 | Stationary |
| logLF | -3.225 | -3.662 | -2.964 | -2.614 | 0.0186 | Stationary |

Source: Author's calculations

Table 2 presents the findings of the ADF test for the first difference where the null hypothesis is the existence of unit roots whereas the alternative is the negation of the null hypothesis, that is the existence of stationary time series. All the t-statistics are greater than t-critical values at 1%, 5%, and 10% levels of precisions, and P- values are statistically significant which provided much evidence to reject the null hypothesis and accepted the alternative hypothesis stating that series are stationary at the first difference or order one. This result shows that there is a long-run relationship among the endogenous variables.

Once cointegration is detected in the model, Johansen Cointegration is used to prove its existence. In this study, the Johansen cointegration test was used to determine the number of cointegrating vectors indicating cointegrating equations in the long run. Thus, before performing the Johansen Cointegration test, the determination of maximum lag following the information criteria such as Akaike Information Criteria, Final Prediction Error, Hannan-Quinn Information Criterion, and Schwarz information criterion proceeded.

**Table 3: The order of the maximum lags**

| Selection-order criteria<br>Sample: 1988 – 2019 | | | | | Number of obs = 32 | | | |
|---|---|---|---|---|---|---|---|---|
| lag | LL | LR | df | p | FPE | AIC | HQIC | SBIC |
| 0 | 174.78 | | | | 1.1e-12 | -10.4577 | -10.5488 | -10.2739 |
| 1 | 393.91 | 438.26 | 36 | 0.000 | 1.2e-17 | -21.9944 | -21.3567 | -20.0706 |
| 2 | 462.952 | 138.08 | 36 | 0.000 | 1.9e-18 | -24.0595 | -22.8752 | -20.4868 |
| 3 | 524.305 | 122.71 | 36 | 0.000 | 8.6e-19 | -25.6441 | -23.9132 | -20.4224 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 4 | 671.252 | 293.89 | 36 | 0.000 | 7.1e-21 | -32.5782 | -30.3008 | -25.7076 |
| 5 | 4033.65 | 6724.8 | 36 | 0.000 | 8.e-107* | -240.478 | -237.654 | -231.959 |
| 6 | 5593.01 | 3118.7 | 36 | 0.000 | | -337.563 | -334.648 | -328.769 |
| 7 | 5717.02 | 248.03 | 36 | 0.000 | | -345.314 | -342.399 | -336.52 |
| 8 | 5754.7 | 75.358* | 36 | 0.000 | | -347.669* | -344.754* | -338.875* |
| Endogenous: log GDP log K log PER log SER log TER log LF<br>Exogenous: _cons maxlag(8)<br>* indicates selected lag at 1% critical value | | | | | | | | |

**Source:** Author's calculations

The outputs in Table 3 show that majority of the information criteria namely AIC, HQIC, and SBIC indicated that eight lags can be used to perform the Johansen Cointegration Test for our model.

### 4.2 Results of the Cointegration test

**Table 4: The Output of Johansen Cointegration test (Trace test)**

| Unrestricted Cointegration Rank Test (Trace) | | | | | | |
|---|---|---|---|---|---|---|
| maximum | | | | trace | 5% critical | 1% critical |
| rank | parms | LL | eigenvalue | statistic | value | value |
| 0 | 192 | 2881.417 | | 2012.154 | 104.94 | 114.36 |
| 1 | 203 | 3418.936 | 1 | 937.1145 | 77.74 | 85.78 |
| 2 | 212 | 3887.494 | 1 | 0** | 54.64 | 61.21 |
| 3 | 219 | 3887.494 | 0 | 0 | 34.55 | 40.49 |
| 4 | 224 | 3887.494 | 0 | 0 | 18.17 | 23.46 |
| 5 | 227 | 3887.494 | 0 | 0 | 3.74 | 6.4 |
| 6 | 228 | 3887.494 | 0 | | | |
| There are 2 cointegrating equations (ie, r*=2) | | | | | | |

**Source:** Author's calculations

Running the Johansen Cointegration test using the Trace test, indicated that the maximum lags to perform the test were six and the model has two cointegrating equations. It is seen in table 4 that the trace statistic is less than the critical value at 5% and 1% level at rank 2 which implies that Ho was rejected in favour of an alternative that concludes the existence of 2 ranks in the model.

**Table 5: The Output of Johansen Cointegration test (Maximum eigenvalue test)**

| Unrestricted Cointegration Rank Test (Maximum Eigenvalue) | | | | | | |
|---|---|---|---|---|---|---|
| maximum | | | | max | 5% critical | 1% critical |
| rank | parms | LL | eigenvalue | statistic | value | value |
| 0 | 192 | 2881.4166 | | 1075.039 | 42.48 | 48.17 |
| 1 | 203 | 3418.9363 | 1 | 937.1145 | 36.41 | 41.58 |
| 2 | 212 | 3887.4936 | 1 | $0^{**}$ | 30.33 | 35.68 |
| 3 | 219 | 3887.4936 | 0 | 0 | 23.78 | 28.83 |
| 4 | 224 | 3887.4936 | 0 | 0 | 16.87 | 21.47 |
| 5 | 227 | 3887.4936 | 0 | 0 | 3.74 | 6.4 |
| 6 | 228 | 3887.4936 | 0 | | | |
| There are at least 2 cointegrating equations (ie, r*>=2) | | | | | | |

Table 5 presents the findings obtained after running the Maximum Eigenvalue test where the null hypothesis states that there is r rank while the alternative hypothesized that there are greater or equal r cointegrating equations. Therefore, the results proved that there are at least 2 cointegrating equations at 5 % and 1% critical values.

In the conclusion, Trace statistics provide more evidence than Maximum Eigenvalues as mentioned by Econometricians. Thus, our model has two cointegrating equations in the long run. The existence of the cointegrating vectors of the non-stationary series indicates the error correction term adjustment from the short-run equilibrium dynamics to the long-run equilibrium. Therefore, the Vector Error Correction Model (VECM) was used to determine the long-run relationship between economic growth and human capital investment in Rwanda which is performed for verifying the hypothesis of this study.

### 4.3 Vector Error Correction results

Once cointegration is detected, means that short-run and long-run linear relationships exist. To estimate the long-run equilibrium, the vector error correction was performed for indicating the speed of adjustment from the short-run to the long-run equilibrium relationship. The VECM was estimated by taking one rank and optimal lag (6) determined following the AIC.

**Table 6: The VECM Estimates results**

| Dependent variable ΔlogGDP | Coef. | Std. Err. | z | P>\|z\| |
|---|---|---|---|---|
| ECT t-1 | -0.0982 | 0.010478 | -9.37 | 0.000000 |
| ΔlogGDP t-1 | -2.82263 | 0.137923 | -20.47 | 0.000000 |
| ΔlogGDP t-2 | -4.03289 | 0.207649 | -19.42 | 0.000000 |
| ΔlogGDP t-3 | -6.2064 | 0.383883 | -16.17 | 0.000000 |
| ΔlogGDP t-4 | -4.25461 | 0.390575 | -10.89 | 0.000000 |
| ΔlogGDP t-5 | -2.07883 | 0.291316 | -7.14 | 0.000000 |
| ΔlogK t-1 | 0.513038 | 0.15431 | 3.32 | 0.001000 |
| ΔlogK t-2 | 0.709391 | 0.112034 | 6.33 | 0.000000 |
| ΔlogK t-3 | 0.365548 | 0.072839 | 5.02 | 0.000000 |
| ΔlogK t-4 | 0.891066 | 0.082537 | 10.8 | 0.000000 |
| ΔlogK t-5 | 0.643197 | 0.081976 | 7.85 | 0.000000 |
| Δlog PER t-1 | 2.330482 | 0.516979 | 4.51 | 0.000000 |
| Δlog PER t-2 | -4.76215 | 0.53771 | -8.86 | 0.000000 |
| Δlog PER t-3 | 1.573175 | 0.249719 | 6.3 | 0.000000 |
| Δlog PER t-4 | 2.60084 | 0.235765 | 11.03 | 0.000000 |
| Δlog PER t-5 | -3.03951 | 0.531069 | -5.72 | 0.000000 |
| Δlog SER t-1 | -0.17378 | 0.147482 | -1.18 | 0.239000 |
| Δlog SER t-2 | 0.587546 | 0.169796 | 3.46 | 0.001000 |
| Δlog SER t-3 | -0.71719 | 0.141605 | -5.06 | 0.000000 |
| Δlog SER t-4 | 0.678741 | 0.148609 | 4.57 | 0.000000 |
| Δlog SER t-5 | 1.864289 | 0.222623 | 8.37 | 0.000000 |
| Δlog TER t-1 | 0.205379 | 0.053613 | 3.83 | 0.000000 |
| Δlog TER t-2 | 0.813759 | 0.070231 | 11.59 | 0.000000 |
| Δlog TER t-3 | 0.927774 | 0.108022 | 8.59 | 0.000000 |
| Δlog TER t-4 | -0.076 | 0.194231 | -0.39 | 0.696000 |
| Δlog TER t-5 | 0.957995 | 0.078692 | 12.17 | 0.000000 |
| Δlog LF t-1 | -46.8622 | 6.557885 | -7.15 | 0.000000 |
| Δlog LF t-2 | 155.4522 | 9.300987 | 16.71 | 0.000000 |
| Δlog LF t-3 | 91.60129 | 10.82572 | 8.46 | 0.000000 |
| Δlog LF t-4 | 30.82162 | 12.29282 | 2.51 | 0.012000 |
| Δlog LF t-5 | -71.4193 | 11.14679 | -6.41 | 0.000000 |
| _trend | 0.005332 | 0.001086 | 4.91 | 0.000000 |
| _cons | -0.00989 | 0.032528 | -0.3 | 0.761000 |

Source: Author's calculations

The findings in table 6, show that there is a short-run adjustment for the long-run equilibrium in the model. The VECM estimates show that the Error Correction Term (ECT) is statistically significant and revealed that there is a short-run adjustment of the endogenous variables for maintaining the long-run equilibrium. That is, there is a 9.82% adjustment from a deviation or chock of the short-run to the long-run equilibrium. This implies that there is a causal effect of human capital on economic growth in Rwanda since ECT is statistically significant.

More specifically, Gross capital formation coefficients were statistically significant and have a positive effect on economic growth. It is indicated that a 1% increase in gross capital increases economic growth by approximately 0.5% at lag one, 0.7 at lag two, 0.36% at lag three, 0.89% at lag four, and 0.64% at lag five. This finding is consistent with macroeconomic principles arguing that savings in the previous year influence economic growth since are used to do investments in the next financial years (A.Ribaj and F.Mexhuani, 2021).

Concerning education as a proxy of human capital (from primary up to tertiary education), coefficients indicated that education influences economic growth because they are significant. A 1% increase in primary education influences economic growth by approximately 2.33% at lag one, -4.76% at lag two, 1.57% at lag three, 2.6% at lag four, and -3.03% at lag five. Then, a 1% increase in secondary education affects economic growth by approximately 0.58% at lag two, -0.72% at lag three, 0.67% at lag four, and 1.86% at lag five. Whereas a 1% increase in tertiary education affects economic growth by approximately 0.2% at lag one, 0.81% at lag two, 0.93% at lag three, and 0.96% at lag five. The evidence shows that there is a negative influence of primary and secondary education at lag two and three respectively, which were unexpected. According to World Bank (2018), unexpected outcomes among other factors would result in data or methodology used (Interpolation of data). Other than that, we can suspect insufficient budget allocated to education, lower foundational skills gained from primary education, and persistent school drop-out of the school (G. Nizeyimana et al,2021; World Bank & UNICEF,2018; J. Nkurunziza,2015). Furthermore, the model shows that primary education has highly contributed more to economic growth than secondary and tertiary education in Rwanda. This finding is consistent with the empirical study conducted by Stamatakis (2002) in Pakistan contested that developing countries benefit more from primary education and secondary while developed countries benefit more from tertiary education.

So far, the evidence indicated that the labour force is paramount to the economic growth of Rwanda. Our model shows that the coefficients of the labour force are significant. It is indicated that a 1% increase in the labour force influences economic growth by approximately -46.86% at lag one, 155.45% at lag two, 91.60% at lag three, 30.82% at lag four, and -71.42% at lag five. The Labour force has a higher impact relative to other human capital variables used in this study. This is because the labour force combines both education and health. It is known that healthy and educated people contribute more to economic growth (Bergheim, 2005; Barro, 1996). The empirical research conducted by Ogundari&Awokuse, (2018) in Sub-Saharan Africa where Rwanda is located, complemented this study by saying that health has more influence on economic growth than education. However, negative signs of the coefficients at some lags are explained by the inefficient methodology of data collection (interpolation) due to a lack of overtime collection of data (World Bank, 2018). Besides that, it might be caused by the unemployment rate which is very high among youth even though the government of Rwanda has made strides in promoting technical and vocational education, innovation, and job creation toward encouraging foreigners and national investors.

### 4.4 Diagnostic test

Concerning the diagnostic of the model, the Wald test was performed to check whether the short-run coefficients have causal effects. The test revealed that all the independent variables used are significant and influence the dependent variable. Specifically, gross capital formation, school enrolment rate from primary to tertiary, and labour force as proxy variables of human capital affect economic growth.

## V. CONCLUSION

The main objective of this study was to estimate the relationship between human capital investment and economic growth in Rwanda. The human capital proxy variables were the Gross Capital Formation, the Labour Force, the Primary school enrolment rate, the Secondary school enrolment rate, and the Tertiary school enrolment rate as independent variables against the GDP per capita as the dependent variable. These time-series data were captured from the World Bank website on World Development indicators as open source. Then, these time series data were sampled from 1980 to 2019 and interpolated for further analysis. The logarithm was used to transform these time series and test for stationarity. All variables were found to be stationary in the first difference, denoted I(1). This implied that there is long-run relationship between human capital investment and economic growth in Rwanda. Thus, the Johansen cointegration test was performed and proved the existence of 2 cointegrating vectors.

The estimates were obtained by running the Vector Error Correction Model (VECM). The findings showed that human capital investment has a strong influence on economic growth in Rwanda. Therefore, the labour force is more contributing to growth than other variables used in the model as it combines both education and health components. This is meaningful because educated and healthier people provide efficient labour. In this perspective, the results also show that primary education followed by secondary education is more influential than tertiary education. However, health and education as components of the human capital complete each other. It is known that further education contributes to obtaining decent work which in return improves the health conditions of an individual. Consequently, the employees become able to use the technology in the production of goods and services, and their life expectancy increases which constitute what is called efficient labour.

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